# **Democritus c. 460** вс**-с. 370** вс

(Also known as Democritus of Abdera) Greek philosopher.

The following entry provides criticism of Democritus's life and works. For additional information about Democritus, see *CMLC*, Volume 47.

# **INTRODUCTION**

Democritus of Abdera, a contemporary of Socrates, stands out among early Greek philosophers because he offered both a comprehensive physical account of the universe and a naturalistic account of human history and culture. Although none of his works has survived in its entirety, descriptions of his views and many direct quotations from his writings were preserved by later sources, beginning with the works of Aristotle and extending to the fifthcentury AD Florigelium (Anthology) of Joannes Stobaeus. While Plato ignored Democritus's work, largely because he disagreed with his teachings, Aristotle acknowledged Democritus as the most important physicist of his age, primarily for his exposition of the theory of atomism, which holds that everything in the universe, from objects to human souls, is a result of the interactions and rearrangements of the atoms in the void. Democritus is also known for his ethical theory, based on the thesis that wisdom is the greatest good for humans because it enables a stable and tranquil condition. His position was highly influential during the Hellenistic period, when it was further developed by Epicurus and his followers, who also built on Democritus's physical theory and theory of knowledge. Although Democritus's philosophy fell into obscurity during the Middle Ages because of its association with Epicurean hedonism and atheism, it became the focus of renewed interest during a revival of atomism in the Renaissance and early modern period, and today scientists cite the philosopher as an important early contributor to scientific thought.

# **BIOGRAPHICAL INFORMATION**

Little is known about the life of Democritus. Basic biographical information about the philosopher is disputed, including the dates of his life, the identity of his teachers, the extent of his writings, and the facts about his death. Because the available sources of information contradict one another, certainty about the details of his life is impossible.

It is known that Democritus was born in Abdera, a Greek city-state located in modern-day Thrace that was also

home to the philosopher Protagoras. There are several indications, both external and internal to his writings, that Democritus may have held office in Abdera and that he was a wealthy and respected citizen. It is also known that he traveled widely in the ancient world, visiting not only Athens but Egypt, Persia, the Red Sea, possibly Ethiopia, and even India. Scholars also agree that he lived a very long life of between 90 and 109 years.

Democritus is said to have been a pupil of Leucippus, an important figure in the early history of philosophy about whom little is known. Aristotle and others credit Leucippus with devising the theory of atomism, and it is commonly believed that Democritus expanded the theory under his tutelage. However, some scholars have suggested that Leucippus was not an actual person but merely a character in a dialogue written by Democritus that was subsequently lost. A similar strategy was employed by the philosopher Parmenides, who used the character of a goddess to elucidate his views in his didactic poem, *On Nature*.

# **MAJOR WORKS**

Like his biography, the basic facts about Democritus's works are disputed. At one extreme, some scholars suggest that he wrote as few as two works, Megas Diakosmos (The Major Cosmic System) and Peri Physeôs kosmou (On the Nature of the World). At the other extreme, some researchers have suggested that he authored dozens of works, touching on nearly every subject in philosophy and science. In the latter camp is Diogenes Laertius, who, writing in the second to third century AD, preserved a list of Democritus's writings compiled by the editor Thrasyllus of Mendes (c. 1 AD). Thrasyllus arranged Democritus's works in tetralogies, under the headings "ethics" (two tetralogies, or eight works), "works on nature" (sixteen works), "mathematics" (twelve works, including cosmography and geography), "literary criticism and fine arts" (eight works), and "technical" works or textbooks (eight works, including several works on medicine). There are also nine additional "unclassified" works and nine collections of notes. Diogenes Laertius pointed out that some works circulating under the name Democritus at the time were compilations and that others were spurious. Similarly, a collection of letters alleged to have been written by Democritus and the philosopher Hippocrates have been deemed inauthentic. Scholars continue to rely on the list preserved by Diogenes Laertius. Walter Leszl (2007; see Further Reading), for example, drew extensive inferences

about the contents of Democritus's writings from the information contained in the list.

However much he may have written, all that survives of Democritus's works, apart from what are likely imitations by such philosophers as Plutarch and Seneca, is testimony about his physics in the works of other writers, beginning with Aristotle, and fragments of his ethics collected in various sources, especially the famous Anthology of Stobaeus. The standard edition and enumeration of these fragments is Hermann Diels's Die fragmente der Vorsokratiker (6th ed., 1951-52; The Fragments of the Presocratic Philosophers). The edition and Russian commentary of Salomo Luria (1970) greatly expanded the number and context of fragments beyond Diels's edition, which was explicitly intended as a provisional collection. Recent translations of much of the extant evidence include the works of C. C. W. Taylor (1999) and, in Italian, Leszl (2009).

# **CRITICAL RECEPTION**

Although Democritus had followers, they did not form a school as did the followers of Plato and Aristotle; consequently, the works of Democritus are not as well known as the works of the latter philosophers. Famously, Plato never mentioned Democritus in his own work, although scholars have established beyond doubt that he engaged Democritean ideas in several dialogues, most notably the *Timaeus*. Aristotle, however, repeatedly referred to Democritus as his most important predecessor in physics. It is also probable that Aristotle drew on Democritus's ethical thought in composing his own work, as he wrote at least two books about the earlier philosopher and was therefore familiar with his ideas.

In the Hellenistic period, Epicurus adopted and adapted Democritean physics and ethics in his own philosophy. He introduced crucial modifications throughout, especially in physics. Democritus's reputation subsequently suffered from his association with Epicurus. Although he still had admirers in addition to the Epicureans in the Hellenistic period (for example, Plutarch and Seneca), the association of his philosophy with atheism and hedonism led to its rejection by the early church fathers, who wrote forceful polemics condemning materialist philosophies, of which Democritus was supposed to be the principal proponent. The revival of Democritean thought and Epicureanism in the Renaissance was spearheaded by the recovery, editing, and republication of the works of Diogenes Laertius and Lucretius, an Epicurean poet who authored a didactic epic in Latin about atomistic philosophy. Since that time, Democritus has been widely admired by natural philosophers, including Francis Bacon, James Clerk Maxwell, and Erwin Schrödinger.

Contemporary scholarship on Democritus stems from the identification and classification of Democritean fragments

and references by German philologists, including Diels, in the nineteenth century. The most important and sustained work on Democritus in the first three quarters of the twentieth century was conducted by Italian scholars, who drew important connections between Democritus and his contemporaries and successors. These scholars offered an estimation of the systematicity and importance of Democritus's ethical fragments, and they also speculated about the relationship between Democritus's ethics and his physics. In addition, Italian scholars have led the way in defining the relationship between Democritus's philosophy and Epicureanism.

English-language scholarship focused on Democritus's work has grown significantly during the twentieth and twenty-first centuries. Gregory Vlastos's (1945-46) influential two-part study examined Democritus's physics and ethics, challenging the conventional wisdom that the two were only vaguely related by positing a number of previously ignored connections. Donal McGibbon pursued a similar vein, arguing in his 1965 essay (see Further Reading) that Democritus's religious views are connected to his atomism through his emphasis on the human soul as a compilation of atoms. More recently, James Warren (2002; see Further Reading) offered an overview of the intermediaries between Democritus and Epicurus that yielded fresh insights into the relationship between Democritus's ethics and physics. Integrated views of Democritean ethics and physics have been challenged, however, by several scholars, some of whom have gone so far as to suggest that Democritus did not author the ethical texts attributed to him. Debate regarding the relationship between the philosopher's atomism and his ethical perspective continues to inspire critical commentary.

Democritus's ethical and religious thought has also garnered significant critical attention independent of his physics. Julia Annas's 2002 essay, for example, offered an interpretation of Democritus's ethics that emphasized its relationship to the ethical theories of better-known philosophers such as Socrates, Plato, and Aristotle. Annas pointed out the importance of Democritus to the interpretation of Socrates, who is traditionally credited with inventing philosophical ethics even though, unlike Democritus, he wrote nothing.

Democritus's atomism has been the subject of extensive critical discussion in recent decades, as scholars have tackled core interpretive issues, including the intrinsic properties of Democritus's atoms and his understanding of the infinite void. David Furley's 1983 essay, for example, examined the issue of atomic weight, exploring available source material in an attempt to determine whether Democritus's conception of the atom included weight as an attribute. Stephen Makin (1989) built on the work of Furley, extending his discussion of the atom's attributes to include its indivisibility. Alexander P. D. Mourelatos (2005; see Further Reading) offered further clarification of Democritus's terminology in physics and cosmology, including the atom, differentiating the meaning of Democritus's terms from the terms used to describe his theories by later philosophers, particularly Aristotle.

The sizable body of scholarly criticism treating Democritus's work attests to its enduring philosophical importance. Christoph Lüthy (2000) traced the ways in which Democritus's work has been interpreted throughout history, examining how Democritus himself has been construed and mythologized in the more than two-thousand years since his death.

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# **PRINCIPAL WORKS**

- \**Megas Diakosmos [The Major Cosmic System]*. Late 5thearly 4th century BC. (Philosophy)
- \**Peri Physeôs kosmou [On the Nature of the World]*. Late 5th-early 4th century BC. (Philosophy)
- *†Ioannis Stobaei Florilegium [Johann Stobaeus's Anthology].* 5th century. (Philosophy)
- ‡Diels, Hermann. Die fragmente der Vorsokratiker [The Fragments of the Presocratic Philosophers]. Ed. Walther Kranz. 6th ed. 3 vols. Berlin: Weidmann, 1951-52. (Philosophy)
- §Demokrit [Democritus]. By Democritus. Ed. Salomo Luria. Leningrad: Nauka, 1970. (Philosophy)
- ||Leszl, Walter. I primi atomisti: Raccolta di testi che riguardano Leucippo e Democrito [The First Atomists: A Collection of Texts Related to Leucippus and Democritus]. By Leucippus and Democritus. Florence: Olschki, 2009. (Philosophy)

# **Principal English Translations**

- Freeman, Kathleen, and Hermann Diels. Ancilla to the Pre-Socratic Philosophers: A Complete Translation of the Fragments in Diels, Fragmente der Vorsokratiker. Cambridge: Harvard UP, 1957. Print.
- Taylor, C. C. W. *The Atomists: Leucippus and Democritus*. Toronto: U of Toronto P, 1999. Print.
- \*The attribution of these works to Democritus is not universally accepted.

†An important source of Democritean fragments.

<sup>‡</sup>This anthology contains fragments of works by Democritus and other pre-Socratic philosophers.

\$This compilation of fragments of Democritus's works is more comprehensive than that contained in Diels's *Die fragmente der Vorsokratiker*.

||The collection of Democritean fragments contained in this anthology of the works of Democritus and Leucippus is the most comprehensive to date.

# CRITICISM

#### Gregory Vlastos (essay date 1945-46)

SOURCES: Vlastos, Gregory. "Ethics and Physics in Democritus." *Philosophical Review* 54.6 (1945): 578-92; 55.1 (1946): 53-64. Print.

[In the following essay, Vlastos disputes the claim by the prominent classicist Cyril Bailey that Democritus's ethics does not constitute a moral theory. Through an analysis of Democritus's language, Vlastos demonstrates that the philosopher couches his discussion of ethics in terms related to the body, developing "a physical concept of the soul" and a theory of moral behavior closely linked to his physics.]

"Democritus' 'ethic' hardly amounts to a moral theory," writes Cyril Bailey; "there is no effort to set the picture of the 'cheerful' man on a firm philosophical basis or to link it up in any way with the physical system."<sup>1</sup> Coming at the end of the most valuable study of Democritus that has yet appeared in English, this conclusion can not be ignored. If one dissents, one must give reasons.<sup>2</sup> Yet mere polemics would be an unprofitable exercise. Bailey's conclusion issues from an interpretation of the fragments. It can best be met by an alternative, or rather, supplementary interpretation. I turn to it directly with one precaution to the reader: What follows does not attempt a discussion of Democritean ethics in its entirety. It leaves out the whole of the social ethic, including the most important concept of aidos. It keeps deliberately to those aspects of Democritean ethics which can be linked, directly or indirectly, to the physics.

# I. PSYCHE

1. Scientific medicine assumed that intelligence has a bodily basis,<sup>3</sup> that mental disease has a bodily cause and is susceptible of bodily therapy.<sup>4</sup> Democritus, himself the author of medical treatises,<sup>5</sup> was no doubt willing to follow this methodology as far as it would go. Yet when he consciously generalized the concept of disease from "body" to "life" (βίος) and "house"<sup>6</sup> he was going one step further. He was asking for a new science (σοφίη) that would do for the soul what medicine did for the body.<sup>7</sup> Against the physician's professional bias to make the logos of the body the key to the well-being of both body and soul,8 Democritus insists: "It is fitting for men that they should make a logos more about the soul than about the body. For the perfection of the soul puts right the faults of the body. But strength of body without reasoning (λογισμός) improves the soul not one whit" (B. 187).

2. The first axiom of this *logos* of the soul is the ethical corollary of a proposition established in the physics, that

the soul moves the body:<sup>9</sup> soul, not body, is the responsible agent. This is not in any sense an assertion of dualism.<sup>10</sup> For though the body is simply the soul's "instrument" or "tent,"11 it is nonetheless absolutely essential to the integrity of the soul. Unlike Aristotle's active nous, "which is itself only when separated,"12 or Plato's soul, for which the bodily partner is a moral nuisance,<sup>13</sup> the Democritean soulcluster would dissolve if deprived of the body. And there is no hint in Democritus, as in Plato, that the soul is in danger of corruption or distraction through the body's needs and appetites. In so-called bodily excesses soul, not body, is to blame.<sup>14</sup> Drunkenness and voluptuousness are foisted on the body by the soul, not the reverse.<sup>15</sup> For that very reason Democritus would advise men, exactly as did Socrates, to care for their souls.<sup>16</sup> There is a difference to be sure. "Socrates preaches and proselytizes."<sup>17</sup> Democritus lets the physical and moral facts speak for themselves. Yet both appeal to the same earthly logic. "You don't get virtue from money, but money from virtue," says Socrates (Ap. 29b). "Men don't get happiness from bodies or money, but from right living and wide thoughts," says Democritus.18

3. So far everything follows in line with the basic physical conception. Does the connection snap when Democritus goes so far as to speak of the soul as "divine"?<sup>19</sup> Platonic idealism makes sense of such language.<sup>20</sup> But it seems nonsense in the framework of atomic materialism. Then why does Democritus use it? Does he cut loose from his physical premises to say, "he who chooses the goods of the soul chooses the more divine, he who chooses those of the body chooses the more human"?<sup>21</sup> The sense of this fragment parallels B. 57 and B. 105, where the spiritual/bodily contrast is not rendered as divine/human (B. 37), but human/animal (κτήνος, Β. 57; ζωώδες, Β. 105). In all three fragments Democritus is saying that to a man his soul ( $\psi \upsilon \chi \eta$ , B.37 =  $\nu \upsilon \upsilon \upsilon \varsigma$ , B. 105 =  $\dot{\eta} \theta \upsilon \varsigma$ , B.57) is infinitely more important than his body. Then why not say so? Why use at all the term "divine"?

4. The answer is to be found in the well-established practice of Ionian rationalism to salvage religious terms so long as: (a) they can be adapted to the exigencies of naturalistic logic; and (b) they do not inhibit rationalist criticism of magic. So, for example, the Hippocratean treatises: Call the "sacred" (or any other) disease "divine," if you will, but (a) understand its natural cause;<sup>22</sup> and (b) do not let religious symbols deliver you into the hands of the "magicians, purifiers, charlatans, and quacks" who practice under religious auspices.<sup>23</sup> That is how Democritus appears to treat the term "divine." He does not mould his view of nature to satisfy religious longings. On the contrary, he takes religious terms like ambrosia and Hades and offers a rather disconcerting naturalistic explanation.<sup>24</sup> He is content to say, "the gods give men all good things" (B. 175), so long as men remember that "sharp-eyed intelligence (sc. of men themselves) directs most things in life" (B. 119); so that if, for example, it is health men want, they will have to get it by intelligent self-control.<sup>25</sup>

5. In that spirit Democritus speaks of the soul as "divine." "The soul is the dwelling-place of the *daemon*" (B. 171) means in effect, 'in the soul you will find the only *daemon* there is to find.'<sup>26</sup> So we can now interpret B. 37 to imply, 'devote to the soul that supreme concern you have been taught to give to things divine.' But religious promises of immortality precluded by the laws of atoms and the void are sharply denounced ( $\psi \epsilon \dot{\upsilon} \delta \epsilon \alpha \mu \upsilon \theta \sigma \lambda \alpha \sigma \tau \epsilon \alpha$ ).<sup>27</sup> Exalting the soul's moral (and in B.18 and 21, poetic) dignity, the term "divine" does not cast so much as a shadow of other-worldliness across Democritus' naturalism. The contrast with Socrates and Plato remains unbridgeable.

# II. "Well-being."

1. "Cheerfulness," we are told in B. 191, comes through "moderation of enjoyment and harmony of life ( $\beta$ ( $\alpha$ ς)." But this is immediately pushed further to a physical level of explanation: it is "great movements" or "movements over large intervals" in the soul which prevent it from being "cheerful" or "steadfast." Here "steadfast" builds a verbal bridge between the two senses of stability, physical and moral. Similar words are used by later interpretations of Democritean "cheerfulness":

"Unperturbedness" (ἀταραξίη), Stobaeus 2.7.3i (A. 167);

"Calm" (γαληνῶς ... ἡ ψυχὴ διάγει), D.L. 9.45 (A.1);

"Tranquillitas, securitas," Cicero, *De Fin.*, 5.8.23 (A.1 69). But none of them has the force of the Democritean "undismay" (ἀθαμβίη, B.4, A. 169, B.215; *cf.* also 75.B.3), where stability of soul appears not as a passive state but as a dynamic quality, able to withstand external shock without losing its inner balance.

2. For the technical Democritean term which denotes the physical ground of this resilient, undisturbable cheerfulness, we must look to "well-being" (εὐεστώ).28 In literary usage this means broadly "prosperity."29 But to an atomist ἐστώ (Doric for "being") can mean only one thing: atoms and the void.<sup>30</sup> And when we recall how self-conscious Democritus is in terminological matters, how boldly he bends language to the needs of his philosophy,<sup>31</sup> it is quite unlikely that he would use εὐεστώ carelessly. He could adopt it as a general cognate of 'cheerfulness' (B. 4) only if it meant the soul's 'well-being' in an ontological, i.e. physical, sense.<sup>32</sup> We can then understand why motions of wide amplitude are precluded: because they are prejudicial to the order and integrity of the atomic soul-cluster. This is never stated explicitly in the surviving fragments. But there are strong indirect indications that this is just what Democritus had in mind.

3. It is a common idea in the medical treatises that violent organic motion is injurious to health in general and mental health in particular. "A man is in the best possible condition when there is complete coction and rest" (*On Anc. Med.*, 19.54). The emphasis here falls on the technical

term "coction" (πέψις), and its associated ideas of "balance" (κρῆσις) and "blending" (μίξις), 19.9. But the notion of "rest" is associated as a matter of course with proper "coction." The treatise *On the Sacred Disease* thinks of violent motion in the brain as the physical condition of mental derangement, and concludes: "So long as the brain is quiet (ἀτρεμήσῃ), so long is man intelligent (φρονεῖ)," 17.<sup>33</sup> *On Breaths*, 24, has a different aetiology for the "sacred disease," but the actual state of the disease is again described as a "disturbance" (in this case, of the blood): "The disease finally ends when ... the blood has composed itself (καταστάντος) and calm has fallen over the body."

4. Surviving scraps of Democritean physiology offer some hints of his ideas on organic disturbance, its causes and effects. In a discussion of miscarriages (Ael., *N.H.* 12.17; A. 152) Democritus traces the cause to the hot southerly winds which produce a three-fold effect on the parent body:

- (i) expansive (διίστασθαι τὰ σώματα ... διίστασθαι τὰς φλέβας, τὰ ἄρθρα),  $^{34}$
- (ii) relaxing (χαυνοῦσθαι),
- (iii) disorganizing (οὐχ ἡρμοσμένου πλανᾶσθαι).

Under the influence of the cold wind, on the contrary, the body becomes 'hard to move,' is therefore strong ( $\check{\epsilon}\rho\rho\omega$ - $\tau\alpha\iota$ ), harmonious ( $\sigma\acute{\nu}\tau\sigma\nu$ ov), and is able to perform its natural function.<sup>35</sup> Thus organic strength comes with a tight, stable condition of the bodily atoms; organic weakness with the reverse.

5. There is more to the same effect in the theory of sensation and thought as reported by Theophrastus.<sup>36</sup> Thus the sweet flavor "disturbs" (ταράττει) and "leads astray"  $(\pi\lambda\alpha\nu\hat{\alpha})^{37}$  atoms with which it comes in contact; "moistened and moved out of their order (ἐκ τῆς τάζεως κινούμενα) they flow into the belly" (Par. 65). Here is an implied picture of clusters of atoms in the body each with their own order. If this order is disturbed, they can no longer keep their place in the body. The soul-atoms too must preserve an analogous order, a "harmonious balance" (συμμέτρως κατά την κρησιν) otherwise the soul can not perform its normal function, thought (Par. 58). A soul unbalanced by too much heat or too much cold would go out of its mind (ἀλλοφρονεῖν).38 Incidentally, Theophrastus' mention of the two extremes of temperature (and, consequently, of too much or too little motion)<sup>39</sup> should warn us against defining the physiological optimum in terms of absolute rest.<sup>40</sup> The opposite to the "great movements" of B. 191 would therefore be a dynamic equilibrium—which is exactly conveyed by krēsis.

6. This *krēsis*, however, is not merely a balance within the bodily microcosm.<sup>41</sup> It is also a dynamic relation between microcosm and the surrounding portion of the macrocosm.<sup>42</sup> This is well illustrated in Democritus' theory of

respiration (Arist., de Anim. 404a and de Resp. 472a). The environment here is no static reservoir of soul-atoms, but an ominous, compressing force that would crush the soul out of our body if we did not have the power of respiration.<sup>43</sup> Thus the environment as such is neither 'good' nor 'bad,' but both—a source of danger (as ἐκθλίβον) and a source of relief (since it is the in-coming soul-particles that "check the crushing," 427a 9). The decisive factor rests with the organism itself. We shall find this attitude again in Democritus' conception of "external" goods. "Through those very things whence we derive food we also either get evil or else escape evil" (B. 172). This, of course, reinforces in yet another way the case of the soul which may thus wrest good from evil or, conversely, may find that even good things turn into their opposite if the soul is too clumsy to shape their course (B. 173).

# III. THE PLEASANT AND THE GOOD

1. That a *physiologos* should think of the good of the soul in terms of "well-being" =  $kr\bar{e}sis$  seems logical enough. But why think of it also in terms of *pleasure*? A glance at contemporary literature suggests one answer: Fifth century is still largely untouched by that ascetic distrust of pleasure which sweeps over the ancient world in later times.<sup>44</sup> In whole-hearted, unashamed words so pious a poet as Sophocles speaks of it as the thing without which life is not worth living: "With pleasures lost, a man I think, no longer lives; I deem his life a living death."45 Pleasure is so essentially the sense of life, that Aeschylus thinks of death as "the realm where joy is never known" (Eum. 301, 426; cf. Soph. O.C. 1218). So when Democritus defines the best life as "the most cheerful, least disturbed" (B. 189), he announces no novelty to his time. There is nonetheless a deep consistency with his physics in thus singling out the most vividly this-worldly aspect of the good life. For if the good be pleasure and, by common consent, there is no pleasure in the after-world, then the physical annihilation of the after-life does not diminish the goodness of human existence by so much as "the shadow of a smoke."

2. In scientific thought pleasure enjoys an equally high status. The medical association of pain with disease is so sweeping that "pain" and "illness" are commonly used as equivalent terms,<sup>46</sup> and pain is linked with the most general formulae of health and disease: "balance" and "symmetry" preclude pain; pain comes when the proper "mixture" is lost.<sup>47</sup> Philosophers take much the same attitude. Diogenes of Apollonia offers a perfectly general psychological theory of pleasure in terms of the proper (κατὰ φύσιν) "mixture" of the air in the blood; and this same "mixture" is also the basis of "courage (θάρσος), health and their opposites."<sup>48</sup>

3. Here then Democritus finds a hygienic view of pleasure ready to hand. He does not have to enunciate either the doctrine that pleasure is the normal concomitant of wellbeing and pain of the reverse; nor of the corollary that,

therefore, the quest for pleasure should be assimilated to the discipline of the "measure." This latter was also implicit in the theory and practice of contemporary medicine. "To live for pleasure" is the medical term for the haphazard, unregulated life, the negation of medical regimen.<sup>49</sup> The doctor would have to advise—in the very words of Democritus (B. 74)--- "accept no pleasure, unless it agrees with you." The word συμφέρειν used here is the key concept of Hippocratean regimen; it denotes what is in harmony with nature and is thus essential in preserving or restoring health.<sup>50</sup> It is interesting to see that not only  $\tau \dot{o}$ συμφέρον, but nearly all the normative terms of Democritean ethics-metron, metrion, harmonia, to deon, kairos, to kalon, to dikaion-are also used by the medical writers to express the conduciveness of any process or act (whether of the body itself, or of its natural environment, or of the physician) to the state of health.<sup>51</sup>

4. However striking this parallelism may be, it should not permit us to forget the distinctive purpose of Democritean *sophiē*: to heal the soul directly through reasoning ( $\lambda o\gamma$ - $\iota \sigma \mu o \varsigma$ ). Democritus, therefore, must transform a medical analysis into a moral argument. He must (i) show what control the soul itself has over pleasure and pain; and (ii) persuade the soul to exert this control. (i) will be discussed in Section IV of the sequel. (ii) is a simpler matter, though it too has far-reaching theoretical implications. Many a doctor must have tried his hand at it to wear down a patient's resistance to a disagreeable regimen: 'Give up this pleasure now,' we can imagine him pleading, 'and with your health back, you will more than make it up in pleasure.' But strictly speaking such arguments are not the doctor's business.<sup>52</sup> It is for the moralist to argue:

B. 233: If you step over the due measure ( $\mu \epsilon \tau \rho \iota o \nu$ ), the most agreeable things will become most disagreeable.

B. 236: ... having over-stepped the time-limit ( $\kappa \alpha \iota \rho \delta \nu$ ), ... their pleasures are brief and short-lived, ... their pains many.

#### Therefore,

B. 211: Moderation (σωφροσύνη) increases enjoyment and makes pleasure all the greater.

5. What then can be the meaning of B. 188, "enjoyment and its opposite are the landmark (ὄρος) of what does or does not agree with us (συμφόρων καὶ ἀσυμφόρων)" and of B.4, "enjoyment is the landmark (οὖρος)"? The customary rendering "limit" for οὖρος is confusing. For Democritus has told us, "accept no pleasure unless it agrees with you" (B.74).<sup>53</sup> How can he then say that pleasure is itself the "limit" of what does or does not agree with us? We can avoid the vicious circle by keeping to the literal sense of οὖρος, "landmark." In that famous simile in the *Iliad* (xii, 421), where two men dispute over the "landmarks" (οὖροι), they hold a "measure" (μέτρον) in their hands. The "landmark" is not itself the "measure," except derivatively; it is only the visible marking-point which reveals what only measurement initially decides. This is a good clue to what Democritus had in mind: pleasure is the sign,<sup>54</sup> the appearance of "what agrees with us." The parallel in the theory of knowledge is "appearances are the sight of things unseen."<sup>55</sup> The objective atomic pattern which constitutes well-being is "unseen" in itself; pleasure is the "appearance" which shows it up. This "landmark" is not, of course, the unproved pleasure which stands *sub judice*, until proved hygienically sound; it is the proved pattern of pleasure, duly selected to accord with "wellbeing" and "cheerfulness."<sup>56</sup> Just as the boundary-stone makes visible the actual area within which a piece of property is located, so pleasure in this latter sense marks out the area of action which "agrees with" the well-being of the soul.

7. We can now make good sense of the crucial fragment B. 69, "The good and the true are the same for all men; the pleasant differs for different people" ( $\ddot{\alpha}\lambda\lambda\phi$   $\ddot{\alpha}\lambda\lambdao$ ), and integrate Democritean ethics and epistemology:

(i) "The pleasant" in B. 69 corresponds to "sweet, bitter" etc. in B. 9 (and "sight, hearing" etc. in B. 11). In both cases we have "appearances," i.e. felt qualities which vary from one percipient to another,<sup>57</sup> because in each instance they depend on the percipient's bodily condition<sup>58</sup> and reflect its peculiarities.

(ii) "The good and the true" in B. 69 correspond to "being" ( $[\tau \dot{\alpha}] \dot{\epsilon} \tau \epsilon \hat{\eta} [\check{0} \vee \tau \alpha]$ ) in B. 9, etc. "Being" is obviously the atoms and the void, and "the good" cheerfulness and well-being. Paired with "the true" in opposition to "the pleasant" in B. 69 "the good" can, therefore, only refer to atomic "being" itself. This confirms the present interpretation, which takes "well-being" to refer to the soul's atomic configuration (above, II, 2).

(iii) Now we know that "the good," superseding pleasure in the sense of (i), does not supersede pleasure altogether. On the contrary, the good is itself revealed in a pattern of pleasure. Similarly with sensation. Superseded in the sense of (i) by "genuine knowledge," it is not superseded absolutely. We are told as much in B. 125: for "mind" ( $\phi p \dot{p} v$ ) to "overthrow" the senses would be to overthrow itself ( $\pi t \hat{\alpha} \mu \dot{\alpha} \tau o t \tau \dot{\alpha} \kappa \alpha t \dot{\alpha} \beta \lambda \eta \mu \alpha$ ). Unlike Platonic being which, immaterial by definition, is never given in sensation, Democritean being is the material stuff of nature as we see, touch, and taste it.<sup>59</sup> The "assurance" ( $\pi (\sigma \tau t \varsigma)^{60}$  of its existence must, therefore, be given in the phenomenon.<sup>61</sup> This "sight of things unseen" is not the crude sensation of (i), but sensation enlightened by the "subtler" ( $\dot{e}\pi \dot{\lambda} \epsilon \pi \tau \dot{\sigma} \tau \rho v$ ) investigations<sup>62</sup> of atomic theory.<sup>63</sup>

8. "The good and the true are the same for all men" sounds like an explicit denial of Protagoras' "I call some things better than others, but none truer" (*Theaet.* 167b). The contrast epitomizes the difference between the last of the *physiologoi* and the first of the "sophists." Abandoning *physiologia*, Protagoras knocks down the physical scaffolding of truth. He can still find, he thinks, a basis for judgments of "better" and "worse" in the efficacy of "art."<sup>64</sup> But having lost a physical meaning for "being," he can only say that there is no truth except in appearance.<sup>65</sup> For the physical basis of objectivity Protagoras substitutes a political one: the collective phenomenon becomes the only "measure" for the individual phenomenon.<sup>66</sup> Democritus, on the other hand, can take "man is the measure" in an entirely different sense. His physical concept of the soul defines a unitary human nature<sup>67</sup> which affords a basis for universally valid judgments.<sup>68</sup> In Protagoras, on the other hand, "man is the measure" means sensation without being, pleasure without well-being. Democritus should be remembered in the history of thought as the first to answer the Protagorean challenge. Paradoxical as it may seem, Sextus' association of the materialist, Democritus with the idealist, Plato, in opposition to Protagorean phenomenalism is profoundly true.<sup>69</sup>

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# IV. MAN MAKES HIMSELF

It may seem strange to us that Democritean cosmology should include a chapter on the origins of civilization.<sup>70</sup> It did not seem so to the Ionians. Thus Anaxagoras' fr. 4 assumes as a matter of course that civilization is a cosmic episode: the works of man ( $\pi \acute{\alpha} \lambda \epsilon \iota \varsigma$ ,  $\check{\epsilon} \rho \gamma \alpha$ ,  $o \acute{\iota} \kappa \acute{\eta} \sigma \epsilon \iota \varsigma$ ) are implicit (ἐνεῖναι) in the original "mixture;" they are the physical consequence of the cosmogonic "separation."<sup>71</sup> Yet it is one thing to conceive of man and his arts as the creation of nature; it is quite another to purge one's own mind completely of the traditional, anthropocentric worldview. Anaxagoras gives himself away in this fragment with the assumption that each "separation" is bound to produce men, and that "these will have a sun and a moon and the rest as with us."72 Democritus' doctrine that "some worlds are without any sun or moon ... and some are without any living creatures" (Hipp. Ref. 1.13.3; A. 40) looks like a conscious repudiation of the teleological streak in Anaxagorean physics. Schooled to "refer to necessity all things which nature employs" (Arist., de gen. an. 789b 4), Democritus could assimilate the origins of human culture to the same methodology. The result was a profound imaginative innovation. Anankē, which figured in Aeschylus, not only as alien to technē, but as its obdurate, invincible opponent,73 now displaces Prometheus himself as the progenitor of technē. Democritus' phrase, "necessity separated them out (sc. the arts)" (B. 144), follows Anaxagoras in thinking of the event in terms of the cosmogonic "separation." But adding "necessity" (τάναγκαίον) he carries the logic of the Ionian position to its ultimate necessitarian conclusion.

2. Just how did Democritus think of necessity "separating out" the arts? For the general outlines of his answer we can only look to the Hecataean fragment in Diodorus I.8. There "need" or "necessity" are man's "teachers."<sup>74</sup> Struggling to survive against hostile forces in his environment,<sup>75</sup> man is compelled to associate himself with other men; hence speech (I.8.3,4). He is also compelled to learn from

experience (πεῖρα, I.8.7); hence the mechanical arts.<sup>76</sup> These "discoveries" (εὑρήματα) change not only external arrangements, but his very life (βίος).<sup>77</sup> And since we know that Democritus thinks of "life" as dependent upon the form of the soul (B. 61), the change goes further still: it is tantamount to a transformation of the soul. The nature of the soul is not fixed by the original pattern of the soul-atoms. This pattern itself can be changed: "Teaching (διδαχή) re-forms (μεταρυσμοῖ) a man, and by reforming, makes his nature (φυσιοποιεῖ)" (B. 33, Bailey's tr.). Both verbs in this sentence deserve close attention:

(a) *Metarysmoi* (matched by the equivalent term ἀμειψιρυσμεῖν)<sup>78</sup> must refer to a change in the ultimate physical *rysmos* (configuration) of the soul-atoms.<sup>79</sup>

(b) *Physiopoiei*, unique in Greek literature, suggests the force with which Democritus grasped the idea of "human nature in the making."

3. To be sure, the concept of nature as itself the product of teaching and custom is not unique in Democritus. It is the common property of the age. For the sophist it provides an *apologia pro arte sua*. For the medical man it expresses a norm of "nature" which takes into account not merely anatomical structure but also the patient's established habits and mode of life.<sup>80</sup> Yet philosophical originality lies not so much in novelty, as in powerful generalization and fruitful interrelation of ideas. This Democritus did with his concept of "teaching that makes nature," turning it into a nest of interconnections between physics and ethics:

(i) "Teaching" frees man not from necessity (which is absolutely impossible) but from chance (which is largely possible);

(ii) "Teaching" can be directed not only outwards, upon external nature, but also inwards, to attack the salient which chance holds within man's own nature—sensation and pleasure;

(iii) The combined effect of (i) and (ii) is the use of man's own proper power to increase that power and thus advance his self-sufficiency.

4. So much talk of chance in the ethical fragments seems "odd" to Cyril Bailey: "there is here a striking contrast to the suppression of the idea of chance in the physical theory and it seems to show that Democritus' ethics are largely independent of his physics" (*op. cit.*, 188). But chance is not only consistent with physics (Bailey says, "not necessarily inconsistent," 187); it can only be correctly explained through the physics. It enjoys the same kind of status as, *e.g.*, color:<sup>81</sup> Neither exists absolutely in the atoms themselves. Both exist in relation to our own sentience or action—and this not in spite of atomic law, but because of it. As the author of *On Nutriment* speaks of "spontaneous" organic processes, "spontaneous with regard to us, but not spontaneous with regard to the cause,"<sup>82</sup> so Democritus speaks of "chance" events.

Ignoring this distinction, "bastard knowledge" attributes color and chance absolutely to being. In the case of chance this is more than error; it is 'rationalization.' The fiction of chance excuses, and therefore confirms, our own stupidity and helplessness (πρόφασις ἰδίης ἀβουλίης, B. 119). Thus the misunderstanding of the relative reality of chance means an absolute reduction in our own natural power. Hence Democritus' preoccupation with chance in the ethics. It is no mere matter of linguistics to be settled in a semantic footnote. It is a moral encounter with the competitor and opponent of "teaching," that has power to change human nature after its own pattern: "The stupid are formed (ρυσμοῦνται)<sup>83</sup> by the gains of chance; but those who understand these things (are formed) by (the gains of) wisdom" (B. 197).

5. We can now integrate this notion of chance with that distinction between crude and enlightened sensation, between questionable and sound pleasure, which is at the heart of Democritean epistemology and ethics (Part One, III, 7). This change in our rysmos for whose control "teaching" contends with "chance" occurs to a lesser, but equally definite, extent with the impact of every incoming stimulus upon our senses. Every perception is such an impact (B. 9); and when knowledge is nothing more than the cumulative sequence of such external impactsand in that sense the child of chance-then it is "bastard knowledge." Only when fathered upon our senses by the soul's inherent power to move itself in the "subtler" inquiry of reason, is it "genuine knowledge." This interpretation, of course, is pure reconstruction. There is no evidence in the sources that Democritus so applied the notion of chance to his theory of knowledge, though it is so applicable. But we know that he applied it in ethics through the cognate notion of teaching, "hard work" (πόνος):84 "Learning (μάθησις)85 achieves good things through hard work; but bad things grow spontaneously without hard work" (B. 182). So too B. 178 tells us why "indulgence" (εύπετείη, the negation of hard work) is the "worst possible thing": for this is what gives birth to "those pleasures, from which badness comes into being."

6. Here is a more powerful idea than the notion of "overcoming" pleasure.<sup>86</sup> It is particularly important for Democritus' hygienic conception of pleasure. For it clearly thinks of pleasure as the creature, not the creator, of the good life. "Badness" does not come from pleasure as such (any more than drunkenness, etc. come from the body, cf. above Part One, I, 4). The pleasures from which it comes are not given in human nature as such; they are formed in human nature through the soul's failure to make for itself a nobler pattern of pleasure:

B. 189: "It is best for man to lead his life with the maximum of pleasure and the minimum of grief. This would come about if he would not *make his pleasure* in mortal things" (μή ἐπὶ τοῖς θνητοῖσι τὰς ἡδονὰς ποιοῖτο).

B. 235: "Those who take their pleasures from the belly (ἀπὸ γαστρὸς τας ἡδονὰς ποιἑονται)" ... The locus of pleasure is thus not decided for us by our 'given' constitution. There is the body, to be sure, with its relatively fixed loci of pleasure. But the soul retains the power to integrate these as subordinate parts of a larger pattern of pleasure which is decisive for its happiness. Failing to use this power it will have to fall back on the pleasures of the belly, will demand more of these pleasures than they can give within the law of the limit, will therefore overstep the limit and pay for it in pain.

7. But would not the life of "hard work"—with its double association of exercise and painful exertion<sup>87</sup>—be the negation of pleasure and thus the wedge that pries "well-being" loose from "cheerfulness"? There are four considerations in Democritus to meet this:

(i) In the absence of hard work, pleasures (as we have seen) would "grow wild," and the short-lived ones that are followed by pain would luxuriate (So B. 235; cf. also B. 242);

(ii) "Continuous hard work grows ever lighter through habituation" (B. 241).

(iii) Achievement makes hard work more pleasant than even rest would be. Only when unsuccessful is hard work "annoying and miserable" (B. 242).

(iv) In any case, the life of hard work guarantees, as haphazard living never can, the essential condition of "cheerfulness" and "well-being": self-sufficiency ( $\alpha \dot{\nu} \dot{\alpha} \dot{\rho} \kappa \epsilon_{10}$ ). "Chance is a giver of great gifts, but uncertain. Nature is self-sufficient" (B. 176). "Chance spreads before us a lavish banquet, but moderation a self-sufficient one" (B. 210).

8. In this first encounter with the concept of self-sufficiency we should note its ambivalence: It may mean the deflation of desire and curtailment of enterprise to forestall any collision with the impossible; or else it may mean the resourceful extension of skill, enlargement of purpose, enhancement of power through the better understanding of the possible. The two moods are not incompatible. They can blend under the dominance of the second to produce a confident, adventurous, experimental attitude towards life. But if the balance tilts in favor of the first, self-sufficiency becomes the maxim of an introverted quest for security, seeking peace of mind through the inhibition rather than the extension of action. So we may see it in Democritus' own social ethic.88 But this is not the form in which it appears in the present context. "Nature is self-sufficient" here has much the same sense as the medical rule that the state of "balance" is "most self-sufficient":89 selfsufficiency is the power of self-maintenance given to the healthy creature in its very nature. Nature is this power of self-maintenance;90 hence the expression "one's own power and nature," as we find it both in Democritus and in the medical literature.<sup>91</sup> As such, nature defines an order of what is "possible" and "impossible."92 But man's nature is not fixed; as Heracleitus thought of man, he is a "self-increasing logos" (B. 115). Through

"teaching" he can make his own nature, and has been making it ever since he was first taught by necessity to turn necessity, through "art," into the ally of his power. There is nothing in the concept of self-sufficiency as such to negate this dynamic view of human nature. There is simply the reminder that this development can proceed only within the limits of the "possible." Nature is selfsufficient because it never oversteps those limits. Neither must "teaching," if it is to be the "teaching that makes nature." Contrariwise, attempting the impossible, it would prove the undoing of art, and thus submission to chance.

## V. THEORY AND PRACTICE

1. The contrast of "deed" (*Ĕ*ργον) and *logos*, so familiar, even commonplace, in fifth-century literature, can now find its proper place in Democritus' system.<sup>93</sup> Logos is morally important only in so far as it is "teaching that makes nature" and thus affects action.<sup>94</sup> This is no platitude if we think of it against the sophist's glib claims for the power of his *logos* to produce right action.<sup>95</sup> Democritus counters with, "many who have never learned logos live in accordance with logos" (B. 53), while "many practice the noblest *logoi* while doing the basest deeds" (B. 53a). The tone of the argument grows sharper with B. 82, "those who do everything in *logos*, nothing in action, are fakes; they have only the semblance of truth" ( $\dot{\alpha}\lambda\eta\theta_0\phi\alpha_$ véec), and B. 145, "logos is but the shadow of the deed." Such sayings, incidentally, also distinguish Democritus from his paradoxical allies in the battle against Protagoras. Socrates and Plato would level the charge of ἀληθοφάνεια directly against the *logos* of the sophist. It is characteristic of Democritus that he should find in the deed the touchstone of sophistic unreality.

2. But neither does Democritus underrate the distinctively psychic function of intention and wish:

B. 68: "The trustworthy and untrustworthy man (δόκιμος, αδόκιμος) is to be known not only from what he does, but also from what he wants."

B. 62: "It is not the absence of injustice that is good, but the absence of the desire (to commit injustice)."

B. 89: "Not he who wrongs you, but he who wants to wrong you, is the enemy."

One should not interpret such sayings as a retreat in the direction of subjectivism. Why should a man of action underestimate the importance of intention for action? Thus a speaker in Thucydides (VI.38.4) remarks: "One must take defensive measures not only against what the enemy does, but also against what is in his mind."<sup>96</sup> In a philosophy where soul moves body the emphasis would naturally fall on the doings of the soul even when (or, rather, especially when) these are incompletely revealed in the body's outward motion. For here are the springs of action and, sooner or later, the real intention of the soul becomes the body's deed.<sup>97</sup>

4. And for this very reason wisdom can serve as an inner discipline. By discerning the limits within which the external world can be changed, the wise soul changes itself, educating desire and making hope itself reasonable.<sup>99</sup> Without this process of reconciliation with reality there is no "cheerfulness," as one can see from what happens to the "stupid," who "live but get no enjoyment from life."<sup>100</sup> Why not?

(i) Their battle against necessity is necessarily selfdefeating. Fleeing the inescapable—*e.g.*, old age, and death—all their efforts bring them, like Oedipus, nearer the fateful end (B. 203, B. 205).

(ii) A mirage robs them of satisfaction from the perfectly satisfying things that come their way. "The desire for more loses what is in hand: it is like the dog in Aesop" (B. 224; cf. B. 202). Often enough Democritus illustrates this with commonplace exhortations to be content with what one has. But he is also capable of applying the underlying idea with astonishing subtlety and depth: "the stupid, hating life, want to live for fear of Hades" (B. 199). Instead of enjoying life for what it is, they hate it for what it is not, the prelude to Hades; so they want to prolong the life they hate, in order to postpone death. It would be hard to find a better example of man being his own worst enemy through stupid disregard of the limit.<sup>101</sup>

#### CONCLUSION

At the risk of repetition, I add (a) a list of the concepts which mark the main junctions between ethics and physics, and (b) a more general interpretation of the historic importance of Democritean ethics, as the first rigorously naturalistic ethics in Greek thought.

#### (A) The Leading Concepts

(i) The soul: a specific atomic cluster, dependent for its integrity upon another cluster (the body), and having the power to move the latter. This determines an ethic which is soul-centered, but free from dualism.

(ii) The "divine": any natural entity whose moral value is not less than that traditionally attached to supernatural

entities of popular religion. In this sense the soul, though mortal, is divine.

(iii) "Well-being": the physical and moral state of the "cheerful" soul. It is defined positively as healthful balance ( $\kappa \rho \eta \sigma \iota \varsigma$ ), negatively as the absence of violent motion.

(iv) Pleasure: the "appearance" of "well-being;" therefore, to be pursued only in accordance with "what agrees with" (συμφέρειν) the soul's well-being.

(v) "Art": the soul's power to change nature. Discovered under pressure of "necessity," it can operate within the limits fixed by necessity to advance man's "power" ( $\delta \psi - v \alpha \mu \zeta$ ) and "self-sufficiency."

(vi) "Chance": events uncontrolled by art.

(vii) "Teaching" (διδαχή) and "hard work" (πόνος): the directed change of the soul's inner nature. Such moral change has physical effect, since it alters the pattern (ρυσ-μός) of the soul-cluster.

(viii) The deed ( $\check{\epsilon}\rho\gamma\sigma\nu$ ): the moral (and physical) motion within which the good is realised. *Logos* exists for the sake of the deed.

(ix) Wisdom ( $\sigma o\phi(\eta)$ : insight into the order of nature which enables the soul to direct both external forces and its own inner motions of desire and hope.

# (B) Democritus' Naturalistic Ethics

When Anaximander spoke of nature as an order of "justice," he did more than eke out with political metaphor the archaic vocabulary of his physics. Consciously or not, he grounded justice in a realm as immortal and indestructible as the traditional gods, but fully intelligible to man. In Heracleitus nature consciously takes the place of Olympus as the matrix of law, justice, measure, and *logos*. It is itself the "nutriment," the "common" basis and guide of all human action, public and private. Nature so regarded is more than nature. Justice is naturalized by moralizing nature. Parmenides and Empedocles continue in this path. It is "justice" that holds Parmenides' Being within "the bonds of the measure;" and the moral axioms of the democratic polis determine the design of Empedocles' equalitarian universe.<sup>102</sup>

The atoms and the void destroy forever this Greek venture in romantic naturalism. Nature is now de-humanized, demoralized as never before in Greek imagination. It is the nature of Thucydides, implacable and aloof. Is there room for the law of the measure in the world such as this? It was the genius of Democritus to define an ethics that meets the conditions so fixed by Leucippean physics. Nature is "necessity," not "justice;" neither good nor evil in itself; not intelligent, though intelligible. Yet its intelligibility alone, divested of any moral quality whatsoever, yields sufficient ground for the law of the measure. The good is not given to man; it is not "chance." It must be created by man; it is "art." Yet art is itself the child of necessity. As Plato would note with extreme displeasure, it is a late-comer in nature.<sup>103</sup> But it advances nonetheless man's self-sufficiency in nature, and this not only by mechanical invention, but also by the power of the "teaching that makes nature" to transform chance pleasure into cheerful well-being.

Anything more or less than this would be *hybris*: desire for the impossible, or contempt for the possible. *Nemesis* follows on any act thus disregarding the humanly possible within the limit of the naturally necessary. This is the measure; and its knowledge empowers the soul to build upon nature goodness and justice which would otherwise not be found in nature at all. Because it masters the world so far as it can be mastered, and cures the ills of the soul so far as they can be cured, this "wisdom undismayed is worth everything" (B. 216).

# Notes

1. The Greek Atomists and Epicurus, 522.

- In this I have drawn heavily upon two recent studies: H. Langerbeck, Δόξις Ἐπιρυσμίη, Neue Philologische Untersuchungen, 10 (1935), and K. von Fritz, Philosophie und Sprachlicher Ausdruck Bei Demokrit, Plato und Aristoteles.
- 3. This assumption is so universal in the medical treatises that documentation is superfluous. For its earliest expression in our sources see Heracleitus B. 117 and B. 118; Alcmaeon A. 5 (Theophr., *de sensu* 26) and A. 8 (Aetius 4.17.1); and Parmenides B. 16. (N.B. All references to pre-socratic fragments are to the fifth edition of *Fragmente der Vorsokratiker*, Diels-Kranz; the numbering of doxographic material is prefaced by the letter A, and that of genuine fragments by the letter B.)
- 4. E.g. On the Sacred Disease explains all abnormal states as due to physical changes in the brain (c.17), whence it follows that "whoever knows how to cause in men by regimen moist or dry, hot or cold" (c.21) can cure mental disorder. So too On Diet I.35 prescribes a bodily regimen to secure the proper balance ( $\kappa\rho\eta\sigma\iota\zeta$ ) of the physical ingredients of the soul and "speed up the revolutions" of the slow-witted.
- 5. B. 26b, c, d.
- 6. B. 288.
- 7. B. 31. Diels thought this fragment spurious (he refers it to the "Letter to Hippocrates," Diels-Kranz, II, 227, line 11). But its component ideas occur also in B.288 and B. 187.  $\pi \alpha \theta \circ \varsigma$  should, of course, not be read in the Aristotelian sense of "passion," but in the

Hippocratic sense of "disease," as e.g. in On Airs, Waters, etc., 22, ταῦτα τὰ πάθεα θεῖα.

- As one would expect, there are exceptions, when the medical men too think of a health-regimen for the soul in terms of the soul's own distinctive activities. There is more than a hint of this in *Visits* VI.5.5, "Exercise (πόνος) is nourishment for the limbs and the flesh, sleep for the viscera. The soul's own exercise (περίπατος) is reflection" (tr. following Littré, and Werner Jaeger, *Paideia*, III. 30).
- 9. To think of this proposition as Platonic is anachronistic. In Democritus it is an elegant deduction from the first principles of atomic physics:

(i) soul-atoms are small and spherical (*de An.* 409a 32, 406b 20); therefore, (ii) they are most mobile (*de Caelo*, 306b-307a, "because they offer the fewest points of contact and are the least stable"); and (iii) the soul-cluster is more mobile than any other atomic cluster (*de An.*, 404a 6, "because such configurations are best adapted to penetrate everywhere and, being themselves in motion, move other bodies.") Plato on the other hand adopts this idea only at the price of endless difficulties. For how can his own immaterial soul move the material body? Aristotle rightly rejects the soul-circles of the *Timaeus* as a logical answer to the *koinonia* of the soul and body (*de An.* 406 b 26f.).

- 10. Per contra, Langerbeck, op. cit., p. 75.
- B. 159, ὥσπερ ὀργάνου τινὸς ἤ σκεύους. Σκῆνος, Democritus' characteristic term for the body, occurs in none of the pre-Socratics, but is used in medical treatises, as *e.g.* in the fragment *On Anatomy*, which also uses another word of Democritean flavor, ὀμορυσμίη; σκῆνος occurs also in *On the Heart*, 7, where it is used as a synonym to avoid repetition of the word σῶμα.
- 12. de An. 430a 22.
- 13. The body is likened to the soul's chain (*Phaedo* 67d), shell (*Phaedr*. 250c) and tomb (*Gorg*. 493a). It is a pollution (*Rep.* 611b, c) and an evil (*Phaedo* 66d).
- B. 159: it is the soul's "carelessness, drunkennes, voluptuousness" that "destroyed (κατέφθειρε) and broke down (διέσπασε)" the body.
- 15. Ibid.; cf. also B. 223.
- 16. The comparison has point in the light of Burnet's well-known claim that the concept of the soul as the ethical agent is a Socratic innovation ("The Socratic Doctrine of the Soul" in *Essays and Addresses*). If, as Burnet says, the Athenians got a "shock" from Socrates' teaching "that there is something in us capable of attaining wisdom, and that this same thing is

capable of attaining goodness" (140), then Democritus' public must have got the same shock, for that is exactly how he thought of the soul. Burnet's argument is vitiated by the assumption that the ghost-soul remained intact until challenged by Socrates. This does less than justice to the *physiologoi*, who were the first to fashion a natural concept of the soul. In that school advanced spirits like Socrates learned to think of the soul as a non-magical entity.

- 17. Werner Jaeger, Paideia, II, 41, q.v.
- B.40 "Wide thoughts" is Cyril Bailey's rendering of πολυφροσύνη. See also B. 170 and 171.
- 19. B.112, B.37. Cf. also B.18 and B.21.
- 20. Because the soul is consubstantial with the souls of the immortal star-gods (*Tm* 41d), and shares with them the "rational" (circular) motion so different from the six "wandering" (rectilinear) motions of terrestrial beings (*Tm*34a). After death the virtuous soul will share fully the life of the gods. See references given in Rohde, *Psyche* (Eng. tr.), Ch. xiii, notes 62, 63, 66; 70a.
- B.37. Cf. also B.189, where, of course, 'θνητά' is only to be taken as the opposite to 'θεῖα;' taken literally it would be nonsense on Democritean assumptions.
- 22. On Sacr. Dis., 14, "not god, but disease, is ravaging the body." Cf. with *ibid.*, 21, "all divine and all human," or with On Airs, Waters, etc., 22 "these diseases are divine and so are all others and none of them is more divine than the rest." There is no contradiction: "Das Goettliche ist ihm der Naturvorgang selbst," W. Nestlé, *Hippocratea, Hermes* 73 (1938), p. 8.
- 23. On Sacr. Dis., 2.
- 24. B. 25 and B. 1. The question of the gods in Democritus is a more complicated matter. Briefly,

(i) I consider the *eidola* as an aetiological explanation of the popular belief in the gods, and nothing more: Our best source for these eidola, B. 166 (Sextus), represents them clearly as natural objects; and they fall on animals as well as men, A. 79 (Clement). As "perishable" they lack the defining property of the "immortal" gods. To be sure, they are, in Sextus' language "beneficial" or "harmful." But this refers to their specific physical effect on the organism, as in the case of the eidola whose bad effect is described by Plutarch (A. 77): "They disturb and harm body and soul." This interpretation is confirmed by Hermippus (A. 78), while Cicero (A. 74) is inconclusive. Clement's phrase  $\dot{\alpha}\pi\dot{o}$   $\tau\eta\varsigma$  θείας οὐσίας (A. 79) is his own interpretation-clearly a confusion with Epicurean doctrine.

(ii) Sext. ix. 24 and Lucr. V. 1186-93 (under A. 75), in striking agreement with Critias' *Sisyphus*, lines 29-37, are still aetiology—citing ignorance and fear of celestial phenomena. The *eidola* are not essential for this explanation, and are not referred to, nor are they essential for

(iii) Τριτογένεια, (B. 2), which shows an alternative, allegorical pattern of explaining traditional beliefs.

(iv) B. 30 is probably neither a reference to the air of Diogenes of Apollonia (so Otto Kern, *Die Religion der Griechern*, II, 291) nor irony (so Bailey, *op. cit.* 175), but a fragment from a serious explanation of the origin of religion. Ed. Norden, *Agnostos Theos*, shows that in rhythm and style "πάντα Ζεῦς" etc. is a prayer, and a very beautiful one (p. 164); he compares λόγιοι ἄνδρες in B. 70 with πυκνὸς καὶ σοφός τις γνώμην ἀνήρ in Critias' Sisyphus (p. 298).

(b) B. 129,  $\phi p \epsilon v i \theta \epsilon i \alpha v o \hat{v} \tau \alpha i$ , so far from implying the existence of popular gods, is a rationalist declaration that "divine" things must submit to the same canons of analysis as anything else.  $\phi p \hat{\eta} v$  and vo $\hat{v} v$ - $\tau \alpha i$  suggest a conscious reference to critical reason as against "bastard" knowledge (See B. 125 for this use of  $\phi p \hat{\eta} v$ ; B. 64, B. 65 for v $\hat{\eta} \sigma i \varsigma$ ). Hence this fragment may well be a critique of the popular belief in the gods as a "bastard" inference from the senseimpressions produced by the *eidola*.

- 25. Even in B. 175 taken entirely by itself the implication is clear that, had it not been for "blindness of mind and stupidity" men would have got for themselves these "good things."
- As in Heracleitus, "Man's character is his *daimon*," B. 119.
- 27. B. 297, an epoch-making statement. Immortality in any and every sense of the word "is here for the first time in the history of Greek thought, expressly denied," Rohde, *Psyche*, Eng. tr., 386.
- 28. Von Fritz's interpretation is suggestive (op. cit., 35): "Waehrend das Wort εὐθυμίη den Habitus des Gluecklichen in seiner emotionalen und aktiven Bewegtheit bezeichnet, bezeichnet εὐεστώ seinen Zustand, gewissermassen seine Struktur; und waehrend εὐθυμίη den aeusseren Habitus beschreibt, wie er unmittelbar in die Augen faellt, dringt die Bezeichnung εὐεστώ vielmehr analytisch in sein Inneres ein."
- The definition in Hesychius, εὐδαιμονία ἀπὸ τοῦ εὖ ἐστάναι τὸν οἶκον, apart from its wrong etymology (see ἐστώ in Liddell and Scott, *Lexicon*), is unduly narrow. Generally εὐεστώ stands for the prosperity of the individual as much as for that of a community (for both uses see Aesch., Ag. 929 and 647). In any

case, there can be no reasonable doubt that Democritus used εὐεστώ as coextensive with "cheerfulness" (see A. 14.5; A. 167; B. 2c; B. 4; B. 257). I fail to see why Diels-Kranz include the definition in Hesychius among the Democritean fragments (B. 140).

- 30. In 'Philolaus,' B. 6, its sense is clearly ontological, ά μὲν ἐστὼ τῶν πραγμάτων ἀΐδιος ἔσσα ... τὰς ἐστοὺς τῶν πραγμάτων ἐξ ὧν συνέστα ὸ κόσμος. So also Antiphon, the sophist, almost certainly under Democritean influence, uses another compound, ἀειεστώ, eternal being, in his book on Ἀλήθεια (87.B.22).
- 31. See e.g. some of the terms coined by Democritus, B. 130 to B. 139a; cf. IV, 2 in the sequel.
- Exactly as εὐθυμίη too has a physiological meaning; see below, n. 38.
- Affective (ήδοναί, εὐφροσύναι, etc.) and emotional (δείματα, φόβοι, etc.) states are prominently associated with the brain-function discussed in this context.
- This διάστασις of the flesh is bad business from the medical point of view. See On Breaths, 11 and 12.
- This is Aelian's account and we cannot press any of the words too far, though it is tempting to compare διίστασθαι with ἐκ μεγάλων διαστημάτων in B. 191.
- 36. De Sensu, 49-83.
- Cf. οὐχ ἡρμοσμένου πλανᾶσθαι above in Aelian, A. 152.
- 38. Cf. Visits 6.5.5, ὀξυθυμίη ἀνασπῶ καρδίην καὶ πλεύμονα ἐς ἐωυτἀ, καὶ ἐς κεφαλὴν τὰ θερμὰ καὶ τὸ ὑγρόν, ἡ δ' εὐθυμίη ἀφίει καρδίην. Here εὐθυμίη physiologically precludes the excessive warmth that deranges thought. Thus εὐθυμίη and right thinking are physiologically connected.
- Heat implies διάστασις (above, II, 4) and, therefore, least obstruction to the motion of the soul-atoms.
- 40. Excluded, in any case, through the intrinsic mobility of the soul-atom.
- Democritus is apparently the first to use this expression (B. 34, τῷ ἐν τῷ ἀνθρώπῳ μικρῷ κόσμῳ).
- 42. Arist., *Phys.* 246b 4, "Thus bodily *aretai*, such as health or bodily well-being, we regard as consisting in a balance and harmony of hot and cold, in relation either to one another internally or to the environment (πρός τὸ περιέχον)." Cf. κράσει καὶ συμμετρία here with συμμέτρως κατὰ τὴν κρῆσιν quoted in the preceding paragraph. This too is a recurrent theme in Hippocratean literature. See, *e.g.*, *On*

Airs, Waters etc., 12, for the effects of a temperate climate on τὰ ἤθεα τῶν ἀνθρώπων. In *ibid.*, 5, even σύνεσις is affected by the prevailing winds.

- 43. 404a 16, ... ἔως ἄν δύνωνται τοῦτο ποιεῖν.
- 44. I am not forgetting the ascetic strain in Orphic religion. But see Rohde' *Psyche*, 302-303.
- 45. Antigone 1165-71. Athenaeus quotes these lines twice (7.280 and 12.547) and calls Sophocles τῆς ἡδονῆς πρὸ Ἐπικούρου εἰσηγητής—a curious way of reading history backwards.
- 46. This is, of course, a common sense matter that goes much further back than the medical treatises. Such terms as ἄλγος and ὀδύνη are frequently used to denote illness in Homer.
- 47. E.g. On Anc. Med., 14 and 18.
- 48. Theophr. Se sensu, 43. (θάρσος here is suggestive; cf. Democritus' use of  $\theta$ άρσος γνώμης in B. 215). The medical significance of this analysis is confirmed by the fact that, as paraphrased in Theophrastus, it leads directly to the observation: κριτικώτατον δὲ ἡδονῆς τὴν γλώτταν ..., διὸ σημεῖά τε πλεῖστα τοῖς κάμνουσι ἐπ' αύτῆς εἶναι. J. Beare thinks that "Theophrastus here misunderstood the word ἡδονή used by Democritus (and also by Anaxagoras) in the traditional limited sense of 'the pleasure of taste,' or even of 'taste' itself, as an objective thing-savor" (Greek Theories of Elementary Cognition, 169, n. 3.) But why suppose that Diogenes himself made a sharp disjunction between "subjective" pleasure and "objective" savor? The discussion suggests that when he came to taste Diogenes was led by the ambivalence of savor-pleasure in ἡδονή to analyze pleasure in perfectly general terms. The generality of the analysis is confirmed by the fact that it applies to both pleasure and pain. Notice how Theophrastus comes back to  $\lambda \dot{\upsilon} \pi \eta$  in 45, à propos of the sense of pressure in the breast one feels when trying hard to remember--- ὄταν δὲ εὔρωσιν, διασκίδνασθαι [sc. the unmixed air] καὶ ἀνακουφίζεσθαι της λύπης.
- On Anc. Med., 5. Cf. also 10.7, δι' ήδονήν ἤ δι' ἄλλην τινὰ συγκυρίην, contrasted with ἃ συμφέρει.
- 50. *Ibid.* 3.35, where συμφέρουσα τροφή = ἀρμόζουσα τῆ φύσει. The same sense of ἀρμόζον τῆ φύσει in a different context: *On Joints*, 62, ὅπως ἄν συμφέρει τὰς ἀναλήψιας ποιεῖσθαι. The converse (ἀσύμφορα = τῆ ἀνθρ. φύσει πολέμια) in *On Breaths*, 6. See Langerbeck's discussion of τὸ σύμφορον, *op. cit.* 65-6.
- 51. On Anc. Med., 9, δεῖ γὰρ μέτρου τινὸς στοχάσασθαι. On Sacr. Dis., 8, ἤν μὲν καλῶς καὶ μετρίως καθαρθῆ καὶ μήτε πλέον μήτε ἒλασσον

τοῦ δέοντος ἀπορρυῆ, οὔτως ὑγιηροτάτην τὴν κεφαλὴν ἔχει. On Fractures speaks of the "natural position" (τὸ κατὰ φύσιν σχῆμα, c. 2) in which the fractured bone should be re-set as ἡ δικαιοτάτη φὑσις, c. 1; and of κατάτασιν δικαίην καὶ μὴ βιαίην, c. 30. Likewise On Joints, 7, speaks of δικαιότατα μοχλεύειν and δικαιόταται ἀντιρρόπαι. As for ὑπερβάλλειν (thrice in Democritus: B. 191, 233, 235), see the definition of the medical art in On Breaths, 1, ἀφαίρεσις ὑπερβαλλόντων, πρόσθεσις ἐλλειπόντων

- 52. In Plato, *Gorg.* 465b we see the specialist in persuasion taking over when the doctor gives up.
- 53. See also B. 262, ... κέρδει ὑρίζων ἤ ἡδονῆ, ἀδικεῖ. (Cf. Thuc. 3.82.8, οὐ μέχρι τοῦ δικαίου καί τῆ πόλει ξυμφόρου προτιθέντες, ἐς δὲ τὸ ... ἀεὶ ἡδονὴν ἔχον ὑρίζοντες.)
- 54. In much the same sense as Plato uses σημεῖον κατὰ τὴν αἴσθησιν in *Theaet*. 192b, or as Aristotle speaks, still more broadly, of ἐλευθερίας σημεῖον in *Pol*. 1317b 10.
- 55. Anaxagoras, B. 21a. On this see further note 61, below.
- 56. An interesting medical parallel:

(i) On Use of Liquids (Littré vi, 120): τὰ δ' ἄλλα βλάπτει καὶ ώφελέει τὰ εἰρημένα [as evidenced in] ἡδονῆσι καὶ εὑφορίησι καὶ ἀχθηδόσι καὶ δυσφορίησιν....

(ii) On Sacr. Dis., 17, καὶ τούτῷ [sc. τῷ ἑγκεφάλῷ] φρονἑομεν μάλιστα καὶ βλέπομεν καὶ διαγινώσκομεν τὰ τε αἰσχρὰ καὶ καλὰ καὶ κακὰ καὶ ἀγαθὰ καὶ ἡδἑα καὶ ἀηδἑα, τὰ μὲν νόμῷ διακρίνοντες, τὰ δὲ συμφἑροντι αἰσθανόμενοι. (Τὰ μὲν probably refers to αἰσχρὰ, κακά and their opposites; τὰ δὲ to ἡδἑα καὶ ἀηδἑα. Or, alternatively, each of the three pairs of opposites are meant to be subdivided into one area of conventional discernment and another of perception through συμφέρον. Either interpretation makes sense for our purposes.)

(i) conveys in somewhat restricted form the physiological equivalent to Democritus' psychological rule: pleasure, etc. are the manifestation of benefit or injury.

(ii) inverts this situation. Instead of taking pleasure as the sign of the  $\sigma \upsilon \mu \phi \dot{\epsilon} \rho \sigma v$ , the  $\sigma \upsilon \mu \phi \dot{\epsilon} \rho \sigma v$  is taken as the basis of judgment ( $\delta \iota \alpha \gamma \upsilon \phi \dot{\sigma} \kappa \sigma \mu \epsilon v$ ) of what is pleasant and unpleasant. Here the pleasant is the cognoscendum, while in (i) it is the cognoscens a neat parallel to pleasure *sub judice* and pleasure as landmark of  $\epsilon \dot{\upsilon} \epsilon \sigma \tau \dot{\omega}$  *judicans* in Democritus.

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- 57. Cf. ἄλλῷ ἄλλο in B. 69 with A. 139 (Sextus), ἐκ τοῦ τὸ μέλι τοῖσδε μὲν πικρὸν τοῖσδε δὲ γλυκὴ φαί-νεσθαι and Theophr. *de Sensu*, 69, ἀπλῶς δὲ τὸ μὲν σχῆμα καθ' αὐτὸ ἐστί, τὸ δὲ γλυκὴ καὶ ὅλως τὸ αἰσθητὸν πρὸς ἄλλο καὶ ἐν ἄλλοις, ὥς φησιν [Democritus].
- κατὰ τὴν τοῦ σώματος διαθήκην, B.Q.; and ἐπιρυσμίη ἡ δόξις in B. 7, if Langerbeck's interpretation is accepted.
- 59. I cannot follow Cyril Bailey (*op. cit.* 184) in singling out touch as *the* sense which reveals "being." In B. 11 touch is put in the same boat with the other senses. The "appearances" of touch need interpretation through the "more subtle" inquiry just as much as those of the other senses.
- 60. Πίστις in B. 125: φρήν gets its πίστεις from the senses. This is confirmed by Sextus (Adv. Math. 7.136; B. 9 in Diels-Kranz), who tells us that in his essay entitled, κρατυντήρια, Democritus "promised to assign to the senses the power of evidence (τὸ κράτος τῆς πίστεως)." This last should be compared with πίστιος ἰσχύς in Parmenides, B. 8, 12. Πίστις in the pre-socratics is not an inferior form of knowledge as in Plato, *Rep.* vi.511e, but *evidence*, both in the subjective sense of confidence that one's belief is true and in the objective sense of reliable signs which justify such confidence.
- 61. This is the general principle of scientific procedure among the historians and the medical men: What can not be known (or seen) directly must be judged from what can. So Herodotus II.33, judging the unknown (τὰ μὴ γινωσκόμενα) from the known (τοι σι έμφανέσι); and On Anc. Med., 22, καταμανθάνειν δεί ταῦτα (sc. the internal organs which are not open to view) ἔξωθεν ἐκ τῶν φανερών. Anaxagoras generalizes this methodological rule into an epistemological proposition, out άδήλων τὰ φαινόμενα, B. 21a. Gorgias must have had this dictum in mind when he wrote (B. 11, 13), μετεωρολόγων λόγους, οἴτινες ... τὰ ἄπιστα καὶ άδηλα φαίνεσθαι τοῖς τῆς δόξης ὃμμασιν ἐποίησαν. Note the association ἄπιστα καὶ ἄδηλα in joint opposition to  $\phi \alpha i \nu \epsilon \sigma \theta \alpha i$ ; thus the phenomenon brings with it  $\pi$ iotic as well as  $\delta$  $\eta\lambda\omega\sigma$ ic—exactly as in Democritus' view of sensation (see preceding note). Gorgias' τοῖς τῆς δὀξης ὄμμασιν is, of course, devastatingly sceptical: the phenomena are "sight of things unseen," but only to a mind under the spell of the μετεωρολόγων λόγοι.
- 62. Cf. S. Luria's elegant interpretation of the epistemological basis of Democritus' defense of the tangent against Protagoras (*Quellen und Studien zur Geschichte der Mathematik* 2 (1933), 121): We cannot see a line touching a curve at one and only one point.

But we can see that "je genauer unsere Zeichnung ist, desto kleiner die Strecke wird, auf welcher sich der Kreis mit der Tangent beruehrt." "Genuine knowledge" continues and completes this sensible series: ὅταν ἡ σκοτίη μηκέτι δύναται μήτε ὀρâν ἐπ' ἔλαττον μήτε ἀκούειν ... μήτι ἐν τῆ ψαύσει αἰσθάνεσθαι, then "genuine knowledge" must proceed ἐπὶ λεπτότερον. Thus, I suggest, the final "assurance" that there is such a thing as a tangent does not come from sight, unless you know *how* to look, i.e. how to interpret the sensible image in the light of the "more subtle" atomic theory, and thus use "the appearance" as "sight of things unseen."

- 63. This account helps clear up the contradiction in the tradition which represents Democritus as saying, (A) the phenomenon has no truth (e.g. Sextus 8.6 and 7.369; A. 59 and A. 110 in Diels-Kranz); and (B) truth is in the phenomenon (e.g. Arist. 315b 9 and 404a 28). (A) must refer to the phenomenon as in (i), i.e. as "bastard knowledge;" (B) to the phenomenon as in (iii), i.e. as "sight of things unseen." This position is a subtle one; it requires an imaginative effort to which Democritus' ancient interpreters proved unequal, notably Aristotle (cf. 1109b 11 with 315b 9 or 404a 28). Theophrastus too found Democritus hopelessly self-contradictory (*de Sensu*, 69).
- 64. As presented in *Theaet*. 166d f. this position is ingenious and sophisticated; whether it is tenable is another matter.
- Theaet. 166d, τῷ μὲν ἄλλα ἔστι τε καὶ φαίνεται, τῶ δὲ ἄλλα. Cf. 80.A.14 and 15 (Sextus); 80.A.19 (Arist. 1062b 19); and 80.A.16 (Hermias).
- 66. Theaet. 167c; and cf. 172b where the disconnection with *physis* is made explicit by Plato. It has been noticed that δοκῆ, δόξαν allude to ἔδοξεν used in official decrees (J. Stenzel, in his article on Antiphon, Pauly-Wissowa R. E., Suppl. 4, 38b). Adolfo Levi (*Philosophy* 15 (1940), 165f.) suggests that Protagoras cut ethics loose from physics precisely to forestall the dangerous social doctrines derivable from *physis*, as *e.g.* by Callicles in the *Gorgias*.
- 67. Can this be the sense of that baffling fragment, B. 124: "One (man) is (many) men and all (men) are man"? Diels-Kranz give it up as unintelligible.
- 68. This is how medical thought faced the problem of the άλλο άλλφ. Cf. On Anc. Med., 20: Cheese agrees with some people, but not with others. The physician must therefore understand "human nature" and its "causes" so that he may discover rules which are valid for all men. It is interesting to see how empirically the search for this universal proceeds, investigating relations and consequences: ὅτί τε ἐστὶν ἄνθρωπος πρὸς τὰ ἐσθιόμενα ... καὶ ὅτι πρὸς τὰ

άλλα ἐπιτηδεύματα, καὶ ὃτι ἀφ' ἑκάστου ἑκάστῷ συμβήσεται.

- 69. Adv. Math. 7.389 (Diels-Kranz, 80.A.15).
- 70. See the material collected by Diels under B. 5; and my paper, "On the Pre-History in Diodorus," which is to appear shortly in the *American Journal of Philology*.
- The conflict of *physis* and *nomos* is not a symptom of the dissociation of man from nature, but the reverse. Archelaus, whose cosmology also carried over into pre-history (A. 4), taught that our ideas of what is just and base are not φύσει but νόμφ (A. 1, and A. 2).
- 72. Uxkull's valuable study *Greichische Kultur-Enstehungslehren*, 10 f. outstrips the evidence on this point, making Anaxagoras the philosophical source of the anthropocentric theory of culture in the fifth century. Between Anaxagoras and the simple piety of Xenophon's *Mem.* iv. 3, a great gulf is fixed. Socrates' yearnings for a teleological universe found slim comfort in Anaxagoras. It seems more consistent with the evidence to acknowledge the conflict between teleology and mechanism in Anaxagoras' thought, with mechanism dominating the actual working out of the system.
- 73. Pr. V., 514, τέχνη δ' ἀνάγκης ἀσθενεστέρα μακρῷ.
- 74. Diod. I.8.7., καθόλου γὰρ πάντων τὴν χρείαν αὐτὴν διδάσκαλον γενέσθαι τοῖς ἀνθρώποις. As for τὴν ἀνάγκην σχόντες διδάσκαλον, it occurs in the Tzetzes excerpt (Diels-Kranz, II, 138, line 1) which is even less reliable as a source than Diodorus; however, the term ἀνάγκη, matching τἀναγκαῖον in B. 144, may safely be accepted as genuine. Cf. On Anc. Med., c. 3, where ἀνάγκη and χρείη are used interchangeably as mainsprings of progress in the medical arts.
- 75. Beasts of prey the year round, cold and food-shortage in the winter (I.8.2 and 6).
- 76. Aelian N. H. 12.6 (A. 151), in his account of the discovery of the mule, gives an illustration of what Democritus meant by "learning from experience":

(a) something happens "by chance" (*i.e.*, by necessary forces beyond human control);

(b) men observe how it happened;

(c) they can then convert "chance" into "custom" ( $\sigma \upsilon \gamma \eta \Theta \epsilon \iota \alpha$ ). This must be the general pattern according to which men are "taught" by nature (cf.  $\mu \alpha \theta \eta \tau \dot{\alpha} \varsigma$  here with B. 154. See also below, note 16.) But to complete the pattern we should add

(d) man's own "need" which sensitizes him to the value of a useful sequence when he runs into it. (Cf.

the account of the origin of fire in Diod. I.13.3 with Lucr. V, 1091 f. Lucretius simply describes the natural means by which the fire was produced. Diodorus, whose Hecataean source may reflect Democritean ideas, dwells on the connection of the event with human need and on the human means by which the physical event was appropriated.)

- 77. Pre-civilized life was less than human, ("disorderly," "beastly," "solitary": Diod. I.8.1).
- Άμειψιρυσμίη is defined in Hesychius' dictionary as άλάσσειν τὴν σύγκρισιν ἢ μεταμορφοῦσθαι (B. 139), and it is matched in turn by ἀμειψικοσμίη (B. 138). That this concerns an important part of Democritean thought is clear from the title of two treatises, Περὶ Ἀμειψιρυσμιῶν (B. 8a) and Περὶ Διαφερόντων Ρυσμῶν (B. 5i), both classed by Thrasyllus under Φυσικά.
- Διαθιγή and τρόπος which, with ρυσμός, explain all qualitative differences in atomic physics (Arist., *Metaph.* 985 15 f.), turn up in various compounds in ethical fragments:

(a) Εὐτροπίη in B. 57, where ἡ τοῦ ἤθεος εὐτροπίη is used as the broadest possible description of *human* virtue to balance "bodily strength" in animals. Again, τρόπος εὕτακτος is used of the inner order of the soul which determines the order of man's outward life (B. 61).

(b) κακοθιγίη, Diels' conjectural reading in B. 223, if correct, would be the ethical counterpart of (bad) atomic διαθιγή, which I interpret following Beare (*op. cit.*, 37, n. 2), "Probably διαθιγή is dialectic = διαθήκη, *i.e.*, διάθεσις and not = 'contact' ( $\sqrt{-\theta_1^2}\gamma$ -)."

- 80. Διδαχή φυσιοποιός is closely paralleled by μάθησις έμφυσιωθεῖσα in the Hippocratean Nomos, 2. On Airs, Waters, etc., 14, explaining longheadedness as a result of shaping artificially the head: the work of νόμος becomes φύσις with the passage of time. Even more striking is the use of such terms as the following in diagnosis: τὸ σύνηθες, Prognostic, 3.19 and 3.25; τὸ ἔθος, On Anc. Med., 10; τὸ μεμαθηκός, ibid., and also in On Diet in Acute Illness, 28.
- Arist., *de gen. et cor.* 316a 1, "he denies the being of color; things get colored by configuration (τροπŷ)."
- 82. c.14. Cf. also On Anc. Med., 9, καθαιρόμενοι, η αύτόματοι η ἀπὸ φαρμάκου. In general "chance" in Hippocratean literature refers to anything that happens in default of art, especially medical art; thus, On Anc. Med., 1, τύχη δ' ἂν πάντα τῶν καμνόντων διοικεῖτο (i.e., before the discovery of medicine); and ibid., 12, ὡς καλῶς καὶ ὀρθῶς ἐξεύρηνται καὶ ούκ ἀπὸ τύχης.

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- 83. The verb ρυσμόω here is apparently the only instance of its kind, apart from one other in the late writer, Symmachus. As in μεταρυσμεῖν, Democritus must be thinking of the basic ρυσμός of the soul-atoms.
- 84. Two things are worth noting about  $\pi$ óvo $\zeta$  in Democritus:

(i) It is the process by which art itself is appropriated: B. 59, τέχνη and σοφίη are achieved only through μάθησις; B. 182, ... τοῖς πόνοις ἡ μάθησις ἐξεργάζεται; and B. 157, τὴν πολιτικὴν τέχνην ἐκδιδάσκεσθαι καὶ τοὺς πόνους διώκειν.

(ii) It covers the whole area, physical and spiritual, which science wrests from chance. See B. 179, which brings explicitly under  $\pi \circ v \epsilon \hat{v} v$  athletic excellence, letters, music, and, most important of all, "reverence" ( $\alpha i \delta \omega \varsigma$ ). B. 157 brings in also political skill under  $\pi \circ v \circ \iota$ .

- 85. Cf. μάθησις in A. 151, B. 254, and B. 59; also in Diod. 1.8.7.
- 86. B. 214, ὁ τῶν ἡδονῶν κρείσσων vs. those who γυναιξὶ δουλεύουσιν. The same idea in Gorg. B. 11a (15), οἱ κρείττονες τῶν τῆς φύσεως ἡδονῶν vs. οἱ δουλεύοντες ταῖς ἡδοναῖς, and in Antiphon, the sophist, who presents most sharply the underlying idea of self-mastery: αὐτὸς ἑωυτὸν κρατέειν (B. 58) and κρατήσας αὐτὸς ἑωυτὸν · κόσμιον παρέχεται (B. 59).
- So in Hippocr. lit. See Littré's Index under "Exercice" and "Peine." Its most common meaning elsewhere is most nearly rendered in English by "hard work" (*e.g.*, Xenophanes B. 25, Antiphon B. 49, Epicharmus B. 36).
- 88. In general, wherever self-sufficiency appears in the context of social relations the mood 'be content with what you have, don't ask for more' predominates in Democritus. So, for example, in B. 191. Langerbeck's interpretation is too one-sided to admit this (*op. cit.*, 59). It is true that ἀρκέεσθαι *may* mean "Nichtbeduerfen," not "Sich begnuegen." But what else than "Sich begnuegen" is there in "comparing your own life with that of those who are worse off and congratulating yourself at the thought of their misfortunes" (B. 191)? This fragment drifts into this mood precisely when it passes from the physical basis of "cheerfulness" to the social context.
- On Diet, I, 35, κρῆσις αὐταρκέστατον. Cf. Thuc.
  2.51.3, no one's physique proved self-sufficient (αὕταρκες), *i.e.*, strong enough to resist the disease.
- For a quaint instance of nature as αὐτάρκης because of its power of self-help, see Aeschylus, *Choe.* 757, νέα δὲ νηδὺς αὐτάρκης τέκνων.

- 91. Cf. τὴν δὐναμιν ἑωυτοῦ καὶ τὴν φύσιν in B. 3, with τὴν τοῦ ἀνθρώπου φύσιν τε καὶ δὐναμιν in On Anc. Med., 3; ἕκαστον ἔχει (sc. the four humours) δὐναμίν τε καὶ φύσιν τὴν ἑωυτοῦ in On Nature of Man, 5; and φύσιν δὲ ἕκαστον (sc. νόσημα) ἔχει καὶ δὐναμιν ἐφ' ἑωυτοῦ in On Sacr. Dis., 21.
- 92. δυνατά, B. 191; ἐφικτά, B. 58 and 59; ἀδύνατα, B. 58.
- 93. Prior to the fifth century not the contrast but the unity of thought and deed is uppermost. In the epic and the lyric knowledge is practical; to know is to know how; wisdom is skill in action and therefore power to act. Heracleitus, the first of the philosophers to turn to this theme, assumes as a matter of course that *logos* and *sophiē* carry the double reference of true word (and thought) and right deed (B. 112; cf. B. 1). See Jaeger, *Paideia*, I, 180.
- 94. Normally this would involve much more than talk; cf. the concept of  $\pi \acute{o} vo\varsigma$ , above IV, 6-8). Other fragments on *paideia* set example above precept (B. 208) and recommend the *mimēsis* of the good man (B. 39; cf. B. 79).
- 95. E.g., Plato, Prot. 318a.
- 96. Exactly as in Democritus, B. 193, "it is the job of intelligence to guard against impending injustice."
- 97. I say "real intention" with B. 81 in mind, "to be ever intending (μέλλειν) makes action incomplete." In the last resort only action can sift out real intention from velleity. For the word-deed contrast to express the parallel distinction of true vs. specious intent, cf. Herod. VII. 155.
- 98. Cf. the force of προβουλεύεσθαι as vs. μετανοεῖν in B. 66. For the "stupid" see B. 54 and B. 76; and cf. Hesiod, Op. 218, "the stupid learns through suffering," as well as the theme of πάθει μάθος in Aeschylus.
- 99. Cf. B. 185, ... αἰ τῶν πεπαιδευμένων ἐλπίδες, and B. 292, ἄλογοι τῶν ἀξυνέτων αἰ ἐλπίδες. 'Rational' here does not mean, as in Plato, 'in agreement with an ideal standard' but simply 'realisable within the order of nature' (Cf. B. 58, ἐλπίδες ... ἐφικταί, ... ἀδύνατοι).
- 100. B. 200. The same thought in even stronger form in B. 204, if the Ms reading be retained.
- 101. B. 294-296 shows how "wisdom" deals with an inescapable thing like old age. It takes a grimly realistic view of its losses (B. 296), yet balances them (B. 294, 295) by a clear sense of the complete ( $\tau\epsilon\lambda\epsilon\tau\sigma\nu$ ) good that comes only with old age.  $\Sigma\omega\phi\rho$  or  $\delta\nu\eta$  is finely described as the "flower" of withered age.

- 102. I shall offer shortly a fresh interpretation of this development from Anaximander to Empedocles. There is an excellent discussion of Parmenides and Anaximander in H. Fraenkel, "Parmenidesstudien," *Goettingische Nachrichten*, Philol.-Hist. Klasse, 1930, p. 153 f. See also Jaeger, *Paideia*, I, ch. ix; and R. Mondolfo, *Problemi del Pensiero Antico* (Bologna, 1936), ch. ii.
- 103. As in Laws x, 889c, where the atheistic materialists teach that "as a later product of these (sc. nature and chance), art comes later." Since Plato and Aristotle wilfully use "chance" to denote the "necessity" of the *physiologoi*, this applies exactly, though not exclusively, to the Democritean doctrine.

# David Furley (essay date 1983)

SOURCE: Furley, David. "Weight and Motion in Democritus' Theory: A Discussion of D. O'Brien, *Theories of Weight in the Ancient World*, Vol. I *Democritus.*"<sup>1</sup> Oxford *Studies in Ancient Philosophy: Volume 1*. Ed. Julia Annas. Oxford: Oxford UP, 1983. 193-209. Print.

[In the following essay, Furley discusses whether Democritus understood atoms to have weight. Many scholars have argued that weight was only later added as an intrinsic property of atoms by Epicurus in order to address Aristotle's objections concerning the "natural motion" of atoms in the void. Furley concludes, however, that Democritus did in fact consider weight a property of atoms.]

From the earliest recorded times, Greeks measured weight by using balances. The Mycenean Linear B tablets use an ideogram representing a balance for the standard unit of weight (the symbol now conventionally labelled L).<sup>2</sup> The balance is referred to as a well-known device in the Homeric poems, under the name  $\sigma \tau \alpha \theta \mu \delta \zeta$  or  $\tau \alpha \lambda \alpha \nu \tau \alpha$ , the latter being used mainly in metaphors.<sup>3</sup> The metaphorical use of τάλαντον occurs in Theognis.<sup>4</sup> The σταθμός is referred to in Herodotus, Aristophanes, and Hippocrates; under the label  $\zeta \upsilon \gamma \acute{o} \nu$ , which is properly the beam of the balance, it is mentioned by Aeschylus.<sup>5</sup> When one side of the balance weighs more than the other, whatever is on the heavier side is said to ῥέπειν, sometimes to ἕλκειν. Aristophanes gives us a relatively full expression: τοῦ ταλάντου τὸ ῥέπον κάτω βαδίζει τὸ δὲ κενὸν πρὸς τὸν Δία ('the preponderant side of the balance goes downwards, the empty side goes to Heaven').<sup>6</sup>

The heavier side goes downwards, the lighter side goes upwards. That is the obvious, well-known, unmistakeable generalization of an experience familiar to every Greek who ever took part in commerce or house-keeping, from Mycenean times onwards. Conceptual problems will arise concerning the definition of 'downwards.' It is intuitively obvious, and can be proved by the use of the plumb-line, which is also an ancient tool,<sup>7</sup> that the line of fall is perpendicular to the earth's surface; but what that means with reference to a larger frame will of course depend on what one takes to be the shape of the earth's surface. That was controversial in classical times. It could be agreed by all that all lines of fall were perpendicular to the surface ( $\pi \rho \delta \zeta \delta \mu \delta \alpha \zeta \gamma \omega v (\alpha \zeta)$ Aristotle, de Caelo, II. 14. 296b20: that is, the angles between the line of fall and lines on the surface radiating from the point of impact are all equal);8 what was controversial was whether or not all lines of fall, with different points of impact, are parallel to each other. For those who believed in a flat earth, all lines of fall must be parallel; for Aristotle and others who supposed the earth to be a sphere, lines of fall must meet at the centre of the sphere. This problem can be shelved so long as we rest content to define 'downwards' with reference to the earth's surface. Flatearthers and sphericists can agree that the balance shows the heavier moving downwards, the lighter upwards.

In the first volume in what he plans to be a series of four on *Theories of Weight in the Ancient World*, Denis O'Brien proposes a new solution of the difficult philological problems that have bedevilled efforts to understand what Democritus said about the weight of atoms.<sup>9</sup>

It is only the supposedly inviolable force of the entailment between weight and movement that leads to the supposition *either* that the atoms have weight and therefore move downwards *or* that the atoms do not fall and are therefore weightless.

The radical alternative will be to abandon the entailment of weight and movement. This will at once enable us to embrace the only two conclusions for which there is sufficient, and satisfactory, evidence.

- 1. The precosmic atoms of Democritus do have weight.
- 2. They do not move only downwards.

(175)

A formidable paradox! Weight is *measured* by its tendency to move the balance downwards: yet we are asked to abandon the entailment of weight and movement. How, then, does the balance do its work?

Later in the book O'Brien writes:

An otherwise sensible scholar (with the limitations as well as the advantages implied in that description) writes recently, when he comes to the question that has been the subject of this essay: 'We may here pause to consider what weight means: it means a tendency to move consistently in a certain direction, what we call "downwards," and a resistance to "upward" movement.'

(Kirk, Presocratic Philosophers, 415)

If only the writer of these words *had* paused to think. And if only, in pausing, he had taken time to reflect not on what

weight 'means,' as though meanings existed in themselves, nor even on what weight 'means' for us, but on what weight might have meant for those first philosophers of Greece, whose ways of thinking are related to, but are remote from, our own.

(363-4)

These hard words invite a response of the same kind. If only O'Brien had paused to seek for evidence of the earliest Greek views on weight, and reflected on their implications, before working out a hypothetical view designed primarily to reconcile the conflicting evidence of Aristotle and the doxographers about Democritus. At least he might then have realized that he owed the reader of his book some answers to a number of pressing questions. Why did Democritus suppose that weight does not entail downward motion, if he did? What did he expect to gain from his theory of weight? What did he hope to explain by its means? And how did he reconcile his theory with the observed fact that on the surface of the earth the heavier pan of the balance always falls? It is astonishing that in a book of some four hundred pages these questions are hardly raised, let alone answered.<sup>10</sup>

\* \* \*

However, all is not lost. O'Brien's book has great merits, and up to a point it will be very useful for further study of the subject. Most of our evidence about Democritus' theory of weight is found in Aristotle and in writers who accepted his concepts and theories. The problem is a notorious one: how are we to discern the Democritean picture through the Aristotelian stained glass? With immense patience, meticulous attention to detail, and scrupulous philological exactness O'Brien examines the evidence and attempts this task. The method is right, so far as it goes.

The main target of O'Brien's polemic is what he calls 'the current compromise' (ch 6 and elsewhere). Aristotle reports: 'Democritus says that each of the indivisibles is heavier according to its comparatively larger (size?) (βαρύτερον κατὰ τὴν ὑπεροχήν)' (de Generatione et Corruptione (GC), I. 8. 326a8). This is not unambiguous, but O'Brien (ch 2) and I agree on its meaning: atoms have weight, and their weight is proportional to their size. This is confirmed by de Caelo IV, where he writes:

Those who say (that the primary, atomic units are) solids [as opposed to Platonists who suppose they are planes] may legitimately claim that the larger of them is heavier ( $\tau \delta$  μεῖζον εἶναι βαρύτερον αὐτῶν).

(Cael. IV. 2. 309a1-2)

Again I agree with O'Brien (ch 3), against Cherniss and others who claim that it is about compounds, that this attributes weight to atoms, in proportion to their size.<sup>11</sup>

But Aetius (I. 12. 6 = DK 68 A 47) explicitly denies that Democritus allowed his atoms to have weight, and even (I. 3. 18, DK ibid) contrasts Democritus with Epicurus on this point. Hence 'the current compromise,' which holds that atoms were taken to have weight *within* a cosmos, and to be weightless in the external void. O'Brien traces the emergence of the compromise from Zeller, who did not adopt it, through Liepmann, Brieger, and Dyroff, to Burnet, Guthrie, Kirk, and others (ch 13, para 1 'Modern Scholarship: the Progress of Error').<sup>12</sup>

I agree with O'Brien that the current compromise is wrong, and in two articles that appeared too late to be noticed, except briefly, in this book, I began an effort to throw doubt on it.<sup>13</sup> I agree that the way to attack it is to show that the preponderance of evidence tells against Actius, and to find reasons why Actius might have been misled. There is no difficulty about the first. As to the second, we can show that Aetius and others were misled about the possible existence of a Democritean atom of vast size, probably by misunderstanding the implication of an Epicurean criticism;<sup>14</sup> we can guess that he was similarly misled about the weight of atoms, mainly by misunderstanding the implication of an Aristotelian criticism-namely, the criticism that Democritus did not specify what is the natural motion of atoms (all this is set out in O'Brien, ch 10). This is correct, I believe, and O'Brien's slow, millimetric examination of the evidence should suffice to convict the compromisers.

But what next? O'Brien seems to me to be left, in the end, in a position that is remarkably close to 'the current compromise.' When we pare away from Aristotle's evidence the obfuscating films of his own presuppositions, we are left with the thesis that Democritus' atoms have weight in proportion to their size. Since Aristotle and others deny that Democritus recognized a natural motion of the atoms, it must follow, O'Brien argues, that the weight of an atom does not entail downward motion. Weight must be 'expressed' in some other way: probably in force of impact, and in speed rather than direction of motion (chs 11 and 12).

But the fact is that near the earth's surface weight expresses itself in motion, and in motion in a determinate direction. I have been complaining that O'Brien takes little notice of this fact, but of course he cannot deny it or ignore it completely. For one thing, the doxographical sources tell us that the size, and therefore the weight, of atoms was significant in the formation of the cosmos out of the  $din\bar{e}$ .<sup>15</sup> And Democritus (although O'Brien does not mention this) was one of the many Presocratics who were concerned to give an explanation of why the earth remains where it is in the cosmos—that is to say, why it does not *fall*, as pieces of earth do.<sup>16</sup> O'Brien concedes, then, that there is a difference between the effects of weight within the cosmic *dinē* and outside it:

Within the cosmos, the weight of atoms is expressed by the distribution of larger and smaller, or heavier and lighter, atoms in a  $din\bar{e}$ , and as an element in the definition of lightness in terms of void.

(346)

In speaking of 'distribution,' O'Brien is evidently thinking of the arrangement of the parts of the cosmos, according to the common fifth-century world picture—earth and water concentrated together at the centre, with air and whatever it is that makes up the heavens above and around them. But this distribution entails some motions, at least during the cosmogonical process:

Movement towards a specific place has its footing in the theory of Democritus. Large atoms, and dense agglomerations of atoms, when they are drawn into a cosmos, will move towards the centre, while small atoms, and rarefied agglomerations of atoms, are squeezed out, and forced towards the circumference, or beyond.

(382)

This does not mention weight, but only size and density. But we know that the weight of an atom is directly proportional to its size; and the weight of a compound, as O'Brien has shown earlier, is dependent on the proportion of atomic material to void in its composition. It is conceivable that O'Brien would wish to maintain that it is only size and density, and not weight, that may be counted as causal factors in the move towards the centre, and thus to remain in a position to affirm that weight never entails movement in any specific direction. But there are many indications that this is not the path he would want to take; and it is in any case extremely implausible.

His position, then, amounts to this: weight is a property of the Democritean atom at all times; when the atom is at large in the void, weight is not expressed in a tendency to move in any particular direction, but 'probably' in force of impact and speed of motion. When the atom is caught in a  $din\bar{e}$ , then its weight may be expressed as a tendency to move in a particular direction. This is to be contrasted with 'the current compromise,' according to which the atom has *no* weight when at large in the void, and *therefore* moves in no particular direction, whereas when caught in a  $din\bar{e}$  it gains weight and therefore moves towards the centre.

\* \* \*

The weakness of both 'the current compromise' and O'Brien's proposal is that they give the vortex the job of causing heavy bodies to move vertically downwards towards the earth's surface. But the vortex is ill suited to this role in fact, and there is good evidence that in the fifth century BC the role that was given to the vortex is inconsistent with that of a cause of downward motion.

In fact, gravity is one of the factors that determine the behaviour of bodies caught in a vortex.<sup>17</sup> In a whirlwind or

'twister,' it is the lighter or less dense bodies that are lifted most violently and carried to a greater distance, while the heavier and denser objects remain on the ground, sometimes collected together at the centre of the whirl. In a liquid vortex, floating objects behave differently from sinkers, but the fact that they float—that is, remain *above* the liquid—is plainly independent of their being caught in a vortex.

The point that tells most forcefully against the two-valued theory of the 'current compromise' and O'Brien's substitute for it is that the vortex is introduced by fifth-century thinkers in order to explain why certain heavy bodies do *not* fall downwards. This is well attested for Anaxagoras and Empedocles, although some of the details are unclear. The evidence is worth a closer look.

Anaxagoras says that the surrounding aether is fiery in substance, and by the force (*eutonia*) of its rotation it lifted rocks up from the earth, inflamed them, and thus made them into stars.

(Aetius II. 13. 3 = D K 59 A 71)

The sun and moon and all the stars [according to Anaxagoras] are burning stones that were caught up by the rotation of the aether.

Each one of the stars [Anaxagoras claimed] is not in its natural place: although stony and heavy, they shine because of the friction and cleaving of the aether, and they are pulled by force in the grip of the whirl and tension of the rotation—just as in the first place they were kept from falling to earth at the time when cold and heavy things were being separated from the whole.

(Plutarch, Lysander, 12 = D K 59 A 12)

There appear to be two somewhat different accounts of the origin of the stars in these quotations. Hippolytus and Aetius describe the stars being lifted up from the earth by the force of the rotation, whereas Plutarch has them somehow up aloft already and prevented from falling to earth at the time when other heavy things were being separated out from the general mass. For our purposes the difference is not significant: what matters is that all agree on the role of the *dinē* in keeping the stars high in the sky. Without the *dinē*, they would be expected to fall, because they are heavy.

In Empedocles' system it is not only the stars that are kept aloft by the rotation of the  $din\bar{e}$ , but the earth itself. The authority is Aristotle:

[We have shown, in Book I, that the body of which the heaven is composed moves eternally without effort with a circular motion.] There is no need, therefore, to suppose, as the ancient myth did, that it owes its security to an Atlas; those who made up that story seem to share the supposition of those of more modern times, in that they treated the upper bodies as having weight and being like earth, and therefore gave them the support in their myth of an ensouled Necessity. So we must not think in this way, nor say, as Empedocles does, that the heavenly bodies are still preserved after all this time because they acquire from the rotation a swifter motion than their own natural impulse.

## (Aristotle, Cael. II. 1. 284a18-24)

So all who posit a beginning of the cosmos say that the earth came together at the centre. They then seek the reason why it remains in place, and some do so in the way we have described, saying that its flatness and its size are the reason, while others do so in the manner of Empedocles, saying that the circular and excessively swift motion of the sky prevents the motion of the earth—like the water in a ladle (*kyathos*) which for the same reason when the ladle is swung around in a circle often does not move when it comes to be underneath the bronze, although it is its nature to move.

(Aristotle, Cael. II. 13. 295a13-22)

Empedocles, then, like Anaxagoras, thought that the stars are naturally heavy, and would naturally fall down unless they were kept in their lofty orbits by the force of the *dinē*. His theory of why the earth stays where it is differs from Anaxagoras, who was among those who invoked the flatness of the earth as the explanation of this. Somehow, Empedocles supposed that the  $din\bar{e}$  could be given this explanatory role as well. The simile mentioned by Aristotle gives a picture that is clear enough: if you fill the cup of a long-handled ladle and swing it round in a vertical circle by the hook at the end of the handle, the contents of the cup are kept in place by centrifugal force. The problem is to understand how this picture can be applied to the stationary position of the earth. Some suppose that Aristotle has mistaken the object of the explanation: Empedocles was not speaking about the position of the earth, but of the stars or other objects above the earth.<sup>18</sup> A recent alternative explanation accepts that the ladle simile may have been applied by Empedocles to the explanation of the heavenly bodies, but goes on to suggest a way in which he might nevertheless have used the dinē to explain the position of the earth 'aloft,' after the analogy of a flat dish raised from the bottom of a kitchen sink by swirling the water vigorously in the sink.<sup>19</sup> But again the details are less important for our purposes than the clear conclusion from this evidence that Empedocles, like Anaxagoras, used the dinē to explain why it is that certain heavy bodies, which we might expect to fall, do not fall.

It would be very surprising if Democritus tried to use the same model of the  $din\bar{e}$  to explain why heavy bodies *do* fall. What connection could possibly be suggested between the daily orbiting of the sun, moon, and stars—acknowl-edged to be the visible remnant of the original cosmic  $din\bar{e}$ —and the fall of a jar knocked off its shelf or the return of an arrow shot vertically upwards? This is an objection that is as old as Aristotle's *de Caelo*:

It is absurd, too, not to perceive that, while the whirling motion (dinēsis) may have been responsible for the original coming together of the parts of the earth at the centre, the question remains, why now do all heavy bodies move to earth? For the whirl surely does not come near to us. Why, again, does fire move upwards? Not, surely, because of the whirl. But if fire is naturally such as to move in a certain direction, clearly the same may be supposed to hold of the earth. Again, it cannot be the whirl which determines the heavy and the light. Rather that movement caused the pre-existent heavy and light things to go to the middle and stay on the surface respectively. Thus, before ever the whirl began, heavy and light existed; and what can have been the ground of their distinction, or the manner and direction of their natural movements? If the infinite exists, there cannot be an 'up' and 'down' in it, and it is by these that heavy and light are determined.

> (Aristotle, *Cael.* II. 13. 295a32-b9; tr. Stocks, slightly adapted)

It might be claimed (although it is not claimed by O'Brien, and I have not observed such a claim anywhere else) that this passage provides evidence that the  $din\bar{e}$  was in fact used by someone to explain why heavy things fall downwards. Why else, it might be asked, would Aristotle argue against it? But there is nothing in this suggestion. It is reasonably certain that Aristotle is here raising a general and theoretical objection against those, like Empedocles (who is the subject of the preceding lines), who fail to recognize *natural* motions and to distinguish them from forced motions. The translation given above accurately captures the nuance of Aristotle's point in the opening sentence: it was absurd of Empedocles and those who followed his line not to observe that they had a question to answer, about the fall of heavy things towards the earth (άτοπον δε και το μή συννοειν ότι πρότερον μέν ... νυν δὲ διὰ τίν' αἰτίαν...;). It is not suggested that any of them thought of the question but then gave a wrong answer to it: Aristotle himself suggests the answer that they might have given, and then dismisses it. If some philosopher as well known as Democritus had already answered the question in this way, we might have expected Aristotle himself or Simplicius in his comment on the passage to mention the fact. Neither of them does so, and the argument from silence has some force in this instance because this chapter of Aristotle is full of such citations.

All this seems to me to constitute rather strong evidence that Democritus did not claim that the  $din\bar{e}$  is the cause of the vertical fall of heavy bodies near the earth's surface. Is there any direct evidence that tells the other way?

One of the properties attributed to the  $din\bar{e}$  by Presocratic philosophers is that of drawing heavy bodies 'to the centre.'<sup>20</sup> This dangerously suggestive phrase may well be the source of much of the error about Democritus' theory. In the world view that was given its definitive form by Aristotle, and adopted by the majority of natural philosophers in antiquity after him, weight is defined as a tendency to move 'towards the centre'—towards the centre of the universe, in Aristotle's own system, towards the centre of the cosmic body according to the Stoics.<sup>21</sup> If the *dinē*, then, produces a tendency in certain bodies to move 'towards the centre,' is this not equivalent to saying that it produces weight? Of course not, in a system like Democritus' in which the earth is flat.<sup>22</sup> But virtually all of our evidence about the use of the *dinē* is transmitted by writers who subscribe to a centrifocal cosmology, and the question of what centre is referred to is easily ignored.

The idea that larger and heavier objects are drawn towards the centre of a dinē was presumably derived from observation. The easiest way to demonstrate the tendency is to spread a number of objects that sink at the bottom of a jar full of water, swirl the water for a while, and see how the objects collect at the centre. They collect at the bottom of the axis of the rotation-at the bottom, because of their density, and at the axis because of the dynamics of the swirl. Much of the effect depends on friction between the objects and the bottom of the vessel and between the objects themselves; and this in particular explains the sorting action of the dinē. Larger and heavier objects collect at the centre at the bottom and remain there; lighter and smaller objects, with less surface friction, may be lifted by the swirl and separated from the larger and heavier ones. As we have already mentioned, a large, flat, object, even if it is relatively heavy, may be lifted and held in suspense by the swirl: it sinks when the water is at rest.

The important point to notice is that whatever centripetal force is produced by the *dine* is towards the central axis. The  $din\bar{e}$  could not and was never intended to produce anything like the centrifocal dynamics of the Aristotelian cosmos, all determined by the central *point* of a sphere.<sup>23</sup> The centrifocal cosmology gets its first clear mention in Plato's Phaedo 108e: Socrates says he has been 'persuaded by someone' anonymous that this is the right picture of the earth and its relation to the cosmos.<sup>24</sup> Its origins are obscure; but no one will want to suggest that Socratesor Plato-learnt it from Democritus. The Atomists and others of the Presocratics are reported to have believed that the cosmos as a whole is a sphere, and that the earth is at the centre of it.<sup>25</sup> But Democritus still believed the earth to be flat, so that lines drawn vertical to the earth's surface (lines of fall) must necessarily be parallel to each other and not centrifocal. He still thought it necessary to explain that the earth is prevented from falling by the support of the air underneath it.<sup>26</sup> His cosmos, even if it was spherical, had a top and a bottom, vertically above our heads and vertically below our feet respectively.

\* \* \*

The interpretation for which I am arguing, against both 'the current compromise' and the O'Brien amendment, goes back to Zeller.<sup>27</sup> Why was it ever abandoned? Plainly I must seek to meet the objections that were raised against it. To keep this article to manageable size it will be necessary to be brief: the opposition to Zeller is set out fully in Adolf Brieger's article of 1884, 'Die Urbewegung ...,'<sup>28</sup> and the course of scholarly controversy before and after this is reviewed by O'Brien (346-64, and in his bibliography, 385-401). I shall confine myself to the core of the matter: the passages in which Aristotle blames the Atomists for neglecting to state either the cause of the original motion of atoms or what kind of motion it is. Brieger (9-11) lists *Metaphysics*, XII. 6. 1071b32; *Physica* (*Ph.*), VIII. 1. 252a34; *de Generatione Animalium* (*GA*), II. 6. 742b17; *de Caelo*, III. 2. 300b8.

The first three of these make what is essentially the same point: the Atomists claimed that motion is eternal, and therefore refused to give an explanation of it. In the first book of the *Metaphysics* (985b20), Aristotle objects that they 'lazily dismissed' the question; elsewhere he suggests that they had an argument for dismissing it:

The necessity that belongs to the cause is not well expressed by those who say that it *always* happens thus and suppose that this is their cause—like Democritus of Abdera—because there is no origin ( $\dot{\alpha}\rho\chi\dot{\eta}$ ) of the 'always' and the infinite, and the cause is an origin, and the 'always' is infinite: so to ask for a cause of things like this, he says, is to enquire for an origin of the infinite.

(GA II. 6. 742b17-24)

The passage from *Metaphysics* I just referred to gives a context for these objections of Aristotle: he is contrasting the Atomists with Anaxagoras, 'who seemed like a sober man' (984b17) and Empedocles (985a4-985b3). Their contribution, as opposed to the Milesian Monists and the Atomists, was to introduce a cause of motion-Anaxagoras' Mind, Empedocles' Love and Strife. What Aristotle misses in the Atomists' theory here is not something like weight or lightness, but something like the movers of the heavenly spheres in his own system. He himself attributes weight and lightness to the four sublunary elements and circular motion to the matter of the heavens, and he claims that the motions of the cosmos are eternal, but he still seeks for an 'origin' or first cause of motion that transcends the properties of physical matter.<sup>29</sup> If the Atomists claimed that the atoms moved eternally and moved because of weight, that claim would go nowhere towards satisfying Aristotle's demand here. So this criticism cannot be used as evidence that they made no such claim.

More damaging is the criticism that they had no theory of *natural* motion:

Hence Leucippus and Democritus, who say the primary bodies always move in the void and the infinite, have got to say what motion they have, and what their natural motion is. For if one of the elements is moved by another by force, they must each have a natural motion to contrast with the forced; and the first mover must move not by force but by nature. For there will be an infinite regress if there is to be no first mover that is natural, but each prior mover is to produce motion by being moved by force.

#### (Cael. III. 2. 300a8-16)

There is no doubt that the Atomists never claimed that *once upon a time* all the atoms moved in one way, and *then* there was an interruption which caused collisions among them. Such a thesis is never in question. They held that the atoms have been jostling among themselves—σταστάζειν is the word used by Aristotle (quoted by Simplicius, *in Aristotelis de Caelo commentaria*, 295.9 from Aristotle's lost *On Democritus*)—from all eternity. The question concerns the components of this jostling motion: can we analyse it into a forced component, due to blows, and a natural component, due to weight? Aristotle says no.

Just this failure to distinguish two components is evidently a major theme in Aristotle's criticism. The Atomists held that the atoms moved hither and thither in the void for all time, and a part of the explanation of the particular motion of an individual atom at any time is the set of collisions that it has most recently experienced. This, in Aristotle's terms, is forced motion, and he demands to know the natural motion with which this is contrasted. But the Atomists did not say, it seems, that it is contrasted with anything: they merely said that it has always happened so, and they did not enquire into the unreal hypothetical question, how would the atoms behave if it were not so. The Epicureans, by contrast, did put this hypothetical question, perhaps because it was forced on them by Aristotle.<sup>30</sup> All this is compatible with the view that the early Atomists believed weight to be a component in the explanation of the motion of atoms in the void. O'Brien holds that this component takes the form of resistance to the force of a colliding atom: I am arguing that it takes the form of a tendency to move downwards.

Other elements in Aristotle's criticism come again from his own theory of natural motion. First is the point that the Atomists are committed to the existence of not more than one kind of substance. Since the natural motion of bodies depends, in his view, upon the kind of substance they have, it follows necessarily that all bodies must have a single natural motion. Hence the Atomists are incapable of producing an adequate theory of natural motion-that means, one that will account for both natural fall of heavy bodies and the natural rise of light ones. This line of criticism is followed especially in de Caelo, I. 7. 275b29-276a-b, and also in Theophrastus, De sensibus, 71. These passages neither assert nor deny that the atoms have a tendency to move downwards because of their weight. The point is simply to insist that having only one kind of substance they can have only one kind of natural motion. Aristotle puts the question of the weight of atoms on one side. In the last sentence he entertains the possibility that they might all have lightness (κουφότης) instead of weight (βάρος),

although he asserts elsewhere that they all have weight (an atom is  $\beta \alpha \rho \dot{\upsilon} \tau \epsilon \rho \sigma \nu$  in proportion to its size, *GC* I. 8. 326a9, quoted above).

A similar point is made in *de Caelo*, III. 5. 304a1-7, where Aristotle claims that the Atomists (they are not named, but the description fits), like Anaximenes, cannot make a definite distinction between fire and air and water and earth because their elements differ only in size: different sizes bear proportional relations to each other and so something will be (say) air just because of the proportion its constituents bear to other bodies. Hence the theory cannot accommodate the absolute distinction between the heavy elements and the light elements. Aristotle might have mentioned in either of these passages that Democritus attributed weight to all atoms and downward motion to weight (if Democritus did, and Aristotle knew he did), but there was no necessity for him to mention it, and neither passage implies its denial.

Aristotle finds another reason why the Atomists cannot produce a theory of natural motion in their thesis that atoms move in a void. In his own view, no proper account of motion in a void can be given: there can be no rational way of determining either the speed or the direction or the duration of a motion through the void.<sup>31</sup>

How can there be any natural motion if there is no difference in the void and the infinite? For being infinite it can have no up or down or middle, and being void it can have no difference between its up and down.

#### (Ph. IV. 8. 215a6-9)

This passage is preceded by some sentences using the same language as the section of *de Caelo* III. 2 which we quote on page 206: so there is a presumption that there, too, Aristotle has in mind the objection drawn from 'the void and the infinite.'

The balance of the evidence suggests, then, that we are not obliged to attribute to Democritus the paradoxical and unmotivated thesis offered to him by O'Brien as a means of saving the doxographical phenomena. We may continue to believe, as Zeller did, that Democritean atoms have weight, meaning a tendency to fall downwards, and this removes the necessity of finding another explanation for the fall of heavy bodies to earth. Democritus did not call this a natural motion, because he thought all the jostling motions of the atoms were equally original, eternal, and natural. Aristotle criticized him for not producing any account of natural motion because he believed the void and the sameness of substance of the atoms made it impossible for him to produce any such account.

#### Notes

1. D. O'Brien, Theories of Weight in the Ancient World: Four Essays on Democritus, Plato and

*Aristotle: A Study in the Development of Ideas,* vol I *Democritus: Weight and Size: an Exercise in the Reconstruction of Early Greek Philosophy* (Les Belles Lettres and Brill 1981), xx + 419; £25.25.

- 2. See Michael Ventris and John Chadwick, *Documents in Mycenean Greek* (2nd edn, Cambridge University Press 1973), 55.
- Iliad, XII. 434: the battle is evenly balanced, as when a careful housewife evens up two lots of wool in a balance (σταθμός). *Iliad*, VIII. 69, XXII. 209 (τάλαντα).
- 4. Theognis, 157.
- 5. Herodotus, II. 65; Aristophanes, *Frogs*, 1365, 1407; Hippocrates, *Anc. Med.* 9; Aeschylus, *Supplices*, 822.
- 6. Fr 488.4.
- 7. The word is  $\kappa\alpha\nu\omega\nu$ , but this word is also used to denote a chalked string used to mark a straight line, then other straight edges, and finally everything taken as standard. I am grateful to my colleague Glenn W. Most for showing me his discussion of Pindar's use of the word  $\sigma\tau\alpha\theta\mu\eta$  (2. 90), and related uses of the word  $\kappa\alpha\nu\omega\nu$ , in his PhD dissertation, *Pindar's Truth: Occasional Unity in the Greek Epinician* (Tübingen 1980), 707-35.
- 8. See Guthrie, Loeb edition of *de Caelo* (*Cael.*), 244 n *b*. He quotes Stocks (note in the Oxford translation of *Cael.* ad loc), who gives the explanation that I follow. Guthrie proposes that it more naturally means that the angles made by one falling body with the earth are similar to those made by another, and compares a second occurrence of the phrase at 297b19, πρòς ὁμοίας γωνίας ἀλλ' οὐ παρ' ἄλληλα. Guthrie is wrong, I think: the proof that the lines of fall meet at the centre of the sphere depends on their being vertical to the tangent to the earth's surface, not on their falling at the same angle as each other.
- 9. See above n 1.
- 10. This is oversimplified. O'Brien does consider the last problem: what he fails to discuss adequately in it is how the suggested solution (the  $\delta i \nu \eta$ ) was supposed to work, and why Democritus put himself to the necessity of having to solve this problem in the first place.
- Harold F. Cherniss, Aristotle's Criticism of Presocratic Philosophy (Johns Hopkins Press 1935), 211 n 253. W. K. C. Guthrie, A History of Greek Philosophy, vol II (Cambridge University Press 1965), 403 n 2.

- Edouard Zeller, Die Philosophie der Griechen, Teil I, Abt. 2, ed Wilhelm Nestle (Leipzig 1920). H. C. Liepmann, Die Mechanik der Leucipp-Democritischen Atome (Fock 1886). A. Brieger, Die Urbewegung der Atome bei Leucippus und Demokritos (Heynemann 1884). A. Dyroff, Demokritstudien (Dieterich 1899). J. Burnet, Early Greek Philosophy (Black 1892). Guthrie, above n. 11. G. S. Kirk and J. E. Raven, The Presocratic Philosophers (Cambridge University Press 1957).
- 13. 'Aristotle and the Atomists on Motion in a Void,' in Peter K. Machamer and Robert G. Turnbull (eds), *Motion and Time, Space and Matter* (Ohio State University Press 1976), 83-100; 'The Greek Theory of the Infinite Universe,' *Journal of the History of Ideas*, XLII (1981), 571-85.
- 14. I argued this in a paragraph in *Two Studies in the Greek Atomists* (Princeton University Press 1967), 96. The same argument, now grown to sixteen pages, can be found in O'Brien's book (282-98). It still seems convincing.
- 15. For example, Diogenes Laertius, IX. 32 (DK 67 A 1); Aetius, I. 4. 2 (DK 67 A 24). See O'Brien, 372-4 on these. Also Simplicius, *in Aristotelis de Caelo commentaria*, 530. 30 f. The point is hardly in doubt, although descriptions in the sources vary: μείζονα καὶ βαρύτατα in Aetius, τὰ λοιπὰ after τὰ λεπτὰ have departed in Diogenes, τὴν γὴν in Simplicius.
- 16. See Aristotle, Cael. II. 13. 294b13.
- Two very helpful articles on the δίνη are John Ferguson, 'Dinos,' Phronesis, XVI (1971), 97-115, and Steven S. Tigner, 'Empedocles' Twirled Ladle and the Vortex-Supported Earth,' Isis, LXV (1974), 433-47. I am also indebted to unpublished work by Professor Tigner.
- 18. H. F. Cherniss, above n 11, 204 n 234. Compare Guthrie's note, above n 11, 198 n 4.
- 19. Steven S. Tigner, above n 17.
- 20. Aristotle, *Cael.* II. 13. 295a10: 'So if the earth now stays where it is by force, so also did it come together at the centre, moved by the rotation; for all of them mention this explanation, from what happens in liquids and concerning the air.'
- 21. For the Stoic view—a very important modification of Aristotle's cosmology—see Plutarch, *de Stoicorum repugnantiis*, 1054e.
- 22. Aetius, III. 10. 5 (DK 68 A 94).
- 23. The difficulties in using the dynamics of a vortex in the explanation of gravity are well illustrated by the theory of Christian Huygens. He proposed an

arrangement of vortices of a subtle material moving around the earth, not on a single axis but circling the earth in all directions. This was to remove the objection to the cylindrical vortices of Descartes, that they could at best explain gravity towards the axis. See his *Discours de la Cause de la Pesanteur, Oeuvres Complètes,* XXI; H. J. M. Bos, s. v. Huygens, *Dictionary* of Scientific Biography (Scribner 1972), esp., 610; A. E. Bell, Christian Huygens and the Development of Science in the Seventeenth Century (Arnold 1947), 161-4.

- The passage of the *Phaedo* is generally thought to reproduce a theory which is to be attributed as a whole to Anaximander, because of Aristotle's mention of Anaximander in this connection at *Cael*. II. 13. 295b10-25. I believe Aristotle attributes much less than the whole theory to Anaximander. I hope to write about this elsewhere soon.
- 25. Aetius, II. 2 (DK 67 A 22). Aetius, III. 10. Aristotle, *Cael.* II. 13. 293a17-18. It is of course our cosmos, not the universe as a whole, that Democritus held to be spherical.
- 26. Aristotle is our authority for this: see *Cael.* II. 13. 294b13-14. Aetius (III. 15. 7) says that Parmenides and Democritus believed the earth to remain where it is because there is no reason for it to move in one direction rather than any other. Aristotle is quite definite about it, however, and it seems we must either think that Aetius was mistaken about Democritus, or read his statement in some fashion that does not contradict Aristotle.
- 27. Above n 12.
- 28. Above n 12.
- 29. I have tried to give some account of the cause of the natural motions of elementary bodies in Aristotle's system in an earlier article (the first article cited in n 13).
- 30. See Lucretius, II. 221-4.
- 31. See Ph. IV. 4.

# Stephen Makin (essay date 1989)

SOURCE: Makin, Stephen. "The Indivisibility of the Atom." Archiv für Geschichte der Philosophie 71 (1989): 125-49. Print.

[In the following essay, Makin critiques interpretations of the Greek word atomos, which means "indivisible." To the extent that atoms are understood to have physical magnitude, however, the term cannot mean that atoms are absolutely, without qualification, indivisible. While traditional interpretations assert the atom's "theoretical" or "physical" indivisibility, Makin argues that the Democritean atom is "an extended body with parts."]

"What are the simple constituent parts of a chair?—The bits of wood of which it is made? Or the molecules or the atoms?—"Simple" means: not composite. And here the point is: in what sense "composite"? It makes no sense at all to speak absolutely of the 'simple parts of a chair." Wittgenstein, *Philosophical Investigations*, par. 47.

I will state the argument which, I hold, grounds the indivisibility of the Democritean atom. I will not, in this paper, discuss the textual arguments which show this argument to have been Democritean.<sup>1</sup> My purpose in this paper is to discuss what we should say about the indivisibility of the atom, assuming that the argument I give provides the Democritean account of atomic indivisibility. I hope also that the account offered provides a new approach to the discussion of atomic indivisibility.

The argument offered by the Atomists for the existence of atoms is of the "everywhere alike" ( $\pi \alpha \nu \tau \hat{\eta} \delta \mu o \hat{\iota} o \nu$ ) form.<sup>2</sup> This argument is closely connected with arguments of the same form used, to a different end, by the Eleatics. This is as we might expect, if the Atomists are reacting to certain conclusions of Eleatic argument (that what there is is indivisible and one) applied to the whole of what there is, but are drawing similar conclusions applied to components of what there is (that what there is is made up of bits which are each indivisible and one). Use of this argument is reported by Aristotle in *De Generatione et Corruptione* 1.8. Any atom is homogeneous (GC 1.8 325a28 f.). If then it were divisible anywhere, it would be divisible everywhere.<sup>3</sup> Homogeneity rules out the finite divisibility of what is homogeneous, since finite divisibility would be divisibility just up to a certain stage, and then the question arises why up to that stage and no further? Clearly no nonarbitrary answer can be given. Since what we are dealing with is homogeneous, there could be no differences in its structure to account for this finitude of division.<sup>4</sup> If finite divisibility is ruled out for a homogeneous body, then only two alternatives remain: indivisibility or divisibility everywhere. But divisibility everywhere is held to lead to contradiction.<sup>5</sup>

It follows then that any homogeneous body is indivisible. Now the Eleatics hold that the whole of what there is is homogeneous, for there is nothing other than being which could provide distinctions within being.<sup>6</sup> The Atomists see that the Eleatic conclusion will not do.<sup>7</sup> At GC 1.8 the Eleatics are said to follow the argument, and to ignore the evidence of sense (GC 1.8 325a13 ff.). They are criticised for the lunacy of this (GC 1.8 325a18-22), while the Atomists' theory is presented as in harmony with the evidence of sense (GC 1.8 325a31). If the homogeneity of all that there is would lead to its indivisibility, and yet it is plain from sense that there is some plurality of what there is, then it must follow that what there is is not homogeneous. Hence the Atomists introduce the void, and thus distinctions within the whole of what there is. There is void (GC 1.8 325a31), and something is divisible insofar as, and to the extent that, there is void in it.<sup>8</sup> It follows then that what contains no void is indivisible. The atom contains no void (GC 1.8 325a25), and thus we have an argument by which the atom is shown to be indivisible. In summary: if an atom is somewhere divisible it is everywhere divisible; since it is not possible that it be everywhere divisible, it is nowhere divisible (i.e. indivisible).

Let it be accepted that this argument grounds the indivisibility of the Democritean atom. The atom is indivisible because it is solid (homogeneous).<sup>9</sup> I now want to consider whether this account of atomic indivisibility is profitably dealt with in the terms typically used in discussion of atomic indivisibility.

As soon as any account of atomic indivisibility is offered, the temptation is to characterize it as one of the two alternatives commonly allowed<sup>10</sup>—physical indivisibility or theoretical indivisibility.<sup>11</sup> I will argue that in fact nothing is put clearly in these terms, and this way of approaching the matter should be abandoned. By this I do not mean simply that Democritus did not draw a distinction between physical and theoretical indivisibility,<sup>12</sup> though it will follow from what I argue that there is no such distinction to be found in Democritus. I mean further that there is no sensible distinction to be made between physical and theoretical (in)divisibility, so that there could be no sense in commentators' importing these terms as exegetical tools.

Now it is clear enough what account I have offered of the indivisibility of the atom: the atom is indivisible because it is solid<sup>13</sup> but whether that is "physical" or "theoretical" indivisibility is unclear.<sup>14</sup> An atom is shown to be indivisible by argument. Take a particular atom. Democritus' view is that *absurdities* follow from supposing it to be divided. If it is divided at any point, then, since it is solid and homogeneous, it can be divided at every point-but that is taken to give rise to absurdities. So it is necessary on the basis of *argument* that the atom be indivisible, and that might lead someone to call it "theoretically indivisible."<sup>15</sup> On the other hand, there is no reason to think that a finitist geometry goes along with this argument, or that the atom is a partless body, and since atomic solidity gives rise to atomic hardness someone might be lead to call the atom "physically indivisible." But the unclarity here is not over the way in which the atom is indivisible, but over what physical and theoretical indivisibility are intended to be.

I shall start by looking at how the distinction of physical and theoretical indivisibility is treated by an influential contemporary writer, David Furley. In view of his influence it is unfortunate that Furley does not make the distinction at all clear. Furley sets out his terms at the start of his work. Two kinds of division are to be distinguished. First physical division:<sup>16</sup> "the division of something in such a way that formerly contiguous parts are separated from each other by a spatial interval." Second, theoretical division, which is defined in terms of a modal notion:17 "an object is theoretically divisible if parts can be distinguished within it by the mind, even if the parts can never be separated from each other by a spatial interval." Presumably a theoretical division is a distinction, within what is divided, of parts by the mind. But what such a distinction of parts is, and how one goes about distinguishing parts within something is unclear. The terminology becomes more opaque when "theoretical indivisibles" are compared with "units within which no distinctions are conceivable at all." For: "A unit which is theoretically indivisible ... may still have extremities which can be conceived in distinction from the unit itself."18 Then Furley seems to have this account: there are two types of division, the theoretical and the physical-and the theoretically indivisible is what cannot be theoretically divided.

One reason for Furley's approach is that it fits well with Epicurus' later developments of atomism. Epicurus did distinguish between the *atom*, which was in one way indivisible, and its *minimum parts* which were indivisible also in another way.<sup>19</sup> The minimum part was something like a minimum sensible: a minimum conceivable, that than which, in virtue of its smallness, nothing smaller can be conceived. The following would, then, be a reasonable historical question to ask: was the Democritean atom indivisible in the way that only the Epicurean minimum part was, or in the way that the Epicurean atom also was?<sup>20</sup>

That question would not, however, cast any light on what is being interpreted, unless the sense in which the Epicurean minimum part was indivisible was clear. It is not sufficient to note that *Epicurus* relied on an analogy between the mind and sense perception, for if the analogy is carrying the weight of explanation of the notion of theoretical indivisibility the analogy has to make some sense to us. Notice, for example, how a reliance on the Epicurean analogy renders Furley's account of the indivisibility of the atom extremely unclear at the very point where it begins to look interesting. A quotation from Furley makes this plain:<sup>21</sup>

What could be the reasoning behind the assertion that smallness is a cause of indivisibility? Simplicius ties smallness to partlessness ... The most likely line of argument, then, is the one used by Epicurus ... from the analogy with perception. There is a minimum perceptible quantity within which no parts can be distinguished by a perceiver. The mind's eye, as it were, functions as a microscope: it can distinguish much smaller parts than the senses can, but there is still a lower limit beyond which it cannot make any distinctions ... Since Democritus appears to have drawn a general analogy between sense perception and thought, and since the concept of something too small to be seen was certainly familiar to him, it seems quite likely that he might have used the idea of something so small that no parts can be distinguished even by the mind.

If it is this analogy which explicates the way in which the atom is indivisible for Democritus, then I for one just have no clear understanding of what such a notion of indivisibility is. If I do not understand the notion of indivisibility involved, then I am not able to assess the claim that Democritus held the atom to be indivisible in that sense. For the same question will always arise for me in my consideration of Democritus: *what* notion of indivisibility is the language and concepts that we are using to interpret his theories, it follows that the concepts have to be clear if we are to make any profitable exceptical use of them. My argument in this paper is that since the notion of theoretical indivisibility is *not* a clear notion, the question "physically or theoretically indivisible?" should be dropped.

Now of course there are distinctions that can be drawn concerning indivisibility. Something is indivisible if it is not possible that it be divided. Clearly there are different types of impossibility. For example, it is impossible (i.e. not permitted) to run across Buckingham Palace lawn, it is impossible to run faster than 90 mph, it is impossible to run faster than the speed of light. Equally there are different types of division.<sup>22</sup> For example, a physical separation of parts, as when I saw up a plank; or a mathematical division, as when I bisect an angle in a geometrical problem; or the division of a point by lines leaving it in different directions, where the point represents the focus of forces and the lines the directions in which the forces act; or the division of the colour orange into the colours red and yellow; or the division of a colour into hue, saturation and brightness. To say of some object that it is indivisible means something different depending on how the modality is understood and what notion of division is in play.

Consider, then, the way in which modalities and notions of division are specified. It precisely depends on the *theory* against the background of which an assertion of divisibility or indivisibility is being made, although in some cases "theory" may seem a somewhat grandiose term to use. The point here can be illustrated by consideration of a specific question: "Is it theoretically impossible for a man to run at 100 mph?" The obvious and correct response to this guestion is that it depends on the theory one has in mind. Given the theoretical background of anatomy, it is theoretically impossible, unlike, for example, the impossibility of my running at even 15 mph given the same theoretical background. Alternatively, given the theoretical background of physics, it is not theoretically impossible that a man should run at 100 mph, unlike, for example, the impossibility of a man's running faster than the speed of light, given the same background.

This example shows something of the role of the term "theoretical" in the phrase "theoretical indivisibility." The term "theoretical" is a place holder, with no content of its own. It makes no sense to talk of theoretical indivisibility simpliciter, unless some specific theory gives a content to "theoretical." Much the same point applies with respect to the term "indivisible." It makes no sense to talk of the indivisible simpliciter, unless a particular notion of division is in play. What is theoretically indivisible could only be taken as what cannot, by the lights of some theory or other, be divided. Thus theoretical indivisibility will be a wider concept than physical indivisibility. A diamond is physically indivisible to me, since I am not physically capable of dividing one, and what it is physically impossible for a man to divide is what is in one way theoretically impossible to divide—namely, what it is impossible by the lights of some theory of human strength to divide. So theoretical indivisibility is a cover-all concept. There is no sense in supposing there to be some privileged sense of indivisibility, which would be what is indivisible by some privileged theory.

Consider the example of the geometrical point. That is indeed theoretically indivisible: i.e. it is impossible by the lights of Euclidean geometry to divide it, given that Euclidean geometry specifies *both* what is to count as a division (a separation into parts of smaller magnitude) and that the point is without magnitude. But the point is not indivisible in any privileged or especially strong sense. There could be sense to a theory according to which the point was divisible, if, for example, it is taken as divided by lines leaving it in different directions, the point representing the focus of forces and the lines the directions in which forces act. It would be senseless to speak of the point as theoretically indivisible simpliciter. That could at best mean what is not by the lights of any theory divisible. The question then would be why we should suppose that there could be any such thing.

There is an important general point here about indivisibility. Something is indivisible if it is impossible to divide it. Then *all* indivisibility is theoretical in this way: both the impossibility, and what is to count as a division, need to be specified by some theory. In terms of that theory modalities are set up (which gives a sense to "impossible"), and a whole-part relation specified (which gives a sense to "division"). Given this general point, there really is little to be gained by seeking to put an answer to the question "In what way is the Democritean atom indivisible?" in terms of the supposed alternatives "theoretically or physically." The Democritean atom is theoretically indivisible in that its indivisibility is required by the Democritean theoryrequired, that is, to account for sensory evidence of plurality in the world and to avoid the contradictions consequent upon allowing divisibility everywhere. There is a difference, then, between the indivisibility of the atom and the indivisibility of a piece of rock or diamond. But in both cases the obstacles to an actual separation of parts are hardness and solidity, in the case of the atom, as I have outlined above, in the case of diamond, because its hardness will be due to a relative absence of void. But neither of these characterizations, as physically or theoretically indivisible, explains anything about the indivisibility of the atom. For that explanation it is necessary to provide the "everywhere alike" account.

Plainly, though, commentators who talk of theoretical indivisibility may have some further explication of "theoretical" and "division" in mind. We have seen that Furley explains theoretical indivisibility by reference to a type of division (a distinction of parts within something by the mind), but we have also seen that this explanation leaves a lot to be desired. Jonathan Barnes, too, looks at what theoretical indivisibility might mean.<sup>23</sup> Some consideration of what he has to say leads on naturally to a discussion of partlessness as being the only viable explication of theoretical indivisibility.

Barnes offers the following. By theoretical indivisibility might be meant (a) conceptual indivisibility, (b) geometrical indivisibility, or (c) logical indivisibility. Now (a) is just the Epicurean notion whereby, as with the power of sight, there is a lower limit to the power of thought. We have seen already that this Epicurean notion does not give any clear sense to talk of theoretical indivisibility. As regards (b) and (c), the distinction between them seems unclear. If we take theoretical indivisibility as (c), then the claim that atoms are theoretically indivisible is the claim that "if a is an atom, then it is logically impossible to divide a."<sup>24</sup> But this seems unlikely to give us any useful exegetical notion, unless it collapses into (b), that atomic volumes contain no mathematically distinguishable parts. For it is plain that the Democritean atomic theory is an *a priori* theory. Now to show *a priori* that there are atoms is to show that there is a *logical* contradictionsince there are no other types of contradiction-in supposing that any and every bit of matter can be divided. It will be a matter of logic that there are atoms, whether the atoms are very hard bits of stuff or whether they are of mathematically indivisible volume. For the point of the Zenonian arguments is that there is a logical difficulty in supposing matter to be infinitely divisible.

But now it may seem that I am being obtuse. For, it may be objected, there is a concept at hand that *will* explain the notion of theoretical indivisibility, namely, partlessness. This is precisely what Barnes suggests as his (b): "the volume occupied by an atom has no mathematically distinguishable parts."<sup>25</sup> The theoretically indivisible will be what has no parts, and so cannot be divided, as opposed to what does have parts but cannot be divided into them. So we see that commentators take as important evidence in favour of the atom's being theoretically indivisible Simplicius' remark at DK 67 A 13 that Leucippus and Democritus hold the atom to be indivisible not only because of its impassivity, but also due to its smallness and partlessness (ἀλλὰ καὶ τὸ σμικρὸν καὶ ἀμερές).<sup>26</sup>

In the remainder of this paper I will consider what can be said about the partlessness of the atom. In the course of doing so I will consider the role of the notion of partlessness in the Eleatics, and what is to be said in general about the partless.

A constraint on any sensible interpretation of Democritus is that plainly the atoms differ in size. If someone claims they are also partless, then if we are to take this as clarificatory we need an explanation of how partlessness is consistent with variation in size. Those commentators who give interpretations in terms of theoretical indivisibility somewhat neglect this. Furley, for example, notices the problem, but does not tackle it.27 Konstan thinks there would be a conflict between the partlessness of atoms and the existence of very large atoms.<sup>28</sup> But it is unclear what problems are raised by the existence of large atoms that are not equally obviously raised by the existence of atoms of different sizes, even if all small. It is not clear then that the notion of partlessness could give a philosophically sensible account of the indivisibility of the Democritean atom.

Whether or not atoms have parts cannot be settled by reference to the quoted words of Democritus, nor to explicit doxographical reports. Philoponus reports that Democritus said that the soul was partless,<sup>29</sup> meaning that it is not differentiated into faculties. There are two reports concerning the partlessness of the atom, but both are elsewhere contradicted by their reporters. At DK 67 A 13 Simplicius compares Democritus and Leucippus with Epicurus: Leucippus and Democritus have not only impassivity (ἀπάθεια) but also smallness and partlessness as causes of the indivisibility of the atom; Epicurus later dropped partlessness.<sup>30</sup> This is not conclusive. It could well be Simplicius' report of the Epicurean account of the difference between themselves and the earlier Atomists, and so little evidence that Democritus said anything about the partlessness of the atom.<sup>31</sup> Anyway Simplicius himself contradicts this, Luria pr 212: there is this sense of "indivisible," having parts and magnitude ... like each of the Democritean atoms. There is no reason to prefer one report to the other.<sup>32</sup> Second, Aëtius, DK 68 A 48, refers to the atoms as partless bodies: où từc ở tóu ouc,  $\pi$ ερὶ từ άμερη ίστασθαι καὶ μὴ εἰς ἄπειρον εἶναι τὴν τομήν.33 This would be an untrustworthy piece of evidence as the sole basis for supposing that Democritus held the atom to be partless. Aëtius himself is one of those who reports Democritus' view that some atoms are very large, DK 68 A 47: "it is possible for there to be world sized atoms." So here we have a clash of evidence, with little reason to prefer one to the other. Thus the doxographers are inconclusive over the partlessness of the atom.

But there might be indirect evidence that the Democritean atom was taken to be partless. I said earlier that the atomic theory was a reaction to Eleaticism. If the Eleatics claimed to show that the whole of what there is is partless, or if a reply to any of their arguments would require a partless entity,<sup>34</sup> then in charity we could suppose the Atomists to have seen that, and accordingly made the atom partless. Even if that were the case, it would still only be a start. In order for the notion of partlessness to cast any light on the indivisibility of the atom we should need to understand how the Atomists rendered partlessness and variation in size consistent.

First, though, it is unclear that the Eleatics did argue the whole of what there is to be partless. Parmenides did not mention partlessness. Nor did Zeno. The term "partless" does occur in certain passages that present Eleatic reasoning. For example, in Simplicius in Phys. 139.27-140.6<sup>35</sup> the term "partless" occurs twice. The argument there is claimed to show that what there is is just one, and both partless and indivisible, and the conclusion is that what there is is indivisible and partless and one. But nothing in the argument requires partlessness, over and above the conclusion that the whole cannot be divided. Use of "partless" could easily be an inference by the doxographer from "one." The pseudo-Aristotelian De Lineis Insecabilibus is concerned with partless things,36 and reports as conclusion to a Zenonian argument that there exists a partless magnitude: "Again, Zeno's argument proves that there must be a partless magnitude" (968a2). But this is a later work, and "Zeno's argument" seems to refer just to a dichotomy argument. We are given refinements about the traversal in thought of a magnitude, and the counting of an infinity, which are almost certainly later refinements and not from Zeno. So this gives little ground for supposing that Zeno argued the whole to be partless.

Now Melissus does link being one with being partless.37 But we know that Melissus differed from Parmenides in some respects, and we might have a case in point here. I will say considerably more about the points raised by what Melissus says later. For the present, as regards Parmenides consider also DK 28 B 8.25: "the whole is continuous, for what is clings close to what is." This is something accepted as true by Parmenides. But then what clings close to what? Not one entity to another, since there is just one indivisible being. The natural thing for us to say is: one part of a single indivisible whole to another.<sup>38</sup> But there should be no cause for concern here, unless it is supposed that having parts is ipso facto being divided. It will emerge presently, though, that there is much confusion in that notion of what divisibility is, and it will become clearer what the talk of parts and partlessness comes to.

Perhaps consideration of the *texts* of Parmenides and Zeno does not require introduction of a notion of partlessness. However, it is often thought that Zeno's dichotomy arguments, while they do not *mention* parts, are aimed at what has parts, and would be avoided only by a partless entity.<sup>39</sup> As a result both the Democritean atom and the Eleatic One are taken to be partless.

The best way to approach this matter is through consideration of a problem. At DK 29 B 2.17f. Simplicius refers to an argument of Zeno's in summary: "he shows this having shown first that each of the many has no magnitude since each is the same as itself and one."<sup>40</sup> The inference is generally expanded via mention of partlessness, with Melissus B 9 in mind. If something is self-identical and one, then it is partless, and so has no magnitude. Now suppose we add Zeno's argument B 2 that what has no magnitude is nothing and does not exist. But the Eleatic One is one and self-identical. Then it will not exist by Zeno's argument, and the inference will be strengthened if it is partless. How might this conclusion be avoided?<sup>41</sup>

The argument summarised by "each of the many has no magnitude since each is the same as itself and one" is aimed at each of the many. It does not apply to the Eleatic One, since the Eleatic One is not the one of a plurality—a putative unit. Zeno's point can be explained by reference to the principle that any plurality requires a unit of which it is a plurality.<sup>42</sup> Whatever the criteria are by which something is judged to be a plurality, there need to be units which are units by those criteria. On that basis Zeno can make this charge against his pluralist opponents. If you take the whole to be a plurality because it is obviously differentiated into this thing and that thing,<sup>43</sup> then by those criteria the unit will require to be non-differentiated (selfidentical). But it is only insofar as it is extended that you suppose the whole to be a plurality, in which case the unit will be something non-extended. But there could be no such unit, and thus there could be no such plurality as the pluralist alleges.

On this account the thrust of "each of the many has no magnitude since each is the same as itself and one" is not that *any* unit must have no magnitude, but that what is a unit by the pluralist account of what is a plurality must have no magnitude. Since the pluralist is in no position to differentiate between the whole and any putative unit (since both will be extended things), to arrive at a unit that *is* distinguished from the plurality of which he takes it to be a unit he will need to make it non-extended.

Now the Eleatics can avoid all this. Since they don't suppose the whole to be a plurality in the first place, they do not require any unit which would drive them to the non-extended to ground the plurality. The Atomists too can avoid these difficulties. By introducing the void as non-being they can give an account of why the whole is a plurality—it contains void. Then the unit required by those criteria of what a plurality is would be something that did not contain void, i.e. the atom. Since the Atomists do not judge the whole to be a plurality just in virtue of its being extended, nothing in their arguments suggests that the unit required should be non-extended.

The upshot of these remarks on "each of the many has no magnitude since each is the same as itself and one" is that however that argument be expanded as regards the pluralists against whom it is aimed, it does not imply that the *Eleatic One* was an entity taken to have no parts, since the argument is not applicable to the Eleatic One at all. As a result, therefore, the argument does not tend to suggest that the Democritean Atom would need to be an entity with no parts either.<sup>44</sup>

The argument of Zeno B 1 is also commonly taken to generate the notion of a partless entity, so that, if Atomists are to respond to that argument, then the atom will need to be a partless thing. The sense of B 1 can be put as follows.

(1) If there is 'a plurality' each thing must have some magnitude or depth, and one of it must be far from another.<sup>45</sup>

(2) The same story applies to what is in front. For it too will have a magnitude, and some of it will be in front.

(3) It is all the same to say this once and to say it over and over.

(4) For no such thing of it will be last, nor will one not be opposed to another.

(5) So if there is a plurality, the same things must be both small and large: so small as not to have magnitude, so large as to be infinite.

The argument draws absurd consequences from the supposition "if there is a plurality." The central idea, which powers the argument, is that once division into a plurality gets going it can never be stopped. No support for this, e.g. for step (3) in the text as given, is provided. But the line that Zenonian support would take should be clear. Because the whole is everywhere the same, as being, since there is no non-being or void, any division only up to a certain point would be arbitrary. So if there is any point of divisibility within the whole then every point is a point of divisibility. Once (3) is granted the argument goes ahead. It is clear why the absurdities are conditional upon there being a plurality, hence "if there is a plurality" in (5). If there is a plurality, then the putative constituent units—"each thing" in (1)—must have magnitude and depth, otherwise the whole which they compose could not have magnitude and depth. It is precisely such a whole that Zeno's opponents want to save. Furthermore the units must be 'separate' from one another. But any putative unit will be in just the position of the whole, so that it too can be considered as a plurality of units. Since there is no end to this, (4), the absurd conclusion follows, doubtless via the view that an infinite collection of parts each of which has magnitude must itself have infinite magnitude.

What can be told from this argument about the indivisibility of the atom, assuming that the atom is indivisible in a way necessary to avoid the conclusion of the argument? One point we can start from is that the atom is indivisible in the same way as is the Eleatic One, since in the case of each, the argument is applied in the same way. We can tell from the logic of (1)-(5), as a reductio ad absurdum of "there is a plurality," that the argument shows the existence of what is not a many. But why does it follow from that that the Eleatic One has no parts? Presumably because it is held that, if the Eleatic One *did* have parts, then it would not be one but many.<sup>46</sup> But why should *that* be believed? Perhaps it might be thought obvious. But if *that* is thought obvious then what are we to say about Democritean atoms which will be, by the same argument, partless and yet various in shape and size?

It seems just as obvious that partless bodies cannot differ in shape and size as that a body which is one, and not many, is a partless body. If we want a philosophically reasonable account of the indivisibility of the atom, and we want to be reasonably charitable about what Democritus understood about the philosophical problems raised by the notions of unity and plurality, then one of these implications has got to give. Either partless bodies can differ in size and shape, or there is a concept of unity (indivisibility) unconnected with that of partlessness and adequate to avoid the Zenonian argument. Now the latter is the preferable alternative, for indeed there is a concept of unity (indivisibility) grounded in homogeneity, viz. the "everywhere alike" concept, that is distinct from the notion of a partless body. That concept would be at home in the context of the Zenonian argument, since it is the notion of homogeneity that grounds the step (3) that generates the conclusion of the argument. In terms of this concept it can be seen that the Zenonian argument works both against Zeno's 'crude' (non-atomistic) pluralist opponents, and how it can be used positively by the Eleatics and Atomists. For what the argument shows is that, if something is ever divisible, then it is divisible ad infinitum, which is absurd.

Now we have a notion—homogeneity—which explains the indivisibility of the Eleatic One and of the Democritean atom. Consider, then, what role is left for the notion of partlessness in casting light on what is going on. In Parmenides the unity of the One is grounded in its homogeneity and continuity. We would naturally explain these notions of homogeneity and continuity as relations between parts. That is, it is homogeneous because every part is just alike being. If this is the correct way to explain homogeneity and continuity, and if those notions explain indivisibility, then, since neither Parmenides, Zeno nor Democritus *say* that unity is grounded in partlessness, the Eleatic One, and the Democritean Atom, will each emerge as an entity with parts that cannot be divided from one another.

Now this is not to say that Parmenides and Zeno held the One to have parts. The important points are rather these. There is no explicit statement in Parmenides or Zeno that the One is partless, or one in virtue of its partlessness. Zeno's arguments do not generate that as conclusion. If commentators on Zeno B 1 are to be believed, the partlessness of the Eleatic One would entail its non-existence. Zeno B 1 argues from the supposition that there is some plurality to the absurd conclusion of infinite size. Support is here provided by the homogeneity argument. It does not make the argument any clearer to insist that Zeno B 1 would tend to prove the existence of a partless body, unless it can first be made clear what it is to have parts and what it would be for the extended to be partless. Nothing in Parmenides or Zeno says that the One has parts either, though homogeneity and continuity might naturally be explained in terms of parts. The crucial point is that the explanation of how the Eleatic One is one and indivisible, because homogeneous, makes no reference to parts, and the notion of parts is not so independently clear as to impress itself upon the explanation. In Parmenides, the One is indivisible due to its homogeneity and continuity. This notion also occurs in doxographical reports of Zeno.<sup>47</sup> Zeno B 1 and B 2 do not controvert this approach. In fact, B 1 and B 2 require the notion of homogeneity.

It does appear however that Melissus links being one with being partless, at DK 30 B 9: "if it had bulk, it would have parts, and would no longer be one."<sup>48</sup> This raises some difficulty for the claim that it is no part of Eleatic thought concerning divisibility and indivisibility that being one (indivisible) entails being partless.<sup>49</sup>

I will later consider, in abstraction from exegetical concerns, the *philosophical* question of how the notion of partlessness is to be given a sense. In that connection I will argue that the concept of having parts whereby something has parts just in virtue of being corporeal is a wholly unclear concept. That then gives us reason not to rely on that concept in order to explain Eleatic and Atomist thought. I will here consider the exegetical question of whether Melissus B 9 provides any substantial indirect evidence that the Democritean atom should be taken to be partless.

We can start from what we have already established about Parmenides and Zeno. We have seen no positive grounds for supposing that Parmenides and Zeno took what there is to be partless. More than that we have seen that reading partlessness into Parmenides' and Zeno's discussions would generate some difficulties: for example, as regards Parmenides B 8.25, or Zeno B 2. These conclusions stand independently of what we say about Melissus B 9. So if we take Melissus B 9 at face value we have to conclude that on this issue Melissus is at variance with Parmenides and Zeno. This conclusion should generate no great difficulty, for we know that Melissus differed from Parmenides in some respects and this *must be* such a case. There is a tradition that Melissus' grasp of the issues discussed by the Eleatics tended to be crude.<sup>50</sup> Given this, it is reasonable to suppose that Democritus is reacting to the thought of Parmenides and Zeno rather than to the somewhat divergent, and slightly cruder, thought of Melissus. This exegetical conclusion will be borne out later, when we see that Melissus' notion of indivisibility as involving partlessness cannot have any coherent application to the Democritean

account of a plurality of indivisible bodies of differing sizes and shapes.

We might wonder anyway whether Melissus B 9 can bear a great deal of exegetical weight. Firstly, there is some tension between B 9 and the assertion of homogeneity, for example at B 7.3 f., "In this way, then, it is eternal and infinite and one and all the same,"<sup>51</sup> or at Aristotle, *De Mel.Xen.Gorg.* (DK 30 A 5) 974 a 13 f.: "Being one it must be the same throughout; for if it were not the same, it would be several and thus no longer one but many." For, as with Parmenides B 8.25, how can something be *all* the same if it is a partless entity? For what is the same as what? If *it* (the partless entity) is the same as *it*, then it is inappropriate to talk of it as *all* the same, since "all" suggests some sort of plurality. On the other hand, if it is partless we cannot say what it would be most natural to say, that homogeneity is a relation holding between the parts of a thing.<sup>52</sup>

Secondly B 9 seems contradicted by other texts of Melissus, for we can find a reasonable amount of evidence that Melissus did not hold that what there is is incorporeal. For example, according to B 3 it is unlimited in magnitude. According to B 7.34 f. it must be full because it is not empty. According to B 7.33 f. it neither gives way nor receives. Further De Mel.Xen.Gorg. appears to assert that what there is is corporeal (for example at 976a10-13 and in passing at 976a21 f.). If B 9 should, on these grounds, be held suspect and unreliable, then, in the face of reasonably clear indications that neither Parmenides nor Zeno rely on the notion of partlessness to do any philosophical work, we should not take Melissus B 9 as substantial evidence that in the Eleatic background to which the Atomists are responding there is a concept of indivisibility based on partlessness.53

The consequence of all this as regards the Democritean atom is that we cannot conclude from the fact that the Democritean atom was intended to evade Eleatic arguments that it was a partless body.

There is another contribution that Zeno is thought to have made to the account to be given of the Democritean atom besides that deriving from the arguments against plurality. There is a view that partless atoms are required to answer Zeno's arguments about motion and traversal. Furley is explicit about this.<sup>54</sup> If an atom had parts, then it could never be traversed in thought. For if one imagines half then one has to imagine half of the remainder, and then half of a remainder and so on. Talk of "movement in thought" is a refinement to Zeno's argument,55 but that refinement is not necessary to cause a problem for the Atomists. Since atoms move, it will happen that one passes in front of another. But how is that possible? For first it must pass in front of half of it, and then in front of half the remainder, and so on. The thought is that had the Atomists reacted to an Eleatic argument, they would have required a response to this. A partless atom is presumably the response needed. And so Democritean atoms are viewed as being partless.

But really, this is not at all convincing. First the tension between atoms as partless and atoms as of different sizes is all the more obvious. If A cannot move across B part by part, because B is partless, then A cannot differ in size from B either. For suppose A is smaller than B. Then what growth would be necessary for A to be the same size as B? It would first have to increase by half the difference, then half the remainder and so on. It is not relevant that atoms cannot change in size. The example brings out that if atoms differ in size then we can consider the difference between them in such a way as to imagine movement across it. But this is not possible if movement is of partless atoms. Second, it is not sufficient to have partless atoms. A partless structure for space would be required too.<sup>56</sup> For how can one atom ever come into contact with another? First it would have to cover half the distance between them, and then half the remainder, and so on. If the Atomists knew Zeno's dichotomy argument, and posited partless atoms in order to avoid it, then it seems hard to suppose they were so unobservant as not to notice its application to space. Doubly hard, since the Achilles is immediately applicable to atomic motion. How could one atom ever catch up and collide with another? But there is no evidence that Leucippus and Democritus had an atomic account of time and space. Then there seems as little reason to say that Democritus upheld partless atoms because he would have to avoid the Zenonian dichotomy arguments, as there is to say that he upheld partless spaces because he would have to avoid Zenonian arguments.

A question does remain though: how did Democritus answer Zenonian arguments against motion? For the Democritean theory was intended to save both plurality and motion. Zeno presented arguments against both, but I have given an account only of the Democritean reply to the arguments against plurality. It would be implausible to say that the Atomists never knew of the Zenonian arguments against motion. But it is certainly true, as Aristotle's account of the origins of the Atomic Theory in GC 1.8 suggests, that the arguments against the possibility of motion that worried the Atomists most were not dichotomy arguments but those based on the impossibility of motion without void. It seems equally implausible to say that Democritus and Leucippus adopted a granular structure for space and time. Perhaps Democritus had some mathematical refutation of the error in Zeno's arguments, concerning the infinite series employed,<sup>57</sup> which has not survived. Or perhaps he held that the arguments did not apply to void since, being nothing and empty, there was no sense to considering it divided progressively. At least we have no positive evidence at all from the Zenonian paradoxes of motion that Democritus held the atom to be partless.

I have argued that there is nothing in the texts and doxographies of the Eleatics and Atomists to justify us in basing a notion of indivisibility on partlessness—in effect, nothing to rehabilitate a notion of theoretical indivisibility. I will now approach this matter from a slightly different angle, by considering, in abstraction from exegetical concerns, how the notion of being partless is to be given a sense. It will then follow, first, as regards the Eleatics, that the question whether or not the One has parts is senseless; second, that sense *can* be given to talk of the parts of the atom; third, that we must talk of the atom as what has parts, but cannot on pain of absurdity be divided into them.

One idea would be that having parts and being divided should be explained together, so that if one is clear then so is the other. This suggests the following account of partlessness.<sup>58</sup> Something has actual parts if it is actually divided into them; actual parts are the parts produced by an actual division; something has potential parts when it could be divided; its potential parts are what it could be divided into. Then what cannot be divided will have parts neither actually nor potentially. The partless is just the indivisible.

This is all right as far as it goes, but really it clarifies nothing. Should we say, in terms of this notion, that the Democritean atom is partless? On the one hand, it seems, yes. It cannot be divided on pain of absurdity, since if it could be divided anywhere, it could be divided everywhere, which is taken to be absurd. On the other hand, it seems, no. If one atom is larger than another, then the smaller atom is the same size as part of the larger, and can move across part of the surface of the larger. One might, of course, not call this dividing. This is precisely the crux of the matter. What is to count as a division and what is to count as a part have yet to be specified. There is no general sense to "having a part" or "being a part," and so no sense to the general question "does such and such have parts?" This is why debate over the question "does the Democritean atom have parts?" is likely to be confusing and fruitless.59

It is specified what are to count as parts of a thing when it is specified how parts are to be marked out. For this reason the general question "does such and such have parts?" is empty. The best that the partless *simpliciter* could be would be that of which parts cannot be marked out in any way whatever. But it is surely implausible to suppose that the Democritean atom, or indeed anything whatever, could be in *that* way partless.

The importance of specifying the parts of a thing by saying how they are to be marked out can be seen by consideration of the question "how *many* parts does such and such have?" Like the question "does such and such have parts?" it is senseless in its general form. Take a very clear case. Suppose we specify of the human body that we want its parts marked out by function. Then clearly enough it has

parts—for example, heart and liver—though we may not be able to count them, due to some unclarity over what is to count as the same function. If, alternatively, we specify that parts are to be marked out by the way in which their reproduction contributes to the reproduction of the whole body, then we will take cells to be parts of the body, since within the body it is cells that reproduce to give cells and not, for example, organs that reproduce to give organs. It would then be possible to count the cells in the body at a given time. By that account, a cell would be one of the partless constituents of the body. Specifying how a part is to be marked out gives a sense to the notion of partlessness. Without such a specification the notion of partlessness has no sense.

Now when we consider the Eleatics and Atomists, we plainly do not have such a clear cut example of the specification of parts as with the human body. But attempts to specify what are to count as parts can still be seen in the case of the Eleatics and Atomists, and those are ipso facto attempts to give a sense to the notion of partlessness. Consider the Epicurean analogy with the minimum visible. In that case parts are marked out by sight. A patch has visible parts if I can see something smaller. What has no visible parts, the minimum visible, is that than which I can see nothing smaller. An explanation can be provided for that inability to see something smaller. It is due, as we would say, to some facts about light and vision. But this analogy would not provide any general account of the partless. What has no parts would presumably be that than which there can be nothing smaller. But at once the question of why there cannot be anything smaller arises. If that question cannot be answered, then the sense in which there *cannot* be anything smaller is opaque, and really nothing is explained. Why might I not just insist that there always is something smaller than any given thing, namely half of that thing?

In the case of the Eleatics it is opaque what the marking out of parts could be. Parts could not be marked out by any other thing or any movement, for the Eleatic view is that there is just one thing and no movement. It is similarly opaque how parts could *fail* to be marked out, for there is no other thing or motion by reference to which a marking out could fail. The upshot of this is that it is unclear whether the Eleatic One has parts or is partless, since it is unclear what the sense of talk of partlessness is in this instance.

Plainly enough, when commentators such as Furley talk of the impossibility of drawing mental distinctions within the One, what they are after is some sense for the marking out of parts. The view would be that parts are marked out by the mind, and since no marking out by the mind is possible within the Eleatic One, it is partless. The trouble with this is that the notion relied on for explanation, i.e. marking out by the mind, really is no clearer than that purportedly explained, i.e. having parts. It does not have the recommendation of being the Eleatic's own favoured mode of explanation, nor is it in itself clear. What stops me making mental distinctions within a thing? How do I try to perform such a division? Surely if a thing *did* have parts, it *would* be possible to consider them separately, so that having parts should explain the possibility of distinguishing them mentally, and not *vice versa*. Further, what would be gained by attempting to make clear a sense of marking out parts, in terms of which we could then say that the Eleatic One is partless? This in itself will not cast any light on *how* the Eleatic One is indivisible and one, for that is to be explained in a different way, in terms of homogeneity and continuity. So the attempted account would be superfluous and confusing.

Perhaps some sense of having parts can be got out of what Melissus writes at DK 30 B 9: εἰ μὲν οὖν εἴη, δεῖ αὐτὸ ἓν εἶναι, ἓν δ'ἐὸν δεῖ αὐτὸ σῶμα μὴ ἔχειν. εἰ δὲ ἔχοι πάχος, ἔχοι ἂν μόρια, καὶ οὐκέτι ἕν εἴη. This embodies a common view of what constitutes the possession of parts and partlessness, still presented as an account of a type of indivisibility by commentators. For example, Guthrie writes:<sup>60</sup>

What is one ... is a single whole, without parts, on the primitive logical ground that one and many are contradictory attributes which cannot apply to the same thing ... the atoms were for Leucippus and Democritus without parts, logically as well as physically indivisible, although each was a physical body possessed of a certain magnitude. The infinite divisibility of matter was inconceivable.

There are two views combined here. First that something could have parts just in virtue of being corporeal. This is clearly what Melissus intends by  $\varepsilon i \delta \varepsilon \varepsilon \chi \circ i \pi \alpha \chi \circ \zeta$ ,  $\varepsilon \chi \circ i$ αν μόρια. Second that what has parts is *ipso facto* many. But what is the sense of "having parts" whereby it follows from its being corporeal that an entity has parts? What, for example, does Guthrie *mean* by the *logical* divisibility of a magnitude? There may be some idea of a mathematical construction. Given a certain geometrical theory, it is always possible to construct a magnitude smaller than a given magnitude. The extension to the possession of parts by a body would then be this. What is corporeal is some stuff, and therefore has a certain magnitude, and given the geometrical theory one can always take a smaller magnitude than a given magnitude.<sup>61</sup> But then to hold that a body is partless would rest on a finitist geometry. If this is what is involved in the very concept of partlessness, then, apart from any purely philosophical problems we may find with a finitist geometry, that concept of partlessness will not be of help in discussion of the Eleatics and Atomists. For there is little evidence of any finitist geometry in connection with the Eleatics or Democritus.<sup>62</sup>

We might further ask *why* having parts should pose any threat to the unity of a body, allowing that being corporeal is *ipso facto* having parts. Certainly the Eleatic entity and each Democritean atom are one and not many. They *cannot* be divided. A perfectly good explanation can be given, in terms of homogeneity and continuity. What more could be required to secure the unity of those entities? There might be the feeling that it is necessary to say explicitly that the One, for example, is partless. Otherwise it will seem to be in some way many. But no explanation of being partless is offered, and the notion appears as just an idling addition. It is better to abandon the question "partless or not?" in connection with the Eleatics, once it is seen that there is no mention of finitist geometry. As regards the atom ( $\pi \alpha \nu \tau \eta$  oµoîov), and an account of "having parts," to be given below, which does not threaten that unity. This is preferable to reliance on unexplained and unclear notions of partlessness and logical indivisibility.

There is the sense of partless in which what is unextended is partless, for example the geometrical point. But that sense will not be of help in discussion of the partlessness of the Eleatic and Atomist entities. First, there is little reason to think that the Eleatic One is punctiform. According to Parmenides it is like a sphere,<sup>63</sup> while according to Zeno B 2 its being without magnitude would entail its being nonexistent. Second, even if it could be made plausible that the Eleatic One is punctiform, clearly the Democritean atom is not, and so all parallel between Eleatic and Atomist thought would be lost.

The claim that there is no *sense* to talking about parts in connection with the Eleatic One (so that the question whether or not it has parts cannot be sensibly raised) is clearer if the case of the Eleatics is compared with that of the Atomists, where there *is* sense to be attached to the marking out of parts, and if we compare the Eleatics also with those ancient philosophers who did make a stand on the partlessness of the atom, for example, Diodorus Cronus.

As regards the Democritean atoms there are clear senses to the marking off of parts, for the atoms mark off parts in relation to one another. For example, by their difference in size. It can be explained what it is for an atom to have parts thus. An atom S has parts if there is an atom S\* that is smaller than S. For in relation to S what will the atom S\* be the same size as? Clearly a part of S. This gives a genuine explanation of what the possession of parts is, for the relation "being the same size as" is perfectly comprehensible. Atoms will mark off parts too by moving past one another, or in virtue of their differences in shape. It is impossible to make sense of any of these notions, of difference in size and shape, and the existence of relative motion, as applied to *partless* bodies. The reason is a deep one, that the notion of a body's being partless could only be given a *sense* in terms of some one of those notion's not applying.

This is borne out in those cases where a stand is made on partlessness. Diodorus Cronus believed the indivisible elements of the world to be partless bodies, and there is good reason to think that Diodorus gave an atomistic account of time and space too.<sup>64</sup> It is for precisely this reason that sense can be made of talk of the partlessness of the Diodoran atom. An atom of space is partless in that necessarily it is either full or it is empty, it is not possible that it be partly occupied, partly unoccupied. An atom of time is partless in that necessarily either something is so throughout it or is not so throughout it, it is not possible that it should be first so and then not so within an atom of time. An atom of stuff is partless in that necessarily either it is all in an atomic space or it is all not in an atomic space, it is not possible that it should be partly in and partly out.

So partless bodies, times and spaces are to be explained talk of their partlessness is to be given a sense—all together, in terms of modalities applied to motions and positions. This casts some light on what Diodorus is saying, since, if someone finds the idea of a partless atom of space difficult, we can offer some explanation. To say that it is partless is just to say that necessarily either it is full or it is empty.

Notice that it *follows* from these accounts of what partlessness is that atomic spaces are all of the same size, and ultimate atomic bodies too. Suppose partless space A were larger than partless space B. Then if X were an atom of stuff occupying B, it would occupy only a part of A, which is impossible. So partless atomic spaces are of the same size. So too with atomic bodies. By similar reasoning one could show that all partless atomic bodies and all partless atomic spaces are of the same shape too.

If the sense of talk of partlessness (what partlessness *is*) can be given only by reference to possible motions and positions—and it's not clear how else it could be given—and it follows from this that partless bodies and partless spaces are all of the same size and shape, then the view that the Democritean atoms, which differ from one another in size and shape, could be partless is not just difficult to accept. It is senseless. It leaves us wholly confused as to what is meant by saying they are partless.

My conclusion concerning the Eleatics and Atomists is this. As regards the Eleatics there is no possibility of relations between time, space and bodies, for they are excluded from the Eleatic scheme. If we try to explain what the partlessness of the Eleatic One would be, in a counter-factual way, then either there is little connection with Eleaticism, and we may as well be considering Atomism—if, for example, we were to say that the Eleatic One is partless in that *if* there were another body, it *could not* move across the One part by part—or we become involved in an unexplanatory quagmire—if, for example, we were to say that the Eleatic One is partless in that one cannot mentally distinguish parts within it. With the Atomists there *are* relations of time, space, and motion, so that there is some sense to the question "partless or not?"

But the variety of atomic size and shape, which must serve as a constraint on any coherent interpretation, and the absence of any evidence for spatial or temporal atomism in Leucippus or Democritus, make it impossible to put forward an account of the Democritean atom as a partless body that would give a view to which any coherent sense could be attached. If, therefore, we want, as interpreters, to treat the Democritean view seriously, as of some philosophical sense and interest, we are forced to see the atom as an extended body with parts, and shown indivisible by an argument, the  $\pi \alpha v \tau \eta \dot{\eta} \phi \mu \hat{\eta} o v$  argument, starting from the homogeneity of the atom.

#### Notes

- 1. I discuss the use of this argument form by the Eleatics in my "Zeno On Plurality," *Phronesis* 1982. I do not, in this paper, *establish* that the Democritean account of the indivisibility of the atom is based on the argument form I outline in the paper. To establish that convincingly would require making a long paper considerably longer. For it would be necessary to consider at length the reports by Aristotle at GC 1.2,8. I discuss those Aristotelian texts in a separate paper currently in preparation.
- For uses of the phrase παντῆ ὁμοῖον in the Eleatics, see Simplicius in *Phys.* 139.27-140.6; this passage is discussed in the paper cited in note 1 above. Reference to the Greek commentators is to the page and line number of the *Commentaria in Aristotelem Graeca* edition.
- 3. The point is put at GC 1.8 325a9-12 in connection with the Eleatics.
- This argument is of a more general form, known as où μαλλον arguments, after the Greek phrase meaning "no more-than." On those arguments see my paper, "Buridan's Ass," *Ratio* 1986.
- 5. See Aristotle's summary at GC 1.8 325a8 f. in connection with the Eleatics. Compare also GC 1.2 316a5 ff.
- 6. See Parmenides, DK 28 B 8.22, 25.
- Note the use of φανερόν (plain, obvious) at GC 1.2 316b29.
- 8. Simplicius, in *De Caelo* 242.20 on = DK 67 A 14.
- 9. Compare the passages cited by Luria pars. 220-235. Especially the analogy suggested by Aristotle *De Caelo* 1.7, 275b30 on: as if each atom were in separation gold.
- See, for example, Furley, *Two Studies in the Greek* Atomists (Princeton University Press, Princeton/New Jersey, 1967), Study I; Stokes, *One and Many in Presocratic Philosophy* (Centre for Hellenic Studies, Washington DC, 1971), pp. 225 on; Sorabji, "Atoms

and Time Atoms," in *Infinity and Continuity in Ancient and Medieval Thought*, ed. N. Kretzmann (Cornell University Press, Ithaca and London, 1982), gives the question and summarizes a list of opinions. This work has now been reworked and expanded in Sorabji, *Time, Creation and the Continuum* (Cornell University Press, Ithaca and New York, 1983)—see p. 354, note 18.

- 11. As Furley. "Conceptual indivisibility" is sometimes put instead of "theoretical indivisibility."
- 12. This interesting line has recently been argued for by Sorabji, *op. cit.*, pp. 354-357 and "Atoms and Time Atoms," *op. cit.*, pp. 44 f. Leucippus and Democritus did not, he argues, distinguish between physical and theoretical (conceptual) indivisibility. Epicurus did later, and commentators read his distinction back into the early Atomists. This account fits well with Sorabji's view, expressed in his "Aristotle and Oxford Philosophy," *American Philosophical Quarterly* 6 (1969), pp. 127-135, that Aristotle did not distinguish between logical and non-logical necessities. It explains also the clash in the doxographical evidence on the indivisibility of the atom.
- 13. Besides the solidity of the atom there is its hardness. These are distinguished in the doxography. E.g. it is not simply repetition when Simplicius writes, Luria par. 212: ... ἦ τῷ μόρια ἔχειν καὶ μέγεθος, ἀπαθὲς δε είναι δια στερροτήτα και ναστοτήτα, καθάπερ ἑκάστη τῶν Δημοκρίτου ἀτόμων. Now hardness and solidity are distinct properties. The former is the capacity to retain shape under pressure, the latter is the absence of internal gaps. Yet Democritus would have grounds for holding that a solid atom is a hard atom too. The link of atomic hardness and atomic solidity is built on Democritus' principle that there is just one type of atomic stuff, referred to at fn. 9 above. Since the void offers no resistance to intrusion, nothing on the macroscopic level can be any harder than the single stuff of which the atoms are formed. Therefore any strength or hardness on the macroscopic level must be due to the hardness of the atomic stuff. But it is plain that some things on the macroscopic level are extremely hard. So the atom must be at least that hard. Since the void offers no resistance, and anything perceptible contains some void, it is plausible to suppose that it is the presence of void that is the source of weakness or softness on the macroscopic level. Theophrastus De Sens. par. 62 confirms that Democritus did draw this conclusion. In that case the atom would be far harder than any stuff on the macroscopic level.
- 14. Note that Sorabji talks of solidity as evidence of *physical* indivisibility, *op. cit.*, p. 355: "A second consideration suggesting physical indivisibility is that many passages give us Democritus' reasons

for the indivisibility of the atoms their solidity ( $\nu\alpha\sigma$ tot $\eta\varsigma$ ,  $\sigma\tau\epsilon\rho\rho\sigma\tau\eta\varsigma$ , *soliditas*) and the absence of void within them, and these sound like physical reasons."

- 15. I would thus disagree with Barnes' remark that with the case of solidity "we have here a physical, not a metaphysical hypothesis ... solidity does not logically imply indivisibility; but the physical process of division requires a porous body to work upon." *The Presocratic Philosophers* (Routledge and Kegan Paul, London, 1979), Vol. 2, p. 47.
- 16. Furley, op. cit., p. 4.
- 17. Ibid., my emphasis.
- 18. Ibid., pp. 95 f.
- 19. See Epicurus, Letter to Herodotus, pars. 57-59.
- 20. Compare Sorabji, op. cit., p. 348.
- 21. Furley, op. cit., pp. 95 f.
- 22. This is precisely the point made by Wittgenstein in the passage from *Philosophical Investigations*, par. 47, with which this paper opens.
- 23. Barnes, op. cit., Vol. 2, pp. 54 f.
- 24. Ibid., pp. 54 f.
- 25. Ibid., p. 54.
- See for example Furley, op. cit., p. 94. Or Guthrie, A History of Greek Philosophy (Cambridge University Press, Cambridge, 1965), Vol. 2, pp. 127-135.
- 27. Furley (*op. cit.*, p. 97) writes: "... Democritus' atoms were supposed to be so small that distinctions could not be made inside them. Yet they had some magnitude and many variations in shape and size. There seems to be an inescapable contradiction here." He is content though to go on to make textual objections to Luria's heterodox view that the Democritean atom, like the Epicurean, was theoretically divisible into minimum parts.
- 28. Konstan, "Problems in Epicurean Physics," *Isis* 70 (1979), pp. 394-418. See p. 399, note 17: "There is a tradition that Democritus believed that atoms could be very large, even the size of the cosmos; ... If this is credible, then the argument for indivisibility on the grounds of smallness or partlessness must go."
- 29. DK 68 A 105.
- 30. See also Stobaeus, Ecl., 1.14.1.
- 31. I owe this suggestion to David Sedley. I heard him make it in a seminar. I do not know whether he agrees with this use of it, or even whether he intended it as anything more than just a suggestion in passing.

Compare the similar suggestion at Sorabji, *op. cit.*, p. 356, note 27.

- 32. Furley, *op. cit.*, p. 95 says that Simplicius' "hasty reference" at Luria, par. 212 (in Phys. 82.1 on) "should not be preferred;" but that assertion seems to be unsupported.
- Luria, par. 106, also from Stobaeus: Δημόκριτος ... περὶ τ'ἀμερὴ ἴστασθαι τὴν τομήν.
- 34. It is sometimes claimed that only partless entities would avoid Zenonian arguments. For example, Sorabji, *op. cit.*, p. 356. I will discuss whether or not the Zenonian arguments require a notion of partlessness below.
- 35. The argument of this passage is discussed and analysed in my "Zeno on Plurality."
- 36. De Lineis Insecabilibus, 968a2.
- Melissus B 9: εἰ δὲ ἔχοι πάχος, ἔχοι ἂν μόρια, καὶ οὐκέτι ἕν εἴη.
- 38. There is something paradoxical in the remark by Stokes, *op. cit.*, p. 135: "in respect of being there is no distinction between the parts (which makes it difficult to talk about parts at all, and Parmenides sedulously avoids doing so)."
- 39. See for example Furley, *op. cit.*, pp. 85 f. and the passage cited from Sorabji at note 34 above.
- Reading as Frankel, rather than Diels-Kranz who put ἐκ τοῦ before ἕκαστον. See Frankel, "Zeno of Elea's Attacks on Plurality," in *Studies in Presocratic Philosophy* (Routledge and Kegan Paul, London, 1975), Vol. 2, especially pp. 110 f. and notes.
- 41. It is possible of course that just such considerations lead to the view that Zeno did away with the One and the Many. See Eudemus at DK 29 A 21. On Zeno's support for Parmenides see my "Zeno on Plurality," note 6.
- 42. This form of argument, based on the move "plurality presupposes a unit" is often attributed to Zeno. See the reports of Simplicius and Philoponus at DK 29 A 21, and of Eudemus at 29 A 16. The argument is common also in later philosophers. See for example Leibniz, *The Leibniz-Arnauld Correspondence*, tr. H. T. Mason (Manchester University Press, Manchester, 1967), p. 121, from Leibniz to Arnauld 30 April 1687. Also Hume, *A Treatise of Human Nature*, 1.2.2, ed. L. A. Selby-Bigge (Clarendon Press, Oxford, First Edition, 1888), pp. 30 f.
- 43. See the passage from Philoponus in Phys. 42.9 on (partly at DK 29 A 21), given by Lee, *Zeno of Elea* (Cambridge Classical Studies: Cambridge University Press, Cambridge, 1936) at par. 8: the opponents

of Zeno base their support for a plurality on its obviousness (ἐνάργεια).

- 44. It can also be seen from what I have said of the argument that the summary given, along with the rest of B 2, does not threaten the view of Zeno as a supporter of Parmenides. On this, compare note 41 above.
- 45. The opening εἰ δὲ ἔστιν of B 1 is just hanging: "if it is what" or "if what is"? From B 8.10 (οὕτως εἰ πολλὰ ἔστιν) πολλὰ or τὰ πολλὰ is intended.
- As Melissus B 9, ... ἔχοι ἂν μόρια, καὶ οὐκέτι ἕν εἴη.
- 47. See the discussion in my "Zeno on Plurality."
- 48. εί δὲ ἔχοι πάχος, ἔχοι ἂν μόρια, καὶ οὐκέτι ἕν εἴη.
- 49. I would like to thank an anonymous referee for *Archiv für Geschichte der Philosophie* for emphasising the importance of the difficulties posed by Melissus B 9.
- 50. See Aristotle, *Phys.* 186a8 f., *Met.* 986b26f. More recently Barnes has contested this opinion, *op. cit.*, Vol. 1, pp. 180 on. But the passage he quotes from Plato, *Theaetetus* 183 e, agrees exactly with Aristotle's estimate at *Met.* 986b26 f. of the *relative* merits of Parmenides and Melissus.
- οὕτως οὖν ἀίδιον ἔστι καὶ ἄπειρον καὶ ἕν καὶ ὑμοῖον πῶν.
- 52. It is interesting to notice that a similar point is made at *De Mel.Xen.Gorg.*, 976a 13 ff., about the homogeneity of the universe.
- 53. Barnes, op. cit., Vol. 1, pp. 226 ff. discusses the difficulties of reconciling B 9 with other of Melissus' texts. Somewhat hesitantly, Barnes adopts the view that B 9 is not about the Eleatic One, but is part of an attack on the pluralist opponents of Parmenides. If that is the correct account to give of B 9, then the question arises of whether, for the opponents of the Eleatics, having parts would entail being many. That question, and its relevance to the account to be given of atomic indivisibility, has already been dealt with in discussion of Zeno B 2 and B 1 in the body of this paper.
- 54. Furley, op. cit., p. 86.
- On the argument thus refined, see Epicurus, *Letter to Herodotus*, par. 57; pseudo-Aristotle, *De Lineis Insecabilibus* 968a27; Aristotle, at *Physics* 8.8 263a27 on; Simplicius, *In Phys.* 1289.5 on.
- 56. Also for time. These links were made by Aristotle, Physics 6.1, and in the atomist tradition by Diodorus Cronus. On the atomism of Diodorus Cronus, see

Denyer, "The Atomism of Diodorus Cronus," *Prudentia* 13 (1981), pp. 33-45. See also Sorabji, *op. cit.*, chap. 24.

- 57. This suggestion was made to me in passing by David Sedley.
- 58. This account was suggested to me by Nicholas Denyer, as an account that an Aristotelian might give of the partless. If it appealed to some Aristotelian commentator, then we can see how the partlessness of the atom got into the tradition of discussion of the early Atomists. For the Democritean atom is without doubt what cannot be divided.
- 59. As regards this account of the partless-as-indivisible in the history of discussion of the atom, what sense does it allow us to make of Simplicius' characterisation at Luria par. 212 of a sense of ἀδιαίρετον thus: ... ἦ τῷ μόρια ἔχειν καὶ μέγεθος, ἀπαθὲς δὲ εἶναι διὰ στερροτῆτα καὶ ναστοτῆτα, καθάπερ ἑκάστη τῶν Δημοκρίτου ἀτόμων?
- 60. Guthrie, op. cit., Vol. 2, p. 503.
- 61. This is the way that a scholiast on Euclid 10 takes the Democritean theory. See DK 68 A 48a; the text is given more fully at Furley, *op. cit.*, p. 98, note i: ὅτι οὐκ ἔστιν ἐλάχιστον μέγεθος, ὡς οἱ Δημοκρίτειοι φασὶν, καὶ διὰ τούτου τοῦ θεωρήματος δείκνυται, εἰ γε παντὸς τοῦ ἐνκειμένον μεγέθους δύνατον ἕλαττον λαβεῖν.
- 62. On this see Vlastos, "Minimal Parts in Epicurean Atomism," *Isis* 56 (1965), pp. 121-147, especially pp. 125-131.
- 63. DK 28 B 8.42 ff.
- 64. See the collection by K. Doring, *Die Megariker*, (Amsterdam, 1972), pars. 116, 117 A—F, 120. See also Denyer, *op. cit.*; Sorabji, *op. cit.*, chap. 24.

# Todd Stuart Ganson (essay date 1999)

SOURCE: Ganson, Todd Stuart. "Democritus against Reducing Sensible Qualities." *Ancient Philosophy* 19.2 (1999): 201-15. Print.

[In the following essay, Ganson disputes Aristotle's claim that Democritus considered such sensible qualities as taste and color to be reductive, or determined by the atomic-level structure of the perceived object. Rather, Ganson explains, Democritus argued instead that, based on his observations of sensory variability, sensible qualities are the products of individual perceivers' physiologies.]

Aristotle and Theophrastus have preserved for us what they take to be Democritus' definitions of colors and
flavors, accounts which seem to identify these sensible qualities with micro-physical features of things in the environment.<sup>1</sup> For example, we find that being sweet just is being constituted predominately from round, large atoms (DK 68A129 and 135.65). In this way Democritus apparently makes room for colors and flavors in a world constituted from colorless and flavorless atoms: macroscopic objects possess colors and flavors in virtue of their constitution at the atomic-level.<sup>2</sup>

Aristotle refers to this approach to sensible qualities when he tells us that Democritus 'reduces the flavors to the shapes' (εἰς δὲ τὰ σχήματα ἀνάγει τοὺς χυμούς, DK 68A126). In Aristotle's usage, 'A reduces to B' expresses a claim of explanatory priority.<sup>3</sup> In many cases, including the case at hand. Aristotle takes reduction to involve identification,<sup>4</sup> and in such cases 'A reduces to B' apparently amounts to something like the following: A and B are identical and, by referring to the item in question as B, we are picking out the item in an explanatorily more fundamental way than if we refer to it as A. For example, if we say that honey tastes the way it does because it is sweet, this explanation-however sound it may be-is not as causally deep as an explanation which makes explicit the micro-structure of the honey, and yet being sweet just is having that micro-structure. In what follows, I will adopt Aristotle's terminology, often speaking of a 'reductive' approach to colors, flavors, etc.

The evidence in favor of a reductionist interpretation of Democritus is considerable,<sup>5</sup> and the philosophical position is itself attractive,<sup>6</sup> so we have good reason to take this reading seriously. However, my concern here is not principally with the evidence suggesting that Democritus thinks of sensible qualities as causally efficacious features of the world around us; rather, I am interested in certain reports which speak against this interpretation. As we shall see, there is reason to believe that Democritus is unhappy with the project of reducing sensible qualities to microproperties of external objects. I want to try to understand what it is about this project that Democritus finds objectionable.

For the details of Democritus' views on sense-perception we must turn to Theophrastus' lengthy discussions in *De sensibus* and *De causis plantarum*. Later authors such as Sextus, Galen, and Plutarch make only brief and casual remarks about Democritus' theory, and they do not exhibit the sort of familiarity with Democritus' writings on the subject that we find in Theophrastus. So the project of figuring out what Democritus thinks about the status of sensible qualities ought to begin with the task of determining how Theophrastus understands Democritus' position.

The testimony of Theophrastus is clearly indispensable, but we need to proceed with caution because Theophrastus is not always altogether charitable to Democritus. Consider the most relevant example here: Theophrastus does not hesitate to attribute to Democritus an incoherent position on the ontological status of sensible qualities (see DK 68A135.60-61 and 135.69). Following Aristotle's interpretation, Theophrastus tells us that Democritus endorses reductive definitions of colors and flavors; at the same time, he reports that Democritus argues against a reductive approach to sensible qualities. But even if Theophrastus is not entirely charitable to Democritus, I do think that he is duly impressed by Democritus' reasoning about whether sensible qualities reduce to micro-features of the world. In the course of setting out Democritus' views concerning the objects of sense-perception, Theophrastus credits Democritus with a remarkable argument which is supposed to show that the phenomenon of sensory variability undermines the project of reducing sensible qualities. In his own attack on the reductive approach to sensible qualities, Theophrastus shows his respect for Democritus' argument by repeating it.

I believe that commentators have missed the interest of Democritus' appeal to the phenomenon of sensory variability because they have not paid close enough attention to Theophrastus' report at *De sensibus* 63-64. In section one I briefly describe how Aristotle and Theophrastus criticize Democritus' (alleged) attempts to reduce sensible qualities to micro-properties of external objects. These preliminary remarks prepare us for Democritus' argument set out at *De sensibus* 63-64. After considering this argument in section two, I explore some familiar aspects of Democritus' views on the ontology and epistemology of sensory experience.

Ι

In this section I assume, with Aristotle and Theophrastus, that Democritus developed a number of reductive definitions of colors and flavors. Whether or not Democritus in fact endorses these accounts as *definitions* of the qualities is a question I will set aside (though, I am inclined to doubt that he does).<sup>7</sup> What I want to explore here are Aristotle's and Theophrastus' criticisms of these definitions. In the next section I compare these criticisms with what is supposed to be Democritus' own objection to this way of defining the properties in question.

I begin with Aristotle's critique of Democritus in *De sensu* 4. In Aristotle's terminology color is the proper object of sight, flavor of taste, odor of smell, etc.; they are proper objects for the reason that they cannot be perceived by another sense (see *De anima* 418a11-12). The common objects of perception are, e.g., shape and size, objects of more than one sense. Aristotle tells us that Democritus and other unspecified students of natural science treat common objects as though they were proper:

they use the objects common to all the senses as proper objects; for size and shape, roughness and smoothness, moreover sharpness and bluntness in bodies, are common to the senses, if not to all, at any rate to sight and touch.

(442b4-7)

Democritus is somehow committed to the view that the proper objects of sight turn out to be properties like roughness and smoothness. Why does his theory have this consequence? Aristotle explains:

Some reduce the proper objects of perception to these  $\langle sc.$  the common objects of perception $\rangle$ , as does Democritus. For he says about white and black that the one is roughness, the other smoothness, and he reduces the flavors to the shapes.

(442b10-12)

An object's whiteness is identical with a certain sort of smoothness. Since white is a proper object of vision, this smoothness turns out to be a proper object of sight. So Aristotle's claim that students of nature like Democritus treat common objects as proper objects is explained by the further claim that they reduce sensible qualities like sweetness to properties like shape at the micro-level. Notice that reduction involves identification here.

Aristotle argues that Democritus' reduction is unsuccessful because it leaves central facts about the colors and flavors unexplained. Here are his two most significant objections:

Further, all sensible qualities have contrariety, e.g., in color white to black, in flavor bitter to sweet, but shape does not seem to be contrary to shape; for what polygon is contrary to the circle? Further, since the shapes are infinite, it is necessary that the flavors also be infinite; for why would one flavor produce perception, but another not?

### (442b17-23)

A familiar fact about black and white is that they are opposite to one another. A successful reduction of these qualities will account for this fact, but Democritus' theory does not. Furthermore, the number of flavors is finite. Again, it does not seem that Democritus can account for this fact.

We need to be clear about what Aristotle's argumentative strategy is here. As I pointed out in note 3 above, when Aristotle talks about Democritus' reductionist efforts, he is speaking of attempts to *account for* phenomena. On Aristotle's usage, to say that the colors and flavors reduce to the shapes is to say that facts about the colors and flavors, literally, *lead back to* facts about the shapes: familiar truths about colors and flavors follow from facts about the shapes. So Democritus' reduction of colors and flavors will succeed only if he is able to derive familiar facts like the opposition of black to white from an analysis of the relevant micro-entities. Given this understanding of Democritus' project, Aristotle's argumentative strategy is a good one.<sup>8</sup> He hopes to point out explanatory gaps in Democritus' theory that cannot be filled within the constraints imposed by that very theory itself. Democritus cannot respond to Aristotle by insisting that the opposition of white to black is guaranteed by facts about our visual organs, for this sort of explanation is not a case of 'reducing to the shapes.'<sup>9</sup>

In *De causis plantarum* vi Theophrastus raises two objections to Democritus' attempt to define flavors 'by means of the shapes.' Like Aristotle, Theophrastus assumes that Democritus' definitions are intended to explain observable facts about the flavors. And like Aristotle's, Theophrastus' strategy is to locate explanatory gaps in Democritus' theory. I am going to focus here on the first of Theophrastus' two criticisms.

On Theophrastus' understanding of Democritus' reduction of the flavors, Democritus is attempting to explain observable effects which the flavors have on the gustatory organ:<sup>10</sup>

When  $\langle Democritus \rangle$  assigns  $\langle$  the flavors $\rangle$  in this  $\langle$  reductive $\rangle$  manner, he thinks he is providing explanations of why it is that one flavor puckers, dries, and solidifies, while another smooths over, balances, and restores, and another separates, disperses, and so on.

(2.1)

The problem with this project, as Theophrastus sees it, is that Democritus' explanations are inadequate: Democritus' definitions of the flavors simply cannot account for these effects (see DK68A130; cf. A135.72). Suppose that sweetness is correlated with effects A, B, and C on the gustatory region, while bitterness is correlated with D, E, and F. By defining sweetness as being constituted predominately from round, large atoms, Democritus is, among other things, attempting to explain why sweet things produce A, B, and C, rather than D, E, and F, and so on. However, it turns out that something's being constituted predominately from round, large atoms is not sufficient for its bringing about A, B, and C. Whether A, B, and C occur depends on facts about the perceivers affected. After all, a different set of perceivers might experience D, E, and F upon eating things constituted from round, large atoms. Hence, Democritus' definitions cannot explain the observable effects which they were intended to explain. An adequate explanation must invoke facts about perceiving subjects, so a reduction proper is not possible.

In setting out this objection, Theophrastus appeals to Democritus' views on sensory variability. According to Theophrastus, Democritus assumes that the same microproperty will often have significantly different effects on differently constituted sense-organs (see *De causis plantarum* vi 2.1-6.2.2). Accordingly, in order to explain why things taste as they do, one must make reference to facts about us. Democritus' reductive definitions are thus unable to account for a fundamental fact about the flavors: that they taste as they do. Since a correct explanation must invoke facts about the physiology of perceivers, Democritus' reduction to the shapes is unsuccessful.

It is clear from the discussion in the previous section that Aristotle and Theophrastus employ the same sort of strategy when they take on what they assume to be Democritus' attempts to reduce colors and flavors. They both believe (for different reasons) that his reductive definitions are inadequate as reductions of the properties in question because they fail to account for phenomena which any reductive theory needs to explain. In this section I suggest that this argumentative strategy originated with Democritus himself.

The relevant passage here is *De sensibus* 63-64. Theophrastus has just explained that Democritus embraces reductive definitions of the heavy, light, hard, and soft. For example, lead's being heavier than iron consists in its having less void, and in general what is lighter has more void (62). Theophrastus then goes on to tell us that Democritus rejects this reductive approach in the case of other sensible qualities like heat and the various flavors:

He defines heavy, light, hard, and soft in these terms. Of none of the other sensible qualities is there a  $\phi \dot{\upsilon} \sigma \iota \varsigma$ ; rather, all are affections of the altering sense-organ from which the appearance comes to be. For a  $\phi \dot{\upsilon} \sigma \iota \varsigma$  does not belong to the cold, nor to the hot; rather, the shape, as it changes, effects an alteration in us as well ... A sign that (the other sensible qualities) are not  $\phi \dot{\upsilon} \sigma \iota$  is the fact that the same things do not appear to all animals; rather, what is sweet to us, this is bitter for other animals, sharp for others ... Furthermore, (men) themselves change in composition according to their affections and age; whence also it is clear that the disposition is causally explanatory of the appearance.

According to Theophrastus, Democritus offers an argument from sensory variability to show that colors, flavors and the rest are different from properties like *being heavier than iron* and *being lighter than lead*, an argument which demonstrates that the former, unlike the latter, do not have a  $\phi \dot{\upsilon} \sigma \iota \varsigma$ . Two obvious questions about this passage need to be considered. First, what does Theophrastus mean when he says that something has a  $\phi \dot{\upsilon} \sigma \iota \varsigma$ ? Second, what is the argument here for the conclusion that colors and flavors lack  $\phi \dot{\upsilon} \sigma \iota \varsigma$ ? I begin with the first question.

There is an issue about how we ought to translate the term  $\phi \dot{\upsilon} \sigma \varsigma$  which Theophrastus uses throughout his discussion of Democritus and Plato on sensible qualities (59-91). Theophrastus begins his treatment of views on sensible qualities by asserting that no one before Democritus and Plato had sufficiently attended to the nature ( $\phi \dot{\upsilon} \sigma \varsigma$ ) of each of the qualities (59). After quickly dismissing the views of Anaxagoras and Empedocles, Theophrastus

explains that, while Democritus and Plato do define the φύσις of each of the sensible qualities, they get into real trouble concerning φύσις (60-61). If we follow G. M. Stratton's translation, there is a shift in the meaning of φύσις from 59 to 60. In 59 Theophrastus is clearly denying that Anaxagoras and Empedocles adequately investigated the nature (φύσις) of each quality. But in 60 Stratton thinks that the issue has become the 'external reality' of the qualities: Democritus and Plato both get into trouble when it comes to thinking about the external reality  $(\phi \dot{\nu} \sigma \iota \varsigma)$  of sensible qualities. The issue here is whether we should follow Stratton and suppose that the meaning of φύσις shifts, so that Theophrastus begins in 59 by talking about the *nature* of the qualities (what each is) and then turns in 60 to the externality of the qualities (where each is).

The main problem with Stratton's interpretation is that it does not sufficiently take into account the larger context of 60. In 60 Theophrastus explains that both Democritus and Plato fail to be consistent in their thinking about the φύσις of sensible qualities. In the case of Plato Theophrastus begins by claiming that Plato does not deprive sensible qualities of φύσις, and a few lines later he tells us that Plato ends up speaking in a manner which conflicts with his initial assumption that sensible qualities have φύσις. Theophrastus' meaning here is clarified in his lengthy discussion of Plato (83-91). Plato starts out by offering explanatory definitions of the sensible qualities; e.g., he defines heat in terms of shape (87). But when Plato turns to the flavors, he fails to tell us what the φύσις of each is (89).<sup>11</sup> Instead of offering us an account of the essence ( $\tau \eta v$ oύσίαν) of each flavor, Plato merely describes their effects on the sense-organs. Notice that Plato's problem concerning φύσις has nothing to do with the external reality of the qualities; Plato never denies that flavors are features of the world around us. The problem is that Plato has an inconsistent approach to defining the qualities. In the case of heat Plato's definition appeals to a causally explanatory property: shape. But in his accounts of the flavors Plato merely says things like 'what is astringent contracts the pores.' According to Theophrastus, this account of astringency fails to get at the φύσις of the flavor, for accounts of this sort fail to reveal what the essence (την οὐσίαν) of each flavor is and why the flavors have the effects they do (διὰ τί ταῦτα δρῶσιν). In general an account of the φύσις of a sensible quality will tell us what that quality is such that it has the effects that it does. So φύσις in 60 should be understood as nature or explanatory essence, not as external reality.<sup>12</sup>

We began by asking about the meaning of  $\phi \dot{\upsilon} \sigma \iota \varsigma$  at *De* sensibus 63-64, where Democritus is arguing that colors and flavors are different from the properties *being heavier than* and *being softer than* because the former, unlike the latter, lack  $\phi \dot{\upsilon} \sigma \iota \varsigma$ . My view is that  $\phi \dot{\upsilon} \sigma \iota \varsigma$  has the same meaning at 60 and 63-64, so that Democritus is arguing that colors and flavors do not have a  $\phi \dot{\upsilon} \sigma \iota \varsigma$  in the sense of

an *explanatory essence*. The things we call 'heavy,' 'sweet,' and 'hot' all have familiar effects on us and other bodies. To say that the property *being heavier than* has a nature is to say that a definition of that quality will capture what heavy things are such that they bring about these familiar effects. Clearly, if the project of developing such explanatory accounts of, say, the flavors cannot succeed, then fruitful reductive definitions of the flavors will not be forthcoming. So, on my reading, Democritus' argument at *De sensibus* 63-64, if successful, will demonstrate that we cannot reduce flavors to explanatory features of the world.

But why do I assume that φύσις has the same meaning at 60 and 63-64? Attention to the discussion of Democritus which follows 60 reveals that 63-64 is simply developing the remarks on φύσις in 60. In 60 Theophrastus asserts that Democritus and Plato are both inconsistent in their approach to the  $\phi \dot{\upsilon} \sigma \iota \varsigma$  of sensible qualities. Whereas Plato begins by treating sensible qualities as explanatory features of the world around us, Democritus starts out from the assumption that such qualities lack nature. And while Plato seems to abandon his project of offering explanatory accounts of the qualities, Democritus ends up developing reductive definitions of colors and flavors not unlike Plato's definition of heat in terms of shape. At 63-64 Theophrastus is substantiating his claim in 60 that Democritus deprives sensible qualities of nature; he provides what he takes to be Democritus' argument for the thesis that sensible qualities lack φύσις. (And at 65-67 and 73-78 Theophrastus backs up his assertion that Democritus offers reductive definitions of the flavors and colors.) Since 63-64 develops Theophrastus' point about φύσις at 60, φύσις surely has the same meaning in both texts.

We can now turn to Democritus' argument for the conclusion that a reductive approach to sensible qualities cannot succeed. Democritus' reasoning, as it is captured in 63-64, appeals to the phenomenon of sensory variability. Democritus apparently starts out from the assumption that sensible-quality appearances sometimes differ among members of different species. Theophrastus does not tell us on what grounds Democritus recognizes cases of appearances differing inter species. Perhaps he is impressed by differences in behavior, as Heraclitus before him (see DK 22B13 and B61) and Pyrrhonists after (see Sextus, Outlines of Pyrrhonism i 55 ff.). Theophrastus does, however, provide Democritus' explanation of such differences. The explanation is stated in 64: 'whence also it is clear that the disposition is causally explanatory of the appearance.' It is first of all evident that a difference in appearance between members of different species is often best explained by a difference in physiology. But humans themselves differ from one another in physical constitution, and it is evident also in these cases that differences in constitution can explain differences in sensible-quality appearance. That is, whether an object tastes sweet, bitter, or otherwise depends on one's physiology. Or, as Theophrastus puts it, one's bodily constitution is causally explanatory of the appearance which one enjoys.

How do these reflections on the phenomenon of sensory variability reveal the inadequacy of a reductive approach to the sensible qualities? On Theophrastus' understanding of the argument, Democritus arrives at the preliminary conclusion that one's physical condition causally explains one's sensible-quality appearances. That is, the distinctive ways that sensible qualities appear cannot be explained without reference to the physiology of perceivers. Why does this conclusion undermine a reductive approach to the sensible qualities? For Theophrastus the answer is obvious. A reductive account of, say, the flavors will derive the fundamental truths about the flavors from the reduction base. What Democritus' argument shows is that essential features of the flavors-their distinctive appearancescannot be explained in this manner. The phenomenon of sensory variability points to an explanatory gap in the reductive approach. Hence, reduction here is not viable.

It is now easy to see that Democritus and Theophrastus raise the same problem for the project of reducing colors and flavors to micro-properties. Both argue that a reductive approach to these sensible qualities cannot succeed because there are central facts about such qualities facts about how they appear—which cannot be accounted for except in terms of the physiology of perceivers. Presumably Theophrastus restates Democritus' argument in his own attack on the reductive approach because he thinks it is a good one.

# III

In the last section we found Democritus appealing to the phenomenon of sensory variability in an attempt to undermine the reduction of sensible qualities to microproperties. While this rejection of a reductive approach presumably plays a crucial role in Democritus' reasoning about the status of sensible qualities, we should hope that Democritus has more to offer in defense of his alternative suggestion that sensible qualities are affections of our sense-organs, for he has hardly shown that, in Sextus' words, 'there isn't anything sweet among external things' (Against the Mathematicians viii 184). Democritus has not even ruled out the possibility that sweetness is identical with a micro-physical property of external objects, for such an identification could perhaps be secured by means other than reduction. So we still want to know why Democritus deprives the external world of colors and flavors.

Theophrastus provides the answer here: 'earlier he [sc. Democritus] said the following: [i] dissimilar things appear to those who are dissimilarly disposed, and [ii] one attains the truth no more than another' (DK 68A135.69). On the assumption that [i] and [ii] are his premises, it is easy to see how Democritus establishes the claim that colors and flavors are no part of the world

around us. Take [i] as affirming that differences in bodily constitution systematically result in incompatible sensiblequality appearances. For example, individuals will routinely be in genuine disagreement about what flavor a certain wine has as a result of a physiological difference, a difference in the condition of the gustatory organ. And in general any apparently flavored object will present incompatible gustatory appearances provided that the relevant bodily constitutions are suitably distinct. Accordingly, for any object which seems to have a flavor, the various bodily conditions will not all yield veridical gustatory appearances of that object. Premise [ii] states that all of the various bodily conditions are on a par with respect to tracking the truth about what flavors things have: one bodily constitution is getting at the truth if and only if the others are. Hence, none of the bodily conditions yield veridical gustatory appearances of any object, and all of our attributions of flavor to objects around us are mistaken.

This argument is evidently valid and its conclusion is striking, so we have reason to take an interest in the premises. I focus here on premise [ii].<sup>13</sup> Democritus has already shown that the fundamental truths about the sensible qualities are not grounded in rerum natura. One cannot explain why the colors are the way they are simply by investigating the world around us; rather, color truths flow from facts about us, our physiology. Now if disagreement about the colors occurs among us because of some difference in physiology, nothing in rerum natura could decide the disagreement.<sup>14</sup> For the color truths simply do not derive from the world around us. We might put the point by saying that there is no 'objective' measure of truth here. But without some objective standard to decide such disagreements, the various bodily constitutions seem to be on a par with respect to truth, as premise [ii] states.

Premise [ii], then, evidently depends on the assumption that the fundamental truths about the sensible qualities are not derivable from facts about objects in the environment. Since the truths about the sensible qualities do not follow from the natures of things, nature cannot favor one group over another in disagreements concerning the qualities. The argument against reduction thus plays a crucial role in Democritus' defense of the claim that 'there isn't anything sweet among external things.' Democritus needs to rule out the possibility that there might be some objective standard for deciding disagreements about the sensible qualities. The argument against reducing sensible qualities to features of external objects is precisely what he needs here.

I conclude that we have reason to see the argument against reducing sensible qualities at *De sensibus* 63-64 as an important part of Democritus' approach to sensible qualities. However, there are certainly other ways of interpreting the basis of Democritus' claim that sensible qualities have no place in the world around us. Why, then, do I favor the reading set out above? A complete answer to this question would involve a critical examination of all previous interpretations. Fortunately, Timothy O'Keefe has recently done an excellent job of undermining the prominent readings of Democritus on this topic (see O'Keefe 1997, 122-124). I will therefore limit my discussion of alternative interpretations to that of O'Keefe.

O'Keefe correctly takes De sensibus 63-64 to be a central text for understanding Democritus, but he neglects the context of the passage in ways that are problematic. On his reading, Democritus is arguing for the claim that sensible qualities 'do not exist in reality.' I am not exactly sure how O'Keefe intends to square this claim with the fact (which O'Keefe acknowledges) that, on Democritus' view, sensible qualities are affections of the sense-organs. Perhaps by 'reality' O'Keefe means the world outside the perceiving subject's body. In that case O'Keefe's interpretation of De sensibus 63-64 follows that of G. M. Stratton: sensible qualities do not have a φύσις in the sense that they do not exist outside of our bodies. I have already raised some doubts about Stratton's interpretation, so I will focus here on O'Keefe's understanding of the premises of the argument. O'Keefe finds Democritus arguing from two assumptions: (i) that sensible qualities are relational, rather than intrinsic, properties, and (ii) that relational properties are unreal, no part of reality. The problem with this reading as an interpretation of De sensibus 63-64 is that Theophrastus has just set out Democritus' reductive accounts of the properties being heavier than iron and being lighter than lead. Far from denying the reality of relational properties, Democritus seems to identify some of them with causally efficacious features of the world around us. Hence O'Keefe's understanding of the argument from sensory variability at De sensibus 63-64 does not fit with the immediate context.

# IV

So far we have been thinking of Democritus' reasoning about sensory variability as concerned with a matter of ontology: he is hoping to secure a view of the ontological status of sensible qualities. Aristotle's report of Democritus' thinking about variability has a different emphasis:

Furthermore, contrary appearances of the same things arise for many of the other animals and for us, and even for each individual in relation to himself things do not always seem the same according to perception. So which of these is true or false is unclear, for 'these are no more true than these, but similarly.' For which reason Democritus says that either nothing is true or for us at any rate it is unclear.

## (Metaphysics 1009b7-12)

Aristotle reports a disjunctive conclusion: either no creature is getting at the truth (i.e., all of our experiences of color and flavor are illusory) or the truth is unclear to us. This apparently skeptical dimension of the argument is new to us. We have seen how Democritus defends the first disjunct. Why might he have added the second?

Democritus' reasoning about sensory variability has shown the senses to be thoroughly illusory: our experiences represent objects around us as having colors and flavors, when in fact these properties have no place in the surrounding world. Galen tells us that Democritus is not entirely happy with the epistemological consequences of this problematic reasoning:

when (Democritus) attacked the appearances, saying 'by convention color, by convention sweet, by convention bitter: in reality atoms and void,' he made the senses respond to reason as follows: 'Wretched mind, taking your evidence from us, you overthrow us? Our overthrow is your downfall.'

#### (DK 68B125)

Democritus' reasoning about variability seems to undermine the testimony of the senses. But if we cannot trust our senses to reveal to us what external objects are like (a consequence of the reasoning), then, for all we know, external objects may have the very flavors and colors which our experiences attribute to them (contrary to the reasoning). By undermining the testimony of the senses, reason seems to undermine itself.

Democritus' reasoning about variability indicates an epistemic gap between us and the world around us. For without trust in our senses, how are we to go about determining what external objects are like? Since (as this problematic reasoning has made clear) our senses are a very poor guide to what is going on in the world around us, for all we know honey really is sweet (contrary to the problematic reasoning). Here we are confronted with an epistemic limitation: we have no reason to believe that honey is sweet rather than bitter. We are compelled to recognize this limitation because of our commitment to the metaphysical thesis that all of the bodily constitutions are on a par with respect to truth. Aristotle captures this move from the metaphysical to the epistemological when he writes: 'So which of these is true or false is unclear; for "these are no more true than these, but similarly.""

We can now understand why Aristotle reports a disjunctive conclusion. Either all of our experiences of color and flavor are illusory (as the problematic reasoning suggests) or (contrary to the problematic reasoning) some of our experiences are veridical. But even if the latter is perhaps the case, we can hardly determine that this is so. Hence, 'either nothing is true or for us at any rate it is unclear.'

# V

We have seen why Democritus rejects the claim that sensible qualities are features of the world around us; we have not yet considered his positive suggestion that sensible qualities are affections of the sense-organs.<sup>15</sup> In this concluding section I want to make a few points about this remarkable thesis.

When Democritus banishes sensible qualities from the external world, he is not retreating to a private, mental realm. Democritus is, of course, a thoroughgoing materialist, so he is not going to think of the objects of sensory awareness as mental objects. Assuming, then, that there are objects of sensory awareness and that they are no part of the surrounding world, Democritus is compelled to identify these objects of awareness with some state or part of the body. His suggestion, according to Theophrastus, is that colors and flavors are physiological alterations of the sense-organs. For example, the effect of a cluster of round, large atoms on the gustatory region, this affection of the sense-organ, has the name 'sweet.'<sup>16</sup>

Colors and flavors thus seem to be perfectly 'objective' features of the world, but we have to be careful here. According to Theophrastus, Democritus distinguishes the affection of the sense-organ from the appearance ( $\phi \alpha v \tau \alpha \sigma i \alpha$ ) to which it gives rise (*De sensibus* 63).<sup>17</sup> Perhaps only the affections which give rise to appearances count as sweet, hot, etc. In that case colors, flavors, and the rest would be subjective in the sense that they could not exist without appearing to a subject.

As we have seen, Democritus denies that sensible qualities are reducible to micro-features of the world around us; they cannot be reduced in this manner because important truths about these qualities cannot be derived from the reduction base. Does Democritus instead suppose that sensible qualities are reducible to affections of the sense-organs? We can hardly rule this possibility out, but we certainly have reason to be skeptical here. First, it is doubtful that Democritus actually carried out such a reduction, for Theophrastus criticizes Democritus for having nothing significant to say about how the senses are actually affected in sense-perception (DK 68A130 and 135.72). Second, we would have to suppose that familiar truths about the colors and flavors would, on Democritus' view, be derivable from facts about these affections, but among the truths which need to be explained are facts concerning the causal role of, say, flavors in the production of such affections. As Theophrastus notes (DK 68A130), Democritus expects reductive definitions of the flavors to explain why these qualities affect the tongue as they do. In other words, affections of the senses are themselves evidently explananda for a reductive theory, so they are illsuited to serve as a reducer.

Accordingly, I am inclined to think that Democritus is opposed to *any* sort of reduction of the sensible qualities. Democritus' identification of flavors with affections of the gustatory organ appears to have a revisionary character:<sup>18</sup> rather than preserving all of our core beliefs about flavors (e.g., by way of a reduction), Democritus seems to

abandon our ordinary notion in favor of a novel and scientifically respectable conception of the flavors.<sup>19</sup>

### Notes

- 1. See Diels and Kranz 1966, 68A126, 129, and 135.65-67 and 73-78. All translations of Greek texts in what follows are my own.
- 2. For the colorlessness and flavorlessness of individual atoms, see DK 68A49, 57, 59, 124, and 125.
- 3. Aristotle discusses Democritus' reductionist tendencies in two other passages. At De generatione animalium 789b2-4 Democritus is said to neglect final causes, reducing all the operations of nature to necessity. And at Physics 252a32-5 Aristotle tells us that Democritus reduces causes in nature to the principle that things always happen in this way. I suspect that these two passages are saying much the same thing. In both passages necessity and the constant regularities in the universe (presumably Democritus does not distinguish these) do not stand in need of explanation. All of the natural phenomena which do stand in need of explanation are reduced, literally lead back, to these unexplained, constant regularities or necessities. Evidently, then, 'reduces' expresses an explanatory relation. Phenomena standing in need of explanation are led back to or explained by these constant regularities which do not themselves stand in need of explanation.
- 4. An important passage to consider in this regard is *De* generatione et corruptione ii 2, a discussion of the primary contraries, the *differentiae* of the elements. Aristotle explains that hot, cold, wet, and dry are prior to other tangible qualities because (i) they figure in causal explanations and (ii) all other tangible qualities are reducible to them. While explaining how other qualities reduce to wetness and dryness. Aristotle wavers on whether the reduced item is identical with the reducer or reduction base. In defense of his claim that viscousness reduces to wetness. Aristotle says that viscousness is wetness affected in a certain manner, as with olive-oil (330a5-6). It seems that being viscous is a way of being wet, so that viscousness is identical with a certain kind of wetness. But in his discussion of why softness reduces to wetness, he holds, by implication, that softness is not identical with the reducer or reduction base. For a clear discussion of this point, see Williams 1982, 159. Later we shall see that Democritus' reduction of the flavors to shapes, on Aristotle's understanding of it, involves identification.
- 5. Aristotle and Theophrastus both appear to be familiar with Democritus' writings on sense-perception and both attribute a reductive approach to Democritus. In *De causis plantarum* vi Theophrastus takes

for granted that Democritus offers reductive definitions of the sensible qualities, while in *De sensibus* he claims that Democritus' position is incoherent because he endorses reductive definitions and rejects a reductive approach (see section two below). In *De sensu* 4 Aristotle takes Democritus to be reducing sensible qualities to micro-properties of external objects, but notice the odd remark at *De generatione et corruptione* 316a1-2.

- 6. A reductive approach is attractive (in part) because it allows us to maintain that sensible qualities are causally efficacious features of the world around us.
- 7. I have doubts here because Democritus' position looks a lot more coherent if he is offering *elimina-tive*, rather than *reductive*, accounts of the qualities. That is, he may just be saying that sweetness is really nothing present in the world around us; in the objects we call 'sweet' there are merely atoms with such and such a character.
- 8. And it is not without contemporary relevance. Consider a case where micro-reduction seems to fail because of a failure to account for relevant phenomena. There are a number of facts about the colors which any reduction must account for. I will mention some of the more interesting color truths: that there are exactly four unique hues (red, green, blue, and yellow); that certain binary hues are impossible (e.g., a reddish-green); that the colors bear various similarity relations to one another (e.g., purple is more similar to red than it is to green); that there are complementary colors (as blue is to yellow); that colors are representable as points in a three-dimensional color space; that the spectrally pure colors have a circular structure. Consider the first of the facts I mentioned: that there are exactly four unique hues. We say that orange is a binary hue because any orange we might come across is both reddish and yellowish. Similarly, purple is a binary hue because any purple must be both bluish and reddish. Red, on the other hand, is a unique hue because we would not describe it as a mixture of other hues. (We would not say, for example, that red is a purplish orange.) So why is it that only red, blue, yellow, and green are unique hues? We cannot explain this fact in terms of the relevant micro-properties of colored objects. The correct explanation lies elsewhere, namely, in terms of the biology and psychology of human color perception. In fact, this is true of all the facts I mentioned above. These fundamental truths about the colors of objects cannot be explained in terms of the micro-structures of such objects, so a reductive approach to color does not seem plausible. For an excellent discussion of these matters of explanation, see Shepard 1992.

9. On closer examination, however, I doubt that Aristotle's specific criticisms carry much weight. Recall Aristotle's first criticism: Democritus cannot account for the opposition of white to black and the opposition of sweet to bitter because there is no opposition among shapes. The problem with this criticism is that Aristotle is working with too narrow a conception of Democritus' reduction base. Democritus' reductive definitions involve more than shapes; he also invokes properties like size and texture. And once we acknowledge the richness of Democritus' definitions, it becomes easy to see how he intends to account for these oppositions. In the case of black and white, the reduction to roughness and smoothness at the micro-level evidently preserves the opposition. Aristotle ought to have recognized that Democritus is successful here, since he explicitly tells us about this identification with roughness and smoothness. And in the case of sweet and bitter, the opposition is accounted for, not by shape-which is roughly the same for both-but by size. The constituent atoms of sweet things are rather large, while those of bitter things are small (see Theophrastus, De causis plantarum vi 1.6 and De sensibus 65-66). In this case Aristotle seems to have overlooked an important detail in Democritus' theory.

Now consider Aristotle's second objection. Here we find Aristotle arguing that Democritus' theory gets into trouble because it generates too many flavors. If differences in flavor among objects correspond roughly with differences in the shape of constituent atoms, then the infinite variety of the latter would seem to yield an infinity of flavors. This would surely be a problematic consequence of Democritus' theory if Theophrastus is right that there are only about eight flavors (see De causis plantarum vi 1.2). I think it is fairly clear how Democritus ought to respond here. Only a handful of micro-physical properties are indispensable when explaining facts about the flavors. Democritus' theory reduces the flavors to these micro-properties, so only differences among these properties will correspond with differences among the flavors.

- 10. Theophrastus' own view about the relevant affections of the sense organ is that they are observable (see *De sensibus* 89). I am assuming that Democritus agrees with Theophrastus on this point because Democritus ultimately identifies *sensible* qualities like color and flavor with these affections.
- 11. For further discussion of how we should understand *De sensibus* 89, see Furley 1993 and Ganson 1997.
- 12. We can translate the passage as follows: 'Democritus and Plato have touched upon the subject (of sensible qualities) to the greatest degree, for they define each type. However, Plato doesn't deprive the sensible

qualities of nature, while Democritus makes them all properties of the sense-organ ... Democritus doesn't speak similarly about all, but some he defines by the sizes, others by the shapes, some by order and position. Plato nearly assigns all by reference to the affections and the sense-organ. So each of the two would seem to speak contrary to his own hypothesis. For the one who makes them affections of the sense-organ defines their nature intrinsically, while the one who makes them intrinsic to the substances assigns them by reference to the affections of the sense-organ.'

- 13. My own view is that this argument is unconvincing because premise [i] is far from obviously true. This premise no doubt has some intuitive appeal, but I am not convinced that differences in physiology systematically result in incompatible appearances. Locke's discussion of the possibility of an inverted spectrum seems to demonstrate the possibility of appearances which differ due to a difference in physiology, but which are not incompatible with one another (see Locke 1975, II.xxxii.14). There is, then, a need to defend [i] and I am not at all sure what such a defense would look like
- 14. But even if nothing *in rerum natura* could serve as a measure here, we might think that facts about the perceives themselves might be decisive. Suppose that for 99% of the perceivers in the world a certain substance appears to be bitter, while the remaining 1% find it sweet. It is not unnatural to suggest that the substance is bitter because its flavor is determined by purely statistical facts. However, Democritus explicitly rejects the idea that truth is determined in this statistical manner. See Aristotle's *Metaphysics* 1009b.
- 15. Sextus describes the view as follows: 'Democritus says that none of the sensible qualities subsists; rather, our perceptions of them are certain empty affections of the senses, and there isn't anything sweet among external things, or bitter or hot or cold or white or black or any of the other things appearing to all, for *these are names of our affections*' (Against the Mathematicians viii 184).
- 16. So understood, Democritus' view of the status of sensible qualities does not differ from Galileo's. Shoemaker 1990 speaks of Galileo as identifying sensible qualities with properties of sensations which 'exist only in the mind,' but this interpretation cannot be right. Like Democritus, Galileo identifies sensible qualities with changes in the body brought about by impinging particles. Here is his remarkable discussion of 'heat:' 'I return to my first proposition, having now shown how some affections, often reputed to be indwelling properties of some external body, have really no existence save in us, and apart

from us are mere names. I confess myself to be very much inclined to believe that heat, too, is of this sort, and that those materials which produce and make felt in us the sense of heat and to which we give the general name "fire" consist of a multitude of tiny particles of such and such a shape, and having such and such a velocity. These, when they encounter our body, penetrate it by means of their extreme subtlety; and it is their contact, felt by us in their passage through our substance, which is the affection we call "heat" (Matthews 1989, 59-60).

- 17. Notice that, for Democritus, colors are not properties of appearances; rather, colors give rise to appearances. In this respect Democritus' view is like that of Thomas Reid. For Reid's view of color appearances, see Robinson 1994 and Ganson (forthcoming).
- 18. For an interesting discussion and defense of the revisionary approach to color, see Maund 1995, ch. 7.
- 19. I have been thinking about Democritus on sensory variability since 1994 and have had a great deal of help along the way. I particularly want to thank Terry Irwin and Gail Fine for their insights and criticisms during every stage of my work on the project. For discussion of the philosophical issues I thank Sydney Shoemaker, Dorit Ganson, Todd Blanke, and Charles Brittain. And for extremely helpful comments on recent drafts of this article. I am very grateful to Gail Fine, Ronald Polansky, and an anonymous reviewer at *Ancient Philosophy*.

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## Christoph Lüthy (essay date 2000)

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[In the following essay, Lüthy discusses how conceptions of Democritus changed through the ages such that, by the early modern period, he had been designated (in some ways incompatibly) the roles of atomist, "laughing philosopher," moralizing anatomist, and alchemist.]

In the manuscript treatise De motu (ca. 1590), his first attempt at a reform of the science of motion, Galileo strove to "eradicate with all its roots" the Aristotelian conception of heavy and light as absolute qualitative opposites. In his eyes, it was much more plausible to assume that all bodies were heavy, as some pre-Aristotelian thinkers such as Democritus had previously maintained. "Therefore," Galileo wrote, "we follow in this matter the view of the Ancients, which Aristotle tried in vain to demolish in the fourth book of his De caelo, and we shall examine both what Aristotle confutes and what he affirms in that passage, confuting what he accepts and accepting what he confutes." At the beginning of this century, Louis Löwenheim invoked this and similar passages in support of a thesis that he defended with particular verve in Die Wissenschaft Demokrits und ihr Einfluß auf die moderne Naturwissenschaft. Löwenheim held that Galileo and his students must be credited with nothing less than the reversal of a power constellation that had lasted for one and a half millennia and was marked by the triumph of Aristotle's qualitative philosophy over Democritus's quantitative science. According to this view, the victory of the Galilean science of mechanics symbolizes the passage from a Democritus refuted by Aristotle to an Aristotle refuted by Democritus.1

A look at the development of Galileo's matter theory, which moved ever farther from a Democritean conception and eventually postulated a very peculiar type of unextended mathematical point-atoms (indivisibili non quanti), suffices to show that Löwenheim's theory is either false or at best too simple. In fact, none of this century's historians of science or philosophy have accepted the idea of a simple swap of roles between Aristotle and Democritus. At the same time, the relation between the doctrines of these two natural philosophers has remained a matter of great disagreement. Some historians, following Marie Boas Hall, embraced a view just the opposite of Löwenheim's, claiming that the ancient atomists "had relatively little to offer seventeenth century natural philosophers" and that early modern corpuscularianism derived "from ancient atomism in a very limited sense only, for the actual concept atom is irrelevant to its development."2 Others, like Andreas van Melsen, took a more conciliatory stance, proposing that the seventeenth century did in fact adopt Democritus's teaching as an intact doctrine but subsequently merged it with the Aristotelian concept of natural minima. A variant of this position was held by James R. Partington, who agreed with Robert Boyle's approval of "those theories of former Philosophers, which are now with great applause revived," but insisted that this revival was driven not by the philosophical concerns that had first engendered atomism but instead by science, notably by the vacuum pump, the microscope, and chemistry. But it is precisely this idea of an empirical validation, or even verification, of ancient atomism that Hans Kangro and Christoph Meinel have in turn so successfully undermined.<sup>3</sup> It was certainly not the case, for example, that the newly invented optical instruments could verify the ancient claims of atomism, as some enthusiasts believed: "The Atomes (Brave Democritus) are now / made to appear in bulk & figure too."4

Not only the relation of atomism to empirical research, but also its connection to the mechanistic philosophy, has been a matter of debate. Notoriously, the "occupational vice" of all mechanistic philosophers consisted in their constant search for the "invisible mechanisms" of small, rigid particles underlying the "huge machine" of nature-a search that was intimately connected to the attempt to explain away occult qualities. But, as Richard S. Westfall has well documented, "the mechanical philosophy in its original form was an obstacle to the full mathematization of nature," which after all stood at the center of the triumphant science of mechanics.<sup>5</sup> Given then that the term "mechanistic philosophy" has two divergent meanings, with which, if either, should Democritus be associated? E. J. Dijksterhuis, for one, remained uncertain on this matter. While recognizing the profound difference between ancient atomism and early modern corpuscularianism, he yet credited Democritus with having developed a "mechanistic corpuscular model" that strongly influenced the seventeenth century's conception of the world as a machine. But even this weak claim has not

met with general approval. Against the view that Democritus's achievement lay in his protomechanistic philosophy, it has been argued—most recently by Benedino Gemelli—that most early modern atomists were much more attracted by an animistic notion of atoms, following Lucretius's interpretation of atoms as *semina rerum*.<sup>6</sup>

The underlying problem is, clearly, that the "new sciences" of the seventeenth century are quite visibly overbrimming with atoms, corpuscles, and particles of all sorts. But Giordano Bruno's ensouled spherical monads, Pierre Gassendi's or Giovanni Alfonso Borelli's highly complex corpuscular shapes, Daniel Sennert's atomi-cum-forma, and René Descartes's little chunks of res extensa have conceptually very little in common with each other and also look very different when drawn on paper. Given that the word "atom" was made to function within so many mutually incompatible systems, one feels forced to conclude that it possessed neither a fixed "reference" nor a stable "meaning," to borrow Gottlob Frege's useful terms. Confronted with this observation, there seem to be, prima facie, two possible ways out. One is to follow Stephen Clucas and accept the fact that despite its revivalist claims, early modern atomism is only indirectly related to the ancient model and should therefore more properly be called "neoatomism." The other is to follow Lynn Joy in admitting that there is a surprising "incoherence" in early modern atomist positions and to try to uncover the "unrecognized cultural baggage" responsible for this disorder. That these two approaches can easily be combined is shown in Antonio Clericuzio's recent work on chemical atomism. Clericuzio demonstrates the profound conceptual differences separating ancient atomism from its alleged revival by Gassendi, but he also believes that developing a linear conception of the history of atomism is a futile enterprise because seventeenth-century corpuscularianism derived its inspiration from a number of divergent traditions.<sup>7</sup>

While finding both claims fruitful in their own right, I shall try in this essay to explore a third possibility, which consists in taking the revivalist position seriously and seeking to understand just why Democritus became so enormously popular. For even if the historical evidence seems to confirm Gaston Bachelard's dismissive assertions, first, that ancient atomism played no role in shaping early modern thought, not even in those cases where Democritus was personally invoked, and, second, that the fantastic diversity of the applications of the term "atom" demonstrated that nothing precise could possibly be designated by it, there is obviously something deeply paradoxical about them. For when Bachelard claims that "when Bacon cites Democritus, this happens only so that he can acknowledge his debt for the word atom," it is hard not to feel that he is begging the question. Why should Bacon have wanted to borrow the word "atom" in the first place if he meant to use it in such a novel and un-Democritean manner? Similarly, why should the Pavian professor of medicine Jean Chrisostome Magnen have promised to

reconstruct the old atomist doctrine in his popular *Democritus reviviscens, sive de atomis* (1646), if he implicitly rejected almost every Democritean tenet?<sup>8</sup> Was Magnen simply shrouding himself in a venerable cloak so as to sell his own theory at a higher price?

I will suggest in what follows that a number of these puzzles can be solved, at least partially, by separating the Democritus we are acquainted with from the Democritus of the seventeenth century. A glance at the "Life of Democritus" prefaced to Magnen's treatise shows that this author speaks about a figure who differs considerably from the one described in today's history of philosophy books. This difference, in turn, is due to the fact that the early modern period admitted as authentic a range of Democritean texts and testimonies that today's classicists no longer accept. As a consequence, Magnen's Democritus must look to us almost as heterodox as the atoms associated with him. But this observation opens an intriguing possibility: might it be that Magnen's idiosyncratic atomism was in truth the doctrine that looked most compatible with the "historical Democritus" as he emerged from early modern sources?

It is to this possibility that the present article is dedicated. I shall try to argue that the observed polyvalence of the early modern concept of "atomism" is related to the comparable polyvalence of the revived figure of Democritus. Anyone trying to retrace the *fortuna* of the Abderite philosopher from the period of the Renaissance onward will in fact soon be confronted with no fewer than four distinct Democriti. Although their characteristics partially overlapafter all, they are supposed to belong to a single historical Democritus from the Thracian town of Abdera on the Black Sea-the truth is that the four Democriti owed their raisons d'être to different textual sources and managed to pursue separate "lives" throughout the period under consideration. These four Democriti of Abdera were the natural philosopher and atomist; the so-called laughing philosopher, comrade and antitype of the weeping Heraclitus; the moralizing anatomist visited, described, and praised by the physician Hippocrates; and the alchemist and author of the Physica et mystica.9

I shall show in detail how the odd mismatch between Democritus's genuine doctrines and the theories that were revived in his name is at least partially due to the fact that the Renaissance revival of the second, third, and fourth Democriti preceded that of the first Democritus by a considerable stretch of time. This is all the more significant as the latter three Abderites had no obvious connection with atomism, even where they dealt with medicine or alchemy. And when, toward the end of the sixteenth century, the first Democritus and his matter theory slowly began to attract once more the curiosity of natural philosophers, the ensuing atomist reawakening occurred within the context of an already flourishing cult of the other Democriti. From the point of view of the history of science, this quadruple story is particularly intriguing wherever one of the *doppelgänger* is found to abandon his respective track and to merge with one or more of the other Democriti. Although such fusions always represented attempts at a restoration of the unitary figure Democritus was after all supposed to be, it is obvious that they had to result in curious new hybrids. I shall attempt to document how some of these cross-breeds between the moralist, the anatomist, the alchemist, and the atomist were not just bizarre, but scientifically quite fertile.

The story of these variously assembled and disassembled Democritean *figurae* opens a window onto the picturesque courtyard of early modern science and its literary and philological obsessions. Moreover, it offers one possible approach to the perplexing issue of the unruly atom, that early modern carrier of false reminiscences and incongruous scientific hopes.

### DEMOCRITUS ONE: THE ATOMIST

It seems obvious that our presentation should honor the authentic Democritus (ca. 460-357 B.C., fl. 430 B.C.) before any of the literary fakes that went by his name. But then, even this "real Democritus" is so hard to reconstruct that one soon begins to understand why it has always been so difficult to separate truth from legend. Of his seventy works listed by Diogenes Laërtius, none has survived, and there exists merely one authentic fragment (known as "B 9") that relates to atomism. Life and doctrine must therefore be glued together from roughly 298 often strangely colored mosaic pieces that are scattered here and there in the doxographic literature.<sup>10</sup>

A reader of the early modern period would have found the most coherent but still rather picturesque account of Democritus's life and work in book 9, chapter 7, of Diogenes Laërtius's *Lives of Eminent Philosophers*, a book whose *editio princeps* dates from 1470 and that would have been found in any self-respecting library of the sixteenth and seventeenth centuries. After reporting on Democritus's life—which involved instruction by Magians and Chaldeans, travels to countries as distant as Persia, India, and Ethiopia, poverty upon his return compensated by public honors, and death at the venerable age of 109 years—Diogenes Laërtius offers us the following succinct and important summary of his doctrines:

His opinions are these. The first principles of the universe are atoms and empty space; everything else is merely thought to exist. The worlds are unlimited; they come into being and perish. Nothing can come into being from that which is not nor pass away into that which is not. Further, the atoms are unlimited in size and number, and they are borne along in the whole universe in a vortex, and thereby generate all composite things—fire, water, air, earth; for even these are conglomerations of given atoms. And it is because of their solidity that these atoms are impassive and unalterable. The sun and the moon have been composed of such smooth and spherical masses [i.e., atoms], and so also the soul, which is identical with reason. We see by virtue of the impact of images upon our eyes.

All things happen by virtue of necessity, the vortex being the cause of the creation of all things, and this he calls necessity. The end of action is tranquillity, which is not identical with pleasure, as some by a false interpretation have understood, but a state in which the soul continues calm and strong, undisturbed by any fear or superstition or any other emotion. This he calls well-being and many other names. The qualities of things exist merely by convention; in nature there is nothing but atoms and void space. These, then, are his opinions.

As is well known, Aristotle not only rejected each of these doctrines singly but also combated the general idea behind atomism. Like Cicero a couple of hundred years later, he ridiculed the "puerile" attempt to explain our entire cosmos in all its phenomenal variety with the help of such a poorly equipped toolbox, that is, merely through the metaphysical principle of "necessity," some primordial vortex, and atoms whirling through the void. Aristotle's own explanations relied heavily on form-giving forces, thanks to which matter-a purely abstract, potential entity-could manifest itself in the guise of actual substances, and which continued to act from within these substances as formal causes. But since these forms imposed themselves so thoroughly even upon compound substances as to render them homogeneous, the notion of incorruptible and everseparate atoms had, according to Aristotle, to be false. In fact, in his eyes a body made up of separate atoms did not constitute a substance but was a mere "heap."<sup>11</sup>

In De generatione et corruptione Aristotle therefore claimed that the assumption of atomic structures existing beneath the limits of visuality is self-contradictory, a charge that was to survive almost intact until the early seventeenth century. Although there existed indeed a handful of so-called medieval atomists, it is no substantial exaggeration to say that their concerns were unrelated to Democritean theories of matter and were instead directed at Aristotle's problematic notions of infinity and continuity.<sup>12</sup> None of them may in fact be said to reject hylomorphism. The exclusive predominance of Peripatetic hylomorphism was matched by the ill-repute of Epicurus-the "swine," as some of the Church Fathers called him-and by episodes such as the condemnation of John Wyclif's atomism for its alleged incompatibility with the doctrine of the Eucharist at the Council of Constance in 1415.13

Only with the rediscovery of the Lucretian *De rerum natura* and of Diogenes Laërtius's *Lives of Eminent Philosophers* could the ancient school of atomism begin attracting new attention. But Lucretius's success, first literary and gradually also conceptual, must be viewed with caution. For although this Roman poet invoked Democritus and, even more directly, Epicurus as his teachers, his own atomism reflected also more recent doctrinal developments, notably in the sphere of medicine. It appears that his particular interest in the atomistic explanations of diseases was due to his acquaintance with the atomist physician Asclepiades. His general avoidance of the term "atom" and his preference for "*semina rerum*" is an expression of a certain interest in active principles. This is at least how it was perceived, from the Renaissance physician Girolamo Fracastoro up to the seventeenth-century physician Nathaniel Highmore, who introduced specific "seminal Atomes."<sup>14</sup> The emerging medical atomism, to the extent that it borrowed from Lucretius, had thus a legitimate means of avoiding the dry Democritean materialism described in Diogenes Laërtius.

There is also an altogether different factor that helped Democritean atomism in its re-emergence from underneath the many centuries of Peripatetic refutatations, namely, the Renaissance belief in the existence of a primordial prisca philosophia, which had allegedly sprung up in the vicinity of the divine breath of creation; this belief changed the time axis to the detriment of Aristotle's authority, causing him to appear less as the scientific victor over Presocratic fantasies than as a distant afterglow of earlier splendors. The improving textual base appeared to support such a view, because a comparison between Aristotle's judgment of his predecessors and their rediscovered actual or presumed doctrines encouraged humanist historiographers to charge the philosopher with deliberately misrepresenting the views he reported, an accusation that seems to have first been formulated in 1520 by Francesco Pico della Mirandola. Ernst Cassirer has expressed the belief that Democritus was the main beneficiary of this revisionist reading of the history of philosophy, but this claim seems exaggerated.<sup>15</sup> For we must certainly not forget that the main interest of the new anti-Aristotelians was directed at Plato or at the mythical origins of philosophy and hence at Hermes Trismegistos, Orpheus, and other such sibylline bearers of light. For Democritus, the Renaissance interest in the origins of science had as its only undeniably positive result the attribution of a more important historical role. Francesco Patrizi reported that Democritus was generally accepted as the inventor of physics.<sup>16</sup> But despite this reevaluation of Democritus's place in the history of philosophy, concrete traces of his influence on the development of sixteenth-century scientific thought are sporadic and mostly linked to Lucretian conceptions of effluvia, seeds, pores, and particles.

Only in the last decade of the sixteenth century do we find Democritean atomism all of a sudden held up as a powerful scientific model. Some of the astonishing *archetypi* engraved personally by Giordano Bruno to accompany his *De triplici minimo et mensura* of 1591 in fact not only brandish the name of Democritus but intend to give a graphical representation of the atomic structure of matter. With his "Area Democriti," for example, Bruno means to demonstrate how the spherical atomic units tend to cluster into circular patterns and thus repeat the form of the original minimum. This and a series of related drawings that Bruno inserted into his *De triplici minimo* as well as into the *Articuli adversus mathematicos* (1588) exercised a documented influence on the development of atomic modeling, particularly in the field of crystallography but more generally in the development of corpuscularian matter theory, beginning most prominently with Johannes Kepler's analysis of the structure of the snowflake (1611).<sup>17</sup>

Bruno believed that there existed only one, spherical, type of atom, and he wrongly attributed the same view to Democritus. This intentional error, however, leads us straight to the highly un-Democritean background of Bruno's images. If we retrace their history, we find that they originated with the so-called gnomons, numerologically significant configurations of mathematical unit-points cherished in Christian Pythagoreanism. In that tradition, the seven circles of the "Area Democriti" symbolized, for example, the expansion of the divine monad into the six days of creation, a meaning that Bruno himself also invoked. Bruno's importance lies, however, in the fact that he began to interpret these numerological patterns as representations of veritable physical relations. He did so by projecting them first onto the sky: in both De l'infinito (1584) and De immenso (1591) he uses the seven circles to show the reader how his infinite worlds fill up the spaces of the universe.<sup>18</sup> In a second step, Bruno projected the same imagery down from the celestial orbs and onto the ultimate microstructures of matter. Behind this application of the same imagery to the largest and the smallest physical conditions lay the Cusanian belief in the "coincidence of the opposites" (coincidentia oppositorum), according to which, Bruno maintained, one could "attribute the same figure to the maximum and to the minimum."19 Just as in Boethius's mathematics Pythagorean number units expanded into bodies, so in Bruno's metaphysical physics stars began to multiply toward infinity and monadic atoms clustered into ever larger globular structures.

The role attributed to Democritus in Bruno's writings reflects this development quite faithfully. In his early writings the Abderite appears first as a Pythagorean philosopher and subsequently above all as the proponent of innumerable worlds.<sup>20</sup> It is only in the Frankfurt trilogy of 1591 that Democritus is first and foremost an atomist.

The intimate ontological and visual connection introduced by Bruno into the two Democritean doctrines—infinite worlds and atomism—was not lost on his contemporaries. When Kepler heard in 1610 of the celestial discoveries announced in Galileo's *Sidereus nuncius*, he saw in them a partial confirmation of some of Bruno's Democritean intuitions. Quite possibly under the influence of his friend and patron Johannes Matthäus Wackher von Wackenfels, a great admirer of Bruno's cosmology, Kepler mentioned Democritus and Bruno as Galileo's predecessors in his own *Dissertatio cum Nuncio sidereo*. Kepler's association of Galileo with Bruno and Democritus, in turn, seemed frightening enough to the Roman philosopher Giulio Cesare Lagalla to warrant a hasty response. Lagalla's *Disputatio* of 1612 documents just how close the link between cosmology and atomism must have seemed to Bruno's friends and enemies alike. For although neither Galileo's *Sidereus nuncius* nor Kepler's *Dissertatio cum Nuncio sidereo* had mentioned atomism or any other theory of matter, Lagalla was so strongly under the impression of Bruno's linkage of doctrines that he felt compelled to add to his cosmological discussions a thorough refutation of atomism that culminated in the wholesale charge that whatever doctrines Bruno had espoused were atheist in nature.<sup>21</sup>

The view that the reawakened interest in the doctrine of infinite worlds helped rekindle the interest in Democritean atomism certainly holds true for Bruno himself, whose "Area Democriti," as we have seen, implies a veritable *double entendre*, referring to physical *maxima* and *minima*, to worlds and atoms, alike. And yet, despite this multiple employment of Democritean ideas, Bruno did not want to be considered a strict atomist. "The vacuum alone with atoms will not suffice us," he explained in *De triplici minimo*, "for there must also be a certain matter by which [the atoms] are glued together."<sup>22</sup> In full accordance with his overall worldview—which in fact looks rather like an animist antithesis to ancient materialism—he replaced the vacuum with an enlivened and enlivening ether.

This is no marginal point. For not just Bruno but almost all subsequent atomists were, in one way or another, to criticize the implausibility, explanatory poverty, and impiety of Greek atomism. A good example of the typical adaptations to which the original atom-*cum*-void model was everywhere subjected is given by Walter Charleton, who, though defining himself as a "Gassendo-Epicurean," nonetheless insisted that the following three postulates had to be rejected: "(1.) *Quod mundus non sit a Deo constitutus,* that the World was not constituted by God; (2.) *Quod mundus a Deo non gubernetur,* that the World was not governed by God; (3.) *Quod animus noster non superfit a funere,* that the soul of man doth not survive the funeral of his body."<sup>23</sup>

It must be obvious, however, that the integration of atomism into such a theological framework also had to imply dramatic changes for its physics. A world defined in purely material terms, in which a deterministic necessity ( $\dot{\alpha}v\dot{\alpha}$ - $\gamma\kappa\eta$ ) appears as the only force governing natural phenomena, must needs obey quite different laws than a world in which an omnipotent God directs souls, bodies, and possibly even each individual atom. As a matter of fact, we find that almost all early modern atomists—from Giordano Bruno, Sébastien Basson, and David Gorlaeus up to Pierre Gassendi and Isaac Newton—replaced Democritus's empty space with some ether, a substance that could function as the glue to make particles cohere, as a physical substitute for the Platonist *anima mundi*, as some divine medium standing in for the Aristotelian final cause, or as the transmitter of magnetic forces.<sup>24</sup>

But this observation returns us to the beginning of this essay. It has been precisely these and other profound modifications of the original model that have made the thesis of the alleged success of ancient atomism look so suspicious to historians of science. With respect to the doctrines of this Christianized Democritus, one may justly ask the same question Margaret Osler has formulated with respect to the Christianized Epicurus: "What, if anything, was left of Epicureanism, after Gassendi completed all these repairs? Rather than reviving the philosophy of Epicurus, did he actually drown his ancient model in the baptismal font?" There is, according to Osler, no "unequivocal answer" for the case of Gassendi's Epicurus. By the same token, there seems to be none for the case of Magnen's Democritus: "I wanted to bring back the atomist philosophy, the first-born among all the sects of wise men," announced this author at the beginning of his Democritus reviviscens, sive de atomis, which has already been mentioned. But as we read through the pages of this book, we soon find the void rejected and replaced by air; the remaining three elements are equated with the chemists' tria prima of sulfur, mercury, and salt; the atoms are characterized as elastic bodies and defined, not by their geometry or shape, but by their primary quality; final causes are reinserted into natural philosophy; and, finally, the vortex is reinterpreted in terms of magnetic astral influences whose debt to William Gilbert's De magnete (1600) and to Athanasius Kircher's writings is all too clear. In fact, we find that the author is not even willing to abandon the notion of form but prefers to follow-though he denies it-Daniel Sennert's redefinition of the Aristotelian hierarchy of forms in molecular terms.<sup>25</sup>

In the introduction I mentioned the possibility that this Democritus, so strangely reformed or deformed, must not necessarily be seen as the product of a mere marketing strategy, although in Magnen that element is also force-fully present, but that his Democritean bibliography and biography show the strong presence of pseudonymous sources connected with the three "other" Democriti.<sup>26</sup> In order to understand why Democritus seemed so fascinating to Magnen and numerous others and why there is at the same time no true Democritean philosopher to be found among his self-proclaimed followers, we must turn to his nonatomist *doppelgänger*.

# Democritus Two: The Laughing Philosopher

The first fictional Democritus to be introduced must be the "laughing philosopher": he became a celebrity long before the other Democriti did, and certainly a long time before the atomist from Abdera gained his first modern adherents. The genesis of this literary figure with his epithet "*ridens*," "laughing," is no longer fully transparent, nor does this question need to detain us. That he is a classical figure can

be seen from the fact that he makes his earliest known appearance on the stage of Latin literature in Cicero and Horace. From Seneca and Lucian onward, we find him coupled with his antitype Heraclitus, the "weeping philosopher." Democritus and Heraclitus were destined to become an inseparable pair because their contrary reactions were provoked by the same observation: that all human activity is foolish and in vain. Seneca writes:

Whenever Heraclitus went forth from his house and saw all around him so many men who were living a wretched life—no, rather, were dying a wretched death—he would weep, and all the joyous and happy people he met stirred his pity; he was gentle-hearted, but too weak, and was himself one of those who had need of pity. Democritus, on the other hand, it is said, never appeared in public without laughing; so little did the serious pursuits of men seem serious to him.<sup>27</sup>

According to Seneca, Heraclitus wept thus even when he saw happiness. Given that it was possible for the same circumstances to provoke such different reactions, the choice between them was merely a question of philosophical temperament and religious convictions. For Seneca himself the choice was clear: "Let us rather imitate Democritus than Heraclitus!" But as August Buck and Angel Garcia Gomez have documented in detail, Christian authors initially tended to take the opposite view. Because Christ is reported to have wept, but not to have laughed, weeping was understood by John Chrysostom as an imitatio Christi, and Isidore of Seville was sure that God would exclude those who laughed from his mercy and attributed a redemptive quality to tears. John Ridwall, one of the very few medieval authors who mentioned the philosophical couple, explicated this logic in clear terms circa 1330: "Whatever Seneca's conclusion may have been, we must note that the behavior of Heraclitus is more consonant with the life and conduct of Christ than is Democritus's. ... I therefore praise and approve more Heraclitus's laments over the miseries of the world than Democritus's loud laughter."28

During the Renaissance the topos of the two philosophers enjoyed an unexpected revival. While Petrarch still took Heraclitus's weeping to be a sign of *pietas* and preferred it to Democritus's snickering pride, the late fifteenth century began to witness a general return to Seneca's verdict. The reinterpretation of Democritus's laughter as a philosophical and even melancholy response to the world began with Marsilio Ficino, who returned to the topos repeatedly in his *Epistolae familiares* of 1495 and who attributed to both philosophers a desire for a contemplative life and for the *abstractio animae* necessary for the contemplation of God.<sup>29</sup>

Ficino also owned a double portrait of the two philosophers that was painted by Masolino da Panicale, probably before 1410. Though the painting is no longer extant, Ficino has left us an epistolary description of it: "You have seen painted in my Academy a sphere of the world; on one side Democritus laughing, and on the other Heraclitus weeping. Why is Democritus laughing? Why does Heraclitus weep? Because the mass of mankind is a monstrous, mad and miserable animal." There still exists a sophisticated fresco version of the same theme painted around 1486 by Donato Bramante in the villa of his patron Gaspar Ambrogio Visconti.<sup>30</sup> Much more uncouth is a woodcut that decorated the frontispiece of the work of Visconti's friend Antonio Fregoso, who in the first years of the sixteenth century published an internationally acclaimed double poem entitled Riso de Democrito and Pianto di Eraclito. In the triplets of this somewhat Dantesque work the author narrates his excursions, at the hand of a heavenly guide, to two different mountains, on the first of which he receives instruction from laughing Democritus while on the second he encounters weeping Heraclitus. Both philosophers appear as hermits who survey from above the folly and futility of human action. Despite their antithetical behavior, Fregoso's two philosophers have in common a Stoic intellectual detachment from the world combined with a powerfully emotional response to its aberrations. They resemble Christian saints so strongly that Fregoso deplores that Democritus, "this divine man selected out from all others," "is not of the Christian sect." After each of the two initiation rites, the author returns to the plain in the state of inner peace described by Diogenes Laërtius as the goal of Democritus's philosophy.31

But although, in another work, Fregoso refers to Democritus's atomism, his saintly mountain hermit is exclusively a moralist and shows no trace of natural philosophical inclinations. This separation of Democritean domains was to remain intact through almost all of the sixteenth century. *Democritus ridens* and *Heraclitus flens* became, in the meantime, an ever more popular literary and pictorial commonplace, not least because numerous emblem books, beginning with Andrea Alciati's *Emblematum liber* (1531), adopted the motif.<sup>32</sup>

His emblematic stylization allowed our second Democritus to establish himself at lofty moral heights that he had not approached even distantly in antiquity, let alone in the Middle Ages. Almost all humanists followed Seneca and sided with the laughing philosopher. Ficino's friend Cristoforo Landino, for example, identified Democritus's ideal of inner peace ( $\varepsilon \dot{\upsilon} \theta \upsilon \mu i \alpha$ ) with the heavenly peace (*pax*) of the Scriptures. By Christianizing Democritus's very laughter and mockery, Erasmus of Rotterdam went even further. In his Praise of Folly he not only compared his friend Thomas More to Democritus for his ironical detachment from the world but also claimed that the world is so replete with foolishness as to require not merely one Democritus but a thousand Democriti, with an additional one to cure them all. Particularly influential was Erasmus's use of Democritean mockery against vainglorious institutions such as the papal court, a method soon imitated by all

kinds of wits.<sup>33</sup> But here again, the Democritean *personae* remained separate: the natural philosopher was of little interest to Erasmus, who on only a few rare occasions stooped to chide him for his cosmological fantasies. At the same time, he favored the formerly Stoic or Cynic and now increasingly Christian moralist to the point of allowing him to make an appearance even in the woodcut initial of a pious work. See the frontispiece to this essay, which is taken from Erasmus's edition of Saint Ambrose (1513); the woodcutter, possibly Hans Holbein the Younger, incidentally mixed up the names of the two philosophers.

With Erasmus, a number of developments became possible. One was the reinterpretation of the Erasmian neologism "*Democriticus*" ("Democritean") as "*Demo-criticus*" ("people's critic"), the father figure of the modern "critic," whose most effective weapons continue to be irony and mockery.<sup>34</sup> As early masters in this tradition we must mention specifically Sebastian Franck, with his Democritean conception of history, and Michel de Montaigne, who wrote, in the chapter of his *Essays* entitled "De Democritus et Heraclitus": "I love better the first type of humor; not because it is more pleasant to laugh than to weep, but because it is more disdainful, and because it accuses us more than the other humor."<sup>35</sup>

Another development, which was rooted instead in Erasmus's piety, focused on the perceived religious side of Democritus, ignoring his subversive qualities. Among the landmarks here are the *Démocrite chrétien* (1615) of the preacher Pierre de Besse and the choice of "Democritus Christianus" as the *nom de plume* of the Pietist theologian Johann Conrad Dippel a century later.<sup>36</sup>

But such specific uses are marginal to the widespread and indiscriminate invocation of Democritus's laughter in innumerable comedies, pamphlets, and ditties. Two literary genres came in fact to be directly associated with his name. There existed, first, a semiscientific genre of treatises on laughter that were sometimes accompanied by complementary treatises on crying. These were usually written by physicians who offered their readers a mixture of erudite medical and literary references to ancient and more recent views on the nature, origin, and moral virtue of laughter.37 But our laughing philosopher also lent his name to an infinitely more popular genre of books of "merry stories, jests, epigrams, riddles, repartees, epitaphs, etc.," which made no claims either to authenticity or to erudition and whose exclusive purpose was entertainment. The frontispieces of these books of jokes usually depict Democritus as a bearded fellow with a promising grin. The jester appearing on a Democritus ridens of 1649 introduces himself as an "exorcist of melancholy" and explains, in his "Preface to the Reader," that the political anecdotes narrated in the ensuing pages prove that "I do not laugh in vain." The anecdotes themselves, however, almost never have any philosophical implications; their only aim is to show that the world is ridiculous, from the emperor down to the beggar.<sup>38</sup>

In the seventeenth and eighteenth centuries our giddy philosopher could appear in all possible guises: in farces, as an old fool vying with his own son for the same young girl; or in political tracts or broadsheets, as a sharp-tongued critic of politics and customs, confessional battles, or even inflationary politics.<sup>39</sup> Through to the early twentieth century, this Democritus served not only as a defender of the Enlightenment against all kinds of superstitions but betrayed a particularly during the French Revolution. We possess, from that period, a "Democritean hymn," sung by the Francophile faction at Leiden to the tune of the Marseillaise, which ends on these unforgettable lines: "Strong be our link with France's free terrain! / Democritus's good cheer must never, never wane!"<sup>40</sup>

The list of uses and abuses to which the laughing philosopher was put could be expanded ad libitum. But these examples should be more than sufficient to document how, particularly in the period between the fifteenth and the eighteenth centuries, our Democritus first became a Christian moralist, later a philosophical model for the educated "critic," and finally a household name among readers and theatergoers. The same story has already been told by art historians with regard to the numerous double portraits of Democritus and Heraclitus. This genre, whose Italian origins we have already noted, and which became particularly popular among seventeenth-century Dutch painters, explored and exploited all aspects of the laughing philosopher, depicting him, respectively, as a wise Christianized Stoic, as a sarcastic observer of the vanity of human action, as an impertinent rascal, and as a vulgar and sometimes outright obscene jester.41

Again, the widespread popularity of this laughing philosopher had no connection with atomism. On the contrary, several of the authors who praised Democritus's serene detachment from the world also criticized his cosmological and physical speculations, while others simply ignored them.<sup>42</sup> The attempt of the Roman author Lucian to explain Democritus's laughter with reference to his natural philosophy—"there is nothing serious in [human affairs], but everything is a hollow mockery, drift of atoms, infinitude"—does not seem to have found any direct followers. Whoever else thought of connecting the second with the first Democritus did so in a jocular fashion—for example, the author of that political farce of 1719 who had our philosopher renounce his atomist theory in favor of the view that the world was constituted by money.<sup>43</sup>

But the second Democritus must not be left out of our story of the atomist revival, for without him the first Democritus would not have enjoyed the widespread sympathies that in fact surrounded him. Gassendi rightly insisted that the historical Democritus had been not only a materialist but a radical determinist and that Epicurus's thought was much more compatible with religion, as it left space for gods, free will, and contingency. But Gassendi's reasoning had no lasting success, thanks to the nimbus of morality and wisdom that had surrounded the figure of Democritus since the Renaissance. Already in the fourteenth century, Dante had allowed our philosopher from Abdera to remain in limbo while committing Epicurus to the sixth circle of hell. Despite Gassendi's pleas, this was still where Epicurus belonged, as far as most early modern readers were concerned.<sup>44</sup>

### DEMOCRITUS THREE: THE MORALIZING ANATOMIST

In the years from 1434 to 1450 Rinuccio Aretino, secretary to Pope Nicholas V, translated from the Greek an epistolary novel that was presumably written around 40 B.C., possibly by a physician from the island of Kos. The work consists of twenty-four letters supposedly written or received by the legendary physician Hippocrates. These relate to two different episodes, of which only the second is of interest here: it tells the story, in letters 10-23, of how Hippocrates was begged by the citizens of Abdera to come to their town to cure Democritus and of what happened when he heeded their request. The philosopher had become insane, the Abderites reported: laughing incessantly, he had left the city and settled in a nearby forest where, in a self-inflicted state of negligence, he engaged in odd activities. In the central letter (no. 17), which is known as the "Letter to Damagetus" for the name of its recipient, Hippocrates reports on his visit to the presumed patient. As warned, he found an unkempt Democritus sitting under a tree, surrounded by carcasses and taking notes. The ensuing conversation establishes at once, however, that it is not Democritus who is mad but, rather, the Abderites. Paradoxically enough, it was the very phenomenon of madness  $(\mu\alpha\nui\alpha)$  and its seat in black bile that the philosopher was busy investigating, his method being what we would nowadays call comparative anatomy.45

The conversation between the two men is long and, for the most part, of a moralizing nature. Democritus laments the futility of human activities and chastises his fellow citizens in particular. Only toward the end of the long "Letter to Damagetus" does the topic turn to medical issues, as Democritus recommends that all physicians have recourse to animal anatomy in their investigations. Hippocrates is completely persuaded by this argument: "Democritus is not mad, but he knows about everything, and he makes us wiser and through us every man," he reports.<sup>46</sup> After his departure from Abdera he begins to apply his new teacher's lesson to his own work: the concluding letters of the epistolary novel are in fact Hippocrates' anatomical reports to Democritus.

Although the views attributed to Democritus in this epistolary novel contain some genuine doctrinal traces in addition to what are mostly false or jocular ascriptions, there is at best one indirect reference to atomism, contained in the claim that the air is "full of images" ( $\epsilon$ íδωλα).<sup>47</sup> But while Democritus, the anatomist, appears almost entirely unrelated to Democritus, the atomist, his relation to the second Democritus is obvious: they have in common their laughter and their disdain for the world of mundane activity. In fact, we may now add that if the "laughing philosopher" had been in danger of looking less Christian than his counterpart Heraclitus to medieval readers, then it was the literary rediscovery of the laughing anatomist that persuaded Renaissance readers of his moral superiority.

The religious implications of this kind of laughter were already drawn out in the surprisingly early German translation of the "Letter to Damagetus" of 1521; the translator, Petrus Tritonius, explicitly defended pagan philosophers of the Democritean type: "They have written such things that Christians might almost have decided to live by them. We still call them 'damned,' though in fact they sought such virtue." This admiration increased throughout the sixteenth century and culminated in a call by the philologist Eilhard Lubin, in his 1601 edition of the pseudo-Hippocratic epistles, for the study and emulation included a strong appreciation of atomism.<sup>48</sup>

It took an astonishingly long time before it was generally admitted that this bundle of Hippocratic letters was pseudonymous. Throughout the early modern period, the majority of physicians took them to be genuine. The main reason was that there existed a series of authenticating ancient sources: Diogenes Laërtius, though speaking neither of Democritus's madness nor of his laughter, nevertheless mentions an encounter with Hippocrates. Soranus, by contrast, writes in his Vita Hippocratis that Democritus had been truly insane but that Hippocrates had managed to cure him. Celsus, finally, speaks in the preface to his Medicina of Democritus as a great physician and mentions that many believe that he was also the teacher of Hippocrates.<sup>49</sup> These sources do not fully corroborate each other, but they overlap enough that it seemed plausible to early modern readers that the two men had really met and that, whatever Democritus's clinical condition at the time, he had imparted some knowledge to the visiting physician. This explains why, at the very end of the seventeenth century, Pierre Bayle could receive the following answer from an expert he had contacted about the authenticity of the letters: "M. Drelincourt, professor of medicine at Leiden and one of the most learned men of our century, has assured me that there exists not the slightest reason for doubting that Hippocrates's letters concerning Democritus are authentic; this is the general feeling among physicians, he says."50

Although we have seen that the *personae* of the second and the third Democritus were linked through their philosophical laughter, these two figures not only owed their existence to different sources but also engendered separate literary and artistic conventions. While early literary works were close in spirit to the original setting of the "Letter to Damagetus," Thomas Rütten has documented in detail how in the early seventeenth century the anatomizing Democritus began a surprising transformation that was to separate him again from the second Democritus. Thanks to a redefinition of his behavior in terms of humoral pathology and, specifically, the melancholy temper of the solitary genius described in pseudo-Aristotle's Problemata 30.1, Democritus gradually lost his laughter, assuming instead the serious mien of the contemplative hermit. The paradoxical consequence was that our *phil*osophus ridens, who could still introduce himself in 1607 as "Doctor Merry-man" offering "medicines against melancholy humors," slowly began to resemble the very patients he promised to cure and his research to look more like an attempt to treat his own illness. The culmination of this striking transformation of the Democritus ridens into a Democritus melancholicus is found in a painting by the Neapolitan Salvator Rosa, circa 1650, entitled Democrito in meditazione, in which the traditional Democritus is transformed into a figure whose resemblance to Dürer's Melancolia is striking.51

The great literary breakthrough of this redefined Democritus came with Robert Burton's immensely successful *Anatomy of Melancholy* of 1621. For Burton, who authored his book under the pen name "Democritus junior," the anatomical research and writing of his predecessor represented just a first step toward a personal recovery: "he might better cure it in himself, and by his writings and observations teach others how to prevent and avoid it." Indeed, both C. Le Blon's engraving of the dissecting Democritus on the frontispiece (1628 ed. and later) and Burton's caption (1632 ed. and later) present the aging Abderite philosopher as meditating under the star of melancholy:

Old Democritus under a tree, Sittes on a stone with booke on knee; About him hang there many features, Of Cattes Dogges, and such-like creatures, Of which he makes Anatomy, The seat of black choler to see. Over his head appears the skye, And Saturne Lord of Melancholy.

This figure is a far cry from the jolly Democritus we encountered in the last section, and Burton is quick to distance himself from the giddy philosopher: "and first of the name Democritus," he writes in his opening page, "lest any man by reason of it, should be deceived, expecting a Pasquill, a Satyre, some ridiculous Treatise." But it was not just the second Democritus whom he wished to avoid, but also the first. This is why he hastened to add that he also rejected any "prodigious Tenet, or Paradox of the Earths motion, of infinite Worlds *in infinito vacuo, ex fortuitâ atomorum collisione,* in an infinite wast, so caused by an accidentall collision of Motes in the Sunne, all which *Democritus* held, *Epicurus* and their Master *Leucippus* of old maintained, and are lately revived by *Copernicus*, *Brunus*, and some others."<sup>52</sup>

Burton's references to Copernicus and Bruno show his awareness of recent scientific developments and the concomitant reawakening of interest in Democritus's cosmology and atomism. But like other authors of the same period, Burton tried to keep his anatomizing Democritus separate from the natural philosopher. In Adolphus Tectander Venator's comedy of 1603, for example, we find Democritus and his student Mathetes eavesdropping on two pompous Peripatetic philosophers who debate the riddles of hylomorphic matter theory. But instead of entering the discussion to present his own doctrines, our philosopher turns back to his student so as to discuss the best form of worshiping God. Venator's "pious Democritus," who includes the pursuits of natural philosophers in his laughter, was to have a long tradition. In his Geschichte der Abderiten of 1744 Christoph Martin Wieland showed himself so enamored of the wisdom and detachment of this paradigmatic "cosmopolitan" that he was repelled by the very idea that the same man could have thought up an atomist doctrine: "There are," he exclaims, "certain ideas that only a moron is capable of thinking or of expressing, just as there are misdeeds that only a scoundrel is capable of committing." For Wieland, the ascription of atomism to Democritus is just another act of idiocy committed by the Abderites. Incidentally, this is also the implication of Jean de La Fontaine's fable "Démocrite et les Abdéritain."53

But the same concatenation of ideas could also be turned upside down, which is precisely what Wieland's contemporary, Noël Pluche, did in 1739 in his Histoire du ciel. In this eloquent defense of Mosaic cosmology against all other systems Pluche bravely sides with the Abderites against Democritus, whom he considers the father of all cosmological aberrations, arguing that it was not the citizens of Abdera who were insane but, rather, their local philosopher. His frontispiece in fact turns the tables: this time, it is the good burghers of Abdera who are doing the laughing, for they recognize that anyone who spends his time speculating about things that human reason cannot possibly fathom-notably cosmic systems and atomsmust be mad. In an allusion to the famous conclusion of Voltaire's Candide ("il faut cultiver la terre"), Abdera's champions of common sense collectively exclaim: "Man has been created, not to construct the world, but to cultivate it."54

But though this third Democritus managed to lead a life in the arts and in medical writings that was quite distinct from that of the first Democritus and, to a surprising degree, even the second, he is much more interesting to the historian of science whenever he merges with his atomist alter ego. An important early example is constituted by Francis Bacon, who, though critical of atomism, believed that the anatomizing Democritus had come much closer to grasping the "subtlety" of nature than any other ancient philosopher. In various writings, he associated Democritus in fact with his own proposed method of dissecting nature. But let us here focus on two less studied authors, who were both physicians.<sup>55</sup>

The first is the French physician and teacher of eloquence Sébastien Basson, who with his Philosophia naturalis of 1621 offered to the world a bold, though not terribly coherent, corpuscular theory. In his celebrated preface Basson rehearses the by-then-frequent charge that Aristotle had willfully distorted the views of his predecessors so as to appear to be the first coherent philosopher. But then he goes on to connect this claim with evidence taken from the "Letter to Damagetus" and from Celsus in order to buttress his case. His argument runs roughly as follows: since we know that Hippocrates studied with Democritus, we must assume that Hippocratic medicine is based on the principles of Presocratic philosophy; although the works of Democritus and his peers are lost, we can nevertheless infer from the empirically verifiable superiority of Hippocratic over Galenic medicine that the Democritean principles are better; this, in turn, proves that Presocratic matter theory is superior to Aristotle's and Galen's hylomorphism.56

But whereas Basson invokes the identity of the atomist with the anatomist only in passing and chiefly so as to win a rhetorical argument against the Aristotelians, others took the consequences of this identity much more seriously. The most astonishing text, in this respect, is probably the Zootomia Democritaea (1645) of the Neapolitan physician Marco Aurelio Severino.<sup>57</sup> The centrality of the "Letter to Damagetus" to this work is already apparent from its beautiful frontispiece, which represents the encounter between the physician and the anatomizing philosopher in an oriental setting. As it was the main objective of the Zootomia to persuade physicians of the usefulness of comparative anatomy, the pseudo-Hippocratic Democritus seemed an appropriate patron saint for this enterprise. But Severino's use of Democritus went far beyond emblematics. He was convinced that Democritus had instructed Hippocrates in the principles of a type of matter theory that was particularly suitable to the objectives and methods of medicine. In other words, he believed that anatomy and atomism had a common basis and common objectives, for both were attempts to arrive at the ultimate components of natural objects. It was in fact wrong to define anatomy as a method of "dissection," for it did not "cut up" its objects but consisted of "nothing else but the artificial resolution" of the animal body into its smallest natural parts. It was therefore a technical process that was perfectly analogous to the philosophical method of atomism, which aimed at the logical resolution of entities into their last indivisible constituents. As Severino stated in a later work, the anatomist's scalpel aimed at "resolving, not at dissolving, the Democritean anatomical atoms." So profound was

Severino's conviction that atomism and anatomy were engaged in a joint project that he was even willing to propose an outlandish etymology that anatomized the word "anatomy" not as "ana-tomy," "cutting up," but as "an-atomy," which he took to mean the "uncovering the atoms":

I take the latter part [of the word] to be ἄτομα, [that is] indivisibles; as without doubt an apostrophe is inserted between the vowels, i.e. ἀν' ἄτομα, so that you have to translate [the word] as "resolution into indivisibles," or as it were, "repeated dissection down to the indivisibles." In a similar vein, the Greek word "Zootomy" is a single word drawn together from two: [it means], as it were,  $\zeta \hat{\omega} \alpha$  ἄτομα, which means, the "dissection of animals into indivisibles."<sup>58</sup>

Although none of his followers appears to have wished to repeat Severino's etymological capriole, the great Italian microanatomical tradition of the seventeenth century continued to call by the name "Democritean anatomy" a type of research that had as its goal the uncovering of the ultimate particulate machinery of the human body. Although their microscopical research and their iatromechanical models had in reality nothing in common with the speculations of the original Democritus, Giovanni Alfonso Borelli and his friends and students Marcello Malpighi, Lorenzo Bellini, and Carlo Fracassati were convinced that they were the indirect disciples of the anatomizing atomist from Abdera.<sup>59</sup>

But like Severino himself, these physicians also invoked a third type of "resolution" in addition to atomism and anatomy, namely, some chymica analysis that was said to resolve mixtures into the tria prima and into the four (secondary) elements. And again, the surprised reader finds Democritus invoked as one of the inventors of this "chemical anatomy."60 But before we turn to the last of our four Democriti, to the alchemist, let us mention some of the implications of Severino's concatenation of disciplines for the concept of "atom." First, and most generally, the "Democritean philosophy" cultivated by the Italian microanatomists was not primarily a philosophical system but implied, in imitation of the presumed multiple activities of the Abderite sage, an experimental approach to resolution that involved microscopical anatomy, chemical analysis, and mechanistic model-building. Second, the combination of iatromechanical with iatrochemical methods implied that the resulting concept of matter could be neither strictly "materialistic" nor strictly "mechanical." When Severino insisted that sympathies and antipathies had to remain essential concepts in such an atomist anatomy, he was continuing what had begun, precisely one hundred years earlier, with Girolamo Fracastoro's De sympathia et antipathia rerum: the introduction of Lucretian atomi-semina into a world of sympathetic relations that also happened to be particularly hospitable to alchemical notions.<sup>61</sup> By the same token, the writings of Leonardo di Capoa, a leader of the Neapolitan Accademia

degli Investiganti and one of Severino's former pupils, are teeming with references to Democritus and to the overall analytic goal of science—natural philosophy, anatomy, alchemy, mathematics—associated with his name. But how curious to see that this author, who promotes the search for the "smallest particles" in all of these disciplines, at the same time vehemently attacks the notion of "indivisible atoms" and attributes their invention to Epicurus!<sup>62</sup>

"Democritean analysis," in Italy and elsewhere, had thus come to designate any method of applied science that aimed at dismembering composites into basic substances.<sup>63</sup> These substances were assumed to be made up of minute particles, but there was no scientific need for them to be indivisible; for religious reasons, it was in fact better if they were not. The fact that Democritus could come to be associated with an explicitly divisibilist type of corpuscularianism shows forcefully just how far the early modern conception of "Democritean atomism" could deviate from the original metaphysical concerns of the philosopher whose name it carried. That this was to a good degree due to the intervention and interference of the third Democritus is, I think, beyond dispute. The equally powerful interference of the last of the three doppelgänger is what remains to be addressed.

# DEMOCRITUS FOUR: THE ALCHEMIST

The destiny of the philosopher of Abdera is indeed bizarre: none of his numerous writings are extant, and all of the works that carried his name in the early modern period are spurious. This also holds true for his fourth incarnationas an alchemist-which is almost entirely dependent on a work commonly known as *Physica et mystica*. This title came to be attached to a highly heterogeneous anthology of works that seem to hail from different periods of Egyptian alchemy of the late Hellenistic era and contain recipes for the production of dyestuffs and of purple, a story in which a student conjures up his deceased teacher, ten recipes describing the production of gold, an oration inveighing against rebellious apprentices, three further recipes for the making of gold, theoretical annotations made for the benefit of colleagues, and, finally, nine recipes describing the production of a silvery alloy called *asemon*. Once again we are confronted with the phenomenon of the total separation of personae and doctrines, for none of these fairly unsophisticated texts displays any concern with the material structure of the chemical substances it mentions, let alone with atomism.64

This strange collection of texts is so utterly un-Democritean in spirit and doctrine that it is surprising that it should ever have been associated with the Abderite philosopher at all. And yet, from manuscripts kept at Venice and Leiden which include, notably, a "Letter of Democritus to Leucippus"—it appears that Democritus had somehow managed to become the patron of the Egyptian alchemists. There also exists a commentary tradition beginning with the fourth-century alchemist Synesius that insists on the Democritean authorship of the *Physica et mystica*.<sup>65</sup>

In the late sixteenth century Greek manuscripts containing not just the better part of the *Physica et mystica* but also these authenticating commentaries by Synesius, Pelagius, and others fell into the hands of Domenico Pizzimenti, who is best known as the teacher of the Renaissance *magus* Giovanni Battista della Porta. Pizzimenti, convinced of their authenticity, translated the texts into Latin and published them in 1573 at Padua under the title *De arte magna*.<sup>66</sup>

Doubts regarding the authentic nature of various magical and alchemical treatises circulating under Democritus's name had already been voiced by ancient authors, however. To be sure, Pliny, Petronius, Seneca, and others had mentioned Democritus's travels to the Orient and spoke of arcane secrets he brought back, which included chemical procedures involving the preparation of dyestuffs and the liquefaction of ivory. This tradition explains why it was possible, even before the publication of the Physica et mystica, to celebrate Democritus as a magus and gold maker, as in John Dee's Monas hieroglyphica of 1564. Other ancient sources, however, and notably Diogenes Laërtius, Columella, and Aulus Gellius, testified to the abuse that was being made of the name of Democritus even in their own time.<sup>67</sup> Columella specifically mentions a certain Bolus of Mendes, probably an Egyptian from Alexandria who lived in the second century B.C., as the real author of some of the alchemical writings attributed to Democritus. Looking at the style and contents of the Physica et mystica, early modern readers with philological acumen reached a similar conclusion. Claude Saumaise, for one, was convinced that "although these works circulate under the name of Democritus, they belong to the last period of Greek literature."68

And yet, there existed a party that was intensely interested in defending the authenticity of the alchemist Democritus—namely, the alchemists themselves. In their eyes, the texts rediscovered by Pizzimenti constituted a strong proof of the antiquity and venerability of alchemy and its principles. Already in the second edition of Pizzimenti's translation (Cologne, 1574), Antoine Mizauld not only rebutted doubts regarding the authenticity of this fourth Democritus but skillfully combined him with the third, pseudo-Hippocratic, Democritus in an attempt to demonstrate the age of alchemy and its relevance to the concerns of medicine.<sup>69</sup>

Such rhetorical claims, often repeated in subsequent years, of course affected only those who chose to believe them and were ignored by others. As Allen Debus has shown, Paracelsians, who followed their master in calling fire analysis an "anatomical" procedure, were particularly keen on demonstrating the antiquity of a chemical school of medicine for the existence of which Democritus could, albeit with some difficulties, be called to testify.<sup>70</sup>

It was only during the Parisian controversy over the status and merits of iatrochemical medication, which was initiated in 1603 and petered out in 1609, that the alleged compatibility of the fourth Democritus not just with the third but primarily with the first Democritus was finally put to the test. Since it seems to me that this episode provides the richest example of the various Democritean mergers and that it led to an interesting clarification of theoretical positions, I propose to conclude this essay with an analysis of this controversy and its aftermath.<sup>71</sup>

In 1603 the Parisian court physician Joseph Duchesne, better known as Quercetanus, published under the title De priscorum philosophorum verae medicinae materia a defense of iatrochemical medication against the traditional doubts of the medical elite at the neighboring Sorbonne, thereby renewing his 1575 challenge to the academic establishment. He began his defense with the historical claim that the iatrochemical school, the secta spagirica, did not constitute a new heterodoxy but was in truth much older than the three traditional medical sects of the empirics, the methodics, and the dogmatics. Although Quercetanus's concern was with the propagation of medicines and not with history, he felt compelled to support his claim with a brief genealogical sketch of the spagyrical school. He indicated that it was a tradition that had as its founding fathers Hermes Trismegistus, Orpheus, Democritus, and Hippocrates, though he refrained from specifying in what precise relation these four men were supposed to stand. And since only one of them had left behind some alchemical writings, our author chose, not too surprisingly, to focus on "the Greek prince Democritus." In his proof of the general greatness and venerability of this sage, Quercetanus gathered whatever enriching attributes he could find, mentioning the pseudo-Hippocratic letters, Diogenes Laërtius's description of Democritus's natural philosophy, and of course the latter's treatises on alchemy.<sup>72</sup>

Quercetanus's book attracted immediate criticism, was officially censored (also in 1603) by the Parisian faculty of medicine, and was rebutted by its censor, Jean Riolan the Elder, in an *Apologia pro Hippocratis et Galeni medicina*.<sup>73</sup> In Riolan's eyes, Quercetanus's historical arguments were nothing less than absurd. With respect to Democritus, Riolan pointed to the total lack of atomist thought in the *Physica et mystica;* he also claimed, more generally, that there was no relation between iatrochemistry and atomism.

To a modern reader, Riolan's arguments seem obvious and coherent—all the more so because Quercetanus's spagyrical principles, which substituted "intrinsic essences" for elements and primary qualities, look far less compatible with atomism than the traditional principles he rejects. A related point was in fact raised by the physician Nicolas Guibert, who joined the controversy in 1603 and who declared that though he had been a personal friend of the late Pizzimenti, the inept style of the *Physica et mystica* and its absence from Diogenes Laërtius's bibliography made it impossible for him to accept this work as genuine.<sup>74</sup>

In his reply of 1604, entitled Ad veritatem Hermeticae medicinae, Quercetanus defended his overall historical scheme, but now without assigning any prominent role to Democritus. This time, the name of the Abderite appeared only furtively, amid long lists of ancient adepts. But while Quercetanus seems to have accepted the indefensibility of his Democritean argument, Andreas Libavius, who had entered the Parisian battle at Quercetanus's request and with all the vigor of his vitriolic eloquence, did not. In his 1604 attack on Nicolas Guibert Libavius insisted on the authenticity of Democritus's alchemical work. His "Defensio alchemiae" of 1606 developed these arguments further on behalf of the embattled Quercetanus. Libavius now argued that both the opaque style of the *Physica et mystica* and its absence from the references of ancient doxographers were easily explained by the secret character of its contents. Democritus's impenetrable prose was, in other words, a deliberate feint. But in order to rebut Riolan's claim that alchemy and atomism relied on two incompatible sets of principles, Libavius had to invent an argument that, I believe, he had not developed in his earlier polemics: atomism, he now insisted, was a completely reasonable hypothesis that was both in conformity with sense perception and useful to the ends of alchemy.<sup>75</sup>

Utterly unimpressed by Libavius's arguments, Riolan retorted in his equally aggressive Ad Libavi maniam (1606) that the Parisian censorship of Quercetanus's book was fully justified and that Libavius's reasoning was in every conceivable sense as flawed as that of Quercetanus. While disentangling with astonishing patience the hodgepodge of historical connections that Libavius had attempted to manufacture, Riolan attacked, first of all, the alleged link between Hippocratic medicine and alchemical practice: "I have always been of the opinion that the Democritus who is flaunted by you as the author of chemical works was not that contemporary of Hippocrates, but some Arab physician." Note that Riolan uses the "Letter to Damagetus" as his yardstick for judging the authenticity of the alchemical Democritus! Not just character traits, however, but above all doctrinal differences, spoke, according to Riolan, against Libavius's identification: "Democritus proposed principles of the generation of all things that were a far cry from those of the chemists: for he composed everything out of indivisible corpuscles to which he attributed the causes of all physical effects. But the chemical principles are divisible inasmuch as they are mixed." Riolan's conclusion was anything but flattering: "You adjust Democritus's view on the indivisible corpuscles to the principles of chemistry quite ineptly, not to use any harsher terms!"<sup>76</sup>

In his thousand-page rejoinder, the *Alchymia triumphans* of 1607, Libavius was forced to raise the stakes and in the process took an essential step. This time, he defended at great length not only the historical identity of the alchemist with the atomist but also the doctrinal identity of alchemy and atomism. After summarizing Riolan's argument in the following syllogism—

Democritus composed everything out of indivisible corpuscles;

The chemists have divisible principles;

Hence Democritus was no chemist-

he stated, for what I believe was the first time, that the term "indivisible atoms" referred to the ultimate units of matter and that these were equivalent to the ultimate substances recovered at the end of chemical resolutions. Invoking the evidence furnished by reductions, distillations, and other chemical methods, Libavius now insisted that chemical practitioners were generally convinced of the truth of atomism. He also specified that there existed a "subaltern" relationship between the higher-level mixed substances, the four elements, the tria prima, and the atoms. Finally, he charged that Aristotle's arguments against atomism were all of a logical and mathematical nature-and so remote from physical and chemical evidence that merry Democritus would have laughed them off. Libavius let his arguments culminate in a syllogism whose conclusion proved the contrary of Riolan's:

The person whose doctrine regarding the concretion and resolution of bodies is in agreement with the chemical principles was probably a chemist;

Democritus's doctrine regarding the concretion and resolution of bodies is in agreement with the chemical principles, as we shall now demonstrate on the basis of Riolan's very arguments;

It is therefore probable that Democritus was a chemist.<sup>77</sup>

Riolan died before he could respond to this bold argument, and Libavius was to repeat what he somewhat unfairly called his "unrefuted demonstration" for the reminder of his own life, celebrating it as a decisive victory of alchemy over the Parisian physicians without mentioning that it had been Riolan who backed him into the atomist corner.

Today's reader of Libavius's thousands of pages is left wondering to what extent their author was persuaded by his own argument and how much intellectual energy he was willing to spend in aligning his professed atomism with his alchemy. But it would certainly be unjust to accuse Libavius of mere rhetoric, for it cannot be denied that in the wake of the Parisian controversy he repeatedly resorted to atomist arguments, most importantly in the essential question of the nature of mixtures.<sup>78</sup> Yet his use of the concept "atom" fluctuates somewhat inconsistently—

or pragmatically—between Democritean indivisibles, Aristotelian *minima naturalia*, Paracelsian *tria prima*, and Lucretian *semina rerum*.

An ideal end point for our bewildering Democritean tale is provided by Daniel Sennert, because the roles played by Democritus in the evolution of his thought recapture the fortuna of this Greek philosopher in early modern alchemy. When the name of the ancient atomist shows up for the very first time, in a disputation held under Sennert at Wittenberg in 1599, it is only to confirm the validity of Aristotle's objections to Democritean atomism. Conversely, when Sennert uses the term "atom" for the first time, the reference bears, curiously enough, the imprint of the teaching of Giordano Bruno, who had been at Wittenberg only a few years earlier.<sup>79</sup> But as is well known, between 1600 and 1630 Sennert grew increasingly more interested in atomist explanations. As William Newman's ground-breaking studies show, the development of Sennert's matter theory was much assisted by the existence of medieval alchemical writings with strong corpuscularian implications.<sup>80</sup> Importantly, however, Sennert also stood under the influence of Libavius's arguments in favor of Democritus's alchemical atomism, which he sometimes reiterated in close paraphrase.<sup>81</sup> What is interesting, for our present concerns, is that well into the 1620s he defended the Democritean authorship of the Physica et mystica for the same reasons of historical legitimation as had Quercetanus and Libavius.82 But together with his increasing interest in the use of atomist explanations for chemical processes, his interest in the first Democritus, the natural philosopher, grew, while his enthusiasm for the fourth Democritus, that unconvincing representative of early alchemy, steadily waned. The end point of this noteworthy return to the first Democritus, whose atomism he had so clearly dismissed in 1599, is constituted by the exuberant "praise of Democritus" that Sennert inserted into the chapter "On Atoms" of his Physica hypomnemata of 1637. In this inordinately detailed description of the Abderite's life and doctrine, Sennert unfolds before his readers an extensive *florilegium* of ancient testimonies. And then, remarkably, he ends his presentation by rejecting the Physica et mystica as a genuine Democritean work!83

With this remarkable move from an initial rejection of atomism through Democritean alchemy to a final acceptance of Democritean atomism, our story has also come full circle. The other three Democriti continued their separate or mixed existences in the arts and sciences without much concern for the newly revived first Democritus.<sup>84</sup> And yet, it should have become clear that this revival of the atomist could not have taken place without the help of his much more popular *doppelgänger*. For without their ministrations, his bold but bald model—limited, as in reality it was, to atoms, void, and necessity—would have looked quite unattractive to early modern natural philosophers,

physicians, or chemists. In fact, it would seem that its ability to develop heterodox forms had constituted the only real chance for ancient atomism. And so our indefinitely combinable fourfold Democritus ended up as the patron saint of a multitude of highly diverse types of matter theories.

### Notes

- 1. Galileo Galilei, De motu antiquiora (ca. 1590), in Le opere di Galileo Galilei, ed. Antonio Favaro, 20 vols. (Florence: Barbera, 1890-1909), Vol. 1, pp. 243-419, on p. 355: "Quapropter, in hoc antiquorum opinionem, quam frustra Aristoteles 4° Caeli destruere tentat, sequentes, Aristotelis eo loci tum confutationes, tum etiam suas confirmationes, confutata quidem confirmando, confirmata vero confutando, examinabimus; ..." (Here and elsewhere, translations are mine unless otherwise indicated.) Louis Löwenheim, Die Wissenschaft Demokrits und ihr Einfluß auf die moderne Naturwissenschaft, ed. Leopold Löwenheim (Berlin: Simion, 1913) (suppl. to fasc. 4 of the Archiv für Geschichte der Philosophie, 1913, 26). Democritus represents for Löwenheim "der Hauptvertreter der antiken Wissenschaft," while "Plato und Aristoteles dagegen auf die Entwicklung der Wissenschaft lediglich einen hemmenden Einfluß gehabt haben." According to this view, Galileo eventually managed to remove the Aristotelian obstacle and to re-establish "die moderne Naturwissenschaft wie die moderne Philosophie auf der Grundlage, welche einst Demokrit, der größte Denker des Altertums, gelegt hatte" (p. 15). See also Louis Löwenheim, "Der Einfluß Demokrit's auf Galilei," Arch. Gesch. Phil., 1894, 7:230-268.
- 2. Marie Boas Hall, "Matter in Seventeenth-Century Science," in The Concept of Matter, ed. Ernan Mac-Mullin (Notre Dame, Ind.: Univ. Notre Dame Press, 1963), pp. 344-367, on pp. 345, 347. But Boas Hall maintains in the same essay that Galileo's mechanics and epistemology demonstrate that he "was well read in the classics of ancient atomism" (p. 349). Several of her writings betray in fact the tension between her ascription of a major influence to Hero of Alexandria's atomism and her general denial of any influence of ancient atomism on early modern science. See Boas Hall, "Hero's Pneumatica: A Study of Its Transmission and Influence," Isis, 1949, 40:38-48, where she claims that Hero's theory "was nonatomistic" and at the same time that "by far the most important follower of Hero's atomism was Galileo" (pp. 47, 48). On the development of Galileo's matter theory see William R. Shea, "Galileo's Atomic Hypothesis," Ambix, 1970, 17:13-27; and Pietro Redondi, "Atomi, indivisibili e dogma," Quaderni Storici, 1985, 20:529-571.

- 3. Andreas van Melsen, "Het wijsgeerig verleden der atoomtheorie" (Ph.D. thesis, Univ. Utrecht, 1951), p. 64: "Democritus had reeds een vrij volledige en afgeronde atoomleer, welke vrijwel onveranderd in de 17e eeuw wordt overgonomen." See also van Melsen, From Atomos to Atom: The History of the Concept of Atom, trans. H. J. Koren (Pittsburgh, Pa.: Duquesne Univ. Press, 1952), p. 89: "The seventeenth century ... saw the revival of philosophic atomism in the sense of Democritus and the rise of an original corpuscular theory which, however, in many aspects is related to that of Democritus, namely the corpuscular theory of Descartes." James Riddick Partington, "The Origins of the Atomic Theory," Annals of Science, 1939, 4:245-282, on p. 249; the quotation is from Robert Boyle, The Sceptical Chymist (London: Crooke, 1661), p. 23. Hans Kangro, "Erklärungswert und Schwierigkeiten der Atomhypothese und ihrer Anwendung auf chemische Prinzipien in der ersten Hälfte des 17. Jahrhunderts," Technikgeschichte, 1968, 35:14-36. Christoph Meinel, "Early Seventeenth-Century Atomism: Theory, Epistemology, and the Insufficiency of Experiment," Isis, 1988, 79:68-103, on p. 68: "In atomism, there was no experimental proof possible, although most corpuscular theories of the seventeenth century explicitly claimed to be based upon experience." See also Andrew Pyle, Atomism and Its Critics: From Democritus to Newton (Bristol: Thoemmes, 1995), p. 308, which refutes Reijer Hooykaas's claim that alchemical experiments provided stringent proofs of atomism.
- 4. Henry Power's poem "In Commendation of ye Microscope" (ca. 1661) is reprinted in Thomas Cowles, "Dr. Henry Power's Poem on the Microscope," Isis, 1934, 21:71-80. On the hopes and eventual disillusionment of a visual and optically verifiable atomism see Christoph Meinel, "Das letzte Blatt im Buch der Natur: Die Wirklichkeit der Atome und die Antinomie der Anschauung in den Korpuskulartheorien der frühen Neuzeit," Studia Leibnitiana, 1988, 20:1-18; Catherine Wilson, "Visual Surfaces and Visual Symbol: The Microscope and the Occult in Early Modern Science," Journal of the History of Ideas, 1988, 49:85-108; and Christoph Lüthy, "Atomism, Lynceus, and the Fate of Seventeenth-Century Microscopy," Early Science and Medicine, 1996, *I*:1-27.
- 5. Richard S. Westfall, *The Construction of Modern Science: Mechanisms and Mechanics* (New York: Wiley, 1971), pp. 1, 45. On the attempt to explain away occult qualities see Keith Hutchison, "What Happened to Occult Qualities in the Scientific Revolution?" *Isis*, 1982, 73:233-253; and John Henry, "Occult Qualities and the Experimental Philosophy: Active Principles in Pre-Newtonian Matter Theory,"

History of Science, 1986, 24:335-381. How Galileo's law of free fall came into conflict with atomist models of collision has been discussed most recently in Carla Rita Palmerino, "Infinite Degrees of Speed: Marin Mersenne and the Debate over Galileo's Law of Free Fall," *Early Sci. Med.*, 1999, 4:268-347. On the tension between the two meanings of "mechanization" see Westfall, *Force in Newton's Physics: The Science of Dynamics in the Seventeenth Century* (New York: American Elsevier, 1971), ch. 1; and Margaret J. Osler, *Divine Will and the Mechanical Philosophy: Gassendi and Descartes on Contingency and Necessity in the Created World* (Cambridge: Cambridge Univ. Press, 1994), p. 171.

- 6. The two meanings of "mechanistic philosophy" are discussed in Eduard Jan Dijksterhuis, The Mechanization of the World Picture, trans. C. Dikshoorn (Oxford: Clarendon, 1961), p. 4. On Democritus's influential "mechanistic corpuscular model" see ibid., esp. Pt. 1, Sects. 9, 11; Pt. 3, Sect. 74; and Pt. 4, Sect. 218. Benedino Gemelli, Aspetti dell'atomismo classico nella filosofia di Francis Bacon e nel Seicento (Florence: Olschki, 1996), esp. ch. 7. On the nonmechanical aspects especially of medical atomism see Ugo Baldini, "Il corpuscolarismo italiano del Seicento: Problemi di metodo e prospettive di ricerca," in Ricerche sull'atomismo del Seicento: Atti del Convegno di Studio di Santa Margherita Ligure, 14-16 ottobre 1976, ed. Baldini et al. (Florence: Nuova Italia Editrice, 1977), pp. 1-76, esp. p. 8 ff.
- 7. Stephen Clucas, "The Atomism of the Cavendish Circle: A Reappraisal," Seventeenth Century, 1994, 9:247-273; Lynn S. Joy, Gassendi the Atomist: Advocate of History in an Age of Science (Cambridge: Cambridge Univ. Press, 1987), ch. 5: "Unrecognized Cultural Baggage: The Incoherence of Contemporary Debates about Atoms" (pp. 83-105): and Antonio Clericuzio, "L'atomisme de Gassendi et la philosophie corpusculaire de Boyle," in Gassendi et l'Europe (1592-1792): Actes du Colloque International de Paris "Gassendi et sa postérité (1592-1792)," ed. Sylvia Murr (Paris: Vrin, 1997), pp. 227-235, esp. p. 235. For a discussion of the specific ingredients of seventeenth-century chemical atomism see Clericuzio, Elements, Particles, and Atoms: A Study of Seventeenth-Century Chemistry and Corpuscular Philosophy (Dordrecht: Kluwer, 2001), ch. 1: "From Minima to Atoms."
- Gaston Bachelard, Les intuitions atomistiques: Essai de classification (Paris: Boivin, 1933), pp. 10-11, on p. 10; and Johannes Chrysostomus Magnen, Democritus reviviscens, sive de atomis (Pavia: J. A. Magrium, 1646). From the second edition onward the book carried the title Democritus reviviscens, siva

vita et philosophia Democriti (Leyden: Adrian Wyngaerden, 1648; The Hague: Adriaan Vlacq, 1658; London: Roger Daniels, 1658). For the non-Democritean character of Magnen's atomism see the discussion at the end of the next section.

- 9. Frances A. Yates, *The Art of Memory* (Chicago: Univ. Chicago Press, 1966), p. 106, mentions a tradition that ascribed the invention of the art of memory to Democritus and not to Simonides. Though it would be possible to split the figure of Democritus even further, our limited scheme takes its justification from the existence of exactly four ancient and Renaissance literary traditions. For an interesting recent approach to the figure of Democritus through the early modern reception of his *pseudographa* see Thomas Rütten, "Demokrit," in *Groβe Gestalten der griechischen Antike: 58 historische Portraits von Homer bis Kleopatra*, ed. Kai Brodersen (Munich: Beck, 1999), pp. 230-237.
- A list of seventy books is given in Diogenes Laërtius, Lives of Eminent Philosophers, trans. D. R. Hicks, 2 vols. (Cambridge, Mass.: Harvard Univ. Press), 9.46-49. See also Hermann Diels, Die Fragmente der Vorsokratiker, 6th ed., rev. Walther Kranz, 3 vols. (Berlin: Weidmann, 1952), Vol. 2, pp. 81-230; Geoffrey Stephen Kirk, J. E. Raven, and M. Schofield, The Presocratic Philosophers, 2nd ed. (Cambridge: Cambridge Univ. Press, 1983), pp. 402-433; Alfred Stückelberger, Vestigia Democritea: Die Rezeption der Lehre von den Atomen in der antiken Naturwissenschaft und Medizin (Basel: Reinhardt, 1984); and Stückelberger, "Lucretius reviviscens: Von der antiken zur neuzeitlichen Atomphysik," Archiv für Kulturgeschichte, 1972, 54:1-25.
- Diogenes Laërtius, *Lives of Eminent Philosophers*, trans. Hicks, 9.44-45. For Aristotle's criticism see esp. Aristotle, *Metaphysics* A4 (esp. 985b4-20); *Physics* 4.6 (esp. 213a28-213b12); *De caelo* 1.7 (esp. 275b30-276a18); and *De generatione et corruptione* 1.8 (esp. 324a25-326b28), 1.10 (esp. 327a30-328b24) (on the "heap" see 328a8-10). See also Marcus Tullius Cicero, *De finibus* 1.6.18-21, which ends on the damning phrase: "Quae cum res tota ficta sit pueriliter, tum ne efficit quidem quod vult." Here and throughout, references to specific editions of ancient authors will be made only if a particular translation has been used.
- See, e.g., John E. Murdoch, "Atomism and Motion in the Fourteenth Century," in *Transformation and Tradition in the Sciences: Essays in Honor of I. Bernard Cohen*, ed. Everett Mendelsohn (Cambridge: Cambridge Univ. Press, 1984), pp. 45-66, on p. 57: "Unlike the physical atomism of Democritus or the seventeenth century, which did carry some

explanatory power, however problematic, relative to objects and events in nature, the central task of medieval atomism lay not in such explaining, but simply in the formulation of a consistent and convincing account of the atomistic structure of continuous quantity in the abstract and especially in what such an account would have to be to render the Aristotelian opposition innocuous." See also Murdoch, "Naissance et développement de l'atomisme au bas moyen âge latin," in Cahiers d'études médiévales, Vol. 2: La science de la nature: Théories et pratiques, ed. Guy-H. Allard and J. Ménard (Montreal: Bellarmin; Paris: Vrin, 1974), pp. 11-32, on p. 11: "C'était contre ... la substance même du sixième livre de la Physique, et non pas contre l'opposition d'Aristote à Démocrite, qu'allait réagir l'atomisme qui apparut à la fin du moyen âge." Even if one views the situation with greater optimism-as, recently, has Bernard Pabst, who happily assembles whoever was willing to use the word "atom" in the thirteenth, fourteenth, and fifteenth centuries-one counts only eighteen lonely philosophers: Pabst, Atomtheorien des lateinischen Mittelalters (Darmstadt: Wissenschaftliche Buchgesellschaft, 1994), p. 317. Among them, John Wyclif, Nicolas of Autrecourt, and Nicolas Bonetus may in fact have been the only ones who tried to apply their finitist solution to the problem of the divisibility of the continuum to problems in natural philosophy as well. On the question of the continuities and discontinuities between medieval and early modern atomism see esp. Walter Subow, "Zur Geschichte des Kampfes zwischen dem Atomismus und dem Aristotelismus im 17. Jahrhundert (Minima naturalia und Mixitio)," in Sowjetische Beiträge zur Geschichte der Wissenschaft, ed. N. A. Figurowski et al. (Berlin: VEB Deutscher Verlag der Wissenschaften, 1960), pp. 161-191. Subow incorporates the findings of earlier scholars, notably Anneliese Maier and Xaver Pfeifer, on the medieval mixtio debates. See also Norma E. Emerton, The Scientific Reinterpretation of Form (Ithaca, N.Y.: Cornell Univ. Press, 1984), chs. 3 and 4.

- 13. On the reaction of the Church Fathers to atomism see Kurd Lasswitz, *Geschichte der Atomistik vom Mittelalter bis Newton*, 2 vols. (1890; Hildesheim: Olms, 1984), Vol. 1, pp. 11-30.
- 14. Twice, in *De rerum natura* 3.371 and 5.622, Lucretius refers directly to Democritus's teaching with the verse: "Democriti quod sancta viri sententia ponit. . . ." On his acquaintance with Asclepiades see Stückelberger, *Vestigia Democritea* (cit. n. 10), pp. 150-156. For a vitalist interpretation of atomic *semina* see Gemelli, *Aspetti dell'atomismo classico* (cit. n. 6), pp. 14-15, 128-129, 257-259, 342, and *passim*.

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- 15. See, in this context, Francesco Pico della Mirandola's partial defense of Democritus in *Examen* veritatis doctrinae gentium 6.14, in Opera omnia, 2 vols. (Basel: Officina Henricpetrina, 1572-1573), Vol. 2, p. 792 ff. Ernst Cassirer, Das Erkenntnisproblem in der Philosophie und Wissenschaft der neueren Zeit, 2 vols. (Darmstadt: Wissenschaftliche Buchgesellschaft, 1995), Vol. 1, p. 166: "Der Gewinn dieses Verfahrens fällt vorallem Demokrit zu, dessen Philosophie hier zum ersten Male nach ihrem Grundcharakter erkannt und geschätzt wird."
- 16. Francesco Patrizi, Discussionum peripateticarum tomi quattuor (Basel: Perna, 1581), Bk. 3, ch. 1, p. 293: "Ab Orpheo Theologia universa, a Thalete Mathematica, a Democrito physica, a Pythagora, & tres hae, & praeterea ethica. Haec communis est sententia." Even authors interested in the origins of scientific speculation and not in the Hermetic tradition were far more curious about Pythagoras or Anaxagoras than about the atomists; see Francesco Piccolomini, "De veterum philosophorum placitis in attinentibus ad interna principia generationis rerum natura constantim liber unus," in Librorum ad scientiam de natura attinentium pars prima (Venice: Franciscus de Francisci, 1596), fols. 28r-45v. The view identifying Moses with Mo[s]chus the Phoenician-according to Strabo (from Posidonius) the true inventor of atomism-developed only in the late sixteenth and seventeenth centuries. But instead of inserting Democritus into the holy assembly of prisci theologi it worked in fact to his detriment, as shown by the cases of Ralph Cudworth and Andrew Michael Ramsey, who saw in Greek materialism nothing but the impious debasement of the original. See Danton B. Sailor: "Moses and Atomism," J. Hist. Ideas, 1964, 25:3-16; and Daniel Pickering Walker, The Ancient Theology: Studies in Christian Platonism from the Fifteenth to the Eighteenth Century (London: Duckworth, 1972), ch. 7.
- 17. For the "Area Democriti" see Giordano Bruno, De triplici minimo et mensura (Frankfurt: Wechel & Fischer, 1591), p. 50. See also Bruno, Articuli centum et sexaginta adversus hujus tempestatis mathematicos et philosophos (Prague: G. Daczicenus, 1588); and Johannes Kepler, Strena seu de nive sexangula (Frankfurt: G. Tampach, 1611). On the influence of Kepler's Strena on later works in crystallography see Robert Halleux, J. Kepler: L'étrenne ou la neige sexangulaire (Paris: Vrin, 1975); and Emerton, Scientific Reinterpretation of Form (cit. n. 12), p. 40 ff. On the background of Bruno's atomist imagery and its subsequent impact see Christoph Lüthy, "Bruno's Area Democriti and the Origins of Atomist Imagery," Bruniana et Campanelliana, 1998, 4:59-92.

- Bruno, *De triplici minimo*, p. 10 (arguing for one type of atom); Giordano Bruno, *De l'infinito universo et mondi* ([London: John Charlewood], 1584), p. 145; and Bruno, *De immenso et innumerabilibus seu de universo et mundis* (Frankfurt: Wechel & Fischer, 1591), p. 610.
- Bruno, *De triplici minimo*, p. 49: "Eandem ergo figuram maximo tribuimus atque minimo." See Lüthy, "Bruno's *Area Democriti*" (cit. n. 17), pp. 70-78.
- Lessico di Giordano Bruno, ed. Michele Ciliberto, 2 vols. (Rome: Ateneo & Bizzarri, 1979), s.v. "Democrito."
- 21. Johannes Kepler, Dissertatio cum Nuncio sidereo (Prague: D. Sedesanus, 1610), pp. 2-3: "adeoque vel mundum hunc ipsum infinitum ..., vel, ut Democrito et Leucippo, et ex recentioribus Bruno et Brutio, tuo Galileae, et meo amico, visum, infinitos alios mundos (vel, ut Brunus, terras) huius nostri similes esse." See pp. 22, 24, 25, 30, and 32 for further references to Bruno. Julius Caesar Lagalla, De phoenomenis in orbe lunae ... physica disputatio (Venice: Thomas Balionus, 1612), p. 21: "Verum quia posset adhuc aliquis haec, quae in Luna videntur, vera existimare, prout in Terra sunt, statuens, multos esse terrestres globos, huic nostro adsimiles, & multos Mundos, ut Democritus statuebat, et ut Chaelperus [i.e., Kepler] iocatur in sua dissertatione cum sydereo Nuntio, recentem auctorem damnati nominis [i.e., Bruno], & eius insaniam ridens." For the long attack on atomism see pp. 24-57. The atheist charge occurs on p. 25: "e quorum numero fuit Brunus nouissimus huius sententiae assertor, qui ab Elizabetha Angliae, Άπιστος, και Άθεος cognominari meruit." (My spelling follows the presentation copy corrected by Lagalla: Vatican Library, Barberini N.III.36; the printed version is about as flawed as a text can possibly be.) It is surprising that Pietro Redondi did not discuss these passages, though they corroborate so nicely the chain of association that linked Democritus, Bruno, and Galileo in the eyes of contemporaries. See Redondi, Galileo Heretic, trans. Raymond Rosenthal (London: Penguin, 1983), esp. p. 60.
- 22. Bruno, *De triplici minimo* (cit. n. 17), p. 10: "nobis vero vacuum simpliciter cum atomis non sufficit, certam quippe oportet esse materiam qua conglutinetur."
- 23. Walter Charleton, *The Darknes of Atheism Dispelled* by the Light of Nature (London: W. Lee, 1652), pp. 40-41.
- 24. Andrew Michael Ramsey, for example, was convinced that Mo[s]chus "was the first who taught the atomical doctrine, not in the sense of Democritus

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and Epicurus, but in that of Sir Isaac Newton. See Opt. p. 407," the implication being that there was an ethereal "plastic spirit" holding the atoms together. Cited in Walker, *Ancient Theology* (cit. n. 16), p. 262.

- 25. Osler, Divine Will and the Mechanical Philosophy (cit. n. 5), p. 45. Magnen, Democritus reviviscens (1646) (cit. n. 8), "Prolegomena" (n.p.): "Cum primogenitam inter omnes sapientum sectas atomorum philosophiam resitutere designaverim, eiusque opinionis famam mille calumnis obsoletam vindicare." See also, e.g., ibid., p. 26: "Atomis mutabiles esse figuras;" p. 70: "Tot sunt elementa quot reperiuntur in corporum dissolutione, sed tria tantum reperuntur, ut Chymicis est manifestum qui sulphur, mercurium, & salem in omnibus mixtis reperiuntur, agnosce in sulphure ignem, aquam in mercurio, in sale terram;" p. 169: "Pro mixtione naturali habemus materiam atomos aqueas, terreas, igneas; pro instrumentis erunt qualitates primae atomorum, & siderum influxus, quem vertiginis nomine distinguebat Democritus." On Magnen's teaching see Lasswitz, Geschichte der Atomistik (cit. n. 13), Vol. 1, pp. 498-512; and Manlio Iofrida, "Jean-Chrisostome Magnen," in Die Philosophie des 17. Jahrhunderts, ed. Jean-Pierre Schobinger (Grundriss der Geschichte der Philosophie), Vol. 1, Pt. 1, pp. 882-886. On Sennert's "pluralistic and hierarchical account of form" see Emily Michael, "Daniel Sennert on Matter and Form: At the Juncture of the Old and the New," Early Sci. Med., 1997, 2:272-299.
- 26. Magnen, Democritus reviviscens (1646), pp. 1-8 ("Democriti vita"), 9-12 (bibliography). For the presence of the other three Democriti see, e.g., pp. 4-8: "neque satis ab ea illum suspicione [sc. insaniae] vindicavit Hippocrates. ... In ea solitudine libros conscripsit quorum syllabum connectam; chymicis vacabat operationibus ...; temperamento herculeo fuit, ex bile et melancholia; ... voluptatem praeterea maledicentiae, quae viros in litteris illustres non raro titillat, ita aversus est, ut innoxiis faetiis solummodo luderet, serenoque potius vultu prodiret in publicum ... ut effuse riserit semper." Though Magnen does not accept the authenticity of the Physica et *mystica*, he does accept Democritus's authorship of a magical treatise that he calls "Chirocinera." This title refers to a work that Pliny, in his Natural History, ascribes to Democritus and that treats all kinds of oriental plants and their magical powers. See Plinius Secundus, Historia naturalis 24.102: "Democriti certe chirocmeta esse constat. At in his ille post Pythagoram Magorum studiosissimus quanto portentoisora tradit!"
- Seneca, *De ira* 2.10.5; English trans. from *Seneca: Moral Essays*, trans. John W. Basore, 3 vols. (London: Heinemann, 1958), Vol. 1, p. 187. The laughing

Democritus appears in Cicero, De oratore 2.235; and Horace, Epistolae 2.1.194. He is coupled with Heraclitus in Juvenal, Satyra 10.28-53; Lucian, Philosophers for Sale 13-4 and De sacrificiis 15; and Seneca, De tranquillitate animi 15.2. The theme has been studied in particular in C. E. Lutz, "Democritus and Heraclitus," Classical Journal, 1953-1954, 49:309-314; Zeph Stewart, "Democritus and the Cynics," Harvard Studies in Classical Philology, 1958, 68:179-191; August Buck, "Democritus ridens et Heraclitus flens," in Wort und Text: Festschrift für Fritz Schalk, ed. Harri Meier and Hans Sckommodau (Frankfurt am Main: Klostermann, 1963), pp. 167-186; Angel M. Garcia Gomez, The Legend of the Laughing Philosopher and Its Presence in Spanish Literature (1500-1700) (Cordoba: Servicio de Publicaciones, Univ. Cordoba, 1984); Thomas Rütten, Demokrit, lachender Philosoph und sanguinischer Melancholiker: Eine pseudohippokratische Geschichte (Leiden: Brill, 1992); and Cynthia M. Pyle, "Democritus and Heracleitus: An Excursus on the Cover of This Book," in Milan and Lombardy in the Renaissance: Essays in Cultural History (Rome: Fenice, 1997), ch. 9.

- 28. Seneca, De tranquillitate animi 15.2: "Democritum potius imitemur quam Heraclitum." Buck, "Democritus ridens," pp. 170-172. Garcia Gomez, Legend of the Laughing Philosopher, ch. 2. Joannes Chrysostomus, In Matthaeum Homilia VI, in Patrologiae cursus completus ... series graeca et orientalis, ed. Jacques-Paul Migne (Petit-Montrouge: Migne, 1856-1867), Vol. 57, col. 69. Isidorus Hispalensis, De ecclesiasticis officiis, Bk. 2, ch. 16 ("De poenitentibus"), Bk. 2, ch. 24 ("De baptismo"), and Exhortatio poenitendi; both in Opera Omnia quae extant (Paris: Michael Sonnius, 1601), pp. 605, 612, 343. Joannes Ridevallus: Fulgentius Metaforalis: Ein Beitrag zur Geschichte der antiken Mythologie in Mittelalter, ed. Hans Liebeschütz (Leipzig/ Berlin: Teubner, 1926), pp. 76-77: "Sed notare debemus, quod, quomodocumque sit deducio Senece, factum Eracliti magis consonum est vite et modo vivendi Christi quam sit factum Democriti.... Laudo ergo et aprobo plus Eraclitum mundi miserias deplorantem quam Democritum cachinnantem." (Cf. Buck, "Democritus ridens," p. 170; and Garcia Gomez, Legend of the Laughing Philosopher, p. 49.)
- For Petrarch's view see Francesco Petrarca, *De re-mediis utriusque fortunae libri duo* (Paris: J. Juvenis, 1557), dial. 89, p. 653; see also Buck, "Democritus ridens," p. 171. On the return to Seneca's favorable verdict on Democritus see esp. Jean Jehasse, "Démocrite et la renaissance de la critique," in *Études seiziémistes offertes à M. le Prof. V.-L. Saulnier*, ed. R. Aulotte *et al.* (Geneva: Droz, 1980), pp. 41-64; and Rütten, *Demokrit* (cit. n. 27), pp. 14-27. On

Ficino's view see Garcia Gomez, *Legend of the Laughing Philosopher*, pp. 68-74; and Pyle, "Democritus and Heracleitus" (cit. n. 27), pp. 205-207.

- 30. The Letters of Marsilio Ficino, trans. members of the Language Dept., School of Economic Science, London, 4 vols. (London: Shepheard-Walwyn, 1975), Vol. 1, no. 58, p. 104. Masolino's painting took up a motif described in the fifth century by Sidonius Apollinaris in *Epistulae* 9.9.14; he speaks of the portrait galleries of the gymnasium of the Areopagus and in the Prytanea in Athens, saying that they contained also a "Heraclitus, crying, with closed eyes," and a "Democritus with an open, laughing mouth." On Masolino's painting see A. Blankert, "Heraclitus en Democritus," Nederlands Kunsthistorisch Jaarboek, 1967, 18:31-123, on pp. 36-37. On the double portraits owned by Ficino and Visconti and on the development of this genre see Werner Weisbach, "Der sogenannte Geograph von Velazquez und die Darstellungen des Demokrit und Heraklit," Jahrbuch der Preussischen Kunstsammlungen, 1928, 49:141-158; Edgar Wind, "The Christian Democritus," Journal of the Warburg Institute, 1927-1928, 1:180-182; Blankert, "Heraclitus en Democritus;" O. Ferrari, "L'iconografia dei filosofi antichi nella pittura del sec. XVII in Italia," Storia dell'Arte, 1986, 57:103-181; and Dawson Kiang, "The 'Mappamondo' in Bramante's Heraclitus and Democritus," Achademia Leonardi Vinci, 1992, 5:128-135. On G. A. Visconti see Pyle, Milan and Lombardy (cit. n. 27), ch. 4.
- 31. The *Riso de Democrito* was first printed in 1505; the editio princeps of the double poem is undated but seems to be datable to 1507. See Antonio Fileremo Fregoso, Opere, ed. Giorgio Dilemmi (Bologna: Commissione per i testi di lingue, 1976), p. xxxvii. For the quotations see Fregoso, Riso de Democrito, ch. 12, verses 7, 90-91; for the returns in "inner peace" see *ibid.*, ch. 15, verses 1-6; and Fregoso, Pianto di Eraclito, ch. 15, verses 7-12. "Quïete" and "pace," respectively, are said to have taken possession of the narrator's mind ("mente"). On the diffusion of the theme of Democritus and Heraclitus in Northern Italy see Fregoso, Opere, ed. Dilemmi, p. xxiv n 53; Garcia Gomez, Legend of the Laughing Philosopher (cit. n. 27), pp. 74-89; and Pyle, "Democritus and Heracleitus" (cit. n. 27).
- 32. In his Discorsi cottidiani non vulgari Fregoso summarizes various Greek matter theories, including that of Democritus; see sect. 18: "e tene Democrito per certo/che spirto mobil sia d'atomi inserto." Fregoso, Opere, ed. Dilemmi, p. 301. Ironically, the double poem's only mention of atoms occurs in a description of Heraclitus's tears. Fregoso, Pianto di Eraclito, ch. 14, verses 49-51: "Come atomi nel sole, i tuoi pensieri/nei raggi di vertù scherzando tene,/ché

fuor di quelli faino oscuri e neri." *Emblemata: Handbuch zur Sinnbildkunst des XVI. und XVII. Jahrhunderts*, ed. Arthur Henkel and Albrecht Schöne (Stuttgart: Metzlersche Verlagsbuchhandlung, 1967), cols. 1157-1158, reproduces Andrea Alciati, *Emblematum liber* (Augsburg: Heynrich Steyner, 1531), no. 192 (Democritus and Heraclitus), together with translations into other languages. For another example see Barthélemy Aneau (Anulus), *Picta poesis: Ut pictura poesis erit* (Lyon: Mathias Bonhomme, 1552), p. 51 (Democritus as a blind wise man).

- 33. Cristoforo Landino, Quaestiones Camaldulenses (Florence: Nicolaus Laurentii Alamannus, 1480 [?]), Bk. 2: De summo bono; and Desiderius Erasmus of Rotterdam, Moriae encomium (Basel: Froben, 1515), "Praefatio" and passim. See also Opera omnia Desiderii Erasmi Roterodami, 9 vols. (Basel: Froben & Episcopius, 1540-1541), Vol. 4, p. 41. For Democritean mockery of the papal court see Erasmus of Rotterdam, Adagiorum Chiliades tres (Venice: Aldus, 1508), 3.3.1.
- 34. This thesis is suggested in Jehasse, "Démocrite et la renaissance de la critique" (cit. n. 29), esp. pp. 51-53. Jehasse's argument, which is at times forced, uses as its most convincing literary evidence the "Premier (& Second) Dialogue du Democritic remonstrant au Cosmophile" of the *Dialogues de feu Jacques Tahureau*, ed. M. de La Porte (Paris: Gabriel Buon, 1565), the names of whose protagonists mean "the judge of the people" and "the one who loves the world."
- 35. Sebastian Franck, Chronica, Zeijt buech und geschijcht bibel (Strassburg: Balthasar Beck, 1531), pp. ci-ciiii; see also Jean Lebeau, "'Le rire de Démocrite et la philosophie de l'histoire de Sébastien Franck," Bibliothèque de l'Humanisme et Renaissance, 1972, 33:241-269. Michel Eyquem de Montaigne, "De Democritus et Heraclitus," in Essais (Bordeaux: S. Millanges, 1580), Bk. 1, ch. 50, pp. 459-464, on p. 462: "J'aime mieus la premiere humeur: non par ce qu'il est plus plaisant de rire que de pleurer, mais par ce qu'elle est plus desdaigneuse, & qu'elle nous acuse plus que l'autre."
- 36. Pierre de Besse, L'Héraclite chrétien, c'est-à-dire les regrets et les larmes du pécheur pénitent (Paris: Du Fossé, 1615); and de Besse, Le Démocrite chrétien, c'est-à-dire le mépris et moquerie des vanités du monde (Paris: Du Fossé, 1615). De Besse once again prefers Democritus's laughter, for "rire et se moquer au fort des afflictions, c'est braver les vanités du monde, c'est montrer de la vertu et faire paraître qu'on est homme." On Dippel see Karl-Ludwig Voss, Christianus Democritus: Das Menschenbild bei Johann Conrad Dippel: Ein Beispiel christlicher

Anthropologie zwischen Pietismus und Aufklärung (Leiden: Brill, 1970).

- 37. For an analysis of the most important works of this genre see Rütten, *Demokrit* (cit. n. 27), Pt. 3, ch. 3.
- 38. Anon., Democritus; or, The Laughing Philosopher: A Collection of Merry Stories, Jests, Epigrams, Riddles, Repartees, Epitaphs, etc., Taken from a Manuscript, Found at Herculaneum ... in the Year 1770 (N.p., 1771); and Anon., Democritus ridens, sive campus recreationum honestarum cum exorcismo melancholiae (Amsterdam: Jod. Jansonius, 1649 [and numerous other editions]). Of a similar type are Anon., Der lachende Democritus (Breslau: D. Müller, 1632); Anon., Démocrite et Héraclite riant et pleurant (Paris, 1649); Anon., Lustiger Democritus (Cologne: Andreas Bingen, 1650); etc. Democritus was not the only ancient philosopher named as the alleged author of a popular literary product. A similar phenomenon for the case of Aristotle has recently been discussed in Ann Blair, "Authorship in the Popular 'Problemata Aristotelis,'" Early Sci. Med., 1999, 4:189-227.
- A few typical examples are B.A., Heracliet en Democriet, of de wereld beweend en belacht: Blyspiel met Zang, in één bedryf (Amsterdam: Hendrik Moolenyzer, 1810); [Guillaume de Reboul], La cabale des reformez, tiree nouvellement du puits de Democrite (N.p., 1597); Anon., Den vrolijken Democryt, Lacchende met's Werelds Ydelheden: Met de TegenSprake van den weenenden Heraclytus: Noodig gelesen te werden om de Oogen to openen (Rotterdam: Bartholomeus van Krakou, 1654); Anon., Avisi parnassiaci, das ist: Absonderliche Relationes der teutschen Müintz Unordnung betreffendt ([Prague]: "Gedruckt in der parnassischen Druckerey, anno consumptionis et confusionis," 1623).
- 40. Anon., Democritische Feestzangen, bij der eerste verjaaring der Revolutie van het Jaar 1795 [n.p.], p. 37: "Steeds beloeij' ons vast Verbond met Frankrijks vrij gebiet!/Hoezee! (bis) nooit flaauw' de pret in't vrolijk Democriet! (bis)." For the use of Democritus in the Enlightenment see Wolfgang Promies, Die Bürger und der Narr oder das Risiko der Phantasie: Sechs Kapitel über das Irrationale in der Literatur des Rationalismus (Munich: Carl Hauser, 1966), pp. 160-167. A few typical examples of this genre are Anon., Democritus Turned Statesman: or, Twenty Quaeries between Jest and Earnest, Proposed to All True Englishmen (London, 1659); Anon., Remonstrances philosophiques de Démocrite aux François Héraclites (N.p., 1789); Anon., La réaction à coups d'épingle; ou, Les philosophes vengés des capucins par Démocrite ([Paris], 1789); Anon., Democritus in London (N.p., 1852);

Démocrite, La révolution sociale, l'extinction du paupérisme et l'égalité sociale par la suppression de l'héritage (Paris, 1889); and Gerald Gould, Democritus; or, The Future of Laughter (London: Kegan Paul, 1929).

- 41. The publications listed in note 30, above, contain numerous examples. The richest source is Blankert, "Heraclitus en Democritus" (cit. n. 30).
- 42. Note in particular Erycius Puteanus, *Democritus, sive de risu dissertatio saturnalis, publice Lovanii habita* (Louvain: Ioh. Christoph Elavius, 1612). Although this author is said to have encouraged Gassendi in 1629 to initiate work on Epicurus's atomism, his laughing Democritus of 1612 shows no trace of such inclinations.
- 43. Lucian, Philosophers for Sale, sect. 13, in Lucian in Eight Volumes, trans. Austin Morris Harmon (Cambridge, Mass.: Harvard Univ. Press, 1988), Vol. 2, pp. 474-475. For a jocular connection see [Jacob Campo Weyerman (?)], Democritus en Heraclitus Brabantsche voyage (Amsterdam: Hendrik Strik, 1718), [unpaginated]: "Bloet! dat was geen kleine misslag, wanneer ik sustineerde datze uit Atomi wierd te zamen gestelt, / Want ik zie nu klaar als den dag, datze alleenlyyk spruyt en onderhouden word door geld."
- 44. On Gassendi's view see Lisa T. Sarasohn, Gassendi's Ethics: Freedom in a Mechanistic Universe (Ithaca, N.Y.: Cornell Univ. Press, 1996), pp. 136-141: "Gassendi and Democritean Determinism." Good examples for the continuity of this asymmetrical treatment of Democritus and Epicurus are, on the Protestant side, Johann Franz Budde (Buddeus), Theses theologicae de atheismo et superstitione variis observationibus illustratae (Leiden: Johannes Le Mair, 1767), esp. ch. 1, sect. 19 ("An dentur Athei"); and, on the Catholic side, Cardinal Melchior de Polignac, Anti-Lucretius: Sive de Deo et natura, 2 vols. (Amsterdam: M. M. Rey, 1748). Both exempt Democritus from the charge of atheism brought against Epicurus.
- 45. The editio princeps is Epistolae Diogenis, interprete Francisco Aretino: Accedunt Bruti et Hippocratis epistolae ex versione Rinuccii (Florence: Antonius Francisci Venetus, 1487). Today's critical editions are Dimitrios Th. Sakalis, ed., Ἱπποκράτους Ἐπιστολαί: Ἐκδοση κριτική και ερμηνευτική (Ioannina: Panepistemio Ioanninou, 1989); and Wesley D. Smith, ed., Hippocrates: Pseudoepigraphic Writings: Letters, Embassy, Speech from the Altar, Decree (Leiden: Brill, 1990). For the presumed identity of the actual author see Sakalis, "Beiträge zu den pseudohippokratischen Briefen," in Formes de pensée dans

la collection hippocratique: Actes du IVe Colloque International Hippocratique, Lausanne, 21-26 septembre 1981, ed. François Lasserre and Philippe Mudry (Geneva: Droz, 1983), pp. 499-514. Robert Philippson, "Verfasser und Abfassungszeit der sogenannten Hippokratesbriefe," Rheinisches Museum für Philologie, N.S., 1928, 77:293-328, offers reasons in favor of the assumption that the author was not a physician but, instead, a rhetorician. For the fifteenthcentury translations into Latin see Pearl Kibre, Hippocrates Latinus: Repertorium of Hippocratic Writings in the Latin Middle Ages, rev. ed. (New York: Fordham Univ. Press, 1985), pp. 158-162. For their reception and integration into a humanist program see Thomas Rütten, "Zur Anverwandlungsgeschichte eines Textes aus dem Corpus Hippocraticum in der Renaissance," International Journal of the Classical Tradition, 1994, 1:75-91; and Rütten, Demokrit (cit. n. 27), pp. 145-181. For a short summary of letters 10-23 see Owsei Temkin, "Hippocrates as the Physician of Democritus," Gesnerus, 1985, 42:455-464. For a summary of all the letters see Temkin, Hippocrates in a World of Pagans and Christians (Baltimore: Johns Hopkins Univ. Press, 1991), pp. 57-71. For an extensive discussion see Rütten, Demokrit, Pt. 3.

- 46. Letter 17.
- 47. Letter 10. (For Democritus's belief in vision through "eidola" see Diogenes Laërtius's summary of his teaching early in the section on Democritus the atomist, above). Letter 10 also contains a reference to Democritus's belief in innumerable worlds. See Thomas Rütten, "Zootomieren im hippokratischen Briefroman: Motivgeschichtliche Untersuchungen zur Verhältnisbestimmung von Medizin und Philosophie." in Hippokratische Medizin und antike Philosophie: Verhandlungen des VIII. Internationalen Hippokrates-Kolloquiums, ed. Renate Wittern and Pierre Pellegrin (Hildesheim: Olms, 1996), pp. 561-582, esp. pp. 572-579, which contain references to the secondary literature embedding the pseudo-Hippocratic epistles in various Hellenistic Democritus traditions. See also Max Wellmann, "Spuren Demokrits von Abdera im Corpus Hippocraticum," Archeion, 1929, 11:297-330.
- Petrus Tritonius (Peter Treitenraiff), Von dem leben und gelaechter Democriti, kurtzweilig und fast nutzlich zu lesen ([Augsburg, 1521]), fol. d iv (verso): "Sy haben solche ding geschriben/Das schier ain Christ darbey wär bliben/Noch haisset man sy die verfluchten/Wiewol sy solche tugent suchten." Eilhard Lubin, Epistolae Hippocratis, Democriti, Heracliti, Diogenis Cratetis, aliorumque ad eosdem: Nunc primum editae Graece simul et Latine (Heidelberg: Officina Commeliniana, 1601), "Dedicatio,"

p. 8. See also Lubin, *Phosophrus, de prima causa et natura mali* (Rostock: Ferber, 1596), where the author has recourse to atoms to explain the existence of evil in the created world. See Lasswitz, *Geschichte der Atomistik* (cit. n. 13), Vol. 1, pp. 403-411.

- 49. Diogenes Laërtius, Lives of Eminent Philosophers, trans. Hicks (cit. n. 10), 9.42; Sorani Gynaeciorum Libri IV: De Signis Fracturarum; De Fasciis; Vita Hippocratis secundum Soranum, ed. Johannes Ilberg (Leipzig/Berlin: Teubner, 1927), p. 176; and Celse: De la médicine, ed. Guy Serbat (Paris: Belles Lettres, 1995), pp. 3-4. One reason for the reluctance of philologists to debunk the authenticity of the epistles was their very popularity. Joseph Scaliger, for example, writes in his correspondence that it would be easy for him to prove their inauthenticity but that he prefers to leave the matter to individual judgment: Illustrissimi viri Josphi Scaligeri epistolae omnes, quae reperiri potuerunt, ed. Daniel Heinsius (Leiden: B. & A. Elzevir, 1627), epis. 306.
- 50. Pierre Bayle, Dictionnaire historique et critique, nouvelle édition, 16 vols. (Paris: Desoer, 1820-1824), Vol. 5, p. 465: "M. Drelincourt, professeur en médicine à Leyde, un des plus savans hommes de notre siècle, m'a assuré qu'il n'y a point lieu de doubter que les lettres qui concernent Démocrite, parmi celles d'Hippocrate, ne soient légitimes: c'est le sentiment ordinaire des médecins, dit-il."
- S[amuel] R[owlands], Democritus; or, Doctor Merry-man His Medicines, against Melancholy Humors [1607]. On the transformation see Rütten, Demokrit (cit. n. 27), pp. 168-213; and Stephanie Jacobs and Thomas Rütten, "Democritus ridens ein weinender Philosoph? Zur Tradition des Democritus melancholicus in der Bildenden Kunst," Wolfenbütteler Beiträge aus den Schätzen der Herzog August Bibliothek, 1998, 11:73-143.
- 52. [Robert Burton], The Anatomy of Melancholy: What It Is, with All the Kinds, Causes, Symptoms, Prognostics, and Several Cures of It: In Three Partitions, with Their Several Sections, Numbers, and Subsections: Philosophically, Medicinally, Historically Opened and Cut Up by Democritus Junior (Oxford: John Lichfield & James Short for Henry Cripps, 1621), pp. 6, 1, 1-2. The work was reprinted (at first in augmented editions) in 1624, 1628, 1632, 1638, 1651, 1652, 1660, and 1676. See also Jean Starobinsky, "Démocrite parle: L'utopie mélancholique de Robert Burton," Débat, Mar. 1984, 29:49-72; and Rütten, Demokrit, pp. 181-186. On some of Burton's literary successors see Thomas Rütten, "Johann Georg Zimmermann im Zeichen der Melancholie," in Johann Georg Zimmermann, königlich großbritannischer Leibarzt, ed. Hans-Peter Schramm (Wiesbaden: Harrassowitz, 1998), pp. 155-168.

- 53. Adolphus Tectander Venator, Reden-Vreucht der Wijsen in haer wel-lust/Ende Belachen der dwasen quel-lust/in't lachen Democrit door Persoon-tooningh (Alcmar: Jacob de Meester, 1603), Act 2, Scene 6: "vromen Democritum." Christoph Martin Wieland, Geschichte der Abderiten, Bk. 2, ch. 1: "es giebt Albernheiten, die nur ein Dummkopf zu denken oder zu sagen fähig ist, so wie es Unthaten giebt, die nur ein Schurke begehen kann." Jean de La Fontaine, Fables, Bk. 8, fable 26: the Abderites write to Hippocrates that Democritus believes in infinite worlds, adding: "Non content de ce songe, il y joint les atomes, / Enfants d'un cerveau creux, invisibles fantômes." But as he goes to Abdera, Hippocrates meets no speculative natural philosopher, but a moralist: "Ils tombèrent sur la morale."
- 54. Noël Pluche, *Histoire du ciel*, 2 vols. (Paris: Veuve Estienne, 1739). I have found the frontispiece in Pluche, *Histoire du ciel*, rev. ed., 2 vols. (Paris: Fonds des Frères Estienne, 1788). The text is: "L'homme n'est point fait pour construire la terre, mais pour la cultiver."
- 55. For Bacon's use of Democritus as the "dissector" see Graham Rees, "Atomism and 'Subtlety' in Francis Bacon's Philosophy," *Ann. Sci.*, 1980, *37*:549-571, esp. pp. 567-570. Rütten, "Zootomieren" (cit. n. 47), offers some good eighteenth- and nineteenth-century examples of authors who viewed the anatomizing Democritus in the light of "reductionist materialism," placing him in the context of the Greek school of atomist medicine, notably of Erasistratos and Asclepiades.
- 56. Sébastien Basson, Philosophiae naturalis contra Aristotelem libri XII (Geneva: De la Rouière, 1621), "Ad Lectorem," [pp. xxi-xxix]. An analogous argument was formulated in the very same year in Estevan Rodrigues de Castro, De meteoris microcosmi (Florence, 1621). On Renaissance attempts to dissociate Hippocrates from Galen see Wesley D. Smith, The Hippocratic Tradition (Ithaca, N.Y.: Cornell Univ. Press, 1979), ch. 1. The existence of veritable traces of Democritean thinking in the Corpus Hippocraticum may have encouraged this development; see Stückelberger, Vestigia Democritea (cit. n. 10), ch. 3. On Basson's use of the Democritus argument see Tullio Gregory, "Studi sull'atomismo del Seicento, I: Sebastiano Basso," Giornale critico della filosofia italiana, 3rd Ser., 1964, 43:39-65, esp. pp. 38-45, 49; Lauge Olaf Nielsen, "A Seventeenth-Century Physician on God and Atoms: Sebastian Basso," in Meaning and Inference in Medieval Philosophy: Studies in Memory of Jan Pinborg, ed. Norman Kretzmann (Dordrecht: Kluwer, 1988), pp. 297-369, esp. p. 308; and Christoph Lüthy, "Thoughts and Circumstances of Sébastien Basson:

Analysis, Micro-History, Questions," *Early Sci. Med.*, 1997, 2:1-73, esp. pp. 10-11.

- 57. Marco Aurelio Severino, Zootomia Democritaea: Id est, anatome generalis totius animantium opificii, libris quinque distincta (Nuremberg: Literis Endterianis, 1645). One of the best articles on Severino's microanatomical approach is Luigi Belloni, "Severinus als Vorläufer Malpighis," Nova Acta Leopoldiana, N.S., 1963, 27:213-224. Andreas Holger Maehle, Kritik und Verteidigung des Tierversuchs: Die Anfänge der Diskussion im 17. und 18. Jahrhundert (Stuttgart: Steiner, 1992), pp. 56-60, places Severino in the context of the revival of zootomy and animal experimentation but ignores his specific background. On Severino's teacher, whose portrait is also included in the Zootomia Democritaea, see Paul Buchner, Giulio Iasolino (Milan: Rizzoli, 1958).
- 58. Severino, Zootomia Democritaea, p. 38: "Omnino enim, ut deicam, quod sentio, non tam dissectrix quam dissutrix quaedam ars mihi videtur Anatome." *Ibid.*, p. 43: "apparebit plane, quod nihil aliud sit Anatome quam Resolutio artificiosa compagis universi corporis animalis in partes usque minimas." Marco Aurelio Severino, Antiperipatias, hoc est adversus Aristoteleos De respiratione piscium diatriba (Naples: Heirs of Camillo Cavallini, 1659), p. 105: "verum intentis omnibus ingenii nervis sollicite et curiose in ditis sibi callendis lynceis oculis, tum Dedalaeo scalpello, tum acri diorismo Democritaeos atomos anatomos non dissolvas, sed resolvas." Severino, Zootomia Democritaea, pp. 35-36: "Igitur Anatome duabus est e graecis vocibus conflatum nomen, quarum prior ἀνα; syncategorema quoddam, idem est fere, quod re, rursus Latinis; toun; verò sectio, quasi dicas utramque connectendo, repetita saepius & ad ultimam particularum resolutionem facta resectio. ... De his communi sententia ferme omnes, verum ego, si conceditur, haec eadem paulo aliter explico; ut credam scilicet de priori vocula idem, quod alii: verum posterior pars mihi est άτομα, indivisibilia; ut nimirum interjecta duabus vocibus apostrophe, ἀν' ἄτομα tandem interpreteris, resolutio in indivisibilia, vel quasi reiterata sectio adusque indivisibilia. Simili ratione Zootomia graeca & ipsa vox est, e duabus conflata: quasi ζῶα ἄτομα, id est, animantium ad indivisibilia usque dissectio."
- 59. The expression "Democritean anatomy" occurs in Johann Georg Volckamer's "Praefatio" to Severino's Zootomia Democritaea, [p. iv], and is repeated in the Italian microanatomical literature of the ensuing decades. See Carlo Fracassati, "Exercitatio epistolica de lingua," in Marcello Malpighi, Opera omnia, 2 vols. (Leiden: Peter vander Aa, 1687), Vol. 2, pp. 173-197, on p. 179: "Hinc quantumvis in lingua alia multa

occurrant, in quae oculos Democritea facile intendet anatome. ..." Malpighi wrote in a biographical sketch of 1689 that Borelli "was kind enough to introduce me to the study of free and Democritean philosophy, and I acknowledge that what progress I have made in philosophizing stems from him." Quotation trans. in Howard B. Adelmann, *Marcello Malpighi and the Evolution of Embryology*, 5 vols. (Ithaca, N.Y.: Cornell Univ. Press, 1966), Vol. 1, pp. 151-152.

- 60. See, e.g., Severino, *Zootomia Democritaea* (cit. n. 57), p. 38: "Itaque scire licet, hanc, de qua sermo nunc est, non tam vere sectionem, quam resolutionem videri: eam scilicet intelligo, quae totum in sua consitutentia principia prima revolutum atque eversum tradit; non aliter quippe, quam chymica analysis, quae mistum in tria prima corpora vel in quatuor secunda redigit." On the idea of fire analysis as an "anatomy" of chemical substances see note 70, below.
- 61. Girolamo Fracastoro, De sympathia et anipathia rerum (Lyon: G. Gazeius, 1545). For Severino, the doctrines of sympathy and antipathy, just like atomism, were specifically South Italian Presocratic doctrines; see Marco Aurelio Severino, Vipera Pythia, id est de viperae natura, veneno, medicina, demonstrationes et experimenta nova (Padua: Paulus Frambottus, 1650), p. 384: "Quam antipathiae vim admisit quidem Thomas Campanella Locrus, novus Timaeus, praeceptor meus in Physicis venerandus." The same patriotic pride is also evident in his marginal annotations to William Harvey's Exercitatio anatomica de motu cordis (Frankfurt: Guilielmus Fitzer, 1628), which he had received from its author in 1636. Severino was convinced that Harvey had merely revived Timaeus of Locri's original doctrines; see Houghton Library, Harvard University, call no. \*57-387. On the nonmechanical aspects of medical atomism see note 6, above.
- 62. See Leonardo di Capoa, Parere ... Divisato in otto Ragionamenti, Ne quali partitamente narrandosi l'origine, e'l progresso della medicina, chiaramente l'incertezza della medesima si fa manifesta, 2nd ed. (Naples: Giacomo Raillard, 1689). The eighth and last ragionamento is very much a panegyric on Democritus (p. 379 ff.): it praises his pre-Galilean intuitions (p. 387 ff.) and his natural philosophywhich, di Capoa believes, was burned by envious Plato and distorted by Aristotle (p. 395 ff.). But for di Capoa, Democritus's atoms are mere corpuscles (p. 420): "Ma che questa sostanza, di cui ragioniamo, altro non sia che corpo diviso in minutissime particelle di grandezza, di figura, di sito, di moto, e d'ordine diverse, fu insegnamento, che da' Fenicj [i.e., Mochus the Phoenician; see note 16, above] appre-

sero i primi Greci filosofanti; comechè Democrito, più ch'altri, in prima chiaramente divisato l'avesse." This is followed by an outburst against atomical indivisibilism (p. 423): "Io non so per me come difender mai si possa da'suoi seguaci ciò che Epicuro dice de'suoi atomi, che non possan dividersi."

- 63. Walter Charleton, *The Immortality of the Human Soul* (London: William Wilson for Henry Herringman, 1657), pp. 34-35, describes the members of the London College of Physicians as "these genuine Sons of *Democritus*" who with "admirable dexterity and skill anatomise without confusion of the smallest organ, and instantly explore the proper office of each Organical part."
- 64. A much contested edition of the Greek text of the ΦΥΣΙΚΑ ΚΑΙ ΜΥΣΤΙΚΑ is found in Marcellin Berthelot, Collection des anciens alchimistes grecs, 3 vols. (1888; London: Holland, 1963), Vol. 2, pp. 41-53. The text of the Physica et mystica is discussed, e.g., in Berthelot, Les origines de l'alchimie (Paris: Georges Steinheil, 1885), pp. 46-282; Edmund O. von Lippmann, Entstehung und Ausbreitung der Alchemie (Berlin: Julius Springer, 1919), pp. 27-46; and Jackson P. Hershbell, "Democritus and the Beginnings of Greek Alchemy," Ambix, 1987, 34:5-20.
- 65. On the manuscripts see Lippmann, Entstehung und Ausbreitung der Alchemie, p. 30: "es ist ... zunächst unbegreiflich ... wie gerade der echte Demokritos in den Ruf eines Magiers, Astrologen und Alchemisten geraten konnte." See also Berthelot, Origines de l'alchimie, p. 151: "Certes, il est étrange de voir ainsi un homme tel que Démocrite, doué d'une incrédulité inflexible vis-à-vis des miracles, d'après Lucien, un philosophe naturaliste et libre penseur par excellence, métamorphosé en magicien et en alchimiste." But Berthelot (p. 263 n 2) also mentions two passing references to "atoms" in Olympiodor's De arte sacra (fifth century?) and in Stephanus Alexandrinus's De magna et sacra arte (seventh century?). Such evidence suggests that some traces of the original Democritean doctrines must have survived in the Alexandrinian alchemical tradition. See Stückelberger, Vestigia Democritea (cit. n. 10), pp. 156-159. On the commentary tradition see Hans Daiber, "Democritus in Arabic and Syriac Tradition," in Proceedings of the First International Congress on Democritus (Xanthi: Anthropological Museum, 1984), pp. 251-265.
- 66. Domenico Pizzimenti, *Democritus Abderita De arte* magna, sive de rebus naturalibus: Nec non Synesii, et Pelagii, et Stephani Alexandrini, et Michaelis Pselli in eundem commentaria (Padua: Simone Galignani, 1573). Pizzimenti's translation was reprinted

under its Democritean title even in the eighteenth century: *Democritus Abderita Graecus, De arte magna* (Nuremberg: Heirs of J. D. Tauber, 1717). On Pizzimenti see Luigi Accatatis, *Le biografie degli uomini illustri delle Calabrie* (Cosenza: Tipografia Municipale, 1870), Vol. 2, pp. 46-50; and Nicola Badaloni, "I fratelli Della Porta e la cultura magica e astrologica a Napoli nel '500," *Studi Storici*, 1960, *1*:677-715, on pp. 694-695.

- 67. On Democritus's travels to the Orient see Plinius Secundus, Naturalis historia 24, 102; Petronius Arbiter, Satyricon 88; and Seneca, Ad Lucilium epistulae 90. Diogenes Laërtius, Lives of Eminent Philosophers, trans. Hicks (cit. n. 10), 9.34-35, reports on Democritus's early education by Magians and Chaldeans left behind in his father's house by King Xerxes and speaks of his travels to Egypt, Persia, India, and Ethiopia. For John Dee's view see Monas hieroglyphica (Antwerp: Gulielmus Silvius, 1564), fol. 22v: "His paucis, tales me scio non άφορμὰς solum, sed Apodixes dare illis, quibus Igneus intus viget gliscitque Vigor, & caelestis Origo: ut faciles iam magno Democrito aurem praebeant: τὸ τῆς ψυχῆς praedicenti ἴαμα, καὶ πάντος μόχθουλυτήριον κατασκσευασαι βουλομένοις, non Μυθικόν esse hoc Dogma, sed Μυστικόν.' On "abuse" of the name of Democritus see, e.g., Aulus Gellius, Noctes Atticae 10.12.1, 10.12.6, 10.12.8.
- 68. Columella. De re rustica 7.5: "Sed Aegyptiae gentis auctor memorabilis Bolus Mendesius, cuius commenta quae appellantur Graece Υπομνήματα, sub nomine Democriti falso produntur." On Bolus/Democritus see Max Wellmann, "Die  $\Phi$ Y $\Sigma$ IKA des Bolos Demokritos und der Magier Anaxilaos aus Larissa," Abhandlungen der Preussischen Akademie der Wissenschaften, 1928, Suppl. 7; and Renato Laurenti, "La questione Bolo-Democrito," in L'atomo fra scienza e letteratura, ed. Mavotte Bollack et al. (Genoa: Istituto di Filologia Classica e Mediovale, 1985), pp. 75-106. For further references see Stückelberger, Vestigia Democritea (cit. n. 10), p. 157. For Saumaise's view see Tertullian, Liber de pallio, ed. Claude Saumaise (Salmasius) (Paris: Hieronymus Drovart, 1622), p. 141 ff.
- 69. Antoine Mizauld, Memorabilium, sive arcanorum omnis generis, per aphorismos digestorum, centurae IX: Et Democritus Abderita, de rebus naturalibus, et mysticis: Cum Synesii, et Pelagii Commentarijs: Interprete de Graeca lingua Dominico Pizimentio (Cologne: Ioannes Birckmann, 1574), fol. 4v: "Quid enim Chemia, si nos Arcana rimamur, securius? Deinde: per quae breves ij sunt. De Antiquitate, minime diffiteor, plures dubitaturos. Sed, si ij sunt, quorum nomen ferunt. Antiqui certe sunt. Democritus in

primis. Exstat enim, eius ad Hippocratem: uti Medicorum omnium Principem, ita sane longe vetustissimum, epistola.... Unde, excelluisse doctrina, credendus est maxime."

- 70. Allen G. Debus, "Fire Analysis and the Elements in the Sixteenth and the Seventeenth Centuries," Ann., Sci., 1967, 23:127-147; and Debus, "Guintherus, Libavius, and Sennert: The Chemical Compromise in Early Modern Medicine," in Science, Medicine, and Society in the Renaissance: Essays to Honor Walter Pagel, ed. Debus (London: Heinemann, 1972), pp. 151-165, on p. 153. That the attempts to document the conformity between alchemy and Presocratic thought were not limited to the figure of Democritus has been shown in Bernard Joly, "Les références à la philosophie antique dans les débats sur l'alchimie au début du XVIIe siècle," in Alchimie: Art, histoire et mythes, ed. D. Kahn and S. Matton (Paris/Milan: SEHA-Archè, 1995), pp. 671-690.
- 71. Heavily biased but bibliographically precious summaries of the Parisian conflict are given in Jean Riolan, Ad Libavi maniam, ... responsio pro censura Scholae Parisiensis contra Alchymiam lata (Paris: Officina Plantiniana apud Adrianum Perier, 1606), pp. 3-8; Andreas Libavius, Alchymia triumphans: De iniusta in se Collegii Galenici spurii in Academia Parisiensi censura: Et loannis Riolani maniographia, falsi convicta, et funditus eversa (Frankfurt: Ioannes Saurius, 1607), pp. 5-14, 31-101; and Libavius, Syntagmatis arcanorum chymicorum, ex optimis autoribus scriptis, impressis, experientiae artifice collectorum tomus secundus (Frankfurt: Nicolaus Hoffmann, 1613), "Prooemium." Modern and less biased analyses are found in Lynn Thorndike, A History of Magic and Experimental Science, 8 vols. (New York: Columbia Univ. Press, 1923-1958), Vol. 6 (1941), pp. 238-253; William P. D. Wightman, Science and the Renaissance, 2 vols. (Edinburgh: Oliver & Boyd, 1962), Vol. 1, pp. 256-263; and Allen G. Debus, The French Paracelsians: The Chemical Challenge to Medical and Scientific Tradition in Early Modern France (Cambridge: Cambridge Univ. Press, 1991), pp. 48-65. My attention to the role played by Democritus in this debate has been aroused by Nielsen, "Seventeenth-Century Physician on God and Atoms" (cit. n. 56), pp. 339-341.
- 72. Joseph Quercetanus (Duchesne), *Liber de priscorum philosophorum verae medicinae materia, praeparationis modo, atque in curandis morbis, praestantia* ([Geneva]: Haeredes Eustathij Vignon, 1603), pp. 4-5: "Legimus insuper principem Graecum Democritum, quem tantopere admiratus est Hippocrates, quem Plato ne reprehendere quidem est ausus, a quo promanavit secta Democritea, alias dicta

Abderitica: legimus, inquam, postquam frequentasset Aegyptios, atque Indios, magna exinde secreta reportasse. Nam et ex iisdem scriptis patet eundem insignem fuisse philosophum Chymicum." See also Debus, *French Paracelsians*, pp. 48-51.

- 73. Jean Riolan, Apologia pro Hippocratis et Galeni medicina (Paris: Officina Plantiniana, 1603).
- 74. Quercetanus, Liber de priscorum philosophorum, "Praefatio," [p. iv], defines the principles of the spagyrical sect as follows: "rationem quippe non vulgatis, & vel vulgo notis, elementorum, mixtorumque proportionibus adscribunt, sed res ipsas intuiti, & contemplati, ibi rationem quaerendam efficaciter contendunt, ubi rationem sit fons, & scaturigo: atqui non in extrinsecis, & universalissimis illis mundi elementis, ed in insitis, sed in propriis corporum essentiis quaerendam satius ducunt. His aqua haeret: haec diversitatis occasio: hoc totius spagiricae fundamentum." These "fundamenta" certainly look less compatible with Greek atomism than these Galenic principles [p. iii]: "sed & ipsis primis qualitatibus, in mixtis tamen, seu compositis corporibus existentibus, vim, & potestatem omnem ad profligandos morbos, inesse dixerunt." For, according to this latter view, the qualities are attached to elements that persist even in mixtures, an idea that is commonly associated with an atomist theory of mixtures. Nicolaus Guibert, Alchymia ratione et experientia ita demum viriliter impugnata et expugnata (Strasbourg: L. Zetzner, 1603), p. 63: "Liber qui a chymistis tribuitur Democrito Abderitae de arte sacra seu Chymia cum comentariis Synesii et Stephani cuiusdam, quos olim Dominicus Pizimentius Calaber, dum viveret amicus meus de Graeco in Latinum convertit, tam est Democriti, quam tabula smaragdina Hermetis, id quod praeter alia argumenta satis indicant dicta et sensa inepta ac stulta ac ridicula, quae in eo continentur. Etsi antea reditum esset librum illum a Democrito scriptum, tamen id falsum esse oportet convinceretur ex Laertio a quo Democriti opera enumeratur."
- 75. Joseph Quercetanus, Ad veritatem Hermeticae medicinae ex Hippocratis veterumque decretis ac therapeusi (Paris: A. Saugrain, 1604), e.g., p. 55: "Graece [de alchemia] scripserunt Olympiodorus, Alexandrinus, Osthanes, Pelagius Africanus, Zosinus, Isaac Monarchus, Theophilus Sinesius, Blenidas, Ptolemaeus, Euclides, Apulejus, Heliodorus ad Theodosium, Dardanus Demetrius, Democritus, Aristoteles de mineralibus, Abbugazul Platonis praeceptor, in hac arte Plato iunior, peritus etiam fuit, cuius aphorismos Hamech & Seneca scholiis illustrarunt." Andreas Libavius, Defensio et declaratio perspicua alchymiae transmutatoriae, opposita Nicolai Guiperti Lotharingi Ph. Med. expugnationi virili

([Frankfurt]: Kopff, 1604), pp. 179-182. Libavius, "Defensio alchemiae et refutatio objectionum ex censura scholae Parisiensis," in *Alchymia Andreae Libavii, recognita, emendata, et aucta* (Frankfurt: Kopff, 1606), pp. 2-4.

- 76. Riolan, Ad Libavi maniam (cit. n. 71), p. 13: "Fui semper in ea opinione, Democritum, qui a vobis auctor Chymiae perhibetur, non fuisse illum Hippocrati contemporaneum, sed Arabem quendam Medicum." Ibid., p. 14: "Democritus posuit generationis rerum omnium principia a Chymicis longe differentia: ex individuis enim corpusculis componebat omnia, ad quae effectuum omnium physicorum causas referebat: At principia Chymica sunt dividua, quandoquidem mixta." Ibid., p. 15: "Opinionem Democriti de corpusculis individuis male accomodas Chymiae principis, ne quid dicam acerbius."
- 77. Libavius, Alchymia triumphans (cit. n. 71), pp. 144-162, on p. 154: "Democritus componebat omnia ex corpusculis individuis, scribis. Chymici habent dividua principia. Democritus ergo non fuit chymicus." Ibid., p. 160: "Commentis istis Aristotelicis inductos vos pessime de Democrito statuere aio. Sane quae producuntur contra atoma non sunt physica, sed mathematica de continuis, de corporis mathematici longo, lato, profundo, &c. de lineis insectilibus. Rideret haec Democritus non confutaret. Quia enim atoma sua itidem ponit corpora, agnoscit in illis esse proprietatem corporum mathematicam, sed quae non obstent atomis insensilibus nec proprietates physicas tollant." Ibid., p. 159: "Cuius doctrina de concretione & resolutione corporum consentit cum principiis chymicis, eum fuisse chymicum est probabile. Democriti doctrina de concretione & resolutione corporum consentit cum principiis chymicis, ut iam ex Riolano ostendemus. Democritus ergo fuisse chymicum est probabile."
- 78. See Andreas Libavius, Syntagma selectorum undiquaque et perspicue traditorum alchymiae arcanorum (Frankfurt: Nicolaus Hoffmann, 1611), p. 265, where the author names "Democritum Chymicum, Leucippum, Empedoclem, Anaxagoram & alios" to prove that the transmutation of base metals into gold is possible, invoking in this context the important atomist concepts of σύγκρισις and διάκρισις. For his explanation of transmutation, however, Libavius is forced to combine the atomists' "syndiacritical" approach with a more Paracelsian notion of "essentiae potestatum interiorum."
- Disputatio quinta de continuo et infinito, ... praeside M. Daniele Sennerto, [def.] Adamus Peschelius ... Ad diem 26 Sept. 1599 (Wittenberg: Simon Gronenberg, 1599), thesis 12, on the question of whether the continuum is made up of indivisibles: "Pythagoras,

Democritus, Leucippus, & perique alii, qui Aristotelis aetate floruerunt, atque ipsi Stoici, hac in re Zenonem ducem secuti: sed illorum refutationem suscepit 6. Physicorum. ... In utramque partes etsi non leves sunt rationes, nos tamen ex Aristotelis partibus stabimus, his adductis rationibus." On Sennert's debt to Bruno see Christoph Lüthy and William R. Newman, "Daniel Sennert's Earliest Writings (1599/1600) and Their Debt to Giordano Bruno," *Bruniana et Campanelliana*, 2000, 6 (forthcoming). On Sennert's debt to Libavius see Newman, "Chemical Atomism from the *Summa Perfectionis* to Sennert" (unpublished lecture).

- 80. See esp. William R. Newman, "The Alchemical Sources of Robert Boyle's Corpuscular Philosophy," Ann. Sci., 1996, 53:567-585, on pp. 573-576. On medieval corpuscularian traditions in alchemy see Newman, The Summa Perfectionis of Pseudo-Geber (Leiden: Brill, 1991). For an excellent summary of medieval alchemical corpuscularianism and its later influence see Newman, Gehennical Fire: The Lives of George Starkey (Cambridge, Mass.: Harvard Univ. Press, 1994), ch. 3. On Sennert's atomism see also Lasswitz, Geschichte der Atomistik (cit. n. 13), Vol. 1, pp. 436-454; Tullio Gregory, "Studi sull'atomismo del Seicento, II: David van Goorle e Daniel Sennert," Giornal. Crit. Filos. Ital., 3rd Ser., 1966, 45:44-63; and Michael, "Sennert on Matter and Form" (cit. n. 25).
- 81. Daniel Sennert, De chymicorum cum Aristotelicis et Galenicis consensu ac dissensu liber (Wittenberg: Vidua & haeredes Zachariae Schüreri Senioris, 1629), p. 211, for example, closely paraphrases the passage from Libavius's Alchymia triumphans, p. 160 (note 77, above). Sennert writes that Aristotle's objections "contra dogmata atomorum ... non sunt Physica, sed Mathematica, de continuis, de lineis insectilibus & similibus." Against this, Sennert argues, like Libavius, that "atomos enim corpora ponit etiam Democritus, & quidem in iis non negat proprietates corporis mathematici: per eas tamen etiam proprietates Physicas non tollit." On Sennert's debt to Libavius see also Debus, "Guintherus, Libavius, and Sennert" (cit. n. 70), pp. 157-158.
- 82. For a defense of Democritean authorship see Sennert, *De chymicorum consensu ac dissensu*, pp. 25-26: "Referunt & inter Chymicos Democritum, quem insignem Philosophum fuisse certum est. ... Circumferentur autem quaedam Chymica ejus nomine; quae tamen nonnulli non Democriti hujus Abderitae, sed Arabis cujusdam esse opinantur. Sed exemplum non reperitur, quod Arabes suis Graecorum nomina indiderint: & propterea libri illi vel Democriti hujus Graeci sunt, vel certe ideo Democriti nomine inscripti, quod fama esset, Democritum chymiae no-

titiam habuisse, ut ita de nomine ejus illis libris Fama conciliaretur." That Sennert is consciously siding with Quercetanus and Libavius here is evident from the frequent references to their polemical works.

- 83. Daniel Sennert, *Physica hypomnemata* (Lyon: Pierre Ravaud, 1637), p. 84, notes that there is no need to invoke ancient authorities in order to prove the existence of atoms since experience (ἐμπειρία) furnishes enough proofs. For the praise see *ibid.*, pp. 78-80 ("Democriti laus"). Sennert here invokes all of the available ancient sources, including the "Letter to Damagetus," but ends by discarding the alchemical author: "Non ergo credibile est virum σοφώτατον... tam absurdas, ut hodie ipsi attribuuntur, opiniones fovisse; nec vero consentaneum est ... virum cordatum & sapientem ... res tam perspecue falsas & absurdas, nec occulte modo rationi, sed & aperte ipsis sensibus adversas credidisse & enunciasse."
- 84. Just how independent these sundry traditions remained from each other is charmingly documented by the transformation of Quercetanus, who had so unsuccessfully tried to defend the alchemical Democritus, into a literary figure who had to debate the merits of Democritean laughter and Heraclitean crying with an equally transformed André Laurens. See Giacomo Ferrari, *Democrito et Eraclito: Dialoghi del riso, delle lagrime et della malinconia* (Mantova: Aurelio & Lodovico Osanna, 1627).

### Julia Annas (essay date 2002)

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[In the following essay, Annas presents an interpretation of Democritus's ethical fragments, connecting them with the ethics of Socrates, Plato, and Aristotle. Annas argues that the ethical fragments of Democritus provide significant insights into the origins of ethical eudaemonism, which attempts to outline the principles of living well.]

Democritus' ethical theory, although it has attracted some notable scholarly attention,<sup>1</sup> has not been as central to discussions of ancient ethics as one might expect, especially given the centrality to history of philosophy of his metaphysics and epistemology. This is in spite of the fact that the overwhelming majority of the extant fragments are ethical in content, and despite the fact that Democritus, being contemporary with Socrates, is among the first ancient thinkers from whom we have ethical material.

It is a pleasure to present this chapter as part of an occasion honoring Alexander Mourelatos. His work on the earliest Greek philosophers has raised the level of debate and set high standards of scholarship. It is with some apprehension that I make a foray in this area, although I remain confident that he will, whatever the chapter's merits, receive it with the courtesy and goodwill that have always accompanied his rigorous and careful philosophical investigations.

The reasons for the comparative neglect of Democritus' ethics are familiar. The ethical fragments themselves are highly various, and the authenticity of many of them has been suspected.<sup>2</sup> It is not until the Hellenistic period that we find Democritus referred to, by Cicero, Arius Didymus, Diogenes Laertius, and Clement, as a systematic ethical thinker who offers an answer to what were by then familiar questions of ethics, such as, What is our final goal? What is the criterion for choice?<sup>3</sup> Some scholars have found recognition of a conceptual continuity between Hellenistic thinkers and the earlier author.<sup>4</sup> Others, however, have seen merely a stereotyped assimilation to later ideas.<sup>5</sup> The problem is underlined by the unfortunate fact that our fragments, copious though they are, do not unambiguously indicate an explicit ethical framework. Many of them are gnomai or sayings, and may have been extracted from originally longer and more continuous contexts. The few longer passages that we have, such as fragment 191, leave us regretting that so many of our fragments are snippets and aphorisms.

Faced by this rather discouraging situation, many scholars have fallen back on the view that our sources, both fragments and reports, underdetermine the content of Democritus' ethics to such an extent that it is uselessly speculative to discern theory or structure in the material we have. As a result, accounts of the ethics often limit themselves to treating the fragments as pieces of advice about how to live, as though they were a collection of wise saws. The result is predictably not very inspiring, and moreover looks more like advice as to how to get on in life than any kind of moral theory.<sup>6</sup>

However, this response, theoretically minimalist though it is, is not satisfactory even as an unambitious account of Democritus' ethics. The fragments themselves display differences that compel us to put them in some kind of theoretical framework just to make sense of all of them in a consistent way. The most notable such difference, which has of course been noticed, is that, while some of the sayings are banal and everyday, others stand out for their unconventionality. Some of these are strikingly like sentiments we find in Plato, particularly in Plato's 'Socratic' dialogues.

Thus on the one hand we find banalities such as: 'One should emulate the deeds and actions of virtue, not the words' (fr. 55); 'Continual companionship with the base increases a disposition to vice' (fr. 184); 'It is characteristic of intelligence to guard against future injustice, and of insensibility not to avenge injustice in the past' (fr. 193);

'It is important to think as you ought in misfortune' (fr. 42).

On the other, however, we find: 'The wrongdoer is unhappier than the person wronged' (fr. 45); 'People are happy not because of their bodies or possessions, but because of rightness (ὀρθοσύνη) and breadth of understanding (πολυφροσύνη)' (fr. 40); 'Happiness does not dwell in flocks or in gold; it is the soul which is the home of a person's daimôn' (fr. 171); 'Things turn from good to bad for people, if one does not know how to guide and keep them resourcefully. It is not right to judge these things to be bad; they are goods. But it is possible to make use of good things, if one wishes, to ward off bad' (fr. 173). These claims, that happiness depends on what you make of yourself rather than on what you have, and that the value to you of things depends on the use you make of them, are familiar as 'Socratic' thoughts from Plato's Socratic dialogues. (There are also fragments suggestive of themes in other Platonic dialogues: correct, as opposed to wrong, erotic love (fr. 73); courage shown in resisting desires as well as on the battlefield (fr. 214);<sup>7</sup> strikingly, justice conceived of as the source of an individual's right action in general, not merely in social contexts (fr. 256)).8

It is hard to see how these thoughts, especially the ones which to us sound 'Socratic,' can reasonably be treated as just more wise saws for the person wanting to get on in life. There is a noticeable tension between the worldly-wise tenor of the 'banal' fragments and the strongly revisionary sentiments of the 'Socratic' ones.

This problem can be resolved, of course, by declaring the more 'Socratic' fragments inauthentic or suspicious, as does Guthrie, for example.<sup>9</sup> But to expel or ignore them in this way is not reasonable. According to Guthrie, to suppose that Democritus had these ideas before Plato, or at any rate independently of him, runs up against the fact that Aristotle admires Democritus but always 'gives Socrates the credit for originality in this respect [that is ethics].<sup>10</sup> Aristotle's claim about Socratic originality is, however, limited to general and methodological points, not to more detailed points like the above.<sup>11</sup> His silence as to whether Socrates or Democritus first ventured the thought that the wrongdoer is unhappier than the person wronged proves nothing. In general, no scholar has produced remotely convincing arguments for excluding the original, 'Socratic' fragments.

This means, however, that if we treat all the fragments we have in an undifferentiated way we are ignoring important evidence that Democritus did have an ethical theory, rather than homely practical advice; this is so because we are ignoring a source of conflict among the fragments. Thus, only an attempt to find some theoretical structure in the ethical material will actually do justice to the material that we have.

Further, we have two strong reasons to look, not merely for some structure, but for a eudaimonistic structure in particular. One is that eudaimonism is the structure to be found in all Greek theories that make their structure explicit,<sup>12</sup> and is also the structure to be found in the ethics of Plato and the Platonic Socrates,<sup>13</sup> where it is not made the subject of discussion but is nonetheless explicit.<sup>14</sup> The other is that we have ancient sources which tell us about Democritus' ethics in a way that makes it clear that they read him as a eudaimonist. As already mentioned, the fact that these sources are themselves in a consciously eudaimonist tradition is often held against them, as though it automatically invalidated their claims. It is unclear why being in the same intellectual tradition as someone is held to be a source of bias; it could equally well be argued that the testimony of the Hellenistic authors is especially reliable on this point, since they are in a better position than we are to recognize that a philosopher belongs to their own (eudaimonistic) tradition. At any rate no good grounds have been brought forward for disqualifying the opinion of the Hellenistic authors who see Democritus unproblematically as a eudaimonist.15

We should therefore start with Clement's statement: 'The Abderites also teach that there is an end (τέλος). Democritus in his book On the End says that it is euthumia, which he also calls euestô. He often adds, 'For enjoyment and lack of enjoyment is the boundary" (fr. 4; the final sentence will concern us later). We find other words for the end: harmonia, summetria, ataraxia (Stobaeus, A 167), athaumastia (Strabo, A 168), most notably eudaimonia, the word destined to become the philosophers' norm as an agreed specification of our final end. Aristotle famously tells us in the Nicomachean Ethics that everyone agrees that our final end is *eudaimonia*, but differs as to how to specify it. It is not clear from the fragments of Democritus whether he thought this also, or whether in Ionic Greek none of his variety of terms was regarded as uncontentiously the most general way of referring to the telos. Despite the shared upbeat nature of all the alternatives, Democritus' final end is not to be identified with pleasure, as we learn from a valuable passage of Diogenes Laertius: 'He says that the end is euthumia, which is not the same as pleasure, as some people mistakenly interpret it, but a state in which the soul lives calmly and stably, disturbed by no fear or superstition or any other passion' (A 1.45).

*Eudaimonia* occurs in a key passage from Arius Didymus in which Plato is compared with Democritus in a way which we find unusual and which (perhaps for that reason) has not been influential in interpreting either.

Democritus and Plato unite in placing happiness (*eudaimonia*) in the soul. Democritus writes like this: 'Happiness does not dwell in flocks or gold; it is the soul which is the home of a person's *daimôn*.' He also calls it *euthumia*, *euestô*, *harmonia*, *summetria* and *ataraxia*. He says that it consists in distinguishing and discriminating pleasures, and that this is the finest ( $\kappa \alpha \lambda \lambda \iota \sigma \tau ov$ ) and most advan-

tageous thing for humans. Plato is in harmony with Democritus on this. He writes about the most crucial thing in us [reason], saying that we should suppose that 'God has given it to us as a *daimôn*' and that happiness lies in it. [Tim. 90a] He says that it is a kind of state and disposition of the governing part of the soul. Of this good [happiness] the origin is the emotions ( $\pi \dot{\alpha} \theta \eta$ ), while the boundary ( ${{}^{\!\!\!0}\!\!\!{}^{\!\!\!0}}$  poc) and limit are reasoning. At any rate we can read, '[Pleasure and pain] are the two fountains let loose by nature to flow; the person who drinks from them <whence he should, and where and how> is happy, while the person who does not, is the reverse.' [Laws 636d-e] So, in naming pleasure and pain he establishes the origin of happiness from the emotions; and in saying, 'the person who drinks from them whence he should, and where and how, is happy' he ascribes to reasoning the distinguishing element in happiness. On this point, therefore, Plato and Democritus agree, inasmuch as Plato places in excellence of reasoning the good which is primary and sought for its own sake, and in pleasure that which supervenes, which he also supposes as a consequence to be called by the same words as joy (χαρά) and tranquillity (ἀταραξία).<sup>16</sup>

This passage is from Arius' general introduction to ethics. The whole introduction has been drastically summarized, and its sources are notoriously difficult to sort out, but this specific point has been preserved as a coherent and argued presentation, which is worth taking seriously.

We can see in general that for Democritus our final end starts in some way from pleasure, but is to be identified not with pleasure but with our reason's discrimination of pleasures. This fits with the point from Diogenes Laertius that some people misinterpret Democritus' end as being pleasure itself. In what follows I shall first follow up, with reference to the fragments, Arius' initial point that our final end is internalized, and some consequences of this. Next I shall look at the relevant passages of the *Laws* to see what Arius has in mind in Plato, and ask whether we can find comparable thoughts in Democritus' fragments, especially as regards the role of pleasure in the happy life. Finally, I shall look at the consequences in Plato, and then in Democritus, for the role in the happy life of reason and wisdom.

What does it mean to say that happiness is located in the soul? In the *Laws* Plato is clear that happiness is to be found in the life of virtue, not in the life aimed at acquisition of external goods. There are two kinds of goods, the Athenian says, divine and human; the divine goods are the virtues, and an individual's life should be devoted to virtue rather than wealth and power (and consequently the life of the state should be suitably formed to produce people of this type). This is because the value to the person of external goods depends on the possession of virtue; someone with riches, power and every possible external good will be unhappy if he is not virtuous, while virtue ensures happiness even in the absence of external goods.<sup>17</sup>
We would not expect to find an exactly comparable position in Democritus for a number of reasons, the main one being that our fragments represent the situation Cicero describes by saying that Democritus' position on virtue was scanty and not very well worked out.<sup>18</sup> Even Plato arguably has not worked out precisely what the consequences are for the role of external goods if happiness is 'placed in the soul;' the options here were elaborated later, in the dialectic between Stoic and Aristotelian conceptions of happiness.

However, even though the role of virtue is not prominent, we can see ideas in Democritus which provide a substantial parallel to Plato. The soul is consistently said to be more important than the body, and to be directive and to have influence on the body in a way that the body does not direct it. 'It is fitting for people to make more account of (λ όγον ποιε ισθαι) the soul than the body; for perfection of the soul rights badness of the body, but strength of the body without reasoning makes the soul not a bit better' (fr. 187 = fr. 36); 'What the body requires can easily be got by everybody without effort and misery; the things that require effort and misery and make one's life painful are desired not by the body but by the understanding's mistaking' (fr. 223); 'If the body were to sue the soul for its pains and sufferings all life long, then if he were on the jury he would gladly convict the soul of having ruined some parts of the body by carelessness or dissipated them by drunkenness, and of having destroyed and rendered others by its susceptibility to pleasures. It is just like one's ready blame of the user of a tool or utensil in bad condition' (fr. 159). The goods of the soul are even distinguished as divine, as opposed to merely human, in a way that provides a rather startling parallel to Plato: 'The person who chooses the goods of the soul chooses what is more divine; one who chooses those of the body, chooses what is human' (fr. 37). 'It is best for people to live their life with as much cheer and as little pain as possible. This would happen if they would not get their pleasures from mortal things' (fr. 189).

We thus find that happiness depends on what you are, in the sense of what you make of yourself. The distinction of soul and body here is not dualistic in a psychological sense; rather it distinguishes the soul as the aspect of you that is active and can change and direct the other aspect, here called the body.<sup>19</sup> Happiness is to be found 'in the soul'—that is, in what you do with yourself and your life. 'What is called happiness' is the everyday conception of a successful life, such as the riches that people can amass under tyrannical rule (as opposed to poverty under a democracy) (fr. 251). But real happiness is not made up of things you have, but of what you yourself do with what you have; and this again depends on the kind of person you are.

We also find a thought which follows fairly naturally from this, namely that the value to you of other things depends on the use you (that is, your soul, the active aspect of you) make of them. 'Things turn from good to bad for people, if one does not know how to guide and keep them resource-fully. It is not right to judge these things to be bad; they are goods. But it is possible to make use of good things, if one wishes, to ward off bad' (fr. 173); 'Reputation and wealth without understanding are not safe possessions' (fr. 77); 'Making money is not unuseful, but if as a result of wrongdoing it is worse than anything' (fr. 78).<sup>20</sup> The thought that external goods have value for you in a way that depends on the use you make of them is apparently a commonplace in Plato's time; he pushes it further, to the thought that it is virtue that determines the value for you of external goods.<sup>21</sup> Democritus stays closer to common sense here.

What matters to a person seeking her final good, then, is not what she has, by way of bodily and external goods, but what she does with what she has. Democritus puts this as the thesis that one's soul should direct one's body and goods. Even lacking clear pronouncements on virtue, this is a striking internalization of one's final end; what matters is within you, not without. Perhaps the most memorable expression of this is the thought that your *daimôn* or guardian spirit is in your soul; the factor that accounts for your succeeding in living a good life or not is not an arbitrary allocation of fortune, but your own intelligence and the way you use it.

It is a great pity that Democritus was not more explicit about the role of virtue, especially in the light of the interesting fragments about shame. 'Feel no more shame before other people than before yourself. Don't do a wrong thing any more if nobody will know than if every single person will know. Most of all feel shame before yourself, and set this up as a law for your soul, so as to do nothing inappropriate' (fr. 264); 'Neither say nor do anything base, even if you are alone. Learn to feel shame before yourself far more than before others' (fr. 244). Shame, a reaction that you think of as a response to the views of others, is here treated as a reaction that you should have yourself to reflections about yourself. Bernard Williams has influentially called the ancient idea of shame that of the 'internalized other,' and in these fragments we can, it seems, see the other in the process of becoming internalized.<sup>22</sup> Again, it is what goes on within you that matters, rather than what happens outside you, including the reactions of others.

This is the context in which we should probably consider fragments which stress the inner side of right- and wrongdoing. 'It is good not merely not to do wrong, but not even to want to do it' (fr. 62); 'A man is reputable ( $\delta \delta \kappa \mu o \varsigma$ ) not merely from what he does, but also from what he intends ( $\beta o \iota \lambda \epsilon \tau \alpha \iota$ )' (fr. 68).

By this point most of us are feeling Cicero's frustration: surely what matters is not just to use your intelligence, but

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to use it virtuously, so why isn't there more about virtue? We cannot, of course, satisfactorily answer this question. But we have already seen that some of Democritus' fragments align themselves with Socratic ideas in that they make virtue far more important to the person than external goods are. It can only be the case that wrongdoing makes you unhappier than being wronged if virtue matters more than external goods such as security. It is pretty clear, in fact, that the 'more divine' goods of the soul must be the virtues, as they are divine goods for Plato in the *Laws*, but this cannot be demonstrated.

I shall now turn to Arius' interesting comment that for Democritus as for Plato happiness lies not in our *pathê* of pleasure and pain but in our reasoned distinction and discrimination of them. Elucidating the way Plato is being understood here is clearly the key to seeing what it is in Democritus that is being said to be in harmony with it.

Arius picks out two points: that for Plato our guiding spirit, which leads us to happiness, is just our own reason,<sup>23</sup> and that happiness begins from our *pathê* (feelings, emotions) of pleasure and pain, but resides not in them but in reasoning which distinguishes among pleasures and pains. He illustrates this with a quotation from the *Laws* (636d-e) in which pleasure and pain are two fountains which provide happiness to the person who not merely takes from them but does so 'whence, and where and how' he ought.

Arius has here lighted on an immensely interesting point in the Laws, one which has had surprisingly little modern discussion. There are many passages which express a view which at first looks like hedonism: that everyone wants pleasure and cannot be motivated to do anything except by way of seeking pleasure. Thus we find that we must show that the just life is the pleasantest, 'for nobody could willingly be persuaded to do something, unless more pleasure than pain followed it' (662e8-663b6). We look for a life in which pleasure predominates over pain, because 'we choose less pain with more pleasure, do not choose less pleasure with more pain and when they are equal find it hard to be clear about what it is we want' (732e4-733d6). Pleasure and pain are two original fountains from which we drink, as in the passage quoted by Arius. Most strikingly, pleasure and pain are the strings which direct our movements, when we are conceived of as puppets of the gods (644d7-645c1). Pleasure and pain, then, are basic motivations for us; indeed Plato in the Laws seems to ignore the tripartite psychology of the *Republic* in favor of a simpler way of looking at humans, one in which human motivations are schematized as reason on the one hand and pleasure and pain on the other.

But, despite their importance as basic motivations, pleasure and pain are not the only things that motivate us, nor is rational motivation to be reduced to an instrumental ability to produce pleasure and avoid pain.<sup>24</sup> For it turns out that the human puppet is moved not just by the hard and inflexible strings of pleasure and pain, but by the soft, pliable string of reason. If we yield to our impulses to pleasure and pain in an unreasoned way, we are being jerked about like puppets. But if we follow reasoning, then we follow a source of motivation which makes us 'masters of ourselves;' reason can direct and manipulate pleasure and pain in ways which they, being inflexible and irrational, cannot direct and manipulate it. (Further, reason, being embodied in the law of the state, connects us to other rational beings.) It is by using our reasons that we make ourselves able to shape our lives and to seek pleasure and pain only in the right way—which in the *Laws* is uncompromisingly the way directed by virtue.

In fact, in the Laws Plato is optimistic to the point of naiveté about the power of reason to transform our lives and to direct us to take pleasure in what is underwritten by morality. As in the Republic, there is an extensive educational system. Children's first perceptions, the Athenian says, are of pleasure and pain, and it is 'in these' that virtue and vice first come to the soul. Hence children are brought up in ways that ensure that they take pleasure in what is morally sanctioned and find what is immoral painful and repulsive (653a-671a, esp. 663a-d). Plato even thinks that our pleasure in sex, one of the most basic drives, is so socially conditioned that a change in social conditioning can utterly transform it. In a passage in Book 8 which strikingly suggests the modern view of sexuality as a social construct, Plato thinks that people can be brought, if not quite to desire none but married, reproductive sex, at any rate to find homosexual sex as repulsive as they now find incestuous sex. If homosexual sex is always presented in negative and repellent ways, he thinks, then people will not desire it, or find it pleasant.<sup>25</sup>

In the *Laws*, then we can see ideas which justify Arius' claim that Plato holds that the origins of happiness lie in pleasure and pain as *pathê*, that is, as unreflective feelings or reactions, while the distinguishing element in it is reason. It is because we can reason that we can educate and transform our basic drives for pleasure and pain so that we take pleasure and pain in what reason approves. The person who does this is happy, while the person who merely goes along unreflectively with their feelings will not thereby achieve happiness.

Can we find anything in Democritus which would explain for us why Arius takes him to be in harmony with Plato on this point?<sup>26</sup> We know from Diogenes Laertius (A 1.45) that our final end is *euthumia* and not pleasure, and that the latter would be a mistaken interpretation. Perhaps it is in this context that we should read fr. 69, 'For all people the good and the true are the same; but the pleasant ( $\dot{\eta}\delta\dot{\upsilon}$ ) is different for different people.' What people find pleasant depends on a number of factors which vary between people; but the good, our final end which we seek, can't depend on personal attitude in this way. Pleasure can't be our final end, we might say, because it is subjective, whereas our final end must be objective, something that everyone would agree they had reason to seek. *Eudaimonia*, as we know from Aristotle, fills this bill, and so presumably do the other specifications that Democritus uses. It would be interesting to know, as we cannot, whether the term *euestô* that Democritus employs was chosen because it suggests objective well-being, or whether its presence is merely an accident of Ionic dialect.<sup>27</sup>

Arius himself connects Plato and Democritus in saying that Democritus held that our final end lies in distinguishing and discriminating (διορισμού και διακρίσεως) pleasures, something said to be both most fine (κάλλιστον) and most advantageous (συμφορώτατον). The fragment most obviously relevant to this is fr. 74: 'Accept no pleasure, unless it is advantageous (συμφέρη).' This, however, brings with it a well-known complication in the apparent tension with fr. 188 (cf. fr. 4): 'The boundary (opoc) of what is advantageous and disadvantageous is enjoyment and lack of enjoyment (τέρψις και ἀτερπίη).' Fr. 74 makes good sense in relation to the Arius passage, and it is quite easy to find interpretative contexts for fr. 188 which do not have it coming out in conflict with 74. It is likely that it refers to the final end, rather than to particular occasions of choice, as does 74, and it is also likely that horos here means a boundary in the sense of a sign that the state obtains, rather than something definitive of what the state is.<sup>28</sup> It is a sign of having achieved one's final end, a rational discrimination of pleasures according to Arius, that one enjoys one's life. This is what we would expect from a philosopher who characterizes our final end in terms of enjoyment, cheerfulness, and lack of trouble. However, far from its following from this that every pleasure is to be taken, we should in fact choose only pleasures whose enjoyment will conduce to the attainment of a rational discrimination of pleasures.

This sentiment fits with several fragments on pleasure. Some fragments give a positive role to pleasure. 'A life without feasts is a long road with no inns' (fr. 230); 'Of pleasant things those that are rarest give most enjoyment when they happen' (fr. 232). However, we find that not everybody has a pleasant life, and the reason for this is their lack of intelligence. 'Fools live without enjoying life' (fr. 200); 'Fools desire length of life while not enjoying length of life' (fr. 201); 'Fools desire what is absent, but neglect what is present and past, though they are more fruitful' (fr. 202); 'Fools please [?] nobody their whole life long' (fr. 204); 'Fools desire life because they are afraid of death' (fr. 205); 'Fools wish to grow old because they are afraid of death' (fr. 206). The fools who are lambasted are people who do not use their reason and intelligence, and as a result they do not enjoy life. They cling to life, for example, merely because they are afraid of something worse; and if you don't even enjoy being alive, how can your overall state be a positive, enjoyable one? Intelligence is required, it seems, for the living of an enjoyable life, and we can plausibly connect this to the idea that particular occasions of choosing pleasure should be guided by what is overall to one's advantage, rather than by unreflectively pursuing the immediately pleasant.

We can see this idea in other fragments, for example fr. 146 with its context in Plutarch's *On Progress in Virtue* 81a, which tells us that a person who stands well in his own estimation, and is pleased and satisfied with, rather than disdainful of himself as a competent witness and spectator of fine things, shows that reason is nourished and rooted within himself and that, as Democritus says, 'it is accustomed to find pleasures from itself.'

Most noticeable here are fragments which link our final end not merely to what is overall advantageous but to what is fine (καλόν), which Aristotle characterizes as the aim of the virtuous person. 'One should choose not every pleasure, but pleasure at what is fine' (fr. 207). 'Temperance (σωφροσύνη) increased what is enjoyable (τὰ τερπνά) and makes pleasure greater' (fr. 211). 'A cheerful person who is led to deeds that are just and lawful rejoices day and night, and is strengthened and without care. But whoever disregards justice and does not do what he ought finds all such things unenjoyable when he remembers any of them, and is afraid and reproaches himself' (fr. 174). Here greater overall pleasure is linked not just to rational choice of what is advantageous but to virtue and the fine. Once again we can only lament the absence of texts that would clarify for us the link that Democritus makes between virtue and advantage. Cicero's complaint certainly seems to be supported by the fact that Arius tells us that for Democritus our final end lies in the discrimination of pleasures, and that this is both 'finest and most advantageous' for people. We would expect something more theoretically sophisticated as to why these should go together, but we do not find it.

However, theoretically unsupported or not, we do find the claim that virtue, far from being opposed to pleasure, actually increases it. We can see from the fragments and from Arius' comparison with the *Laws*, the general lines of the idea here. We naturally go for pleasure and pain, but, being humans, we are also motivated by reason, which enables us to reflect on and hence to modify our life, in such a way as to take pleasure in what is moral and advantageous; and this results in a more pleasurable life overall than does the mindless pursuit of particular pleasures.

This brings us to the third point, the prominence in the fragments we have of reason and wisdom as a key to living well. Even in fragments which do not directly link the exercise of intelligence to living more enjoyably or tranquilly, we find a constant harping on the importance of using one's own reason in one's life. Many of these fragments look at first glance like banal advice, but even if this is the impression they produce as individuals, the cumulative impression they produce is that of an ethical philosophy that has grounds for thinking that happiness is the product of one's own reasoning rather than external factors.<sup>29</sup> Using one's own reason is opposed to chance,<sup>30</sup> and also to one's given endowments. In Democritus' view we can be educated to organize our lives in a reflective way which will lead us to happiness.

Thus we find that, 'People fashioned an image of chance as an excuse for their own lack of counsel (ἀβουλίη). For chance seldom fights with practical wisdom, and intelligent sharp-sightedness sets straight most things in life' (fr. 119). This intelligence is something that has to be learned: 'Neither skill nor wisdom is attainable, unless you learn' (fr. 59).<sup>31</sup> Learning is a matter of acquiring rational understanding, not facts: 'Many are polymaths but lack sense  $(vo\hat{v}\varsigma)'$  (fr. 64).<sup>32</sup> Those who do not learn are ignorant in a profounder way than those who are ignorant of facts: 'The cause of going wrong (ἁμαρτίη) is ignorance of the better' (fr. 83). Learning is important because, 'Nature (φύσις) and teaching are close, for teaching reshapes (μεταρυσµoî) the person, and in reshaping makes their nature (φυσιοποιεί)' (fr. 33). Teaching, that is, alters us.<sup>33</sup> It enables us to detach ourselves from the mindless pursuit of present pleasures, and to discriminate and choose between pleasures with a view to obtaining our final end. That is one reason why Democritus is so sure that learning the content of his sayings will improve the reader (fr. 35). The person who has developed his reason through teaching has a surer basis for right conduct than the unreflective person who acts because of motives like fear, or avoidance of law-breaking (fr. 181); the person convinced by 'the persuasion of reasoning' will not do wrong even where he might get away with it. 'Reason is far more powerful for persuasion than gold' (fr. 52).<sup>34</sup>

It is probably in this context that we should understand the repeated claim that wisdom leads us to do the right thing, where this is seen as the mean between two opposed ways of going wrong. 'If you were to overshoot the mean (tò μέτριον), the most enjoyable things would become most unpleasant' (fr. 233). Many fragments develop the related idea that there is an appropriate amount (presumably the mean between excess and defect) of what one seeks, and that hitting this is what correctness of action is. 'For people who get their pleasures from the belly, overshooting the appropriate point in eating or drinking or sex, the pleasures are brief and short-lasting, just for the time they are eating or drinking, while the pains are many. For they always have the desire for the same things; whenever they get what they desire, the pleasure quickly goes and there is nothing good in them but a brief joy. And then they need the same things again' (fr. 235).35

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Many theoretical questions remain unanswered here. The two most prominent are, first, What is the place of virtue in

the happy life? On the one hand it is clearly seen as important for the person seeking happiness, yet obvious problems arise if virtue requires self-denial, for example, while the end we seek is a positive, cheerful one. The person wronged is happier than the wrongdoer, according to both Democritus and Plato; but while this thought is set in context in Plato's Gorgias, it is hard to see how it can be effectively defended as a way of being cheerful or tranquil. Democritus would probably reply that virtue, as a good of the soul, is more divine than the merely human goods that you get by flouting virtue and doing wrong. But perhaps it is not surprising that he said little about virtue, given the difficulty of sustaining such thoughts when happiness is thought of as consisting not in virtue but in a life which is cheerful, balanced, tranquil and so on. Here we can only say that Democritus is a pioneer, but that his work shows up the need for a fuller treatment of virtue as a good of the soul, and the corresponding moral psychology that will go with such a claim.

Second, Democritus locates happiness 'in the soul,' but can the happy life really be internalized in this way?<sup>36</sup> Here we find that even Plato is not as clear as his successors, and arguably clarity on the issue is not achieved until the Stoics, who see that if you claim that virtue is sufficient for happiness, then you have to distinguish sharply between the value of virtue (and the kind of role it has in your life) and the value (and role) of everything else. If virtue is sufficient for happiness, then external goods can be no more than what the Stoics call 'preferred indifferents.' If external goods can add to the happy life, either by helping to make it happy or by making it happier than it would otherwise be, then virtue is important for happiness, but not sufficient, and we need to know what its role is, and how important for happiness it is.

This is not merely a problem for the thought that virtue is what matters for happiness; it arises for any theory which puts happiness 'in the soul,' whether as virtue or as the rational pursuit of advantage. The tone of many of the fragments, as well as the idea that the soul is the user of the body, suggests that Democritus thinks that external goods make a life happy for the rational reflector in a way that they do not for the ignorant. This is compatible with external goods forming a part of the happiness of the rational and wise, so that their happiness would not be completely 'in the soul.' Yet some of the characterizations of happiness, especially as tranquillity (ἀταραξία) look suitable for a theory which does locate happiness completely in what is up to us. This wavering is culpable by the standards of later eudaimonist theory, when there had been much debate over the different options open once something internal to the person is held to be the most important element of happiness. But we can easily understand that at the beginning of eudaimonist theory the most important point would seem to be that of insisting that it is your own rational reflection that matters for happiness, rather than external goods. The different options open after wisdom and reflection are recognized to be more important than external goods cannot be expected to emerge clearly until there has been debate on the topic.

Whether we call Democritus a eudaimonist will depend on how much explicit theory we demand before we are prepared to use the word. He does not clearly stress the formal aspects of our final end (completeness, self-sufficiency), so important from Aristotle onwards, and adumbrated in Plato.<sup>37</sup> Nor does he emphasize the intuitive point that we seek happiness in everything we do, while it cannot be sensibly thought of as a step towards a further end.<sup>38</sup> However, we can see that the fact that some of the fragments have struck people as 'Socratic' is not a matter of copying a few sentiments (whichever be the copier, Democritus or Plato). Rather, Democritus puts forward positions which, like Plato's, require interpretation in terms of a eudaimonist theory to make sense of them.

Democritus, assuming that we seek happiness, has a broadly specified account of what this is, namely cheerfulness, tranquillity, a generally positive view of one's life, one in which virtue is important in an unargued way. In this he differs from Plato, who gives a more emphatic and dominant role to virtue, and he is best seen, as we would expect, as a forerunner of Epicurus, who likewise specifies happiness as a tranquil and positive condition (though unlike Democritus he calls this pleasure). Democritus is, however, similar to Plato in his insistence on the dependence of happiness on your own intelligent organization of your life; the only guardian spirit you have or need is in your own mind.<sup>39</sup> He does not say that the unexamined life is not worth living, but he is sufficiently scathing about fools and the mess they make of their lives for it to be plausible that he would have approved of the idea. Only the reasoned and rationally ordered life has a hope of being happy. Like Plato, moreover, he is clear that the rationally ordered life will be one with different priorities from the lives of ordinary unreflective people. Like Plato's Socrates, he startles us with the claim that the wrongdoer is unhappier than the person wronged, that what matters for happiness is within you, that the commonly agreed criteria for happiness, such as beauty or wealth, are guite mistaken. These striking departures from common-sense rest on a confidence in the results of rational reflection on one's life shared by later, more detailed and explicit eudaimonists.

The view of Democritus as a prosy dispenser of commonsense advice is thus quite mistaken. He thinks that we should live rationally ordered lives focused on a single end, happiness, and follow through the results of thinking this way rigorously even when it conflicts with common sense. For my money this makes him a eudaimonist. It is not, I think, useful to reopen the question of whether he influenced Socrates or vice versa; we shall never be able to determine the answer, and in any case the question of who first expressed a new way of thinking of things is unimportant. But in histories of ethics it would do more justice to Democritus to mention him, at least, as one of the pioneers of the dominant form of ethical theory in the ancient world.

#### Notes

- See Natorp, 1893; Bailey, 1928, ch. III. 9; Guthrie, 1965, pp. 489-97; Vlastos, 1945, pp. 578-92 and 1946, pp. 53-64, reprinted in Allen and Furley (eds), 1975, pp. 381-408; Taylor, 1967, pp. 6-27; Gosling and Taylor, 1982, ch. 2.1; Kahn, 1985, pp. 1-31. In this chapter I shall not have anything to say about Democritus' social and political ideas. On these see Procopé, 1989, pp. 307-31, and Spinelli, 1991, pp. 290-319.
- Some come from a collection of maxims ascribed in the manuscripts to 'Demokrates.' However, the shaky status of our evidence about Democritus' ethics can be greatly exaggerated.
- 3. See Cicero *Fin.* 5.23; Arius Didymus *apud* Stobaeum *Ecl.* 2.52.13 ff.; Diogenes Laertius 9.45; Clement *Strom.* 2.130. I do not think that it is profitable to look for Democritus in Plutarch's *On Tranquillity of Mind*, although its main thought, that it is your inner state which matters for tranquillity of mind rather than your outer condition, is in harmony with Democritus' ideas.
- 4. Notably Natorp, 1893; and Gosling and Taylor, 1982.
- Notably Bailey, 1928, and Kahn, 1985. They are supported by Striker, 1990, pp. 97-110 (reprinted in Striker, 1996).
- 6. See, for example Barnes, 1979, vol. II, pp. 228-33. 'In his collection of *gnomai* we may perhaps discern a consistent outlook, but we shall look in vain for a systematic ethics ... It is a recipe for happiness or contentment, not a prescription for goodness: the system sets up a selfish end for the individual and counsels him on how to attain it; it does not set up a moral goal and offer advice on its achievement. If Democritus' *gnomai* offer an unsystematic set of moral maxims, his reflexions on *euesto* offer no moral speculations at all; instead, they offer a systematic theory of prudence.'
- Cf. fr. 50; the person who can't resist money (χρημάτων ήσσον) will never be just. These fragments point in the direction of the reciprocity of the virtues, but no more.
- Fr. 256 goes, 'Justice (δίκη) is doing what one should do (τὰ χρὴ ἐόντα), injustice (ἀδικίη) is not doing what one should do, but turning aside.' Procopé has the usual reaction in claiming (1989,

p. 317): 'As a definition of justice and injustice, the sentence is hopeless: "what needs be,"  $\tau \dot{\alpha} \chi \rho \dot{\eta} \dot{\epsilon} \dot{o} v \tau \alpha$ , is just too wide a term to make an adequate *definiens*.' Yet surely just such a breadth is needed to explain why everyone in Book I of the *Republic* assumes without discussion that an exploration of justice is the same as a search for the way an individual should live.

- 9. Guthrie, 1965, pp. 490-1, actually seems to hold the view that both the banality of the banal fragments, and the striking originality of the more original fragments, are grounds for suspicion.
- 10. Guthrie, 1965, p. 490. Natorp, 1893, regards Aristotle's insistence that Socrates is the 'founder of ethics' as the explanation of his silence about Democritus' ethics.
- 11. Aristotle remarks at *Metaph.* 987a32-b10, 1078b12-1079a4, 1086a37-b11 that Socrates' innovations were inductive arguments and a search for universal definitions in ethical matters, but that he did not 'separate' the objects of these as did Plato. This whole story, apart from being highly disputable, says nothing about the content of Socratic or Platonic ethics.
- 12. With the exception of the Cyrenaics, who consciously reject it.
- 13. The role of eudaimonism in Platonic (including Socratic ethics) has been increasingly recognized. See Vlastos, 1991, ch. 8; Irwin, 1995, especially ch. 4; Brickhouse and Smith, 1994, ch. 4; Annas, 1999, ch. 2.
- 14. *Euthd*. 278-282, *Smp*. 204e-205a, *Phlb*. 20b-23a, 60a-61a.
- 15. Scholars who ignore the framework tend to give only intuitive, unargued grounds. Thus Bailey, 1928, p. 191: '[B]efore Socrates had turned men's minds to a systematic inquiry into the moral life, it is improbable that any thinker propounded what could in any real sense be described as an ethical system. "Cheerfulness" is put forward by Democritus as the state of mind at which men should aim, in a perfectly simple and naive spirit.' Cf. Striker, 1990, p. 98: 'Indeed, it is likely that Democritus' book was not a systematic treatise on ethics at all' and Kahn, 1985, p. 26: '[W]e need not follow the doxographers in attributing the Hellenistic concept of telos to a pre-Platonic moralist. An unprejudiced reading of the fragments does not support the view that Democritus' ethical thought is dominated by the pursuit of any single goal.' These views cannot account for Democritus' authorship of the works On the End and On Trangillity of Mind, they rely on the idea that Democritus naively missed what Plato found basic, and also

ignore the problem of consistently interpreting all the fragments.

- 16. Arius Didymus, ap. Stob. Ecl. 2.52.13-53.20.
- 17. Laws 660e-663d, especially 661a-e.
- 18. 'Pauca enim, neque ea ipsa enucleate, ab hoc de virtute quidem dicta' (*Fin.* 5.88).
- 19. Kahn makes the point that Democritus does not have a clear and consistent line on which aspects of the self are regarded as active and which as passive, especially with regard to the relation of reason and desires. But it seems clear that the soul is consistently regarded as active, indeed as the user of the body, which is cast as a tool for the soul to make use of.
- 20. Cf. fr. 218: 'Wealth from evil doings makes the reproach greater.' This is rather like the sentiment of the speech in Plato Mx. 246d8-247a4. Fr. 172 gives advice based on the idea that we get good and bad from the same things, depending on how we handle them; we need to work out an intelligent way of dealing with them, analogous to the helpful skill of swimming which makes water manageable for us, rather than a danger.
- 21. *Mx*. 246d-247a4, 247e-248a, *Euthd*. 278-282, *Laws* 631, 661-3.
- 22. Cf. fr. 60: 'It is better to *elenchein* (examine? test?) one's own faults than those of others.' See Williams, 1994.
- 23. Cf. Heracleitus fr. 119: a person's character is their guiding spirit. I shall have nothing further to say about Arius' use of *Tim.* 90a, which seems a reasonable interpretation.
- 24. Hence, despite the insistence on the importance of pleasure and pain, the position of the *Laws* is utterly unlike that of the *Protagoras*. On Plato's various views about pleasure, see ch. 7 of my 1999.
- 25. *Laws* 830b-841e. Plato is thinking only of male homosexual sex. He is right about the ways in which Greek culture of his time encouraged it. His own ideas have been shown to be unrealistic by the continued existence of homosexuality in societies which have tried to discourage it.
- 26. Natorp, 1893, ch. 8, brings out several points of similarity between the two philosophers (unfortunately marred by his tendency to see actual references in Plato to Democritus). These similarities have been underestimated in most accounts of ancient ethics. There is, of course, an immense irony in the fact that Democritus' views on pleasure converge with those of Plato in the *Laws*, the dialogue in which, though Democritus is not named, it

is clear that Plato is attacking metaphysical theories which include his.

- 27. See Taylor, 1967, pp. 11-12 on the word; he shows that Vlastos' claim that there must be a reference to the physical theory of atoms and void has no basis.
- 28. See Gosling and Taylor, 1982, pp. 32-3 for a discussion of the issue (they decide that the exact force of *horos* here cannot be determined).
- 29. Notable here is the very intellectualist advice about having and rearing children; we should not just have what comes along, but choose an already available child, with a view to its doing well. These fragments are so out of line with ordinary Greek thinking about having children that their emphasis on doing the reasonable thing, even when this appears strained and unnatural, would be very obvious to an ancient audience.
- 30. Bailey, 1928, pp. 186-8, points out that acceptance of the role of chance in the ethics is in contrast to the insistence in the physics of the absence of chance. Bailey (and Barnes, 1979) express some surprise that Democritus should keep the physics and ethics apart on this issue, as well as the implication of Democritus' determinism, namely that the status of our free ethical choices becomes problematic. However, there is no solid ground for supposing that Democritus' ethics and physics stood in any close relation (see Taylor, 1967, *contra* Vlastos); nor should we expect it. Ethics and physics are different parts of philosophy, and to carry physical conclusions over to ethics would be a naive mistake.
- 31. Fr. 53 is a bit puzzling in this connexion: 'Many have not learnt reason ( $\lambda \delta \gamma \circ \varsigma$ ) but live according to reason ( $\kappa \alpha \tau \alpha \lambda \delta \gamma \circ v$ ).' Here Democritus seems to envisage people who can follow reason though they have not themselves 'learnt' it, presumably by following the reason of others. This fragment would be easier to understand if we had more of Democritus' social thought. At any rate following reason through your own learning is the best option.
- 32. Cf. also fr. 65: 'One should practice much thinking, not polymathy' (πολυνοΐη, οὐ πολυμαθίη). Thus Democritus joins Heraclitus in deploring confusion of much learning with wisdom (fr. 40). He also (remarkably, in view of the Greek respect for age) makes the point that it is education, not age, which makes a person wise (fr. 183).
- 33. Cf. fr. 197, where fools are 'formed' or 'shaped' (ὑυσμοῦνται) by the gains of chance, people who learn by the gains of wisdom. It is surely grotesque to suppose that the reference is to reshaping *atoms*; the relevant reshaping is of the person's character and desires. Scholars have been overimpressed by the point that *rusmos* is the technical term for the

shape of the atoms; see Taylor, 1967, pp. 14-15. For all we know, however, its use as 'shape' generally may have been widespread in Ionic prose. Our sources are so scanty for Presocratic fragments in non-Attic dialect that it is dangerous to speculate about Democritus' conscious choice of vocabulary.

- 34. We should not, however, forget the depressing fragment 110: 'Let a woman not practice *logos*; it is terrible (δεινόν).' Democritus' reasons for excluding women from the community of reason are the usual unreflective ones which show up in the misogyny of some of the other fragments, where it is said that women use their minds for evil and should ideally not talk much. Among men he favours community of reason over community of kinship (fr. 107).
- 35. On the same theme are fr. 70: 'Unmeasured desiring belongs to a child, not a man,' as well as the long fr. 191, which expands on the advantages of living moderately; cf. fr. 102 that rejects excess and deficiency and says that 'the equal' in everything is fine. Fr. 219 expands on the idea that bigger desires encourage bigger lacks in the future, as does fr. 224. Fr. 71 claims that *akairoi* pleasures produce pains.
- 36. Nill, 1985, p. 83, expresses some pertinent doubts on this point.
- See *Phlb.* 20b-23a, 60a-61a for an argument which relies on the idea of completeness, and even contains vocabulary which is suggestive of Aristotle's discussion in *EN* I.
- 38. Again, contrast Plato, *Euthd*. 278-282, *Smp*. 204e-205a.
- 39. This 'naturalizing' of your *daimôn* does not go with a reductive or dismissive attitude to the gods of popular religion; fr. 175 talks of the gods giving things to humans. But these are moralized gods; fr. 217 says that only those who hate wrongdoing are dear to the gods. The latter sentiment is one shared with Plato.

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# Sylvia Berryman (essay date 2002)

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[In the following essay, Berryman appraises Aristotle's apparent rejection in the Physics, chapters 7 and 8, of Democritus's understanding of the void as a "determining cause" of motion. She concludes that Democritus and the atomists considered the void a cause of motion only insofar as they understood objects to "drift" in the direction of a void.]

Between Chapters 7 and 8 of *Physics* Book IV, Aristotle seems to commit a *non sequitur*. From a previous discussion about the necessity for void as a precondition for change, Aristotle abruptly turns to criticize an argument that the void is an *aition* of motion, specifically of motion

upward or downward: he replies that void cannot be the *aition* if simple bodies have upward and downward motion by nature. The difficulty is to know how to understand the term *aition* at 214b15: Aristotle is often read as attacking the claim that void is no mere *condition* but *the explanation* of motion.<sup>1</sup> Ross (1936, pp. 587-8) states this interpretation succinctly:

Aristotle's argument here is not convincing. The supporters of the void put it forward as an  $\alpha \check{\tau} \tau \omega \nu$  (necessary condition) of locomotion (213b4). He replies that it cannot be an  $\alpha \check{\tau} \tau \omega \nu$  (determining cause) of locomotion in any particular direction. The ambiguity in the meaning of  $\alpha \check{\tau} \tau \omega \nu$  makes the argument worthless.

While Aristotle clearly thinks the atomists attribute to void an explanatory role it does not have, he does not treat his opponents' view as paradoxical. We should hesitate to read Aristotle as saying that the atomists hold the absurd view that void is an efficient cause of motion, or even that it is a sufficient condition. Ross' term 'determining cause' is a convenient label to describe the view Aristotle attributes to the atomists. Let me call 'determining cause' any factor that accounts for the occasion, direction and extent of motion, with no assumption that it exhausts the necessary conditions. I undertake to give sense to this idea that void is a 'determining cause' of motion while avoiding the problematic claim that it is an efficient cause.

TRANSLATION OF PHYSICS IV.8 214b12-215a1

214b12-17: Void can't be responsible for motion<sup>2</sup>

Let us go back to saying that there is no such separated void as some people maintain. If each of the simple bodies has by nature a certain motion (for example, fire upwards, earth downwards and towards the center), it is clear that the void cannot be responsible for the motion. For what then *will* the void be responsible? It is thought to be responsible for change in respect of place, but for this it is not.

214b17-24: Same argument holds for 'place deprived of body' and 'separated place'

Again, if when there is void, it is something like place deprived of body, where will a body, placed in this, move to? It cannot be that it moves into the whole [of the void]. The same argument applies to those who think that place is something separate into which a body moves: how will a body placed in it move or rest? The same argument fits both in the case of upward and downward and in that of the void, with good reason; for those who assert that there is void make it place.

214b24-7: Difficulty of being in separated place or void

And in what way will [a body] be *in* either place or the void? It does not work out, when some body is placed as a whole in a separate place, which persists; for the part, if not placed separately, will not be in place but in the whole.

214b28: No void without separated place

Again, if place is not [separated], then neither will void be.

# 214b28-215a1: Indifference problem

Though some say that there is void because it is necessary if there is to be change, in fact, if one considers carefully, it is rather the opposite that results: that if there is void it is not possible for *anything* to move. Just as some say that the earth is at rest because of symmetry, so in the void too [a body] must be at rest, there being nowhere for it to move to more or less [than anywhere else], since the void, as such, admits no differences.

# ARISTOTLE'S STRATEGY

Aristotle's overall strategy in Chapters 6 to 9 is to claim, not only that void doesn't provide the explanation sought, but that motion is moreover impossible in a void. The impossibility is reinforced by showing how neither Aristotelian natural motion nor Aristotelian projectile motion could happen in a void. Neither of these reinforcements would stand alone: the latter argument based on the proportionality of speed was shown to be fallacious by Philoponus; the former, in that it apparently depends on accepting the Aristotelian account of natural motion, would be ineffectual against an opponent who does not share Aristotle's view.

Some commentators take the introduction of the Aristotelian dichotomy of natural and nonnatural motion after the passage cited to be *elucidating* the above passage. Aristotelian natural motion clearly requires differentiated places; if nonnatural motion is parasitic on the concept of natural motion, as Aristotle argues, both would be impossible in a void.<sup>3</sup> However, there is no need to suppose that Aristotle simply relies on his own account of natural motion in the passage cited above, rather than making only the more general claim that motion in a void is impossible because void is everywhere the same. Others suggest that the reference to the upwards and downwards motion of fire and earth in the passage cited doesn't depend on the doctrine of natural motion, but is only to question whether void could be responsible for *differential* motion, that is, motion in a given direction.<sup>4</sup> On this reading the explanandum is not why Aristotelian natural motion occurs-that is, by nature, not by void-but more simply how bodies could move in specific directions like up and down, if void is meant to be the *explanans*. Note that the reference to the difficulty of 'up and down' in a void is said to apply equally to *motion or rest* at 214b22. I take sections 214b12-17 and 214b17-24 to apply a problem to two conceptions-place deprived of body and separated place-and not to be raising two different argumentsnatural motion and indifference-against the void.5

The Aristotelian dichotomy of natural and nonnatural motion, then, need not be central to the argument of the passage cited. Indeed, if it were, the text would be blatantly redundant.<sup>6</sup> The indistinguishability of places in a void is common to this passage and the argument from natural motion, but it is not necessary to introduce the dichotomy of natural and nonnatural motion to recognize a problem

with distinguishing places in a void. I propose that Aristotle's objection throughout this section is only the more general problem that the void, because of its lack of differentiation, cannot be responsible for motion. But if the passage above is not about natural motion, what claim might it be designed to answer?

The only clue as to how Aristotle's opponents might think void is responsible for motion is the claim made later at 215a22-3, that things go into the void *because of its yield-ing.*<sup>7</sup> Void's lack of resistance has somehow to figure in his opponents' account. This is *prima facie* peculiar, as the atomists are elsewhere reported to say that motion happens by the mutual striking of bodies: mutual resistance, *anti-tupia* or *allêlotupia*, occurs in several reports.<sup>8</sup> Yielding seems to be the antithesis of resistance. Sambursky notes evidence in Plato and in Sextus' report of Epicurus that the two ideas are explicitly opposed.<sup>9</sup> However void is conceived, then, there would be something inherently paradoxical about calling void an agent of change if agency is identified with the striking of bodies against one another.<sup>10</sup>

We shouldn't, then, release Aristotle from a charge of unfair argumentation at the cost of saddling his opponent with a peculiar view that the void, or its 'yielding,' is the efficient cause of motion.<sup>11</sup> (This is apparently how Aristotle's student Eudemus understands it.)<sup>12</sup> The problem, again, is to find a plausible view for the atomists, that the void is a 'determining cause,' but not an efficient cause, of motion.

# IS DEMOCRITUS A 'MECHANIST'?

Before proceeding further, an objection needs to be anticipated. I have been assuming that it would be hasty to attribute to the atomists the view that void is an efficient cause of motion. This might seem to be working too hard: it has been objected that the early atomists are not such strict 'mechanists' as they are sometimes thought to be. Could this mean that they might not have taken such a claim to be absurd? Ulrike Hirsch recently argued against assuming that Democritus' approach is mechanistic and antiteleological (Hirsch, 1990, pp. 225-44). Should this challenge give us pause?

It is certainly true that the term 'mechanistic' has anachronistic associations (see Furley, 1987, p. 13), and Hirsch is right to urge caution against reading later ideas back into Democritus. A key element of Hirsch's critique of a way Democritus is often characterized is that there was no clear statement at the time of a teleological world view for Democritus to be reacting to.<sup>13</sup> For present purposes, the issue is only how consistently the atomists ascribe motion to the striking of bodies against one another: for this, there is no need to suppose that the atomists were rejecting teleological explanation *per se*. One of the positions Hirsch takes issue with, that of Mourelatos in 'Democritus: Philosopher of Form' (1984), in fact addresses the concern about anachronism, inasmuch as it suggests a

#### DEMOCRITUS

background against which the early atomists might have developed a view about the causes of atomic motion. Mourelatos suggests that Melissus' argument that form cannot arise from nothing provides the requisite background for the notion of 'conservative transformation,' the idea that the arrangement of atoms no more than their substance can be taken to come from nothing (Mourelatos, 1984, p. 119). It might be in response to the Eleatics that Democritus formulated a view wherein the rearrangement of atoms can be seen to arise from previous configurations and motions.<sup>14</sup> Without supposing that the early atomists ever formulated anything like laws of motion, they might reasonably be taken to think that the striking of atoms against one another offers an efficient cause of atomic motion in a way that a void space cannot.

Here, for simplicity, the motion of the cosmic whirl and questions arising from the explanation of living organisms will be set aside:15 the question remaining is whether the atomists consistently hold that motion is caused by atoms striking against one another. The main evidence sometimes raised against this is the principle of 'like to like.' If this is understood as irreducible attraction drawing bodies together, the atomists would not take all motion to be caused by the striking of bodies. If so, why should they not think that void is an efficient cause, 'attracting' atoms just as atoms attract each other? The answer is that the motion of likes to likes does depend on the striking of bodies. Democritus needs to explain why the collision of atoms moving randomly in a void should result in the emergence of clustering. The phenomenon suggests that there must be some principle of sorting, by which atoms of similar kind cluster. The examples suggest that the sorting is not by similar quality but similar size and shape: exactly those factors operating in collisions are those that govern sorting.<sup>16</sup> Democritus' analogies are to bodies already in motion: pebbles are riffled by the tide, grains tossed by the winnower.17 'Like to like' need be no more than an observation that similar sizes and shapes cluster together under such circumstances. More explanation might be offered: that smaller bodies sift down through the gaps between larger ones and so travel further, while the compatibility of the hooks and barbs on atoms of similar size explains clustering.

This distinction between the sorting at the phenomenal level and the action of invisible atoms will be of service in understanding how the void might seem to cause motion. The position Aristotle attacks can, I suggest, be understood as the claim that void is a 'determining cause'—but not an efficient cause—of *macroscopic* motion. The explanation depends on efficient causation by *atomic* motion. How this argument would work requires a closer look.

#### THE INDIFFERENCE ARGUMENT

As I read the passage from 214b12-215a1, Aristotle seems to reject the atomists' view because of the lack of differ-

entiation in a void. There is an argument from as far back as Anaximander that the earth stands still because any factors inclining it to move would be equal in every direction. A brilliant piece of reasoning, the equipoise argument—a form of indifference argument—both combats any tendency to extrapolate from the observation that heavy bodies fall to the suggestion that the earth must fall, and suggests that the onus of explanation should lie in showing what might cause the earth to move. The mere presence of a surrounding space in which to move, the argument implies, is not sufficient for motion.<sup>18</sup>

Aristotle seems to have a parallel objection to motion in a void from its lack of differentiation. Any account of place or void as separate from the bodies in it would, Aristotle thinks, have no way to distinguish particular places and hence no way to say 'here rather than there.' Void has no defined places, so cannot be responsible for motion in a given direction (214b12-17). In a void, however conceived, there are no defined places that bodies could be said to move *to* or rest *at* (214b17-24). Without defined places, a void has no places *within* it (214b24-27), that is, no distinction between part and whole. Place can only be thought to be void if it is conceived of as separate from bodies in place (214b28), but would thus have no internal differentiation. Because there are no defined places, a body can't be said to move in a void (214b28-215a1).

Aristotle claims that void cannot account for motion because of its lack of differentiation. But what argument might this be responding to? Aristotle later trails a red herring about void being a cause of upward motion because of differing densities (Ph. IV.9, 217a6-8). He seems to suggest that void theorists take the greater concentration of void in a rare body to be the efficient cause of upward motion. Aristotle objects that if the weight of bodies explains their fall, it should not be the greater amount of void but the lesser proportion of matter that is responsible for the rising (DC IV.2, 309a1-14: see Thorp, 1990, pp. 149-66). This isn't the argument at play in chapter IV.8, since Aristotle here raises as an objection that motion up and down could not be explained by the void. His opponents must have claimed that void is a cause of motion generally, and not specifically of motion up and down.

I think there is another way the atomists might have attributed a role to void, which makes void a 'determining cause' of motion, in my sense, without attributing efficient causality to it. The basic principle is that of 215a22-3, that things go into the void 'because of its yielding.' Given the motion of detached atoms constantly bombarding each other, the overall tendency of a mass will be in the direction of least resistance. Recall the notion of 'like to like' and the strategy of using atomic motion to explain perceptible effects. Constantly moving atoms are repelled from densely crowded areas, so that a mass will tend to drift in the directions where there is less resistance. Thus the presence of a void, merely because it offers no resistance, explains why bodies move at a certain time, in a certain direction and to a given extent.

Note that the drift does not explain the motion of individual atoms but of a cluster of atoms as a whole. If a macroscopic mass of atoms is next to a void space but surrounded by bodies on other sides, the claim is that the mass, insofar as it is composed of independently moving particles, will tend to drift in the direction that offers no resistance. This explanation depends on the fact that individual atoms will be repelled from densely occupied areas, so that the mass seems to gravitate towards the void. The void accounts for the occasion, direction and extent of motion, but it is not, and is not thought to be, an efficient cause (see Berryman, 1997).

It would be a mistake to miss the sophistication of this argument and assimilate it to the more general claim that void space is a necessary condition of motion. For one, it does not claim to establish the existence of void, but merely shows how differential concentrations of void determine the occasion, direction and extent of motion. For another, it depends on a distinction of atomic and macroscopic behavior; third, it accounts for an effect that could not be explained away as circular mutual replacement. Void does not initiate the motion of atoms, but nonetheless explains why a body moves when, where and as far as it does.

Suppose Democritus had advanced this argument about the drift toward a void. The crucial point is that the relative concentrations of void do the work. The indifference argument—that void has no differentiation and hence can't have differential effects—rather misses the point: it is the relative concentration of void in various directions that provides the differentiation. Aristotle's objection would, however, be grounded in a real difficulty. He might reasonably have thought that in an infinite void, relative concentrations of void cannot be compared because the ratios are to an infinite quantity. As the void is infinite in every direction, he might plausibly object, it is no more void in one direction than another. The atomist argument would need to be refined to say that only the relative *local* concentration of void is at issue.

A mass of atoms will drift in the direction, on the occasion and to the extent that it encounters fewest nearby atoms offering resistance. A greater concentration of void is shorthand for a lesser concentration of atoms. It might be said that atomists ought always to explain changes in terms of bodies acting on one another: they should, strictly, explain the resistance to motion of a mass in the direction of greater concentration of unyielding bodies. But it would be an understandable shorthand to say that the void is a determining cause of the drift, since the relative concentration of void accounts for the occasion, extent and direction of motion. The atomists are not disturbed at the absence of an efficient cause at the perceptible level, as they take the action of imperceptible bodies to be the efficient cause.

If this gives a charitable reading to Aristotle's report and a plausible view to the atomists, it further needs to be shown that it is a view Democritus held. Explicit evidence for this argument is found in Lucretius, who points out that a void space in one direction would offer no resistance to moving bodies, so that atoms gravitate towards a void under the pressure of the continual collisions with bodies in all other directions. He compares this to a sail driven by wind.<sup>19</sup> Epicurus uses the 'lack of resistance' to explain the motion of atoms through the void, and the 'drift' argument seems to be implicit in the argument against having finite atoms in an infinite void, since, without sufficient collisions to bring atoms together again they would simply scatter into an infinite void.<sup>20</sup>

Only the one sentence in Aristotle's discussion suggests the use of this principle by the early atomists: the claim at 215a22-3 that things go into the void because of its yielding. Some commentators read this as an argument treating void as an efficient cause of motion, with Aristotle objecting that, in a void, bodies would move in all directions at once.<sup>21</sup> But we needn't think that a single body moves in many directions simultaneously. Ross advances another interpretation of the 'yielding' claim, pointing to Simplicius and Philoponus as authorities for reading this as an argument that a body already moving in a certain direction would go faster through a medium with more void spaces.<sup>22</sup> He reads the yielding passage as a proportionality of speed argument, and takes Aristotle's objection to be that void, because it has no differentiation, would not impede bodies at all. Ross finds this 'unconvincing,' unsurprisingly: the indifference of void makes no sense as a response to a proportionality of speed argument. But this is not how Simplicius understands the argument; and while Philoponus does read the yielding argument as about proportionality of speed, his argument is not Aristotle's.

Simplicius and Philoponus both interpret Aristotle as answering an argument that void is a cause because of its yielding and that the yielding is greater in air and water than in earth because of the greater amount of void space present. Philoponus does consider that the 'yielding' argument be understood as a case of the proportionality of speed argument: void bodies would move either instantaneously or in every direction (In Ph. 645.22-5). However, only the first disjunct would be applicable to a proportionality of speed argument, whereas Aristotle offers only the second. Simplicius does not think that Aristotle's answer is about proportionality of speed or scattering,<sup>23</sup> but that an infinite void has no differentiation (In Ph. 670.31-671.3). A possible reason for introducing 'infinite' here would be to undercut a claim that greater or lesser concentrations of void could explain the motion of bodies: Simplicius could well be reading Aristotle's opponent as making a 'drift' argument that bodies tend to move in the direction of a

rarer medium where there are more void spaces. Neither commentator offers grounds for thinking the yielding argument is about proportionality of speed.

It should, I think, be read as addressing the claim that bodies tend to drift in the direction of a void.<sup>24</sup> Aristotle objects that if there were void in all directions and yielding were supposed to explain motion, the atoms would scatter rather than exhibit a marked drift. If void were indeed undifferentiated, this would be so. It is only if there were a way to distinguish relative local concentrations of void that it makes sense to think that bodies drift in the direction of least resistance in a void.

#### CONCLUSION

The atomists' drift account of the motion of macroscopic bodies, I have argued, only seems to attribute efficient causality to the void, inasmuch as the macroscopic body has no other efficient cause acting on it. In the case of relative speeds of projectiles, there is no propensity to call the void the 'cause' of the greater speed in a rare medium, because there is an efficient cause already apparent of the projectile's motion. In the case of 'drift,' a description of the phenomenal effect could take the void as a 'determining cause,' in the limited sense of accounting for the occasion, extent, and direction of motion. But in atomist theory this would be explained by efficient causal action of imperceptible atoms. In their terms, it should not be surprising that a macroscopic body can move without an apparent efficient cause, given their view that phenomena are caused by the striking of atoms moving in a void. The atomists have, I think, a plausible account of the tendency of bodies to 'drift' into a void.

## Notes

- 1. Guthrie takes Aristotle to read the atomists as treating void as a 'sufficient cause,' Guthrie, 1969, p. 399; likewise Algra, 1988, p. 177. Hussey consider whether Aristotle is rejecting void as a final cause of natural motion: Hussey, 1983, p. 128.
- 2. The translation is by Hussey, 1983, slightly modified. The organization of the arguments has been changed: headings in bold indicate my interpretation. I am grateful for questions from Allan Silverman and David Hahm, which helped in clarifying the structure of the argument.
- 3. It still needs to be shown why void couldn't explain natural motion. Furley thinks that natural motion couldn't occur through a void in which there are no defined places: Furley, 1989, pp. 8-18. He points out that the atomists cannot make sense of the notion of a centre in an infinite void: Furley, 1987, pp. 191-2. Hussey suggests a different reason why the Aristotle might think the void can't account for natural motion, in that natural place has a kind of power, which void couldn't have: Hussey, 1991, p. 239.

- Solmsen, 1960, p. 137; Cherniss, 1971, p. 151; Furley, 1989 p. 87; Makin, 1993, p. 108.
- 5. As Hussey's numbering might indicate: Hussey, 1983, p. 34.
- There are two readings in the manuscripts at 215a2, πρῶτον μὲν οὖν ὅτι and ἔπειθ' ὅτι: the latter signals a new argument. Ross prints the latter, following Simplicius: Ross, 1936, p. 588.
- ἔτι νῦν μὲν εἰς τὸ κενὸν διὰ τὸ ὑπείκειν φέρεσθαι δοκεῖ · ἐν δὲ τῷ κενῷ πάντῃ ὑμοίως τὸ τοιοῦτον, ὥστε πάντῃ οἰσθήσεται. Ph. 4.8, 215a22-4.
- 8. For example, Δημόκριτος τὰ πρῶτά φησι σώματα... κινεῖσθαι κατῷ ἀλληλοτυπίαν ἐν τῷ ἀπείρῷ (Aetius 1.12.6); Λέγει μὲν περὶ Λευκίππου τε καὶ Δημοκρίτου · οὖτοι γὰρ λέγουσιν ἀλληλοτυπούσας καὶ κρουομένας πρὸς ἀλλήλας κινεῖσθαι τὰς ἀτόμους (Alex. In Metaph. 36.21); Δημόκριτος τὴν ἀντιτυπίαν καὶ φορὰν καὶ πληγὴν τῆς ὕλης (Aetius 1.26.2; = fr. 323 Luria). On whether a report (Simplicius In DC 583.20) that atoms move by force is a denial that they have weight, see O'Brien, 1981.
- ή ἀντιτυπία μὲν τοῦ σώματος, εῖξις δὲ τοῦ κενοῦ M 10.221: Sambursky, 1959; cf. O'Brien, 1981, p. 167.
- I take this point to be neutral between Sedley's two conceptions of vacuum: Sedley, 1982; cf. Algra, 1995, pp. 48-52.
- 11. Makin takes this as the most obvious reading of Aristotle's answer: Makin, 1993, pp. 108-9. Furley emphasizes that for Aristotle, void can have no *dunamis*: Furley, 1989, p. 87.
- 12. Simplicius *In Ph.* 533.12 (= fr. 75 Wehrli). Sharples takes 'cause' here to mean 'making such movement possible:' Sharples, forthcoming. Löbl reads Eudemus' report as suggesting that Democritus attributes causality to the void: Löbl, 1987, pp. 138-9.
- 13. Much else in Hirsch's paper deserves attention, and I hope to address the point about anachronism elsewhere. Barnes, 1984 discusses evidence that Leucippus rejected teleology.
- 14. See Mourelatos, 1981; Mourelatos, 1987; Mourelatos, unpublished. Hirsch recognizes the importance of the Eleatic background in understanding early atomism.
- On the latter I follow Mourelatos, 1987, p. 162. Balme argues that ignorance of the laws of motion would have made a mechanistic view implausible: Balme, 1941, pp. 23-8; cf. Edmunds, 1972; McKirahan, 1994, p. 326.
- 16. Sextus Empiricus M 7.117-18 (= fr. 316 Luria). The exception is the reference to birds flocking, and is set

aside as it involves animal behavior. Furley, 1989, p. 79, thinks that the movement of likes is described 'as if' there were a force of attraction; cf. Furley, 1987, p. 142. On analogies, see Lloyd, 1966, pp. 384-420.

- 17. Hesse reads this as mechanical since it uses the 'technique of centrifuging:' Hesse, 1961, p. 53. I am not assuming this, just that mutual striking accounts for the motion. On magnetism, see Berryman, 1997.
- On this see Kahn, 1960, pp. 76-81; Makin, 1993, pp. 101-5; Hankinson, 1998.
- 19. Lucretius *DRN* 6.906-1089: see also the introduction to Hero of Alexandria's *Pneumatics*. I discuss the possibility that Lucretius' 'drift' account lies behind Democritus' account of magnetism in Berryman, 1997, pp. 153-5.
- 20. Letter to Herodotus 42-4. Noted by Furley, 1989, p. 157.
- 21. Cherniss, 1971, p. 151; Hussey, 1983, p. 130; Sorabji, 1983, pp. 149-50.
- 22. Ross, 1936, p. 589. Wicksteed and Cornford, 1927, p. 351, think the passage is about the motion of an individual projectile, but fail to make much sense of Aristotle's response.
- 23. See Simplicius *In DC* 295.14-20. For Cleomedes' use of the scattering argument, see Sorabji, 1983, pp. 150-4.
- 24. In contrast to the suggestion by Apostle, 1969, p. 254 that it makes no difference to the 'yielding argument' whether or not the body is already in motion.

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Ross, W. D. (1936), *Aristotle's Physics*, a revised text with introduction and commentary, Oxford: Clarendon Press.

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Sedley, David (1982), 'Two conceptions of vacuum,' *Phronesis*, 27, 175-93.

Sharples, R. W. (forthcoming), 'Eudemus' *Physics*: change, place and time,' in I. Bodnar and W. W. Fortenbaugh (eds.), *Eudemus of Rhodes*, Rutgers: Rutgers University Press.

Solmsen, Friedrich (1960), Aristotle's System of the Physical World: A Comparison with his Predecessors, Ithaca N. Y.: Cornell University Press.

Sorabji, Richard (1983), Matter, Space and Motion: Theories in Antiquity and their Sequel, London: Duckworth.

Thorp, John (1990), 'Aristotle's Horror Vacui,' Canadian Journal of Philosophy, 20, 149-66.

Wicksteed, Philip H. and Cornford, Francis M. (1929), *Aristotle, The Physics*, London: W. Heinemann Ltd.

# **FURTHER READING**

## Criticism

Bailey, Cyril. *The Greek Atomists and Epicurus: A Study.* Oxford: Clarendon, 1928. Print.

Offers a comprehensive study of Leucippus, Democritus, and Epicurus. Although it is dated, Bailey's work is still the starting point for many discussions of Greek atomism.

Barnes, Jonathan. *The Presocratic Philosophers*. 2 vols. London: Routledge, 1979. Print.

Surveys the entire history of early Greek philosophy and the Sophists, presenting the atomists and Democritus as the culmination of early Greek natural philosophy. [Excerpted in *CMLC*, Vol. 47.] Brancacci, Aldo. "Democritus' Mousika." Democritus: Science, the Arts, and the Care of the Soul. Ed. Brancacci and

Pierre-Marie Morel. Leiden: Brill, 2007. 181-205. Print. Provides evidence of Democritus's direct contributions to poetics, aesthetics, and the philosophy of language through an examination of works attributed to the philosopher by Thrasyllus, a firstcentury-AD grammarian. In Thrasyllus's catalogue, these works are grouped under the heading "works on music," with "music" referring to a wide range of cultural communications.

Cole, Thomas. Democritus and the Sources of Greek An-

- *thropology.* Cleveland: P of Western Reserve U, 1967. Print. Establishes Democritus as the primary influence on speculation about human prehistory in Greek philosophy and literature.
- Furley, David J. *The Formation of the Atomic Theory and Its Earliest Critics*. Cambridge: Cambridge UP, 1987. Print. Provides a detailed study of early Greek cosmology, emphasizing the important role of the atomists in presenting an alternative to the creationist cosmologies preferred by Plato.

Havelock, Eric A. "The Political Theory of Democritus." *The Liberal Temper in Greek Politics*. New Haven: Yale UP, 1957. 125-54. Print.

Presents a comprehensive reading of the fragments of Democritus's works in the fields of anthropology, ethics, and politics. Havelock argues that these fragments show Democritus to have been a radical democrat, egalitarian, and supporter of contract theory, with liberal tendencies contrary to the political thought of Plato. [Reprinted in *CMLC*, Vol. 47.]

Kahn, Charles H. "Democritus and the Origins of Moral Psychology." *American Journal of Philology* 106.1 (1985): 1-31. Print.

Finds from a study of fragments of Democritus's ethical writings that the philosopher was a teleologist in the realm of ethics—that is, he defined ethical conduct in terms of its consequences. Kahn's account of Democritus's views on the nature of desire and pleasure offers a corrective to superficial readings of Democritus as a hedonist. [Reprinted in *CMLC*, Vol. 47.]

Lee, Mi-Kyoung. "Democritus on Appearances and Perception: The Early Sources." *Epistemology after Protagoras: Responses to Relativism in Plato, Aristotle, and Democritus.* Oxford: Oxford UP, 2005. 181-216. Print.

Discusses the influence of Protagoras, a fifth-century-BC Greek philosopher, on Democritus's studies of perception. Lee uses readings of Democritus by Aristotle and his disciple Theophrastus to show that Democritus, like Protagoras, adopted a "radically subjectivist" view of sensory perception: "a thing has a sensible quality if and only if it appears so to the perceiver."

Leszl, Walter. "Democritus' Works: From Their Titles to Their Contents." *Democritus: Science, the Arts, and the*  *Care of the Soul.* Ed. Aldo Brancacci and Pierre-Marie Morel. Leiden: Brill, 2007. 11-76. Print.

Utilizes the list of seventy works attributed to Democritus by Thrasyllus and Diogenes Laertius to draw conclusions about the likely contents of Democritus's works and, thus, the nature of his philosophy. Leszl shows that, by following the indications in the list, scholars can better understand the historical and philosophical contexts of the surviving fragments of Democritus's works.

McGibbon, Donal. "The Religious Thought of Democritus." *Hermes* 93.4 (1965): 385-97. Print.

Examines Democritus's perception of the soul (or mind) and his religious references in an attempt to refute claims that Democritus either denied the existence of gods or ignored the question of their existence entirely. He finds that Democritus believed in numerous gods who "actualised Mind to a perfect degree" that allowed human beings to develop their potential qualities.

Mejer, Jørgen. "Democritus and Democracy." *Apeiron* 37.1 (2004): 1-9. Print.

Considers the political aspects of Democritus's ethical fragments and shows how these aspects are related to modern understandings of democratic government. Mejer emphasizes that Democritus "did not find a direct opposition between law and nature" and that he considered the intellectual capacity of a citizenry to be more important to the preservation of society than established laws.

Morel, Pierre-Marie. *Democrite et la recherche des causes*. Paris: Klincksieck, 1996. Print.

Offers an in-depth study of Democritus's theory of causality and scientific explanation and its application to various aspects of natural philosophy. Available only in French.

Mourelatos, Alexander P. D. "Intrinsic and Relational Properties of Atoms in the Democritean Ontology." *Metaphysics, Soul, and Ethics in Ancient Thought: Themes from the Work of Richard Sorabji.* Ed. Ricardo Salles. New York: Oxford UP, 2005. 39-63. Print.

Discusses differences in the ways Democritus and later philosophers, including Aristotle, conceived of the atom. Mourelatos discerns in Democritus's terminology, which focuses on the atom's "rhythm, contact, and turning," a dynamic or kinetic characterization that contrasts with Aristotle's emphasis on the atom's "shape, arrangement, and position." The classic edition of the fragments of Democritus's ethical works, with commentary by a notable German scholar and philosopher. Available only in German and ancient Greek.

Procopé, J. F. "Democritus on Politics and the Care of the Soul." *Classical Quarterly* 39.2 (1989): 307-31. Print.

Analyzes several key fragments of Democritus's political writings. Procopé's investigation discerns important facts about the origin, transmission, and significance of those fragments.

. "Democritus on Politics and the Care of the Soul: Appendix." *Classical Quarterly* 40.1 (1990): 21-45. Print.

Supplements with philological detail Procopé's study of fragments of Democritus's political writings.

Salem, Jean. Democrite: Grains de poussière dans un rayon de soleil. Paris: Vrin, 1996. Print.

Assesses Democritus as a philosopher, taking into account all of the important ancient evidence that has affected judgments of the significance and originality of his works. Available only in French.

Taylor, C. C. W. "The Atomists." *The Cambridge Companion to Early Greek Philosophy.* Ed. A. A. Long. Cambridge: Cambridge UP, 1999. 181-204. Print.

Offers a brief, accessible overview of the main points of atomism, including Democritus, and current interpretive controversies.

Warren, James. *Epicurus and Democritean Ethics: An Archaeology of Ataraxia*. Cambridge: Cambridge UP, 2002. Print.

Analyzes the influence of the intermediaries between Democritus and Epicurus on the development of Epicurean ethics and psychology. Warren demonstrates the considerable extent to which Epicurus adopted (and adapted) Democritean views on ethics.

Zatta, Claudia. "Democritus and Folly: The Two Wise Fools." *Bibliothèque d'Humanisme et Renaissance* 63.3 (2001): 533-49. Print.

Examines the incorporation of the figure of Democritus in Desiderius Erasmus's 1509 treatise *Moriae Encomium* (*In Praise of Folly*). Zatta demonstrates the connection between the ideas associated with Democritus in Erasmus's treatise and stories of the philosopher contained in the *Pseudoepigrapha*, a work dating to the Roman imperial period.

Additional information on Democritus's life and works is contained in the following sources published by Gale: *Classical and Medieval Literature Criticism*, Vol. 47; and *Literature Resource Center*.