

EMPEDOCLES' SUN

Few things can be more confusing, or confused, than the ancient reports about Empedocles' astronomy. Attempts in the modern literature at resolving the difficulties invariably either add to the confusion, or end by urging the need to 'acknowledge the insufficiency of our data and suspend judgment'.¹ In fact, as we will see, it is possible not only to reconstruct Empedocles' own ideas but also to retrace the history of their subsequent misunderstanding.

The first text we need to look at comes from Aëtius.

Ἐμπεδοκλῆς δύο ἡλίους· τὸν μὲν ἀρχέτυπον, πῦρ ὃν ἐν τῷ ἐτέρῳ ἡμισφαίρει τοῦ κόσμου, πεπληρωκὸς τὸ ἡμισφαίριον, αἰεὶ κατ' ἀντικρὺ τῇ ἀνταυγείᾳ ἑαυτοῦ τεταγμένον· τὸν δὲ φαινόμενον, ἀνταύγειαν ἐν τῷ ἐτέρῳ ἡμισφαίρει τῷ τοῦ ἀέρος τοῦ θερμομιγροῦς πεπληρωμένῳ, ἀπὸ κυκλοτεροῦς τῆς γῆς κατ' ἀνάκλασιν γιγνομένην εἰς τὸν ἥλιον τὸν κρυσταλλοειδῆ, συμπεριελκομένην δὲ τῇ κινήσει τοῦ πυρίνου. ὥς δὲ βραχέως εἰρησθαι, ἀνταύγειαν εἶναι τοῦ περὶ τὴν γῆν πυρὸς τὸν ἥλιον.

Empedocles says there are two suns. First there is the archetypal (*archetypos*) sun. This is fire in one hemisphere of the cosmos; it fills the hemisphere and is always positioned opposite its own reflection (*antaugeia*). Second there is the visible sun. This is a reflection (*antaugeia*) in the other hemisphere: the hemisphere that consists of air mixed with heat. The reflection is produced as a result of light bouncing off the circular earth onto the crystalline sun while it – the reflection – is dragged round with the motion of the fiery hemisphere. In short, the sun is a reflection (*antaugeia*) of the fire around the earth.²

Leaving aside the word for 'reflection', *antaugeia* – a word which, as we will soon see, goes back to Empedocles himself – here we find ideas and terminology that are noticeably late.³ But, this observation apart, it is somewhat of an understatement to describe the passage as a whole as 'unclear'.⁴ The passage is not only unclear: it is also nonsensical. To begin with, it makes nonsense because it contradicts itself. First of all, the 'fiery hemisphere' – the 'archetypal' or 'crystalline' sun – is clearly described as always situated opposite the visible sun; but then the visible sun is explained as a product of reflection from the earth back onto the fiery hemisphere. Because the earth for Empedocles was located at the centre of the universe, and so at the mid-point between the two hemispheres, this reflection from the earth onto the fiery hemisphere could only possibly occur if the visible sun was in the *same* hemisphere as the 'archetypal' sun – not in the opposite one.⁵ And the text also makes nonsense for

¹ C. E. Millerd, *On the Interpretation of Empedocles* (Chicago, 1908), 67.

² Aëtius 2.20.13 = Emped. A56a Diels-Kranz. Apart from being unnecessary and making the passage even more nonsensical, Bernardakis' supplement *κυκλοτεροῦς τῆς <αὐ>γῆς* is also contra-indicated by the final *περὶ τὴν γῆν*.

³ On the term 'archetypal', *archetypos*, cf. H.-R. Schwyzer in J. Mansfeld and L. M. de Rijk (edd.), *Kephalaion: Studies in Greek Philosophy and its Continuation Offered to Prof. de Vogel* (Assen, 1975), 217–20, and for the idea in later Greek philosophy of two suns – one archetypal, the other its visible copy – cf. e.g. H. Lewy, *Chaldaean Oracles and Theurgy* (2nd rev. edn, Paris, 1978), 151–2 with P. Boyancé's comments, *Études sur le Songe de Scipion* (Limoges, 1936), 73–4: the indebtedness to popular Platonism is obvious. For the idea of two celestial hemispheres rotating around the earth see below, with the refs in n. 14.

⁴ Diels-Kranz, ad loc. (*Die Fragmente der Vorsokratiker*⁶ [Berlin, 1951], i. 293.32, apparatus).

⁵ Even without the statements of later writers there would be no reason to doubt that Empedocles placed his earth at the centre of the cosmos; cf. Aristotle, *De caelo* 295a13–34, Philo, *De providentia* 86.28–30 Awgerian, W. K. C. Guthrie, *A History of Greek Philosophy* ii (Cambridge, 1965), 198, W. Burkert, *Lore and Science in Ancient Pythagoreanism* (Cambridge,

another reason. If we follow its logic in presenting the fiery hemisphere as always located opposite the visible sun, we are bound to conclude that this fiery hemisphere or 'archetypal' sun is for us the hemisphere of night. The attempt has been made in recent times to defend this conclusion, as one that Empedocles himself could have maintained; but the attempt is easily refuted.⁶

Finally, there is yet another respect in which Aëtius' report is blatant nonsense. If we abandon its initial portrayal of the visible sun as always positioned in the hemisphere opposite the 'archetypal' sun, and focus instead on its second explanation of our familiar sun as the product of light bouncing off the earth onto the fiery hemisphere, we are again left with an impossible situation. This is, in fact, the aspect of Aëtius' report which modern scholars have tried most earnestly to make sense of. Guthrie, for example, appeals to 'the use of convex mirrors as burning-glasses', adds that

this is obviously what was in Empedocles' mind here. The whole bright fiery hemisphere shines on to the earth, where its light and fire are collected into a focus and then thrown back... to form the sun,

and ends his explanation of 'what was in Empedocles' mind' with the disclaimer, 'It is natural that Empedocles should have been neither accurate nor very clear about the laws governing the direction of reflexions'. But there are some elementary principles involved here, which we ourselves need to be quite clear about.⁷ In spite of Guthrie's assertion, no convex mirror has ever been used as a burning-glass. For the purposes of collecting and focusing light, what is needed is either a convex, transparent *lens* or a reflective mirror which is *concave* in shape. The problem here is that for Empedocles the earth was almost certainly spherical – or convex – in shape, and definitely did not have the concave or hollow profile needed if it was to receive light from a fiery hemisphere, gather it into a single focus and reflect it back onto the celestial sphere to create a concentrated area of light.⁸ And we need to bear in mind that awareness of this fundamental distinction between convexity and concavity is not at all dependent on some specialized, technical knowledge of which we can assume Empedocles might have been ignorant. On the contrary, awareness of it is indispensable from a practical point of view and was no doubt common in the ancient world. But what is more, it would be totally wrong to assume ignorance of it on the part of someone such as

MA, 1972), 305, S. S. Tigner, *Isis* 65 (1974), 433–47. The 'crystalline sun' mentioned by Aëtius is plainly a reference to the fiery hemisphere or 'archetypal' sun: compare the reports in Emped. A51, plus A1 §77.

⁶ Millerd (as in n. 1), 68, refuted by Guthrie, *History* ii. 194–5.
⁷ The quotation is from Guthrie, *History* ii. 193. Cf. the detailed – and, from the point of view of the most elementary optics, totally erroneous – diagrams in J. Bollack, *Empédocle* iii (Paris, 1969), 259, 270; and (with more hesitation) Burkert, op. cit., 343 with n. 27. Burkert's apparent claim – *ibid.* with n. 24 – that the word *anaklasis* (Aëtius 2.20.13; cf. Plut. *De Pyth. orac.* 400b, and also ps.-Plutarch, *Strom.* 10 *antanaklasis*) can refer to the phenomenon of refraction as well as the phenomenon of reflection is also incorrect. The word is always used of the bending back of light towards its source; in the famous passage of Theophrastus, *De igne* 73 = Gorgias B5 Diels-Kranz, ἡ ἀνάκλασις ἀπὸ τῶν λείων refers specifically to the reflection of light off smooth surfaces (as understood by H. Diels, *Kleine Schriften* [Darmstadt, 1969], 167–8; for τὰ λεία in the context of mirrors cf. e.g. Plato, *Tim.* 46a). M. R. Wright, *Empedocles* (New Haven, 1981), 201, like Guthrie, confuses the phenomena of 'convex refraction', which focuses light, and convex reflection, which dissipates it. Plutarch, loc. cit. = Emped. B44 is important as indicating that the reports about *anaklasis* in later writers derive in the first instance from Empedocles' own use of the word *antaugein*, and so providing independent confirmation that these reports ultimately refer to what was thought to be a phenomenon of reflection. See further below, with n. 34.

⁸ For the shape of Empedocles' earth cf. Millerd (as in n. 1), 63 n. 6; also Burkert, *Lore and Science* 305.

Empedocles, who was – speaking generally – a particularly ‘shrewd observer of natural phenomena’, and who also happens to have taken a very special interest in studying mirrors and the principles of reflection.⁹

In short, there are inaccuracies and confusions in Aëtius’ chaotic report which were evidently attributed to Empedocles by ancient as well as modern commentators, but which we are unjustified in supposing he could possibly have committed in fact. And there also happen to be other factors which demonstrate, quite independently, that this explanation by Aëtius of Empedocles’ sun as nothing but an intensified reflection of light back onto the crystalline vault is no more than a misguided and unenlightened guess. As we will soon see, one fragment of Empedocles’ poetry (B44) portrays the sun as throwing its beams of light at the celestial vault, which hardly makes sense if it is nothing but a bright spot on the vault itself; while Empedocles’ own description, also preserved in his own words, of the sun as ‘roving around’ the heavens (*μέγαν οὐρανὸν ἀμφιπολεύει*) plainly implies that for him the sun was a free-moving body in its own right and not just some bright spot on the heavens.¹⁰ And, ironically, Aëtius confirms this implication himself when elsewhere he portrays Empedocles’ sun as a distinct cosmic body following its own orbit just *inside* the surrounding celestial vault.¹¹ The chief value of the Aëtius passage we have been considering appears to lie in its ability to clarify what Empedocles himself did not say, rather than what he did.

From these ‘explanations’ in Aëtius of Empedocles’ theory of sunlight – mutually incompatible, demonstrably nonsensical, and contradicting Empedocles’ own words – we need to turn to another report, this time from pseudo-Plutarch.

ἐκ πρώτης... τῆς τῶν στοιχείων κράσεως ἀποκριθέντα τὸν ἀέρα περιχυθῆναι κύκλῳ· μετὰ δὲ τὸν ἀέρα τὸ πῦρ ἐκδραμὸν καὶ οὐκ ἔχον ἑτέραν χώραν ἄνω ἐκτρέχειν ὑπὸ τοῦ περὶ τὸν ἀέρα πάγου. εἶναι δὲ κύκλῳ περὶ τὴν γῆν φερόμενα δύο ἡμισφαίρια τὸ μὲν καθόλου πυρός, τὸ δὲ μικτὸν ἐξ ἀέρος καὶ ὀλίγου πυρός, ὅπερ οἶεται τὴν νύκτα εἶναι. τὴν δὲ ἀρχὴν τῆς κινήσεως συμβῆναι ἀπὸ τοῦ τετυχηκέναι κατὰ τὸν ἀθροισμὸν ἐπιβρίσαντος τοῦ πυρός.

Air was separated off from the primal mixture of the elements, and spread round in a circle. Next, after the air, fire escaped and – finding nowhere else to go – shot up underneath the solid vault surrounding the air. There are two hemispheres moving in a circle around the earth. One consists entirely of fire, the other of a mixture of air with a little fire; and this second hemisphere Empedocles reckons to be night. The movement started as a result of what became of the accumulation once the fire began weighing downwards.¹²

The first point to be noted is that pseudo-Plutarch’s mention of one hemisphere ‘consisting entirely of fire’ and of another consisting ‘of a mixture of air with a little fire’ plainly corresponds to Aëtius’ mention of one hemisphere ‘filled’ with fire and another ‘consisting of air mixed with heat’. But, this basic correspondence apart, here again we immediately run into problems. To begin with, pseudo-Plutarch states specifically that the hemisphere consisting of ‘air with a little fire’ is the hemisphere of night – directly contradicting the first part of Aëtius’ account, which implies that

⁹ Aëtius 4.14.1 = Emped. A88. In particular, knowledge of the use of concave mirrors for focusing sunlight (cf. e.g. Pliny, *Hist. nat.* 2.111.239) will have been widespread precisely because in practical life it was so useful. The quotation is from D. R. Dicks, *Early Greek Astronomy* (London, 1970), 55.

¹⁰ B41. For the language cf. *Iliad* 8.68, Plato, *Phaedrus* 246a, *Timaeus* 41a, Porphyry in Eusebius, *Praep. evang.* 3.12, and Lewy (as in n. 3), 49 with n. 156. For the masculine subject ὁ – i.e. Sun as opposed to Moon – compare B40, 42.1, 47 and Wright, *Empedocles* 200.

¹¹ 2.23.3 = Emped. A58b; Guthrie, *History* ii. 196.

¹² *Strom.* 10 = Emped. A30. The construction of the final clause is difficult: no doubt because pseudo-Plutarch had trouble understanding his source. But the general sense is clear, and Diels’ emendation of κατὰ τὸν ἀθροισμὸν in the final clause to κατὰ τι τὸν ἀθροισμὸν serves (as noted by Bollack, *Empédocle* iii. 218) no function whatever.

the hemisphere consisting of air plus a little fire is the one that always contains our visible sun. Secondly, thanks to Empedocles' own words as preserved for us by Plutarch, we know that he himself explained night not as some celestial hemisphere but, instead, as the direct result of the earth interposing itself between the observer and the rays of the sun; he was clearly just as familiar with this – to us correct – explanation of night as he was aware of the fact that solar eclipses are caused by the moon interposing itself between the sun and the observer on earth.¹³ This is not to say the two explanations are strictly incompatible; but the fact remains that pseudo-Plutarch's notion of a 'hemisphere of night' is suspiciously schematic and crude in comparison with Empedocles' own more dynamic explanation. Bearing this point in mind, it is rather obviously significant that the notion here of a hemisphere of night and a hemisphere of day rotating around the central earth happens to have been an astronomical commonplace very much at home in the intellectual world of late antiquity.¹⁴

There are other, even more serious discrepancies between Empedocles' own words and what pseudo-Plutarch tries to make him say. For instance, it is impossible to reconcile pseudo-Plutarch's implicit notion of the sun as just one point of light in a vast, blazing hemisphere with Empedocles' own awareness that when the moon comes between the earth and the sun – that is, our familiar sun – during a solar eclipse it plunges the earth into total darkness.¹⁵ And finally, all other considerations apart, there is the glaring absurdity of pseudo-Plutarch's 'hemisphere of day'. For Empedocles himself any such hemisphere would have to consist of some fire – which is the element that the sun is composed of – plus a great amount of air.¹⁶ Instead pseudo-Plutarch equates it by implication with the hemisphere 'consisting entirely of fire', which it demonstrably is not: if it was, every day we would be burned alive.

Once again, what we have here is not Empedocles trying to make sense of the world. On the contrary, it is a mass of absurdities and contradictions of the first degree. If there is anything in it that goes back to Empedocles, it has been grossly travestied and distorted.

What are we to make of this string of nonsensicalities, contradictions and absurdities? There can be little doubt as to the direction in which we have to look for an initial answer to this question: back to the ultimate source of both Aëtius and pseudo-Plutarch – Theophrastus.

Fortunately, in helping us determine what is what in this case of Empedocles' solar theory we are able to refer to another case that closely parallels it. This is the 'theory of three suns' which is attributed to Philolaus by Aëtius immediately after his section on Empedocles' two suns. Here Philolaus is credited with the idea that there are 'in a certain sense two suns' (τρόπον τινὰ διττοὺς ἡλίους γίνεσθαι) – 'unless, that is, someone were to say' that Philolaus believed in the existence of a 'third sun' as well

¹³ Night: Plutarch, *Quaest. Plat.* 1006e–f = Emped. B48 (for φαέεσσι cf. Kranz, ad loc., and Hesiod, fr. 252.4 Merkelbach-West: as with B41 [above, n. 10], the reference is plainly to our familiar sun). Solar eclipses: B42.

¹⁴ A. Bouché-Leclercq, *L'Astrologie grecque* (Paris, 1899), 155–7, 276–96; F. Cumont, *Lux perpetua* (Paris, 1949), 193; U. Weisser, *Das 'Buch über das Geheimnis der Schöpfung' von Pseudo-Apollonios von Tyana* (Berlin, 1980), 193 n. 119.

¹⁵ The discrepancy is well noted by G. Kafka, *Philologus* 78 (1923), 214. Cf. Emped. A59, B42.

¹⁶ For Empedocles' sun as made of fire cf. B21.3–4 (Wright, *Empedocles* 177), B22.2, B27.1–2, B41 with Macrobius' comments, *Sat.* 1.17.46, B71.2, B115.9–11; Diogenes Laertius 8.77 = Emped. A1, Aëtius 2.6.3 = A49b, and Philo, *De providentia* 86.18–23 Awgerian; Wright, *Empedocles* 23.

(εἰ μὴ τις καὶ τρίτον λέξει...). As Burnet and others have noted, in this passage Aëtius has plainly preserved some original comments on Philolaus' astronomy by Theophrastus: comments which strike a familiar and recognizable note with their hypercritical 'captiousness'.¹⁷ And as more recent research confirms, here indeed we have the characteristic touches of Theophrastus' own exegetical hand.¹⁸

In general, the principles adopted by Theophrastus in his criticism of the views held by Presocratics are no mystery. Using the methods he had learned from Aristotle, he felt no scruples about deliberately misunderstanding his predecessors. He forced them into corners so as to make them contradict themselves, and subtly twisted what they said so as to make their views sound illogical, nonsensical and absurd. In some cases it emerges that even the minor details of his 'reductions to absurdity' were derived by Theophrastus from Aristotle himself.¹⁹ The end result of this procedure was predictable. What the Greeks called *aporia* in the sense of questioning, of trying to understand what something meant, slipped into *aporia* in the sense of utter chaos and confusion. Those later writers whom Diels dubbed 'doxographers' – in the sense that they occupied themselves with 'writing up the opinions' of earlier philosophers – swallowed Theophrastus' barbed comments hook, line and sinker. What is ostensibly a tradition concerned with preserving the opinions of the Presocratics often turns out to be concerned with preserving the opinions of Theophrastus; and what started off with Theophrastus himself as facetious caricature and thinly-veiled ill-will ended up being converted, with commendable seriousness, into incomprehensible dogma.

In such a situation the prospect of being able to get back behind Theophrastus' smokescreens to Empedocles' own views would seem a hopeless one. But in fact this can be done quite simply. The crucial first step that needs to be taken in reconstructing Empedocles' theory about the sun on the basis of the information available is to stand back and view the evidence in its wider cosmological context. Then all the details – the clues provided by the 'doxographers', by other writers and by Empedocles himself – fall effortlessly into place.

At the start of our world the first element to be separated out from the primal chaos was air, or *aither*; it took up its place immediately under the solid boundary which Empedocles imagined as forming the outer limit for the cosmos as a whole. This was the beginning of 'heaven' as we know it. The next element to be separated out was

¹⁷ Aëtius 2.20.12 = Philolaus A19; cf. e.g. J. Burnet, *Early Greek Philosophy*⁴ (London, 1930), 298 n. 1, Guthrie, *History* ii. 194.

¹⁸ Cf. e.g. H. Baltussen, *Theophrastus on Theories of Perception* (Utrecht, 1993), 145 and n. 42 on Theophrastus' fondness for postulating a hypothetical *τις*, 'someone', in his refutations of Presocratic views (note in particular Theophr. *De sensibus* 12, 14, 23); *ibid.*, 146 and n. 48, 155 and n. 85 on his use of future verb forms (as *λέξει* here) in criticizing them; and *ibid.*, 151 on his forcing of the evidence in his 'eagerness to refute wherever and whenever possible'.

¹⁹ Cf. esp. J. B. McDiarmid, *HSCP* 61 (1953), 85–156 = D. J. Furley and R. E. Allen (edd.), *Studies in Presocratic Philosophy* i (London, 1970), 178–238; also G. M. Stratton's comments, *Theophrastus and the Greek Physiological Psychology before Aristotle* (London, 1917), 52–4, 60–2, Guthrie, *History* ii. 160 (Aristotle), 232–4, 438–9, 444–5, J. G. Stevenson, *JHS* 94 (1974), 138–43, and the note above. For Aristotle's predominant role in determining the methodology and interests of 'doxographic' tradition as known to us see J. Mansfeld in W. W. Fortenbaugh and D. Gutas (edd.), *Theophrastus: His Physical, Doxographical, and Scientific Writings* (New Brunswick, 1992), 63–111. The modern desire to whitewash both Aristotle and Theophrastus by playing down the element of wilful distortion in their treatment of the Presocratics (so e.g. E. Berti in G. Cambiano (ed.), *Storiografia e dossografia nella filosofia antica* [Turin, 1986], 101–25; Baltussen, *op. cit.*, 132–94, 252–3) is misplaced, and sidesteps the essential issues. Certainly their misrepresentations can be said to be justified within a framework of Aristotelian dialectic; but that says nothing about their effect – both direct and indirect – on our understanding of the Presocratics themselves.

fire. It was heavier than *aither*, but more volatile: it ran up under, then through the *aither*, and spread outwards in the heaven.²⁰ If an observer had been able to look up from what was to become the earth's surface, he would have seen what Aëtius and pseudo-Plutarch are obviously attempting to describe: not just a few dots of brilliant, fiery stars but an entire hemisphere filled – at least out at its periphery – with blazing fire.

Next, this fire at the periphery of the cosmos reacted with the *aither* – chemically, as one would now say. With its heat it glazed or 'crystallized' the *aither*, creating a crystalline heaven.²¹ But in certain areas small pockets of fire were apparently formed. 'Squeezed out' – or rejected, as we would say – by the surrounding *aither* and yet still forming a part of the solid, crystallized heaven, these pockets of fire became what we now perceive as the fixed stars.²²

Then something very interesting occurred: something that provides the key to understanding everything else Empedocles is supposed to have said about the formation of our sun. Although more volatile than *aither*, the fire at the upper boundary of the universe was not as light or refined. As a result the cosmos became top-heavy and the fire started to 'weigh downwards', *epibrithein*: a word used by pseudo-Plutarch which very probably goes back to Empedocles himself.²³ It was this imbalance which, as pseudo-Plutarch also mentions, produced the 'movement' that was to become responsible for causing our night and day; but he himself seems not to have realized how exactly it did so. The clue to understanding the whole process lies in his further statement that the downward movement of the fire was accompanied by an accumulation, *athroismos*, of the fire.²⁴ The obvious question which – for all its simplicity – modern scholars seem never to have asked, is what *became* of this accumulation of fire? In fact we have the answer right in front of our eyes. As Aëtius explains, at the primal separation of the elements 'the *aither* became the heaven and the fire became the sun'. Or again, according to the more specific account preserved for us in the Armenian version of Philo's *On Providence*, at this initial separation the *aither* became the all-surrounding heaven while the fire 'grew to become the rays of the sun' (*sa yaregakan čaragayt's ačec'aw*).²⁵ And to dispel any possible doubt about the sequence involved, we only have to note that Diogenes Laertius – using almost the identical word to pseudo-Plutarch – describes Empedocles' sun as, precisely, a vast 'accumulation' or *athroisma* of fire.²⁶ But last of all we have Empedocles' description in his own words of how the sun pursued – and still pursues – its circular course through the heavens 'after it had been gathered together' (*ἀλισθείς*); as Apollodorus points out in quoting this description, Empedocles is here portraying the sun as 'the product of accumulation of much fire' (*συναλισθέντος πολλοῦ πυρός*).²⁷

²⁰ ps.-Plutarch, *Strom.* 10 = Emped. A30; Philo, *De providentia* 86.18–23 Awgerian; Aëtius 2.6.3 = A49b. Cf. also the term *περιαπλωθῆναι*, Aëtius 5.26.4 = Emped. A70.

²¹ Emped. A30, A51 plus A1 §77. In describing this solidifying effect of fire Empedocles no doubt had in mind, among other things, the phenomenon of salt being crystallized by the heat of the sun: cf. Emped. B56, Philo, *De prov.* 86.38–41 Awgerian, J. Longrigg, *CQ* 15 (1965), 249–51, esp. 251 with n. 3.

²² A53, A54.

²³ A30; Guthrie, *History* ii. 186 n. 3, 187, Bollack, *Empédocle* iii. 219. Cf. e.g. *Iliad* 5.91, 7.343, *Odyssey* 24.344, and for the idea of an 'up' and 'down' to Empedocles' universe, D. O'Brien, *Empedocles' Cosmic Cycle* (Cambridge, 1969), 298–9.

²⁴ *Strom.* 10 = Emped. A30.

²⁵ Aëtius 2.6.3 = Emped. A40b; Philo, *De prov.* 86.21–3 Awgerian. For the text of the Armenian Philo passage, with translation and commentary, see my forthcoming *Ancient Philosophy, Mystery and Magic: Empedocles and Pythagorean Tradition* (Oxford, 1995), ch. 2.

²⁶ D.L. 8.77 = Emped. A1 ad fin.

²⁷ Emped. B41 with Apollodorus, *FGrH* 244 F95 §46 = Macrobius, *Sat.* 1.17.46; above, n. 10, 13.

In short, the result of the fire – which at first had spread through the heavens above – starting to fall downwards and mass together into one single body is *our own visible sun*; the ‘fiery hemisphere’ referred to by Aëtius and pseudo-Plutarch simply *no longer exists*. The sun now, as to begin with, pursues its course round the edge of the cosmos – but with one surprising and yet entirely logical difference. Originally, because the movement of the fire had only just begun and the momentum had not yet built up, the sun revolved relatively slowly. But, ever since, it has been rotating faster and faster, with the days on earth getting increasingly shorter.²⁸

The moon, for Empedocles, is not made of fire like the sun is. Instead, similar to the crystalline heaven itself, it consists of air solidified or glazed by the action of fire. The logic, here too, is impressive: Empedocles did not make the moon itself a body of fire because he knew that it borrowed its light from the sun and was bright just as a result of reflection.²⁹ And the moon was not the only celestial body reflective of sunlight. The original fiery hemisphere may have gone, transformed into the ball of our sun; and yet it left behind a crystalline, intensely reflective surface corresponding to our heaven. To understand the rationale behind Empedocles’ idea here of a crystalline firmament, we need to place it in the context of similar ideas current in the ancient world. Apart from the single case of Empedocles, the notion of a crystalline heaven, firmament or celestial sphere would appear to have been unknown to the ancient Greeks; it only became familiar in Europe during the Middle Ages, as a direct result of contact with the Arabs.³⁰ On the other hand, the idea that the heavens are made of crystal, quartz or some other brilliant semi-precious stone was extremely widespread in the ancient Near East. The main reason for its popularity was quite simple: it provided a vivid and impressive explanation for the dramatic effect produced every day in bright climates as the entire firmament, suddenly irradiated by the rising sun, catches the sunlight and takes on brilliant hues apparently all of its own.³¹ This familiar phenomenon is, not surprisingly, referred to by Empedocles

²⁸ A50b (cf. A58b); A75.

²⁹ A30, A60, B43, 45, 47.

³⁰ J. L. E. Dreyer, *History of the Planetary Systems from Thales to Kepler* (Cambridge, 1906), 288–9. Aëtius’ attribution of the idea of a crystalline heaven to Anaximenes (2.14.3 = DK 13 A14b: on the different sources see M. L. West, *Early Greek Philosophy and the Orient* [Oxford, 1971], 102–3) is almost certainly mistaken and due to confusion in the doxographic lemmata: cf. J. Longrigg, *CQ* 15 (1965), 249–50, G. S. Kirk, J. E. Raven and M. Schofield, *The Presocratic Philosophers*² (Cambridge, 1983), 152, 155–6.

³¹ Cf. esp. M. Boyce, *A History of Zoroastrianism* i² (Leiden, 1989), 132–3; A. Livingstone, *Mystical and Mythological Explanatory Works of Assyrian and Babylonian Scholars* (Oxford, 1986), 86, 88; and for transmission to the Arabs, A. M. Heinen, *Islamic Cosmology* (Beirut, 1982), 78–83, 86 and passim. See also R. Eisler, *Weltenmantel und Himmelszelt* (Munich, 1910), i. 94, P. Kingsley, *Journal of the Royal Asiatic Society*³ 2 (1992), 339–46. It will be noted that the later concept of the crystalline heaven as transparent, entirely invisible and merely to be inferred by the mind (cf. e.g. E. Moore, *Studies in Dante*, Third series² [Oxford, 1968], 12) is a pale reflection indeed of this original, intensely visual idea.

The presence of the idea of a crystalline heaven in the Book of Revelation needs to be understood by referring in the first instance not to the same idea in Empedocles (F. Boll, *Aus der Offenbarung Johannis* [Leipzig, 1914], 17 and n. 1), but to the fact that this notion of a crystalline or bejewelled heaven was so prevalent in the ancient Near East that it had already exerted a powerful influence on Jewish apocalyptic tradition (Kingsley, loc. cit.; cf. also C. Clemen, *NJb* 35 [1915], 27). As far as the Zoroastrian evidence is concerned, the testimony of Curtius Rufus regarding Darius III’s use of the symbol of a sun enclosed in crystal during his military campaigns (*imago solis crystallo inclusa*: *History of Alexander* 3.3.8) is particularly significant. It tends to confirm not only the familiarity of this sun-in-crystalline-heaven motif in Zoroastrianism by the 4th century B.C., but also the antiquity of the explanation of the Avestan word *asmān* – as meaning both ‘sky’ and ‘crystal’ – which is known to us from later sources (cf. H. W. Bailey, *Zoroastrian Problems in the Ninth-Century Books*² [Oxford, 1971], 120–48).

himself. In one line, also preserved for us by Plutarch, he describes how the sun 'shines straight at Olympus with fearless countenance' (*ἀνταυγεί πρὸς Ὀλυμπον ἀταρβήτοις προσώποις*): 'Olympus' here is undoubtedly Empedocles' term for the surrounding crystalline vault.³² As the line is quoted in isolation we are unable to reconstruct its broader context; but the simplicity of the idea still speaks for itself.

And yet its simplicity was not appreciated for long. The word that Empedocles uses here for 'shining straight' at Olympus is *antaugēin*: a word often used – especially in poetry or vivid writing – as a stronger form of the simple verb *augein* ('to shine') to convey the idea of light that is obtrusive in brilliance, that shines something or someone straight in the face. This is clearly what the word means here, applied to the light of the sun.³³ But the same word also came to be used in a more specific and technical sense of 'shining by reflection', of returning light to its source. The surviving evidence makes it plain that this is precisely how Empedocles' *antaugēin* came to be understood by later writers.³⁴ The resulting idea – of Empedocles' sun shining with reflected light – was, naturally, bound to produce exactly the same kind of speculation that we find in the case of Philolaus: speculation about him positing another source of light prior to the light of the sun, another 'sun' of which our sun is just a reflection. One of the end results of this theorizing – with misinterpretation compounding misinterpretation – was the passage from Aëtius examined earlier, with its idea of an 'archetypal' as well as a visible sun imported from the world of popular Platonism³⁵ into a context in which it could not possibly make any sense. And yet to set the wheels of this machine of misunderstanding in motion in the first place will have needed someone with a remarkable lack of perception of Empedocles' real meaning, with an

³² Emped. B44. For 'Olympus' as the vault of heaven cf. Parmenides B11.2–3, Philolaus A16, J. Kerschenscheider, *Kosmos* (Munich, 1962), 50, 57–8, 218, Burkert, *Lore and Science* 244–5 with n. 31, 36.

³³ Any assumption that the word must have the more specific sense of 'shining back' and so 'reflecting' is refuted by Chaeremon, *TrGF* 71 F14.6 (*ἀντήγυι*) and Xenophon, *Cyneg.* 5.18 (*διὰ τὴν ἀνταύγειαν... ἀντιλάμπει*), where the idea is certainly not of reflection but of something shining out brightly in contrast to its surroundings. Similarly the word *Ἀνταύγης*, used in Orphic poetry as a name for the sun (fr. 237.4 Kern, *Orphic Hymn* 6.9; cf. also 70.7), hardly means 'Reflector' – which makes no sense – but 'He who shines out brightly'. Again, although the description of the world of the stars in the pseudo-Hippocratic *On Sevens* as *ἀνταύγεια καὶ μάνωσις καὶ ἀραιωτάτη τῆς φύσιος λαμπρότης*, 'brilliance and rarefied substance and the most refined illumination in nature' (for the text cf. M. L. West, *CQ* 21 [1971], 368 §1.2; *ἀραιωτάτη* must, however, be retained), was interpreted in late antiquity as implying that stars shine with the reflected light of the sun (ps.-Galen, *CMG* XI.ii.1. 10.16–17) from the context it is clear that originally the reference was just to the brilliance – so the *splendor* of the Latin translation – and rarefied nature of the stellar sphere. It is also important to note that the term *antaugēia* can, even in technical writing, be used when referring not to reflection or reflected light but to the initial source of illumination *prior* to the stage of reflection: cf. e.g. Aëtius 2.20.12 = Philolaus A19, C. Mugler, *Dictionnaire historique de la terminologie optique des Grecs* (Paris, 1964), 36. Note as well the use of the word *ἀνταυγάειν* in Philo, *De spec. leg.* 1.321 (v. 77.19 Cohn-Wendland), meaning not 'to reflect' but 'to illuminate' (like the sun). Pindar, *Olymp.* 3.20, provides a particularly close parallel to our Empedocles passage with its use of the verb *ἀντιφλέγειν* to portray the moon 'shining directly in front of someone', 'shining in someone's face'. Compare, similarly, the verb *ἀντιλάμπειν*, 'to shine straight at', 'to shine out brightly', in Xenophon, loc. cit., in Plutarch, *De recta rat. aud.* 41c, and used of the sun in Arrian, *Tact.* 27.4 (*ἥλιος κατὰ προσώπου ἀντιλάμπων*); and the word *ἀντιφωτισμός*, 'direct light', 'light shining straight at one' (not 'reflection of light', LSJ) in Plutarch, *Quaest. conviv.* 625e. For the same spread of meanings – 'radiate', 'shine brightly', 'illuminate', but also 'shine with reflected light' – compare the Latin *refulgere*, and the modern Greek *ανταύγεια/ανταυγάειν*.

³⁴ Cf. esp. Plutarch, *De Pyth. orac.* 400b (*ἀνακλάσει... ἀνταυγεί*); also Aëtius 2.20.13 and 2.21.2 = Emped. A56 (*ἀνταύγεια... ἀνάκλασις*), and ps.-Plutarch, *Strom.* 10 = A30 (DK i. 288.29–30) with Guthrie, *History* ii. 192–3.

³⁵ See above, n. 3.

inability – or unwillingness – to appreciate his poetic, non-technical use of language, and with the corresponding ability to exert a disproportionate influence on later Greek philosophical writers. We can be fairly certain that we know who that person was.

It is time to draw a few conclusions. First, it is difficult not to be struck by the consistency, economy and elegance of Empedocles' own explanations of celestial phenomena. With a single stroke of the brush, as it were, he accounts for the origins both of a crystal-like heaven and of the stars, and for the nature and movement of our sun. He even managed at the same time to explain why the celestial axis seems to us tilted: the initial impact of the fire, weighing downwards on the surrounding *aither* as it massed into a ball to form the sun, jolted the framework of the cosmos and created the familiar angularity of the celestial poles.³⁶ As for the supposed theory of a hemisphere filled with fire, according to Empedocles such a hemisphere does not exist and – strictly speaking – never did exist. All that did, once, exist was a celestial hemisphere filled with a layer of fire at its periphery: a layer of fire that was soon transmuted into what are now the stars – including, probably, the 'wandering' stars or planets³⁷ – and our sun.

Second, we are unavoidably confronted with Theophrastus' limitations as an interpreter of the Presocratics, and with evidence suggesting – to speak in the simplest of terms – what a mess he was capable of making. Fortunately, in this particular case we are able to see just where he appears to have gone wrong: he equated Empedocles' 'hemisphere of fire' with the crystalline heaven because he failed to see that it no longer exists, representing a stage of cosmology that belongs in the past. Precisely this type of mistake – of assuming that a condition relating to a cosmological or mythical past is still operative in the present – was common enough in antiquity; cases where the same type of confusion evidently occurred can easily be cited.³⁸ But one senses with Theophrastus that, if he had not made this mistake, he would have been bound to make another. Whatever our verdict on his methods and attitude, accurate representation of the ideas of the Presocratics was ultimately as little a part of his aim as it was Aristotle's; and whatever he says about them must be treated with extreme caution and discrimination.

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³⁶ Aëtius 2.8.2 = A58a. The idea which has sometimes been voiced (e.g. S. Karsten, *Empedoclis Agrigentini carminum reliquiae* [Amsterdam, 1838], 425, Diels, *Doxographi Graeci* [Berlin, 1879], 338.8 app.) that Empedocles is here referring to the tilting of the *earth's* poles is totally unhistorical. From the Presocratics (Anaxagoras A1 §9, A67, Archelaus A4 §4) through to Psellus (*De omnifaria doctrina* 160 Westerink), there was no possibility of 'the tilting of the poles' referring to anything but the tilting of the celestial poles; the notion of a tilting of the terrestrial poles (e.g. Milton, *Paradise Lost* 10.668–71) only came to have any sense, or application, after the time of Copernicus.

³⁷ Aëtius 2.13.11 = A54; cf. Guthrie, *History* ii. 420 n. 2, Burkert, *Lore and Science* 311 with n. 65, M. L. West, *JHS* 100 (1980), 208.

³⁸ Cf. e.g. Kerschensteiner (as in n. 32), 136; M. L. West, *The Orphic Poems* (Oxford, 1983), 214–15.