XIX
The Logic of Locomotion

(a) *Empedocles andantiperistasis*

The neo-Ionian defence of science against Eleatic metaphysics rests at bottom on their vindication of locomotion: if things can move, science is possible; if locomotion is impossible, science falls with it. All three Eleatics argued against locomotion: Parmenides in **156**. 26–33, Melissus in **168,** Zeno by way of his four or five paradoxes. The neo-Ionian defence takes on only Melissus: Parmenides' obscure lines are justifiably ignored; and nothing is said against Zeno. I have no explanation of the latter omission: perhaps the paradoxes were unknown to the neo-Ionians; perhaps they were despised as sophisms or set aside as insoluble problems. With an adequate chronology some of that puzzlement might evaporate; but we have no adequate chronology (above, pp. 305–7). At best, then, the neo-Ionians will achieve a partial success: however powerful their arguments in Melissan country, they have still to fight on Zeno's territory.

We have considerable evidence for the Atomists' attitude to locomotion; we possess a few straws pointing to the position of Empedocles and of Anaxagoras; we know nothing of Philolaus. In this section I deal with Empedocles and Anaxagoras.

Empedocles 'says in general that there is no void' (Theophrastus, *Sens* §13=**31 A 86**). Aristotle gives the same report (*Cael* 309a19= **59 A 68**); and we have Empedocles' own word for it:

> Nor is any part of the universe *(tou pantos)* empty, nor yet overfull **(288: B 13)**.
>
> It…is not empty, nor yet overfull **(289)**.[1]

The clause 'nor yet overfull *(perisson)*' is not casual: an empty space would contain no body; an overfull space would contain more than one body. Melissus' argument against motion needs to deny both emptiness and overcrowding (above, p. 226); and Empedocles is perfectly aware of the fact.

According to Anaxagoras, too, 'nothing is empty' (Aristotle, *Resp* 471a2=**59 A 115**); Aristotle repeats the assertion (Cael309a19=**A 68**), and it reappears in the *MXG* (976b20), in Lucretius (I.843=**A 44**), and in Hippolytus **(A 42)**. We have no first-hand evidence for the ascription, but the doxographical tradition is unanimous and indisputable. Anaxagoras, it is true, held that 'the dense and the rare' could be found in the world **(B 15);** and 'there are some who think it evident from the rare and the dense that there is void' (Aristotle, *Phys* 2l6b22). But the examples of Descartes and of Aristotle himself (*Phys* Δ 9) show that a philosopher may deny the existence of void

and still assign different degrees of density to different stuffs; and that position is, I judge, logically consistent.

It is regularly supposed that both Empedocles and Anaxagoras offered empirical arguments to show that 'nothing is empty'. The source of the supposition is Aristotle:

> Those who attempt to prove that it [sc. the void] does not exist do not refute what men mean by void but only what they erroneously say; e.g., Anaxagoras and those who refute it in that fashion. For they show that the air is something, by twisting wineskins and proving that the air is strong, and by capturing it in clepsydras (**290:** *Phys* 213a22–7=**59 A 68**).

We know that Anaxagoras talked about the clepsydra (pseudo-Aristotle, *Prob* 914b9=**59 A 69**), and Aristotle (despite his plural 'they') may have Anaxagoras alone in mind in this passage. It is, however, regularly connected with a celebrated fragment of Empedocles **(31 B 100)**. That fragment attempts to explain the phenomena of respiration by means of an elaborate analogy with the clepsydra, an ancient device for transmitting liquids from one vessel to another, similar in function and action to the modern chemist's pipette.[2] It is often alleged that the fragment describes an experiment, and that the experiment was designed to disprove the existence of empty space. I shall not try to elucidate **B 100,** which has aroused a busy hum of commentary. But it is, I think, perfectly plain that no 'experiment' is described in the fragment;[3] that if the fragment incidentally implies the corporeality of the air, it was certainly not meant to demonstrate it; and that the whole piece says nothing whatever about the void. Empedocles' clepsydra is a red herring: let us return to the *Physics*.

Air pressure forces liquid out of the pipette and holds liquid in it; the force or 'strength' of the air is tangible in an inflated balloon or a twisted wineskin. There is no reason to doubt that Anaxagoras made these observations, and that he used them to confirm the long familiar fact that air is corporeal. Quite evidently, such observations do not prove the non-existence of the void: some scholars infer that in the *Physics* Aristotle merely misrepresents the purpose of Anaxagoras' remarks.[4] But Aristotle cannot be dismissed so lightly; and we may readily connect Anaxagoras' observations to the void without ascribing any childish error to him. Partisans of the void will have tried to establish their case simply by pointing to the air; 'for the air seems to be empty' (Aristotle, *An* 419b34). Against such people, Anaxagoras' observations are pertinent: they do not show that there is no void, nor were they meant to; but they do refute a simple-minded argument for the existence of empty space.

Why, then, did Empedocles and Anaxagoras reject the void? I suppose that they adopted a Melissan argument.

There is no void. Melissus inferred the impossibility of motion; Empedocles and Anaxagoras believed in locomotion: how did they justify their defiant opinion?[5] Of Anaxagoras we know nothing. He allows that the world contains 'the dense' and 'the rare' **(59 B 15);** and he presumably had some answer to Melissus' assertion that 'the rare is thereby more empty than the dense' **(168)**. But what answer he might have given I do not know; nor can I invent any connexion between degrees of density and locomotion.

Empedocles' fragments are equally silent; but in his case the doxography comes to our aid:

> Similarly Empedocles too says that the compounds are always moving continually for all time, but that nothing is empty; saying that 'of the whole nothing is empty: whence, then, might anything come?'; and when they are compounded into one form so as to be one, 'it', he says 'is not empty in any respect nor overfull'. For what prevents them from travelling and circulating *(peristasthai)* into one another, if at the same time one always changes into another and that into another and another into the first? (**291:** *MXG* 976b22–9=**30 A 5**).

The doctrine ascribed to Empedocles in this passage is that of counter-circulation or *antiperistasis:*

> Nature that hateth emptiness,
> Allows of penetration less:
> And therefore must make Room
> Where greater Spirits come.

Abhorring emptiness and penetration alike **(288),** Empedoclean nature must 'make room' if it is to encompass locomotion. The *MXG*'s mode of expression implies, perhaps, that Empedocles did not make his doctrine fully explicit; but he did, I think, come fairly close to it:

> Empedocles said…that all [the elements] take one another's places *(metalambanein)* (**292:** Aëtius, **31 A 35**);
>
> He says that they give way to each other *(antiparachôrein)* (**293:** Achilles, **31 A 35**).

The doxographers rely ultimately on the Empedoclean phrase that occurs more than once in the fragments: the elements, he says, 'run through one another *(di' allêlôn…theonta)*' (**B 17**.34=**B 21**.13 =**B 26**.3). In the context, it is entirely reasonable to take the repeated phrase as a first, imprecise, formulation of the theory of *antiperistasis*.[6]

What exactly was the theory? And how does it answer the Eleatic challenge? Melissus' argument against motion relied on the following principle (above, p. 219):

(1) If *a* moves to *p* at *t*, then immediately prior to *t p* is empty. A mobile opponent will not grant (1). First, he might suggest that prior to *t p* is occupied by a body, *b*, which is compressible: at *t a* compresses *b* by the force of its trajectory and thus comes to occupy a region formerly occupied by a part of *b*. But that will not trouble Melissus, who has argued that no bodies are compressible: being 'full', bodies are not 'dense and rare'. The opponent turns to a second suggestion: up to *t p* is occupied by *b*, but at *t*, just as *a* enters *P*, *b* moves to a new position p_1.

Melissus will still remain unshaken: instead of (1) he will offer:

(2) If *a* moves to *p* at *t*, then immediately prior to *t* some place or other must be empty.

Admittedly, *p* may be occupied up to *t;* but its occupant, *b*, must move at *t;* and there must be some empty place or other for *b* to move into. Proposition (2) will do all the work Melissus required of (1); and it turns the opponent's second suggestion.

Yet why should a proponent of locomotion accept (2)? Motion, he will say, does not require *any* vacancies. Let *b* occupy *p* up to *t:* then *a* may move to *p* at *t* provided that there are two series of bodies, $_{c1}\ldots\ c_n$ and $d_1 \ldots dm$ such that, first, the places occupied by *a, b,* each c_i and each d_i are all identical in shape and size, and, second, *a* is contiguous with c_1 c_1 with $c_2,\ldots c_{n-1}$ with c_n, *cn* with *b, b* with d_1, d_1 with $d_2,\ldots\ d_{m-1}$ with *dm*, and d_m with *a.* Then a may move to *p* at *t*, provided that each of the contiguous bodies moves, at the same time and the same speed, to fill its neighbour's position. Imagine a card circle, divided by two diameters into quarters labelled *a, c, b, d*. At *t* revolve the circle through 180°; then *a* comes to occupy the place of *b;* and at no time is any part of the circle empty.

That is the theory of *antiperistasis;* and it is that by which Empedocles hoped to vindicate locomotion. The theory had an illustrious life: Plato formulated it clearly (*Timaeus* 80C); and Aristotle produces it as his own answer to the Melissan challenge: 'For it is possible for things to yield place to one another at the same time, even though there is no separable interval [i.e. no empty space] apart from the moving bodies. And this is clear in the case of whirls of continuous things, just as it is in the case of those of liquids' (*Phys* 214a29–32).[7] Aristotle illustrates *antiperistasis* by pointing to children's tops and water eddies; the best known illustration was first produced by Straton of Lampsacus, head of the Peripatetic school in the third century BC: 'Straton's example offers a more suitable escape from these difficulties; for if you put a pebble into a jar full of water and turn the jar upside down while holding the stopper over the mouth, the pebble will move to the mouth of the jar as the water moves around *(antimethistamenon)* into the place of the pebble' (fr. 63 W=Simplicius, *in Phys* 659.22–6).

Those modern thinkers who held that the universe is a *plenum* accepted the ancient theory of *antiperistasis*. Thus Descartes: 'The only possible movement of bodies is in a circle; a body pushes another out of the place it enters, and that another, till at last we come to a body that enters the place left by the first body at the very moment when the first body leaves it'.[8] I see no logical objection to *antiperistasis*. Russell once observed that 'it should…be obvious, even to the non-mathematical, that motion in a closed circuit is possible for a fluid. It is a pity that philosophers have allowed themselves to repeat [the argument that motion presupposes a vacuum], which a week's study of hydrodynamics would suffice to dispel'. It has been asserted that 'the plenum theory inevitably implies the existence of instantaneous physical actions, that is, of actions spreading in space with infinite velocity';[9] for the force transmitted, in my schematic example, from *a* to c_1 must pass in an instant about the 'circle' of bodies to *b*. But that is not so, as the case of the spinning top demonstrates; moreover, it does not seem to me to constitute a logical objection to *antiperistasis*. Melissus' principle (2) is not a logical truth; and locomotion within a *plenum* is a logical possibility.

(b) *The Atomists and the void*

The Atomists did not move by counter-circulation: motion, they held, took place through a void; and there *is* a void.

> Leucippus and Democritus…[said] that there is void not only in the universe but also outside the universe (**294:** Simplicius, **67 A 20**).

The world contains interstitial void between its component atoms; and the world itself is separated from other atomic conglomerates by acres of extra-mundane vacuity. 'In truth, there are atoms and void' **(68 B 125):** in that famous fragment, and in countless doxographical reports, void has a place alongside the atoms as one of the twin pillars of the Abderite universe.[10]

Melissus' rejection of vacancy depended on the premiss that what is empty is non-existent, or nothing (above, p. 218). The Atomists boldly accepted his premiss:

> Leucippus and his associate Democritus say that the full and the empty are elements, calling one existent and the other non-existent; the full and solid is the existent, the empty and rare the non-existent. That is why they also say that what exists exists no more than what does not exist—because the empty [exists no less than] body (**295:** Aristotle, *Met* 985b4–9=**67 A 6**).
>
> What exists subsists no more than what does not exist; and both alike are explanations for what comes into being (**296:** Simplicius, **67 A 8**).

The void is non-existent; the void exists: hence the non-existent exists.

The void is also nothing. And Plutarch quotes a passage from Democritus

> in which he asserts that 'the thing exists no more than the nothing'—calling body thing and the void nothing—on the assumption that this latter too possesses a certain nature and substance of its own **(297:68 B 156)**.

We need not delay over the order of the phrases in this quotation: '*a* exists no more than *b*' and '*b* exists no more than *a*' both mean no more than '*a* and *b* alike exist'; the relative order of *a* and *b* has at most a stylistic point. Nor need the phrase 'the thing' detain us: 'nothing' in **297** translates *'mêden'; mê* means 'not'; subtract *mê* from *mêden* and you get *den*, and that is the word I translate 'thing'. Subtract 'not' from 'nothing' and you get 'hing'; and some scholars proudly offer 'hing' as their translation of *den*. But 'hing' is a nonsense word, *den* is not: it occurs once elsewhere, in a fragment of Alcaeus (fr. 130 LP), and was, it seems, a rare word meaning *'chrêma'* or *'pragma'*—'thing'.[11] Clearly, *den* in **297** is present only for its rhetorical effect: the fragment says no more than that nothing, no less than existent things, exists.

Melissus in **168** uses 'nothing *(mêden)* to mean 'non-existent *(mê on)';* and Democritus in **297** is, I suppose, simply following Melissus, Even so, 'the non-existent exists' does not seem much more promising as an axiom of science than '(the) nothing

exists': the axiom looks flatly self-contradictory. It is tempting to dismiss the remark as a piece of *ad hominem* abuse: 'The void exists, and if Melissus chooses, absurdly, to call the void non-existent, why then, the non-existent exists. But we Atomists will not be outfaced by such a trivially verbal manoeuvre.' Yet Melissus, I have argued, did not simply mishandle the notion of non-existence; and our texts give no hint that, in asserting the existence of the non-existent, the Atomists were merely indulging in raillery.

If we are to take seriously the assertion that 'the non-existent exists', we must make it something more than a simple self-contradiction; and the only way of doing that is to posit two different senses for 'exist'. Democritus, we know, was alive to the possibility of ambiguity (cf. **B 26**); but there is no evidence that he saw an ambiguity in *'einai'*. Nonetheless, I am inclined to think that the Atomists were feeling towards such an insight: at all events, without that supposition we must leave them in the gloomy depths of blank contradiction.

Frege has familiarized us with the distinction between *Esgibtexistenz* and *Wirklichkeit*. In English, the normal phrase for expressing *Esgibtexistenz* is 'there is (are)', and a standard way of expressing *Wirklichkeit* is by means of the predicate 'real'. But both notions can be put across by the verb 'exist'; and similarly in Greek both notions are customarily expressed by the one verb *'einai'*. There are horses, and horses are real (they exist, whereas unicorns do not exist—they are fictional, not real); there are numbers, but numbers (in my book at least) are not real—they do not exist. When 'exist' signifies reality it is a predicate, and the formula '*a* exists' is well-formed; when 'exist' signifies *Esgibtexistenz* then it is not a (first-order) predicate and a exists' is not well-formed.

Let us distinguish the reality sense of 'exist' as 'exist1' and the *Esgibtexistenz* sense as 'exist2'. Then I suggest that the proper sense of 'the non-existent exists' is given by 'the non-existent1 exists2'; i.e., by 'There are things which are not real'. Atoms and void exist; i.e., atoms and void exist2, there are atoms and empty spaces. The void does not exist; i.e., the void does not exist1, the void is unreal.

Now to exist1 or to be real is to be a space-filler; and it is therefore a necessary truth that atoms exist1: atoms are bodies, and bodies exist1. On the other hand, 'void exists1' is necessarily false; for only bodiless places are void. Thus 'the void is non-existent1' is necessarily true, even though it is an axiom of physics that there are empty spaces or that the void exists2. The Atomists can be given a consistent thesis; moreover, their thesis has, to my mind, a considerable plausibility: if we agree with Locke, and several of the ancients, that 'to be (i.e. to exist1) is to be somewhere (i.e. to occupy a space)', then bodies and atoms do necessarily possess a being that empty space necessarily lacks. To pursue that hare further would lead to some of the more horrid thickets of philosophical logic: I shall assume that I have given the Atomists' slogan at least a *prima facie* plausibility, and proceed to the existence2 of the void.

In the *Physics* Aristotle offers a list of arguments which had been used to show the existence of the void: local motion requires void, and so do rarefaction and condensation; growth presupposes a void; a jar full of ashes will hold as much water as the same jar when empty of ashes (213b2–29=**67 A 19**). Some scholars ascribe those arguments to the Atomists;[12] and the argument from locomotion was canonical in Epicureanism: 'If there were not that which we call void and place and intangible

nature, bodies would not have anywhere in which to be or through which to move—and they evidently do move' (*ad Hdt* §40; cf. §67; fr. 272 Us.). Evidently, bodies move; locomotion demands void: *ergo* there is void. Yet no ancient source attributes any of the arguments of the *Physics* to the Atomists; and the arguments are dialectically inapposite: Melissus rejects the void, and therefore motion; the Atomists, seeking to rehabilitate motion, restore the void. If they do so merely because motion requires it, their argument falls shamefully flat.

> Metrodorus of Chios, a pupil of Democritus, said that: Everything that anyone thinks of *(noêsai)* exists **(298:70 B 2)**.

The sentiment is Eleatic in substance and form; and an easy conjecture has Metrodorus attacking Elea with its own weapons: we can think of the void (for we can readily imagine vast oceans of empty space); thus, by the Eleatic principle that thinkability implies being, the void exists. I like to think that Metrodorus used that argument; but no text explicitly mentions it, nor is the Eleatic principle ascribed to Metrodorus' master.

To establish the void, the Atomists used, I believe, their own *Ou Mallon* Principle: Democritus said that 'the thing exists no more *(ou mallon)* than the nothing' **(297);** and *ou mallon* is used in the same context by Aristotle (*Met* 985b8=**67 A 6**) and by Simplicius **(67 A 8)**. The phrase *ou mallon* does not in itself prove the presence of the *Ou Mallon* Principle: '*a* is *ou mallon F* than *b*' may simply mean '*b* is just as *F* as *a* is'. And in **297** it is possible to take *ou mallon* in that way: 'the void is just as existent as the atoms are'. But I dislike that interpretation: the phrase 'more existent' grates on the logical ear; and if Democritus thinks that atoms exist1 and exist.2 whereas the void exists2 but does not exist1, then it is false to say that void exists just as much as atoms. Thus I read the *Ou Mallon* Principle into **297,** and thereby discover the Atomists' argument for introducing the void: 'there is no more reason for there to be occupied than for there to be unoccupied areas of space'; 'there is no more reason for the existence2 of atoms than for the existence2 of void'. And since atoms exist2, so too does void.

The argument rests on two premisses. First, it assumes that Melissus' argument *against* the void has no power; for otherwise there would be 'more reason' for the existence2 of atoms than for the existence2 of void. Second, it assumes the truth of the *Ou Mallon* Principle itself. I shall discuss those two premisses at a later stage of my argument: for the nonce, I leave the Atomists in possession of the field.

(c) *Anaxagoras and mind*

If the neo-Ionians are to succeed in their endeavours, motion must be more than a logical possibility: it must be an actual feature of the world. Parmenides objected to generation by asking, rhetorically, 'what *need* would have aroused it to come into being later or sooner?' (**156**. 9–10); and the same question can be applied to motion: nothing will move unless there is some explanation of its movement; yet what *need* impels things to move? *Aitiologia* or the giving of explanations, is in any case a part of the scientist's art: even without the prick of Parmenides' spur the neo-Ionians would have

searched for explanations; goaded by it they only galloped faster. In the remaining sections of this chapter I shall look at some of the results of their search for explanation; and I begin with the most celebrated of them.

> [Anaxagoras] was the first to add mind to matter, beginning his book, which is pleasantly and grandly written, thus: 'All things were together; then mind came and arranged them' (**299:** Diogenes Laertius, II. 6=**59 A 1**).[13]

Anaxagoras' invention earned him the nickname of 'Mind' (Timon, fr. 24=**A 1**) and it won him rare praise from Aristotle:

> Someone said that mind is present as in animals, so in nature as the explanation of the universe *(kosmos)* and of the whole order of things; he appeared as a sober man compared to his predecessors who spoke at random (**300:** *Met* 984b15–18=**A 58**).

What was Anaxagoras' mind? How was it related to the ordinary stuffs of his world? And how did it operate in and on the world?

Mind *(nous)* is a stuff, or at least stuff-like. The term 'mind' generally functions in Anaxagoras' fragments as a mass-noun, like 'gold' or 'flesh', and not as a count-noun, like 'ingot' or 'arm'. Moreover, mind 'is the finest of all things and the purest' **(B 12):** the reference to the rareness or 'fineness' of mind is often thought to represent an attempt, only partially successful, to express the thin notion of in corporeality. But mind is certainly extended in space **(B 14),** and I am inclined to think that Anaxagoras, far from hinting at mental incorporeality, was bent on the opposite tack: 'mind' is not, after all, a very stuff-like term in its ordinary behaviour; Anaxagoras, given to an ontology of stuffs, was determined to ascribe to mind a material existence and nature which by no means evidently belongs to it.

Since mind is a stuff we might expect it to act like other Anaxagorean stuffs, to have a share of everything and to be in everything; that is, we should expect the following two propositions to hold:

(1) If *a* is a piece of mind, then for any stuff, *S*, *a* contains a portion of *S*.
(2) For any stuff *S*, if *a* is a piece of *S*, then *a* contains a portion of mind.

But mind is no ordinary stuff: its peculiar features are expressed in four fragments:

> In everything there is present a portion of every thing, except mind; and in some things mind too is present **(204: B 11)**.
>
> The other things share a portion of everything; but [i] mind is unlimited[14] and independent *(autokratês)* and has been mixed with no thing but alone is itself by itself. For [ii] if it were not by itself but had been mixed with something else, it would share in all things if it had been mixed with anything (for [iii] in everything there is a portion of everything, as I have said earlier); and [iv] the things commingled with it would obstruct it so that it would not control *(kratein)* any thing in the

> same way as it does when being actually alone by itself. For [v] it is the finest of all things and the purest; and [vi] it has every knowledge about everything, and greatest power; and [vii] mind controls all the things that have soul *(psuchê),* both the greater and the smaller, [viii] And mind controlled the whole revolution *(perichôrêsis),* so that it revolved at the beginning. And [ix] first it began to revolve in a small way, but it revolves more, and it will revolve more. And [x] the things that commingle and those that separate off and those that separate out: mind knew them all. And [xi] what was to be and what was and is not now and what is now and what will be—all these mind ordered, and this revolution in which now revolve the stars and the sun and the moon and the air and the aether that are separating off. But the revolution itself made them separate off. And the thick is separating off from the thin, and the hot from the cold, and the bright from the dark, and the dry from the wet. And [xii] there are many portions of many things; but nothing is altogether separating off or separating out one from another, except mind. And [xiii] all mind is homogeneous, both the greater and the smaller. And nothing else is homogeneous; but each single thing is and was most clearly those things of which most are present in it **(301: B 12)**.
>
> And when mind began to move things, it separated off from everything that was moved; and whatever mind moved, all that was separated out. And as things were moving and separating out, the revolution made them separate out much more **(302: B 13)**.
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> Mind…[15] is now where all other things are: in the surrounding multiplicity and in what are conjoined and in what are separated off **(303:814)**.

At first blush, **204** seems to deny proposition (2), and sentences [i] and [xii] of **301** seem to deny proposition (1). I begin with (2).

'In some things mind too is present': Anaxagoras is simply stating the common-sense fact that some things have minds and others do not; the things that do are presumably those creatures with a soul or *psuchê* which mind 'controls' (**301,** [vii]); the things that do not are stocks and stones.[16] Can we infer from that common-sense proposition to the metaphysical thesis that some stuffs contain no portion of mind? and hence that (2) is false? It would be a rash inference: Anaxagoras might consistently maintain both (2) and the thesis of **204;** after all, when I drink a glass of gin, a 'mindless' stuff, my spirits revive—perhaps I extract a little mind from my drink.17 And **303** does appear to imply (2): if mind is 'in the surrounding multiplicity' and in everything else, then surely every piece of stuff must contain a portion of mind? That easy interpretation is not inevitable; but as far as I can see it is both intelligible in itself and consistent with everything else that Anaxagoras has to say. And I conclude that Anaxagoras in fact assents to (2).

Mind, of course, is pure, unmixed, and by itself; but to say that is to deny (1), not to deny (2); more precisely, it is to assert the contrary of (1):

(3) If *a* is a piece of mind, then for no stuff *S* does *a* contain a portion of *S*.

Why does Anaxagoras maintain (3)? Some see it as an inference from the negation of (2); but Anaxagoras does not deny (2); the inference is plainly invalid; and Anaxagoras himself tells a different tale. In sentences [ii]—[iii], **301** explicitly infers (3) from the negation of (1); and the inference, given Anaxagorean physics, is correct. Given that every stuff contains a portion of every stuff, it follows that if mind does not contain every stuff, it does not contain any stuff.

Why, then, does Anaxagoras reject (1)? Why cannot pieces of mind, like any other bits of stuff, be omnivorous in their appetites? If they were, the characteristic powers of mind would be 'obstructed' according to sentence [iv], and it would lose 'control'. Sentence [v] explains sentence [iv] by reference to the 'fineness' of mind. Perhaps mind's fineness explains why mixture would obstruct its powers: mind is, as it were, a fine penetrating oil; and its penetrative powers, to which it owes its ability to control and know all things, would be inhibited by any commingling with grosser matter. But there is no reason to suppose that commingling would inhibit mind's penetrative capacities: in Anaxagorean physics, 'everything is in everything' and even the grossest body may penetrate the finest of stuffs. Fineness will not explain why mind should be obstructed; and I suppose that sentence [v] justifies the last part of [iv]: fineness explains mind's control 'when being actually alone by itself. (Thus Diogenes of Apollonia held that *psuchê* was air, the 'most fine-bodied of all things', and that *psuchê* is 'mobile *qua* finest': Aristotle, *An* 405a21–5= **64 A 20**.)

A different argument has been offered against (1): mind, alone of stuffs, has motive powers; hence mind must be distinguished from other inert stuffs; and the only mode of distinction is the denial of commixture to mind. But that argument has no textual basis. In any case, every other stuff has powers or properties of its own, yet those stuffs contain portions of everything else: why should mind alone lose its characteristic powers if it were not pure?

A man is made of flesh and blood and bone and mind; the universe contains earth and air and fire and water and mind. Those are platitudes. But, as Aristotle stressed, mind is not on a par with the other stuffs of the world: when we talk of a man's mind we are not speaking of any physical constituent, nor even of a quasi-physical constituent; we are referring, in a collective way, to his powers and his dispositions. If mind is treated as a constituent, physical or non-physical, of a man, confusion is likely to follow. I guess that Anaxagoras half saw that: mind is not like the other things of the world; its defining functions, knowledge and control (cognition and volition in a later argot), reveal the fact. Yet Anaxagoras could not grasp the full implications of his insight: he made mind pure, unmixed, and so on; but he deliberately construed it as a stuff. By accepting (2), he strongly affirmed its stuff-like nature; by denying (1), he hoped, vainly, to preserve its special status as a cognitive and active force.

What, then, are the powers of mind? and how does it operate in the world? The second half of **301** answers those questions. The details of mind's cosmic activity are of no philosophical interest; and I shall note only the main heads under which that activity can be subsumed: they are four.

First, mind knows everything. Perhaps, like the Homeric Muses, Anaxagorean mind knows everything because it is everywhere **(303);** or perhaps mind knows everything because it ordered everything and thus foresees all events in the world's history. (In the same way, some Christian theologians connect God's omniscience with his creativity.)

Second, mind ordered or arranged everything: it planned the blueprint for cosmogony and determined how the primordial mass should be articulated into a world. Third, mind controls some things: some of the events in the present world are brought about by thought or ratiocination; and these, trivially, are the work of mind. Fourth, mind moved the *Ur*-mass; it set the stuffs into a whirl and thus began assembling a cosmos according to its blueprint.

That summary of mind's functions raises several questions. In this section I consider only the most obvious feature of mind: it is, above all, a 'moving cause', a source of locomotion and of change: 'he makes it a principle of motion' (Aristotle, *Phys* 256b25=**A 56**); 'he linked the artist to the matter' (Aëtius, **A 46**); 'he filled out the missing explanation' (Simplicius, **A 41**).[18] Why did the mass of homoiomeries ever begin to whirl and form a cosmos? Because of mind. Why do the heavenly bodies now pursue their ordered courses? Because of mind. The general formula of explanation is this: 'Mind brought it about that *P*'. What is this 'mind'? Some think of a cosmic mind, a vast mass of pure mind which dreamed up and executed the cosmic plan.[19] But **302** implies that there was, at the cosmogonic starting point, no large central mass of mind; and no other text implies that such a mass ever existed. Nor are the ordinary events which mind controls plausibly assigned to any cosmic mind. Perhaps, then, 'mind' refers to the totality of mind stuff, the whole collection of mind portions; and to say that 'mind brought it about that *P* and mind brought it about that *Q*' is not to ascribe two acts to a single subject: water surrounds New Zealand and water flows from Oxford to London, but no one bit of stuff does both these things. For 'Mind brought it about that *P*' we should read: 'Some piece of mind brought it about that *P*'.

'Some', said Berkeley, 'have pretended to account for appearances by *occult qualities*, but of late they are mostly resolved into *mechanical causes*, to wit, the figure, *motion*, *weight*, and such like qualities of insensible particles: whereas in truth there is no other agent or efficient cause than *spirit*' (*Principles*, §102). If a facile comparison sets Anaxagoras on Berkeley's side in this dispute, conjecture readily suggests Democritus as the ancient representative of the proponents of mechanical causes; and there is, I think, a distinction here that is worth bringing out.

Some philosophers, concerned to understand the notion of causation, take the performances of rational agents (in particular, of themselves) as paradigms of causal activity: when I observe myself or another man striking a billiard ball or driving a motor-car, then I am attending to a plain piece of causation. This attitude suggests that causes are *agents*, and that the causal structure of the world is tied together by powers and capacities to act and be acted upon. The canonical formula for causal propositions is: 'Agent *a* brings it about that *P*'.

Other philosophers look outward: causation is the cement of the universe, the adhesive which binds event to event; and we should seek it in the external universe and not in ourselves. When I observe one billiard ball strike and move another, or when I study the intricate mechanism of an internal combustion engine, then I am in the presence of causality. This attitude suggests that causes are antecedent *events*, and that the causal structure of the world is primarily a matter of regularity. The canonical formula for causal propositions is: 'Event *E*2 occurs because event *E*1 occurs'.

I shall call the first of those approaches to causation Berkeleian, the second (with some historical impropriety) Humean; and I suggest that Anaxagoras adopted a Berkeleian approach to causation, and the Atomists a Humean approach.

I have talked, somewhat feebly, of different approaches: do the approaches point to different theories of causation, or offer rival accounts of the notion of causation, or show that we have at least two distinct concepts of what it is to cause something to happen? Let us start by expanding the Humean approach: as well as events, we sometimes cite states of affairs as causes (the glass broke because it was brittle, and the man died because he was old). Since every true proposition describes either an event or a state of affairs, the canonical formula for the expanded Humean-notion is simply: '*P*1 because *P*2'.

The Berkeleian approach admits of a similar expansion: objects as well as agents are designated as causes (Pompeii was destroyed because of Vesuvius, the cricket ball brought about the death of the sparrow). Thus the canonical formula of Berkeleianism is: '*a* brings it about that *P*1' (where *a* names any object or agent). It seems plausible to suppose that '*a* brings it about that *P*1' is true if and only if some proposition of the form '*P*1 because *a* is φ' is true: Pompeii was destroyed because of Vesuvius, i.e. because Vesuvius erupted; the sparrow was killed by the cricket ball, i.e. because the cricket ball struck it. In general, Berkeleian causation is explicable in terms of Humean causation; for Berkeleian formulae are merely abbreviations of Humean formulae, '*a* brings it about that *P*1' is equivalent to a special type of the formula '*P*1 because *P*2, viz. '*P*1 because *a* is ϕ'.

Now even if that unpolished account has some truth at its foundation, there remains an important way in which Berkeleian causation differs from Humean. For in cases where *a* is an agent, the translation of '*a* brings it about that *P*1' into Humean language will always include a reference to *a*'s mind—to his intentions, his desires, his beliefs. 'Brutus', we say, 'killed Caesar.' And that causal hypothesis may be put into canonical Berkeleian form: 'Brutus brought it about that Caesar died. 'That sentence is expandable to a Humean sentence of the form: 'Caesar died because Brutus ϕed'; and that in turn must expand into something like: 'Caesar died because Brutus stabbed him and wanted him to die and believed that if he stabbed him he would die.' Thus even if Berkeleian causes in some sense reduce to Humean causes, they still mark an important sub-class of Humean formulae, viz. those in which *P*2 is a complex proposition including a reference to intentions, desires or beliefs. Let us call that sub-class of formulae the Berkeleian formulae: then Anaxagoras, I suggest, held that science required Berkeleian formulae; the Atomists that it did not.

(d) *Causas cognoscere rerum*

> [Democritus said that] he would rather find a single causal explanation *(aitiologia)* than gain the kingdom of Persia **(304:68 B 118)**.[20]

We possess a quantity of Democritean explanations; many of them are preserved by Theophrastus **(A 135),** from whom I have already quoted (above, p. 373). If we ask, on a more abstract level, how Democritus conceived of causation, we have less information; but a clear and consistent picture emerges.

Epicurus says of the Abderites that:

> Though they were the first to give adequate explanations, and far surpassed not only their predecessors but also their successors many times over, yet here, as in many other places, they did not realize that they were making light of grave matters in ascribing everything to necessity and the spontaneous **(305:68 A 69)**.[21]

For the moment let us ignore 'the spontaneous'; then Epicurus charges that all phenomena in the Atomists' world are necessitated.

> Refusing to mention the final cause *(to hou heneka),* Democritus reduces everything that nature handles to necessity (**306:** Aristotle, *GA* 789b2=**68 A 66**).
>
> Everything happens by fate, in the sense that fate applies the force of necessity (**307:** Cicero, **68 A 66**).
>
> Everything comes about by necessity, since the whirl, which he calls necessity, is the cause of the generation of everything (**308:** Diogenes Laertius, IX.45=**68 A 1**).

These reports bear on Democritus; but Leucippus held the same view. Only one Leucippan fragment survives. It reads thus:

> Leucippus says that everything occurs by necessity and that that is the same as fate; for he says in *On Mind:* No thing comes about in vain *(matên);* but everything for a reason and by necessity *(ek logou kai hup 'anankês)* (**309:** Aëtius **67 B 2**).

Leucippus appears to be stating some version of a principle which we have already met, the Principle of Causality (above, pp. 24–6).[22] He talks of things 'coming about *(ginetai)*' but he presumably means to encompass all events in that term and not merely generations; and it will not be absurd to allow that states as well as events were probably in his mind. Thus **309** asserts that all states and events are explicable by reason and necessity; and I gloss that by:

(1) For any proposition *P,* if *P* is the case, then there is some *Q* such that the fact that *P* is necessitated by the fact that *Q*.

In (1) *Q* is the *logos* or reason for *P;* and the 'necessity' of **309** is expressed by the link of necessitation between *Q* and *P*.

It is, of course, in atomic nature that we must seek the proper explanations of things:

> The reason why the substances [i.e. the atoms] stay together with one another up to a point, he finds in the overlappings and interlockings

> *(epallagai kaiantilêpseis)* of the bodies…. Thus he thinks that they hold on to one another and stay together for a time, until some stronger necessity comes upon them from their surrounding, shakes them about, and scatters them apart (**213,** Aristotle).

The 'stronger necessity' is created by atomic clashings; and thus it is the atomic 'whirl' which ultimately causes all change, and which can therefore be called 'necessity' **(308)**. We are, I think, entitled to particularize proposition (1), and say that: every macroscopic state is explicable by way of some atomic state; every macroscopic event by way of some atomic event. Every atomic state is determined by the properties of its atomic constituents; every atomic event is explained by the locomotion of its atomic constituents. Every atomic locomotion is explained by way of atomic collisions; and atomic collisions depend on the velocity, size and shape of the colliding corpuscles. In that way, the world is explained; and if a complete aetiology of the universe is for ever beyond our powers, at least it is in principle possible.

The Atomists are Humean, in the loose sense in which I use that adjective: they do not talk of agents; and the formula '*a* brings it about that *P*' does not figure in their aetiologies. Were the Atomists

Humean in a more historical sense of the term? Humean causes are prior and contiguous to their effects; and they adhere to their effects with a necessity which Hume explains (or explains away) in terms of regularity. The Atomists are concerned with two different kinds of explanatory hypothesis. First, a macroscopic state or event, *M*1, is explained by way of a microscopic state or event, *M*2. ('The kettle of water is cold, because its constituent atoms have such and such a structure'; The kettle is coming to the boil, because its constituent atoms are moving in such and such a way.') Here *M*2 is not prior to *M*1, but simultaneous with it; *M*2 is not contiguous to *M*1, but identical with it; and *M*1 and *M*2 do not illustrate a merely Humean regularity: rather, *M*2 necessitates *M*1 (in a somewhat Pickwickian sense); for, being identical with *M*2, *M*1 cannot but occur when *M*2 occurs.

Second, a microscopic state or event, *M*2, is explained by reference to an atomic collision, *C*. Here *C* is presumably prior to *M*2. In a loose sense we can say that *C* is contiguous to *M*2, if we suppose that only collisions involving the constituent atoms of *M*2 can result in *M*2. And *C* necessitates *M*2. Is that necessitation to be explained *à la* Hume, by way of regularity? Do the Atomists think that states or events like *M*2 come about whenever collisions like *C* occur? and that such regularity is all that there is to *C*'s necessitating *M*2? Our evidence is silent. That the Atomists believed in causal regularity is not implausible in itself, and it is perhaps implicit in Leucippus' use of the word *logos*. But nothing suggests that the Abderites took a Humean view of necessity.

(e) *Agents and purposes*

'No thing comes about in vain *(matên)*' **(309):** the sentiment is Aristotelian in expression; and when Aristotle asserts that 'God and nature do nothing in vain *(matên)*' (*Gael* 271a33), he means to subscribe to a teleological theory of nature. That cannot, however, be Leucippus' meaning; and we must take *matên* in **309** to mean 'without

cause', not 'without purpose'. For the Atomists rejected all teleological or purposive explanation:

> Leucippus and Democritus and Epicurus [say that the universe is] neither animate nor governed by purpose *(pronoia)*, but by a sort of irrational nature *(phusis alogos)* (**310:** Aëtius, **67 A 22**).
>
> Is there a providence which looks after all things, or is everything created and governed by chance? The latter opinion was propounded by Democritus and corroborated by Epicurus (**311:** Lactantius, **68 A 70;** cf. Aëtius, **67 A 24**).

Humean explanations do not rule out purposive or teleological explanation; but they do not require it. Berkeleian explanations do not entail purposive explanation; but they suggest it. And Anaxagoras for one is generally thought to have fallen in with the suggestion: the issue is celebrated, and it warrants rehearsal at some length.

Socrates bought a second-hand copy of Anaxagoras' book in high hopes; here was a thinker who, unlike his materialistic predecessors, was wise and bold enough to give intelligence a part in the formation of the world. But:

> Proceeding and reading on, I see the man making no use of mind, nor indicating any explanations for the ordering of things, but making explanations of airs and aethers and waters and many other such absurdities (**312:** *Phaedo* 98 B=**59 A 47**).

Aristotle makes the same point more pregnantly:

> Anaxagoras uses mind as a theatrical device *(mêchanê)* for his cosmogony; and whenever he is puzzled over the explanation of why something is from necessity, he wheels it in; but in the case of other happenings he makes anything the explanation rather than mind (**313:** *Met* 985a18–21=**A 47**).

And the point is constantly repeated (e.g., Eudemus, fr. 53W=**A 47;** Clement, **A 57**). 'Mind,' the objection runs, 'is not systematically applied: it is used to explain the initial cosmic whirl; and it is later used to account for one or two otherwise inexplicable interactions in the course of nature; but apart from that, it has no function: mind is not invoked to account for the circulation of the blood or the shape of an oak tree, for the functioning of the nitrogen cycle or the design of a spider's web.'

The point, we might hastily judge, is right in substance but wrong in evaluation. On the one hand, **301** says that mind moves and controls some but not all things: it sets the whirl in motion; but after that, the revolution itself, by its own unmeasurable speed and force **(B 9),** suffices to bring things abput. Mind is the cosmic starter, initiating action by its own intrinsic powers; but once it has imparted motion to the cosmic masses, natural events proceed in a purely mechanical way. That is Anaxagoras' view; and Socrates and the rest represent him correctly. On the other hand, the Socratic criticism is misplaced: the vast majority of cosmic happenings do not require an explanation in

terms of mind; most natural events are in fact explicable in a mechanical fashion, and a reference to mind would be an absurd solecism in a treatise on chemistry or meteorology.

Anaxagoras was right, Socrates and Aristotle wrong; for Anaxagoras wished to banish teleology from science, and they desired to recall it from its exile. As Simplicius saw, Anaxagoras advocates 'the method proper to natural science' (*in Phys* 177.9).

That flattering portrait of Anaxagoras may be embellished. According to Aristotle,

> Anaxagoras says that man is the cleverest of animals because he has hands; but it is reasonable to hold that he acquired hands because he is the cleverest; for hands are a tool, and nature (like a clever man) always distributes each thing to those who are capable of using it (**314:** *PA* 687a7–12=**A 102**).

How pleasantly Anaxagoras' assertion contrasts with Aristotle's superstitious speculation. An anecdote in Plutarch presses the point home:

> It is said that the head of a single-horned ram was once brought from the fields to Pericles, and that Lampon the seer, when he saw that the horn grew strong and firm from the middle of the forehead, said that of the two power groups in the state—that of Thucydides and that of Pericles—control would come to the one to whom the sign was brought. But Anaxagoras had the skull split open and showed that the brain had not filled out its position, but had drawn together to a point, like an egg, at the very place in the cavity where the root of the horn began **(315: A 16)**.

Anaxagoras' explanation is wholly naturalistic; Lampon indulges in a childish superstition. And our admiration for Anaxagoras is scarcely tempered by the fact that Lampon's prediction turned out true.

But that admiration is perhaps hasty: after all, Anaxagoras does not 'banish teleology from science', he merely limits its scope. And those who dislike teleology will be distressed by a cosmogony which rests firmly on teleological principles. Yet perhaps we can alleviate their pain? At all events, several scholars have heroically urged that Anaxagoras gave no teleological explanations at all.[23]

Aristotle's teleology is, in a sense, impersonal: he explains the form and operation of an animal's organs in terms of the function of those organs, not in terms of the purposes of an Author of Nature. Why do cows have a fourth stomach? In order to digest their cud. Why do men blink? In order to moisten their eyes and sharpen their vision. Good digestion is not the purposed end of the cow; for cows do not deliberate. Moist eyes are not my purpose in blinking; for my blinking is a reflex act. Nor is bovine digestion or human sharp-sightedness the goal of some superhuman or superbovine artificer. Teleology, thus construed, posits a *telos* or end; but it does not imply that the *telos* is the goal of any purposive act.

If we look for Aristotelian teleology in Anaxagoras we shall not find it: as far as we know, Anaxagoras did not attempt to explain anything by way of impersonal ends. (For

my part, I put that down to Anaxagoras' credit; but the question is controversial, and I have no space to broach it.) Yet there are personal as well as impersonal ends, and a reference to purpose, aim or design will often figure in our explanations: why do men take exercise? In order to keep fit. Why do men learn Greek? In order to raise themselves above the vulgar herd and reach positions of considerable emolument.

Roughly speaking, an impersonal teleological explanation will be expressed in the form:

(1) *a* is *F* because being *F* leads to being *G* and it is in *a*'s interest to be *G*.

A personal teleological explanation will be expressed by:

(2) *a* is *F* because *b* wants *a* to be *G* and believes that being *F* leads to being *G*.

Now proposition (2) is a Berkeleian explanation; and since Anaxagoras was a Berkeleian, he was thereby given to personal teleological explanation.

Personal teleology is not normally a feature of natural science; yet it will enter the world of nature if natural phenomena are viewed as the operations of an intelligent artificer. Anaxagoras took just such a view; and it is merely perverse to deny that he was a teleologist in that perfectly intelligible sense. Simplicius puts it clearly:

> He seemed to say that all things were together and at rest for an unlimited time, and that the cosmogonical mind, wanting to separate out the kinds which he calls homoiomeries, created motion in them **(316: A 45)**.

Mind 'wanted *(boulêtheis)*' to make a world: the existence of the cosmos is explicable as the aim of an intelligent actor. If the word 'want' does not occur in Anaxagoras' fragments, the verbs 'know' and 'order' do: mind ordered or arranged things, and it knew what was to be. There is, surely, no doubt about the teleological import of all this; and indeed, the very enterprise of setting up mind as a cosmic force is hardly to be detached from a teleological view of cosmic history.

'And what was to be, and what was and is not now, and what is now and what will be—all these mind ordered' (**301,** [xi]). The difficulty with Anaxagoras' view is now the very opposite of the difficulty Socrates discovered: Socrates objected that mind did too little work—the danger is rather that mind does too much. What room is there in Anaxagorean physics for natural causes? If mind arranges everything, what can the 'revolution' do?

Anaxagoras distinguishes between ordering *(diakosmein)* and controlling *(kratein):* mind orders everything but controls only some things. The following explanation suggests itself. Take any causal chain, *E*1, *E*2,…, *En*, in which each E_i accounts for its immediate successor. We may say, using a convenient Aristotelian distinction, that E_i is the *proximate* cause of E_i+1, and that *E*1 is the *ultimate* cause of each subsequent E_i. According to Anaxagoras, *E*1 will always be an act of mind, and it will be expressible by the formula 'Mind arranges that *E*2 shall occur'. Now since all events hinge on an initial arrangement by mind, we may say that mind arranges everything; for *E*1 is the ultimate cause of each E_i. But only *E*2 is immediately linked to *E*1; only for *E*2 is an act of mind a proximate cause. And if we say that mind controls E_i only if mind is a proximate cause of E_i, then mind will not control everything. Anaxagoras' teleology is now reconciled with the possibility of naturalistic explanations: by attending to

Anaxagoras' distinct terms, 'order' and 'control', we can give mind overall responsibility for the world while leaving room for natural necessity.

There is a vulgar objection to that sort of theory: 'The *real* cause of *En* is *E*1; *En*−1 is only a seeming or spurious cause. For if *E*1 causes *E*2, *E*2 *E*3,…and *En*−1 *En*, then it is *E*1 which is the true cause of *En*. Thus if *E*1 is an act of mind, then naturalistic explanation has no room; for the real cause of *everything* is *E*1, and *E*1 is supernaturalistic. 'That strangely persuasive line of argument involves an inconsistency and a false presupposition. The inconsistency is palpable; for the argument asserts both that *E*n–1 causes *En* and also that *En*−1 does not cause *En*. The false presupposition is that in any causal chain there is some one item which is 'the' cause (or the 'real' cause) of any E_i. In fact, as the distinction between ultimate and proximate causes shows, every E_i (for $i>2$) will have several causes; for each E_j (for $j<i$) is a cause of E_i. The noun 'cause' is the evil genius here: instead of talking of causes, we might well stick to the connective 'because': *En* occurs because *En*−1 occurs; *En*−1 occurs because *En*−2 occurs; hence *En* occurs because *En*–2 occurs. There is no temptation to make the absurd inference that, since *En* occurs because *En*−2 occurs, *En* does not occur because *E*n–1 occurs.

(f) *Chance and necessity*

According to the Atomists, necessity governs the world; yet I have already quoted two passages which ascribe great influence to chance. Chance and necessity are surely polar opposites: is not the atomist account of explanation simply contradictory? A similar question arises over Empedocles; and I shall return to the Atomists after running quickly through the Empedoclean material.

At first glance, Empedocles' explanatory mechanism seems simple enough: in addition to the four 'roots' or elements that constitute the world, there are two forces which control their congresses and separations. These forces are denominated Love *(Philia)* and Strife *(Neikos):*

> And dread Strife apart from them [sc. the roots], balanced in all directions,
>
> and Love amongst them, equal in length and breadth (**317:31 B 17**.19–20).

Love accounts for elemental conjunction, Strife for elemental separation:

> Now by Love all coming together into one, now again each carried apart by the enmity of Strife (**194: B 17,** 7–8).

How are Love and Strife to be conceived? Aristotle, for one, thought that Empedocles' conception of them was hopelessly muddled (e.g., *Met* 1075b2–4; cf. Simplicius, **A 28**).

First, Love is frequently treated as an internal moving cause:

> [Love] is thought innate in human limbs, by which men think loving thoughts and accomplish fitting deeds, calling her Joy by name and Aphrodite (**318: B 17**.22–4).

Nor in human limbs alone; for the elements come together in Love, and desire one another (**319: B 21**.8)

Elements, like animals, unite because they are in love.[24]

Second, Love and Strife are sometimes treated as material constituents of natural bodies. The treatment is implicit in **317,** where Strife is 'apart from' the roots and Love 'amongst' them; and it is plain in **B 109** which enumerates the four roots and the two forces without indicating any ontological distinction between them. Thus:

> [Love] gathers together and sets together and holds together [the elements], thickening them by consortings and friendships As when rennet pegs and binds white milk **(320: B 33)**.

In its material form, Love functions as a sort of catalyst: earth, air, fire and water, taken together, will not of themselves unite; pour in a little Love and the reaction will take place.

Most frequently Love is an external force, a divine or semi-divine agent.[25] Thus:

> The divine Aphrodite fitted together the tireless eyes (**321: B 86;** cf. **B73, B87**);

and in general:

> They first grew together under the hands of Cypris [=Love] **(322: B95)**.

Strife too is an agent; for at the start of the cosmogony

> Strife still held [some things] aloft (**323: B 35**.9).

As an internal force, Love wears a Newtonian aspect, being the counterpart of attraction or gravitation; as a material constituent, Love appears in a chemical role; and in its third form, Love is an agent, comparable to Anaxagoras' mind. The ancient commentators, having broken Empedocles' single pair of causes into three disparate fragments, do not desist from their attack; for beside Love and Strife they find three more 'causes' in Empedocles' science.

First, the elements themselves are sometimes endowed with powers of their own.

> [Plants] root downwards because the earth [in them] naturally moves thus, and they grow upwards because the same goes for the fire [in them] (**324:** Aristotle, *An* 415b29–30=**A 70**).

The same point is made anecdotally:

> The natural philosophers actually arrange the whole of nature by taking as a principle the thesis that like goes to like; that is why Empedocles said that the bitch sits on the tiles because she contains a great deal of like matter (**325:** EE1235a10–12=**A20a**).[26]

And we might cite **B 62**.6:

> Fire sent them up, longing to come to its like **(326),**

or **B 90:**

> Thus sweet seized on sweet, bitter jumped on bitter, sharp climbed on sharp, and (?) salty rode upon salty (?) **(327)**.
>
> Second, there is necessity: according to Aristotle,
>
> Empedocles would seem to say that the alternate domination and moving of Love and Strife belong to things from necessity (**328:** *Pays* 252a7–9=**A 38**).

Plutarch reports that Empedocles gives the name of necessity to 'Love and Strife together' **(A 45);** and many more *testimonia* give necessity a niche in the Empedoclean system.[27] From the fragments there is only one reference:

> There is an oracle of necessity, an old edict of the gods, eternal, bound by broad oaths (**329: B 115**.1–2).[28]
>
> Third, there is chance. Aristotle complains that his predecessors

said nothing about chance:

> That is absurd, whether they did not believe it to exist or supposed it to exist and ignored it—and that though they sometimes use it, as Empedocles says that the air is not always separated off upwards, but as it may happen. (At any rate, he says in his cosmogony that: 'running, it met up then in this way, but often in other ways [=**B 53**]'), and he says that the parts of animals mostly come about by chance(**330:** *Phys* 196a19–24).

Commenting on this passage Simplicius quotes six further verses to show the power of chance in Empedoclean physics, and he observes that 'you might find many similar passages from Empedocles' *Physics* to set beside these' (*ad* **B 85**).[29]

We have an *embarras de richesse*. As explanatory powers Empedocles offers us: (a) Love and Strife as physical forces; (b) Love and Strife as catalysts; (c) Love and Strife as semi-divine agents; (d) the natural strivings of stuffs; (e) necessity; and (f) chance. Can we discover a seemly frugality behind this seeming prodigality?

First, (d) and (e) are not in conflict; indeed, it is easy to take (d) as a specification of (e): events occur by natural necessity, and in particular by virtue of the natural powers

of the world's constituent stuffs. Nor, second, are (d) and (a) at odds; for, again, (a) is a specification of (d); the natural powers of stuffs are attractions and repulsions. In a syntactically difficult couplet Empedocles observes, it seems, that:

> The things that are more suitable for mixture are likened to and loved by one another by Aphrodite (**331: B 22**.4–5).

The lines suggest that the natural striving of like for like is explicable by the action of Love. Again **327** employs sexual metaphors to account for the conjunction of like stuffs: like goes to like because like loves like. Thus (d) does indeed reduce to (a).

Third, we may ask how (a) is to be explained: what is it to act 'from Love'? An answer is given by (c): Love is one of the material constituents of any substance, *a;* and for *a* to move 'from Love' is simply for *a*'s motion to be caused by the catalytic action of its connate portion of Love. Moreover, once Love is thus materialized, it is readily deified: before cosmogony has intermingled the roots, Love was present in a great and separate mass; it will not then have worked as a catalyst, but rather as an agent or an artificer goddess. Thus (a), (c), (d) and (e) are reconciled; and (b) is given a natural and reasonable explanation.

The possibility of such a reconciliation explains how Empedocles could offer so many different explanatory notions without blush or apology: the notions are, to a large degree, different ways of expressing one idea. But the reconciliation will not quite do: there is potential conflict between (b) and (e). It is indicated in **B 116,** which says that *Charis* (Grace or Love) 'hates unbearable necessity'; and Aristotle finds it in a second fragment:

> And at the same time he gives no explanation of the change itself [i.e. of the change from the period of Love to the period of Strife] except to say that it occurs thus by nature:
>
> > But when Strife grew great in the limbs, and rose to office as the time was accomplished which had been fixed in alternation for them by a broad oath **[B30]**
>
> —that it is necessary for the change to occur; but he gives no explanation for the necessity (**332:** *Met* 1000b12–17).

The operative times of Love and Strife are determined by a broad oath, and hence (cf. **329**) by necessity: that explains why Love hates unbearable necessity; for necessity fixes the range of Love's affairs. The doxographers, for what it is worth, imply that necessity has a status superordinate to Love and Strife (cf. Aëtius, **A 32, A 45**).[30]

Anaxagoras gives a controlling position in the universe to agent-like causation, and he subordinates natural necessity to the arrangements of mind; the Atomists give universal power to natural necessity and profess to find no domain of agency in the world. Empedocles, it seems, was not so clear: on the one hand, Love and Strife are the supreme causes, and they work as agents; on the other hand, some bond of necessity controls everything, even the workings of Love and Strife.

I have not yet mentioned (f), chance; and some will find in (f) the deepest flaw in Empedocles' explanatory system. The same flaw, as I said at the beginning of this section, is found in the Atomists.

First, let us consider more closely the evidence that chance played a part in Empedoclean and Abderite physics. Of the passages which Simplicius assembles to prove the prevalence of Chance in Empedocles, four contain the verb *'sunkurein'* and two *'tunchanein':* Simplicius evidently interpreted the words as 'chance across' and 'happen to occur'; but both verbs are standardly used in the sense of 'come about', 'actually happen', and they do not by themselves point to chance. But chance cannot be eliminated from Empedocles' system by cunning translation. **B 53,** which Aristotle quotes in **330,** countenances infrequent conjunction, or coincidence.[31] And one fragment appeals explicitly to Dame Fortune:[32]

> Thus by the will of chance everything possesses thought **(333: B 103)**.

For the Atomists we possess no first-hand texts; but the doxography is rich and unanimous:

> From them [sc. the atoms] the earth and the universe are made …by a certain chance concurrence (**334:** Cicero, **67 A 11**).[33]
>
> He sets up chance as mistress and queen of universal and divine things and says that everything happens in accordance with it (335: Dionysius, *ad* **68 B 118**).
>
> Democritus too, in the passage where he says that a whirl of every sort of form was separated off from the whole [cf. **B 167**] (he does not say how or by what cause), seems to generate it spontaneously and by chance (**336:** Simplicius, **68 A 67**).

In his discussion of chance in the *Physics* Aristotle reports the following theories:

> Some…say that nothing comes about by chance, but that there is some determinate explanation for everything which we say comes about spontaneously or by chance (**337:**195b36–196a3= **68 A 68**).
>
> There are some who make the spontaneous the cause both of this world and of all the universes; for they say that it is spontaneously that the whirl comes about, i.e. the dissociative motion which sets everything into its present order…saying that animals and plants neither exist nor come to be by chance, but that either nature or mind or something else of that sort is their cause…but that the heavens and the most divine of visible things come to be spontaneously and that there is no cause for them of the sort there is for animals and plants (**338:**196a24–35=**68 A 69**).

Simplicius identifies the second group of men as the Atomists **(68 A 69);** and on the authority of Eudemus he connects the first view too with Democritus:

> For even if in his cosmogony he seems to have used chance, yet in particulars he says that chance is the cause of nothing, and refers them to other causes (**339:68 A 68**).

The identification in the second passage is certain (though the reference to 'mind or something else of that sort' indicates that Aristotle does not have the Atomists uniquely in his thoughts); and the identification in the first passage is corroborated by Diogenes of Oenoanda, who criticizes Democritus for 'saying that the atoms have no free *(eleuthera)* motion' but that 'everything moves necessarily *(katênankasmenôs)*' (**68 A 50**).

> At first sight those passages seem to import a horrible muddle. As we have already seen, Democritus is committed to:

(1) Everything happens by necessity.
Eudemus and Diogenes now give him:
(2) Nothing happens by chance.
But the doxography offers:
(3) Everything happens by chance,
and Simplicius produces:
(4) Some things happen by chance and others are caused.
Surely (1)–(4) are flatly inconsistent, and the Atomists foolishly confused?
The confusion is, I think, purely verbal.[34] Plato helps to clear it up:

> They say that fire and water, and earth and air, all exist by nature and chance, and none of them by art *(technêi)*, and that as to the bodies that come next in order—earth, and sun, and moon, and stars—they have been created by means of these absolutely inanimate *(apsucba)* existences. The elements are severally moved by chance and some inherent force according to certain affinities among them: of hot with cold, or of dry with moist, or of soft with hard, and according to all the other things which are mixed by the mixture of opposites in accordance with chance from necessity *(kata tuchên ex anankês)*. In this way and in this manner the whole universe was created, and everything in the universe, and animals too and all plants; and all the seasons come from these elements, not because of a mind, they say, nor because of some god or by art, but, as we said, by nature and chance only (**340:** *Laws* 889 BC trans. Jowett=**31 A 48**).[35]

There are obscurities of detail in this paragraph; but one moral emerges quite plainly from it: '*E* happens by chance (*tuchêi*)' and '*E* happens of necessity *(ex anankês)*' are not, as we might incautiously think, incompatible. Plato plainly ascribes to his opponents the view that everything happens *both* by nature or necessity *and* by chance; and the sense he gives to 'by chance' indicates how he can do so. '*E* happens by chance' means '*E* happens and *E* was not brought about' by design'; no mind, no god, no art planned or executed the event. That is a normal sense of 'chance' in English, and

evidently it was a normal sense of '*tuchê*' in Greek: in that sense, every event in a wholly deterministic world might occur by chance.

Empedoles' bow to Dame Fortune in **333** is thus perfectly compatible with his reverence for stern necessity (though it is not compatible with a strictly agent-like interpretation of Love and Strife); and the Atomists' proposition (3), which simply reflects their denial of *pronoia* (Aëtius, **67 A 22**), sits in happy concord with (1).

But 'by chance' does not only denote the absence of purpose: it may also denote the absence of causality or natural necessity. '*E* happened by chance' may mean not only 'E happened and was not purposed' but also '*E* happened and was not necessitated'. And in that sense, (2) follows at once from (1), and is perfectly compatible with (3). Aristotle knows that in this sense chance and necessity are oppugnant; and that is why he objects to Empedocles' use of chance. His own analysis of chance in *Physics* II 5–7 is intricate; but it is worth pulling out one relevant strand of it here. Chance is standardly construed by Aristotle as coincidence: if E occurs by chance, then *E* is a conjunctive event, described by a formula of the form '*Fa* and *Ga*'; and *E* occurs by chance if and only if neither all nor most *Fs* are *G*. Chance contrasts with regularity: a chance event is a rare event, a freak or extraordinary occurrence. Whether or not that is a decent account of chance I do not ask; I mention it only to draw attention to one obvious feature: a fully deterministic world may, on this analysis, be riddled with chance events. If *E*1 is necessitated and *E*2 is necessitated, then the conjunctive event *E*1+*E*2 is necessitated; yet that event may be a coincidence, *a*'s being *F* and *a*'s being *G* may be necessary, even if few *Fs* are *G*.

Thesis (4) remains to be accounted for. According to Aristotle, 'some think that chance is a cause, but one unclear to human intelligence, being something divine and somewhat demonic' (*Phys* 196b5=**68 A 70**): when we say '*E* occurs by chance' we may mean only 'We cannot tell why *E* occurs' That use is, I think, found in English; and I assume that Aristotle speaks with authority for Greek. If we apply it to (4), then (4) is rendered consistent both with (2) and with (3); and it becomes an honest confession of the weakness of the human mind—a weakness which, as we shall see, Democritus was quick to notice and to emphasize.

For the sake of clarity, then, we may rewrite (1)-(4) as follows:

(1*) All states and events are causally determined.
(2*) No states or events lack a necessitating cause.
(3*) No states or events are the results of purposive agency.
(4*) Of some states and events the causes are accessible, of others they are not.

Together, (1*)–(4*) form a consistent theory of the possibility of explaining natural phenomena. And they form a popular and a plausible theory: here, too, the Abderites prove themselves hard-headed and influential philosophers of science.