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ARTICLE

ANAXAGORAS'S QUALITATIVE GUNK¹

Anna Marmodoro

Are there atoms in the constitution of things? Or is everything made of atomless 'gunk' whose proper parts have proper parts? Anaxagoras (fifth-century BC) is the first gunk lover in the history of metaphysics. For him gunk is not only a theoretical possibility that cannot be ruled out in principle (as it is for modern gunk lovers). Rather, it is a view that follows cogently from his metaphysical analysis of the physical world of our experience. What is distinctive about Anaxagoras's take on gunk is not only what motivates the view, but also the particular type of gunk that he develops. It is *qualitative* gunk, rather than *material* gunk. Anaxagoras's ontology was developed before matter was 'invented'. It includes quality tropes only; they are gunky. The resulting metaphysical view – a world of qualitative gunk – is new, in the sense of being hitherto unexplored; and yet, it is derived from Anaxagoras's writings. Drawing on Anaxagoras's insights, this paper offers a sketch of what qualitative gunk ontology looks like; it explores what motivates it; and it highlights the differences of qualitative gunk from material gunk.

KEYWORDS: Anaxagoras; mixture; gunk; powers; infinity

INTRODUCTION

Are there atoms in the constitution of things? Or is everything made of atomless 'gunk', whose proper parts have proper parts?² Anaxagoras (fifth-century BC) is the first gunk lover in the history of metaphysics. For him gunk is not only a theoretical possibility that cannot be ruled out in principle (as it is for modern gunk lovers). Rather, it is a view that follows cogently from his metaphysical analysis of the physical world of our experience. What is distinctive about Anaxagoras's take on gunk is not only what motivates the view, but also the particular type of gunk that he introduces. It is

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²The expression 'gunk' with this technical meaning was introduced by Lewis (*Parts of Classes*, 20).

qualitative gunk, rather than *material* gunk. Anaxagoras's ontology was developed before matter was 'invented'. It includes quality tropes only; and they are gunky. The resulting metaphysical view – a world of qualitative gunk – is new, in the sense of being hitherto unexplored; and yet, it is derived from Anaxagoras's writings.

Anaxagoras did not have all the answers to the questions his own ontology raises; in fact, we have even fewer of his answers, due to the fact that only fragments of his work remain. But the originality of his thought, and the uniqueness of his ontology in the history of philosophy make the questions it raises worth exploring and pursuing today. Drawing on Anaxagoras's insights, this paper offers a sketch of what an ontology of qualitative gunk looks like; it explores what motivates it; and it highlights the differences between qualitative gunk and material gunk.

THE METAPHYSICAL BACKDROP³

Anaxagoras endorses a cosmology according to which the world we experience originates from a cosmic mixture of all elements together. At some point in time, the mixture is set in motion by a cosmic vortex by a divine mind's intervention. This results in the scattering of the elements to different locations, and the formation of the world of our experience. The elements in question are *properties*, and more specifically, what the ancients called the 'opposites', such as hot and cold, wet and dry, rough and smooth, etc. The fact that Anaxagoras thinks of the elemental properties as opposites has motivated the interpretation, which I share, that they are what we would call *powers* or *dispositions*.⁴ There is not enough textual evidence to allow us to consider whether the distinction between dispositional and categorical natures of powers would apply to Anaxagoras's opposites. On the other hand it is clear from the extant texts that the opposites have a causal and a constitutive role in Anaxagoras's ontology.⁵ Yet, it is relevant to note that the elemental opposites are the sole type fundamental building blocks of reality for Anaxagoras.⁶

³This section offers a quick overview of Anaxagoras's key metaphysical assumptions, bracketing for present purposes some of the scholarly issues, and focusing only on his philosophical position.

⁴The seminal suggestion came from Vlastos ('Physical Theory of Anaxagoras', 41–2).

⁵Here is not the venue where to argue for this interpretation; see Marmodoro ('Everything in Everything').

⁶The interpretation of Anaxagoras's metaphysics I develop in this paper assumes that the opposites are the sole type of fundamental building blocks of reality for Anaxagoras. I cannot argue for this view here for reasons of space, although I have offered arguments elsewhere (Marmodoro, 'Everything in Everything'). For present purposes, I want only to clarify that the overall interpretation I present in this paper does not depend on giving the opposites that particular status in Anaxagoras's ontology. In particular, there is a line of interpretation of Anaxagoras that considers stuffs not derivative, and reducible phenomenal entities, but

Anaxagoras assumes that the opposites can compose into stuff, such as earth and flesh – thus endorsing an early version of the view that things are bundles of properties. Such stuff, along with further constituents – the so called biological ‘seeds’ – contributes to the composition of individuals such as animals and plants.⁷ The elemental properties in question are not types, or universals; rather, they are tropes. The total amount of a specific kind of property in the world, for example, the opposite hot, is the totality of all instances of heat in the world; the dark is the totality of all instances of darkness in the world; etc. These are not fusions of hot *objects* or dark *objects*; they are aggregates of instantiated properties – of *tropes* of the hot and of *tropes* of the dark. An important aspect of Anaxagoras’s ontology is that properties are not instantiated by coming to qualify matter or inhere in matter; they are, rather, instantiated by being located in space and time, just as tropes are. Matter does not figure at all in Anaxagoras’s ontology. ‘Material’ stuff such as earth and milk, are composed of, and reducible to, clusters of tropes located in regions of space.⁸ Anaxagoras’s opposite properties are *not material*, but they are *physical*. They are located in space and time and are subject to physical causation of different kinds.⁹ We can understand their (non-material) physicality, for instance, from the way in which a magnetic field is physical, but not material. A field is a physical quantity that has a value for each region in space and time; likewise Anaxagoras’s opposites are physical quantities in space and time, for example, of heat, of darkness, etc. These are not quantities of matter, but of physical powers, which have a value in every region, indicating the intensity of each property there. According to Anaxagoras, the intensity of a property in a region may also increase as its density increases in that region, through accumulation of instances (more on this in what follows). In sum, Anaxagoras’s opposites are instantiated properties in space and time, which do not

irreducible and real. Thus on this alternative view stuffs such as blood or gold are not composed out of the opposites, but are primitive (see e.g. Graham’s, ‘Was Anaxagoras a Reductionist?’ and Curd’s (*Anaxagoras of Clazomenae*, 158–9) helpful presentation and discussion of the main views in the debate). After having introduced my own interpretation, I will show in footnote 48 how it can be equally developed on the alternative view, following Graham (‘Was Anaxagoras a Reductionist?’). I here also assume that the opposites are pure, that is, the hot is purely hot, even if its instances can only co-occur with instances of other opposites. I argue elsewhere for this last point elsewhere (Marmodoro, ‘Everything in Everything’).

⁷Anaxagoras’ account of *how* individuals come about is not our concern here.

⁸In this secondary sense only, instantiated properties do qualify material body, where matter is reducible to clusters of tropes (rather than presupposed as an underlying primitive for the instantiation of the properties). In fragment B15, for example, Anaxagoras writes, ‘the dense and the wet and the cold and the dark came together here, where [the] earth is now’. This and the following translations of Anaxagoras’s texts are from Curd (*Anaxagoras of Clazomenae*).

⁹For example, by the cosmic vortex, or by the impact of other opposites on them, etc., as, for instance: ‘From the earth, stones are compacted by the cold’ (B16).

qualify underlying characterless substrata of any kind, but which are primitively and eternally instantiated in the world.¹⁰

The second important background assumption that Anaxagoras makes (probably motivated by his allegiance to Parmenides' principles)¹¹ is that we can account for all changes in the physical world in terms of spatial movement over time only. Qualitative change, generation and destruction are for him reducible to spatial movement of instantiated properties.¹² This line of thinking leads him to hold a view of *extreme mixing*, that is, to hold that there is a share of everything in everything. In this way, something can, for example, come into existence without being created, but simply by deriving from a certain mixture.¹³ The next section is devoted to the elucidation of this view.

EXTREME MIXING

Anaxagoras is known (even to contemporary metaphysicians) for the unique metaphysical posture he holds about mixture.¹⁴ With regard to the elemental opposites, he holds what is known as the Everything in Everything Principle (EEP), which says that,

EEP: There is a share of everything in everything.¹⁵

But how can there be a share of everything in everything? EEP is complemented in Anaxagoras's ontology by another key principle, the Unlimited Smallness Principle (USP), formulated thus:

USP: Everything has parts which are unlimitedly small. (There is no smallest of the small.)¹⁶

Anaxagoras likes this paradox; he says that each of the elemental opposites, for example, the hot, the dry, etc., is unlimitedly *large* in amount, and

¹⁰The notion of properties extended in space, but not somehow grounded in something else – matter – might strike the modern reader as unfamiliar. It is, however, in line with modern accounts of individuals as bundles of tropes. In antiquity, the prime example of this conception of properties as instantiated but not en-mattered are the instances of Plato's Forms (Immanent Forms), for example, in the *Phaedo*.

¹¹There is a controversy on this issue, which is well represented in the positions of Curd (*Anaxagoras of Clazomenae*, 54) and Palmer (2009, 227).

¹²See, for example, B17.

¹³The way in which stuffs, substances and human beings are derived from the cosmic mixture is discussed in the section on Preponderance.

¹⁴See, for instance, Sider ('Van Inwagen and the Possibility of Gunk', 287) and Hudson ('Simples and Gunk', 297).

¹⁵See B1; B6; B12.

¹⁶See B1 and B3.

unlimitedly *small*.¹⁷ Their largeness is generally understood as the total amount of each opposite in the universe. Their smallness has been interpreted in the scholarly literature in two different ways, namely in terms of there being very small *particles*, or very small *proportions* of each type of thing in the extreme mixture of everything in everything. But neither of these two ways of taking Anaxagoras's claim delivers a sound philosophical position. To begin with, both interpretations presuppose that what is thoroughly mixed are *material* parts – which is not Anaxagoras's position. On one of the two readings, Anaxagoras is thinking of juxtaposed *particles* of stuff; on the other, he is thinking of *proportions* of stuff in a mixture.¹⁸ These are respectively labelled in the literature, the 'particulate' and the 'proportionate' interpretations. On the *particulate* interpretation, the material components of Anaxagoras's ontology are present *as such* in the mixture, as material particles of finite size that are too small to be perceptually discerned; so they appear mixed. On the *proportionate* interpretation on the other hand, the total quantity of each type of material component is mixed together with the total quantities of the rest of the components, so that the totality is a uniform mixture through and through. On the proportionate interpretation the mixants exist in the mixture only potentially, not actually, like vanilla in a cake, or salt in seawater. The score keeping with regard to the textual fit of each of these lines of interpretation is not relevant here. On the other hand, the scholarly textual debate has generated arguments that will be helpful to draw upon to advance our understanding of Anaxagoras's views. The relevant arguments are what I call here (i) the Saturation Argument; (ii) the Containment Regress Argument; and (iii) the Refinement Regress Argument. They are all arguments that point at the conceptual difficulty of the structure of Anaxagoras's ontology. The reason for introducing them here is to come to understand the depth of the difficulty, and the challenge of making sense of all Anaxagoras's metaphysical commitments as part of a single sound ontology, before introducing an explanation of it in terms of qualitative gunk.

(i) *The Saturation Argument*

This argument is due to Jonathan Barnes and was developed as a critique of the particulate interpretation. Barnes writes,

If every piece of S contains a particle of S1, ... then every piece of S is wholly composed of particles of S1 – which is absurd.

(The Presocratic Philosophers, 255)

¹⁷See B1.

¹⁸Curd (*Anaxagoras of Clazomenae*, Chapter 3) provides a helpful state-of-the-art account of the scholarly debate.

The challenge is that, in the spirit of Anaxagoras's own principles, for every part of S there must be a part of S1 within it. On what reasoning, then, does Barnes hold that if every piece of S *contains* a particle of S1, every piece of S is then *wholly composed* of particles of S1? Consider: suppose that in a piece of S there is a particle of S1. Then either the S1 particle will be the whole of the S piece, which would conclude Barnes's reasoning; or the S1 particle will be a proper part of the S piece, leaving an S-remainder piece.¹⁹ If the latter, there will be a further S1 particle in the S-remainder piece, and it will either be the whole of the S-remainder, or a proper part of it, and so on. Ultimately, in Barnes's argument, the regress stops when there are no S-remainder pieces left in the S pieces, but only S pieces that are wholly composed of S1 particles.

But the soundness of Barnes's argument depends in fact on some further background assumptions that he does not make explicit. His argument is sound if we assume that S is not infinitely divided, since the S1 particles are finite in size; and if S divides into ultimate parts in which S1 particles fit exactly (which satisfies the initial hypothesis that each piece of S contains an S1 particle).²⁰ Indeed Barnes's argument addresses only finite divisions of the mixants, because it is a critique of the particulate interpretation, which does not envisage unlimited smallness of particles, but only extreme smallness. But in contrast to this, Anaxagoras tells us explicitly in USP that all things are unlimited in smallness. If this is so, the pieces of S are unlimited in smallness, and so are the pieces S1. In that case, Barnes's argument is not sound. The requirement, by hypothesis, that every piece of S contains a particle of S1 *is* satisfied, even if S1 particles are always taken to be proper parts of S pieces, leaving an S-remainder part, *ad infinitum*. In such a case, the conclusion that every piece of S is wholly composed of particles of S1 does not follow. There will always be smaller particles of S1 to fit pieces of S as their proper parts, leaving a proper part S-remainder. The Saturation Argument does not as such rule out this type of containment of one element in another. I now turn to explore whether such containment can satisfy the requirements of Anaxagoras's ontology, with the Containment Regress Argument.

(ii) *The Containment Regress Argument*

It might be thought that if one grants Anaxagoras that all the elements are unlimited in smallness, which is what USP states, this would allow for a containment relation among the elements. On this supposition, each part of an element S would contain, not only a part of an element S1, but also a part

¹⁹The remaining piece will be a proper part of the original S piece, according to the Weak Supplementation Principle of mereology (see, for instance, Simons, *Parts and Places*, *Parts and Places*).

²⁰If the particles of S1 did not fit exactly in the smallest pieces of S, the argument would not be sound; there would S-remainders with no S1 particles in them.

of every kind of element there is in the ontology – of which, for Anaxagoras, there are many, if not unlimitedly many, kinds. Thus, given USP, each piece of S would contain parts of S1, S2, S3, ... as proper parts, while still leaving an S-remainder (since it is a piece of S), in every part of S, *ad infinitum*. Yet, a different problem arises now, from the complexity of the structure of the contained elements. The difficulty comes about because it is not only S that contains parts of every type of element, but according to EEP every type of element contains parts of every type of element. What kind of structure emerges from the assumption of such containment? A structure that is barely intelligible. Expressing this thought, Hussey writes:

Within any lump of X, there is a ‘share’ of Y. Either this ‘share’ is present as a number of continuous packets, or not. If not, the visualisation fails already and it is hard to see how talk of *quantities* is to be justified. But if the ‘share’ of Y is present in spatially continuous packets within X, there will presumably be ‘shares’ of X, and everything else within the packets of Y, so that we are started on an infinite progression. This destroys the possibility of drawing any *definite boundary* between the X and the Y in the lump, be X and Y whichever ingredients they may, and this in turns *destroys the notion of a packet* with which the infinite progression has started.

(*Presocratics*, 137, my emphasis)

Hussey’s point is that if shares of each kind of stuff were within every share of every kind of stuff, the resulting configuration would lead to such a degree of structural complexity that, he concludes, we would lose track of the very notion of ‘contained unit’. If to this we add the Anaxagorean *proviso* that each kind is unlimitedly small, with each unlimitedly small part containing a proper part of every kind of opposite, then the structure defies representation: each of the *infinitely* many, infinitely divisible parts of each element contains proper parts of the many qualitatively different kinds of element, with a remainder, and *each* of these (contained, infinitely divisible) proper parts contains proper parts of the many qualitatively different kinds of element, with remainders, and so on *ad infinitum* (vertically and horizontally). This is not an infinite series of regressive steps. It is a series in which countless infinities ‘sprout’ at each step, and in each item of each such infinity, further infinities ‘sprout’, and so forth. This complexity becomes incomprehensible within the first couple of steps of reasoning. Because of this order of considerations, it seems plausible to rule out that this is what Anaxagoras’s ontology would have looked like. On the account of containment just sketched, there is nothing that could differentiate one kind of element from another. Thus the type of containment just envisaged undermines the intelligibility of any attempt to construe *different kinds* of element as *constituted* of every kind of element. By contrast, Anaxagoras’s ontology does admit of elements that are of *different* kinds.

(iii) *The Refinement Regress Argument*

A different version of the problem of there being *different kinds* in an ontology where everything is in everything, is taken up by Gareth Matthews (*On the Idea of There Being Something of Everything in Everything*), at the level of things rather than of elements. The problem is generated by the combination of EEP with a further principle in Anaxagoras's ontology, known as the Principle of Preponderance (PP), which will occupy us at length in the following sections of the paper. The principle says that,

PP: A thing is *f* if and only if the opposite *f* is preponderant in that thing's constitution (in relation to other opposites also present in the thing).²¹

So, for instance, if we mix salt and sugar in water, we will get a savoury drink if there is much more salt than sugar in the mix; or a sweet drink, if the converse is true. But how is this supposed to work in an ontology governed by EEP and USP? Is there room for PP in such ontology? Matthews ('On the Idea of There Being Something of Everything in Everything', and 'Anaxagoras Re-defended') poses the problem as follows;

My watch chain is 'most plainly' gold if, and only if, my watch chain contains more pure gold than anything else it contains. But, if there is no such thing as pure gold [in view of EEP], my watch chain will not contain more of that than anything else, there being no such thing as that.

('On the Idea of There Being Something of Everything in Everything', 1)

Note that here it is not part of the *nature* of each ingredient of the mixture to contain other stuff as part of its constitution, as it was assumed in Containment Regress argument above. Rather, other stuff is mixed with each kind of stuff as 'impurities'. So the idea that Matthews proposes in order to address the problem is that we can form the conception of a pure kind of stuff from the recognition that impure stuff can be purified, even if not completely, at least approximately. Thus, although it will never be the case that there will be pure, for example, gold, there can be purer and purer gold – refined gold. The mixture is that of a golden object because, although successive refinements of gold will never yield pure gold, they will increasingly converge on an amount of refined gold that will be greater than the amount of dross that will be generated by the refinement process. This gives us a way to think of the chain as being 'most plainly' gold if, and

²¹In Anaxagoras's words 'each single thing is and was most plainly those things of which it contains most' (B12). Anaxagoras additionally relativizes preponderance to perceptibility. There are various interpretative questions to be examined about preponderance which I cannot address here.

only if, it contains more refined gold than dross, even if the refined gold is not quite pure. In response to Matthews, and in response to an even more complex analysis and a further generalized version of the recursive refinement, Sisko ('Anaxagoras and Recursive Refinement') argues that on this reasoning the position we are left with is this,

No process of recursive refinement – not monadic, not dyadic, not polyadic recursive refinement – can be used to determine specifically how much gold is in a bar of gold.

(‘Anaxagoras and Recursive Refinement’, 244)

My response to this overall line of interpretation is that Matthews assumes that the process of refinement filters *most*, even if not all the particles of impurity out of an ingredient in the mixture. But Anaxagoras's elements are unlimitedly small, as per USP. Anaxagoras also holds that the elements are unlimitedly large in amount; so what he means by their unlimited smallness is not their total quantity, which is unlimitedly large, but that they are each divided into their unlimitedly small parts.²² As we will see in what follows, this means that their parts are as many as the points in a line;²³ if a mixture of *g* and *j* is like the overlap of a red and a green line, the notion of refining the red line by filtering *most* of the green points out of it would not be applicable; there would always remain as many green points in it as we started with. This may be more Anaxagoras's problem than Matthews's – to explain the preponderance of elements in a mixture in view of their unlimited smallness; but it follows that Matthews's recursive refinement does not help *us* in understanding preponderance, in view of the unlimited smallness of the mixants.

More generally, the midway conclusion we are in the position to draw at this stage is that we cannot understand Anaxagoras's ontology, as governed by EEP, USP and PP, in terms of elements *containing* one another *ad infinitum*, or as somehow merged into a *uniform* blend in which the elements are present as proportions. The first line runs against problems of intelligibility, the second against the textual evidence (I refer to Curd (*Anaxagoras of Clazomenae*) for the state of play in the scholarly debate on how the textual evidence sits with this interpretation). We need a fresh start. It will draw on a largely overlooked part of the textual evidence, where Anaxagoras phrases EEP in terms of the elements that make up his ontology as being *compresent* with one another, rather than as *contained* in one another.

²²On whether the elements are actually divided rather than divisible into unlimitedly small parts, see the section Unlimited Smallness of the Quality Tropes below, p. 12.

²³This is of course only an analogy, since points are not parts of a line; the important aspect of the analogy is the numerosity of the points, rather than their ontological status.

EVERYTHING IN EVERYTHING

We saw that Anaxagoras develops an ontology of opposites such as the cold, the hot, the dark, the dry, etc. They are described as 'all things being in everything' (B6). Each opposite is equal to every other opposite in total amount, being unlimitedly large (B1); and it is equal in the smallness of its shares or instances, which are unlimitedly small (B1), and which are the same in number with the shares of every other opposite (B3; B6). Anaxagoras, with his flair for paradoxes, emphasizes that 'the small, too, was unlimited' (B1) and equal to the large (B3). That is, they are of an infinite amount of instances. He also recognizes that division and separation of elements, which makes them more in number, does not make them more in amount, since dividing the totality, for example, of the hot, does not make the hot more than all the hot there is in the world (B5). So he recognizes that infinite division of an opposite into shares or instances, which makes it infinite in number, does not increase the amount of that opposite, whatever this amount may be.

Anaxagoras's property instances are uniform. Take, for instance, an opposite such as the hot; each part of the instantiated property hot is itself an instance of the property hot. That is, dividing each element into its parts does not change the kind.²⁴ Now recall that when Anaxagoras introduces USP, he gives the example of the property small in order to illustrate the principle: 'Nor of the small is there a smallest, but always a smaller' (B3).²⁵ It is clear that USP, and the example that illustrates it, deliver a description of *gunk*. For a given instantiated property, there is no smallest part of its instances. That is, given any part of an instance, there is a proper part of it that is smaller than the initial part. When we put this together with the claim that each element is unlimited in smallness (B1), we see that each opposite property in Anaxagoras's ontology divides into unlimitedly many, unlimitedly small parts (shares); it comprises unlimitedly many unlimitedly small instances. All the instances of an opposite together amount to an unlimitedly large totality; but each of these instances is unlimitedly small.²⁶ The unlimited smallness of the instances of the numerous kinds of opposites in the primordial mixture makes for a *world of qualitative gunk*, where what is gunky are the instantiated properties. The instantiated opposite properties are the fundamental entities in the ontology.²⁷

²⁴To capture this idea, Aristotle describes Anaxagoras's elements with a term of his own coinage, as homoeomers, in *Physics* 203a19.

²⁵Treating the opposite small as comparable to the property hot or cold is surprising to us but not to the ancients, as we also see in Plato's Forms of the Large, the Small and of the Hot.

²⁶That the unlimitedly many, unlimitedly small instances of each element add up to an unlimitedly large element echoes, or at least matches, Zeno of Elea's paradoxes, where infinite divisibility is taken to add up to endless tasks.

²⁷Please see footnote 48 below about how my interpretation can be extended to incorporate stuffs too as primitive and fundamental elements in the ontology.

Anaxagoras was the first gunk lover in the history of metaphysics. He is also the only (to date) *qualitative* gunk lover. He does not simply describe a world of qualitative gunk; he *derives it* from his metaphysical principles. His key tenet, as we saw, is that there is a share of everything in everything, or in other formulations of his, that all the fundamental quality-tropes are ‘all together’ or ‘inseparable’ from one another. No argument for this conclusion has been preserved in full in the extant fragments; on the other hand, we do have enough to reconstruct Anaxagoras’s line of thinking. In what follows, I reconstruct two arguments; it is the second one that leads to Anaxagoras’s desired conclusion; but both arguments reveal to us some aspect of his thought. I call the two arguments (a) from the Relativity of Opposites, and (b) from the Unlimited Smallness of the Quality Tropes.

(a) *The Argument from the Relativity of Opposites*

Anaxagoras tries to derive the general inseparability of all opposites from their respective opposites, on account of the relativity of the opposites within a given pair. As we will see, the argument does not generalize in the way Anaxagoras intends it to; still, it is important, not only for its relevance to our present inquiry, but also because it enables us to examine how his line of argument unfolds. His starting point is the pair of opposites hot and cold. They are inseparable from each other, as he explains using the small and the large as his example (B3): the small is inseparable from the large, since the small is also large in relation to the smaller. By generalization, Anaxagoras wants to show that all opposites are inseparable from their opposites: the hot is inseparable from the cold, and the large from the small, and for similar reasons, every opposite is inseparable from its opposite, because every instance of one of a pair of opposites is also an instance of the other opposite. This is so because, on account of the unlimited smallness and the unlimited largeness of the instances of pairs of opposites, there are no extremes of intensity in the range of any pair of opposites, for example, there is no smoothest or roughest; there is always less and more. This makes every instance of an opposite also its opposite, for example, the hot is also cold, and vice versa, in relation to more and to less – that is, to hotter and colder. So, Anaxagoras explains that for all the opposite elements in the ontology, every instance of an opposite *f* is also an instance of opposite non-*f*.

On the present argument, every instance of the large is also an instance of the small, and vice versa, since there is always a larger and a smaller. This shows the large to be equal to the small in the number of shares there are of each in the world, since every share of the large is also small, because there is always something larger than it, and vice versa.

The argument however falls short of reaching Anaxagoras’s desired conclusion. It does explain the compresence of the opposites with *their own* opposites; but not the compresence of *different kinds* of opposites. Hence

it cannot show, either, the instances of the large in the world to be the same number with the instances of each other opposite, for example, of the hot or the dry, etc.²⁸

(b) *The Argument from the Unlimited Smallness of the Quality Tropes*

Anaxagoras tells us that, since there can be no smallest, nothing can be separated, rather, everything is together.²⁹ Why can nothing be separated and be by itself, *if there is no smallest?* The reason for this takes us to the essence of Anaxagoras's metaphysics. Let us first examine why no quality trope can be separated from any other. On Anaxagoras's conception, the universe starts as a mixture of all the elements in the universe – all the opposites are mixed together. Things in that universe, for example, a lump of earth, are as it were like a 'cloud' of perfume in the air; they are clusters of quality tropes in the midst of a haze of quality tropes. There is no principle by which to allot shares of opposites to any one thing that one tries to separate away from the rest (for instance, a lump of earth from the rest of the mixture). The shares of the opposites that make up, for example, the lump of earth, are continuum dense as are the shares of the opposites mixed with them and all around them. The reason why the shares of the opposites populate everything so densely is the USP. We saw that the principle commits Anaxagoras to a world where the constituents, the quality tropes, are unlimited in amount and unlimited in smallness. The equal number of the shares of the large and the small results from the unlimited smallness of the shares of the large and the small. But all opposites are also unlimited in amount and in smallness; their shares are unlimitedly small. Hence, the shares of all are equal in number. The density of their unlimitedly small shares (as we shall see in what follows) is continuum-density; it is like the density of the parts (or points) in an infinitely divisible line, which Anaxagoras encountered in Zeno's paradoxes. So Anaxagoras's intuition was that mixing shares of different kinds of opposites together in such densities produces a mixture that cannot be separated again, drawing boundaries between kinds or combinations of kinds in it. (It would require what we would now call super-refinement.) It is for this reason that it is impossible to separate sharply the things the opposites compose from the rest in the mixture.

²⁸Anaxagoras uses the same term, *plēthos*, to state that all opposites are the same in *plēthos* (B1) and that the shares of the large and the small are the same in *plēthos* (B6). The term means 'multitude', but can also be understood as 'amount'. See discussion in Curd (*Anaxagoras of Clazomenae*, 34).

²⁹

[N]or is it possible that [anything] be separate, but all things have a share of everything. Since it is not possible that there is a smallest, it would not be possible that [anything] be separated, nor come to be by itself, but just as in the beginning, now too all things are together.

(B6)

Hence, all opposites are compresent and all together, in everything (as the brief argument of B6 suggests): they are unlimited in smallness, unlimited in amount, inseparable from one another, compresent with one another.

QUALITATIVE GUNK

The thought that Anaxagoras might have been an *ante litteram* gunk lover has been aired in the past (by Sider ('Van Inwagen and the Possibility of Gunk') and Hudson ('Simples and Gunk')); crucially however in terms of *material* gunk, and with no supporting argument or textual analysis. The uniqueness of Anaxagoras's position has so far evaded attention. On my understanding of Anaxagoras's system, his world is a world of *qualitative* gunk, which composes into material gunk. This is Anaxagoras's innovation, and, to my knowledge, the first and only instance of this type of gunk in the history of philosophy. The conclusion, that Anaxagoras introduces qualitative gunk, rests on the fact that what is gunky in his ontology are quality tropes, the opposites, namely pairs of contrary properties; they are the fundamental elements from which everything else in the ontology is made up.³⁰ They are instantiated properties, tropes; not qualifying any underlying matter, but rather making up matter. Furthermore, there is an additional aspect to Anaxagoras's ontology that makes it so distinctive: his opposites are what we would call *causal powers*.³¹ This is not uncontroversial in the scholarly literature on Anaxagoras, and since this is not the venue for engaging in a scholarly discussion, I will not press my line of interpretation further, except to say that if the opposites are indeed causal powers for Anaxagoras, he holds a *power* gunk ontology. If on the other hand one wants to remain uncommitted regarding the nature of the opposites, one can think of them generically as properties, qualities, and his ontology as *qualitative* gunk. What is qualitative gunk?

In Anaxagoras's ontology, a property is physically demarcated by the distribution of the values (degrees) of that property's instantiations in space. We can thus define qualitative gunk in terms of a property's instances in space:

QG: An instantiated physical property is gunky if and only if every part of its instances in space has a proper part where a physical property (of the same type, for homoeomers) is instantiated.

We saw that an Anaxagorean opposite is a physical quantity that does not qualify matter;³² that is, in his system there are degrees of heat, or of

³⁰ This is my assumption in this paper, see also footnote 48.

³¹ See also above, p. 1.

³² Examples of it, familiar to us, are a magnetic field – without its structure – or massless particles like photons.

dryness, etc., of varying values distributed in regions of space. Since for Anaxagoras the opposites are such that their parts are uniform, of the same kind as the whole, the proper parts of an instantiated property in a region of space is of the same kind as the property instantiated in the whole; thus the parts of an instance of the hot are instances of the hot. Now onto the reasons why Anaxagoras holds that reality is atomless. He wants it to be the case that anything can be extracted from anything, to avoid admitting creation *ex nihilo* (B17) and destruction (B3) in his system. Hence he holds that there is a share of everything in everything, which is what allows that anything come out of anything, where it was already. But now, what allows that there is a share of everything in everything? Is it by containment, by juxtaposition, by refinement that this is possible? We saw in the previous section that none of these hypotheses is free from significant difficulties. Rather, I submit that it is the gunky nature of the Anaxagorean fundamental elements, the instantiated opposites, that allows them to be *in everything*, by their literal *compresence everywhere*. To make progress in understanding and addressing the question of their compresence, we need to consider the more general question of how gunk occupies space. Consider a gunky entity (whether a material object or a trope). It will have a spatio-temporal location; its proper parts will also be located there, as will the proper parts of the proper parts, etc. What are the various collocation relations of these entities? Nolan ('Stoic Gunk', 171–2) offers an account of the collocation of blended gunky substances, by drawing a distinction between 'strict' and 'loose' location; he suggested that no one of the blended substances is strictly located in the blend, but are loosely located in it.³³ On account of this distinction it would be possible to allow for the *collocation* of the gunky parts of the Anaxagorean mixture with each other: the gunky parts of the opposites are loosely collocated throughout the mixture that contains them all, but not strictly collocated.³⁴ But this distinction has generated a controversy that Anaxagoras's account does not require me to engage with here. The controversy concerns the metaphysics of space regarding being strictly and loosely located.³⁵

I submit that there is a second way of securing the collocation of the Anaxagorean gunky opposites, which does not lean on differentiating (controversially) ways of being located in space. Two gunky opposites can be mixed by being collocated throughout the space in which the mixture

³³Nolan says, 'the mixture is in a specific location, true enough, but while they remain mixed the components are not in a place at all (at least in the strict sense)' ('Stoic Gunk', 174).

³⁴Nolan is concerned to show that the substances are thoroughly blended; I should point out that Anaxagoras's mixture of the opposites is not a *thorough* blend of the mixants.

³⁵Parsons ('Theories of Location', 203) offers the following definition: 'Informally, the notions are that I am *exactly located* in the space that I entirely occupy,' and 'I am *weakly located* in my office iff I am in my office in the weakest possible sense: iff my office is not completely free of me.' Leonard ('Locating Gunky Water and Wine') argues that the positions of Nolan and Parsons differ in the fundamental intuitions of space.

extends, in the sense that each part of the mixture, no matter how small, contains parts of its constituent mixants, the two opposites. This move is facilitated by the fact that Anaxagoras's ontology is gunky in a 'distributive' sense. It is not the case that the tropes of opposites are *divisible* into proper parts that have proper parts etc. *ad infinitum*; the tropes of opposites exist as *divided* in this way, as if resulting from a completed super-task.³⁶ (Anaxagoras does not in fact posit any super-task process of infinite division that facilitates mixing in his universe; rather, he assumes directly a thoroughly mixed universe.)

What is there, in Anaxagoras's world, when all fundamental elements are unlimitedly small? What are the building blocks, when gunk is thoroughly divided into its parts?³⁷ It cannot be extended *parts*, because they would not be of unlimited smallness; their smallness would be limited by their extension. It cannot be infinitesimally small *simple particles*, because they would be atomic at their limit. It cannot be *point-like* entities of zero extension, because they, too, would be limiting atoms.³⁸ When division is applied within the domain of extension, repeated division is not a mechanism that can rid parts of their extension. The Anaxagorean gunky tropes *approximate zero extension as a limit*, but do not in fact become extension-less. They are scattered into Aleph-1 (i.e. continuum-many) parts.³⁹ This realization enables us to understand how Anaxagoras's scattered gunky tropes are all together. Each part of the mixture contains parts of all the opposites, because *the opposites converge on collocation*. They converge, because the parts of every opposite are unlimitedly small.⁴⁰ Thus the mixture has parts of *every* constituent in *every* part of it. Each opposite is spread over

³⁶All things were together, unlimited both in multitude and in smallness' (B1).

³⁷One might even think that thorough division would *destroy* what is divided. Alexander of Aphrodisias entertains this thought: [...] if the constituents leave no undivided reminder in the blend they would be divided through and through, and not into parts but into divisions, if no particle of them remains beyond the division (*De Mixtione* 221.34-6). Hawthorne and Weatherson consider the same position:

One might ... think that matter sometimes vanishes as a result of some sequence of cuts. ... If we are allowed to suppose that gunk may vanish, then it will be perfectly consistent to say that nothing is left at the limit of super-cutting.

('Chopping Up Gunk', 341)

But we have seen that Anaxagoras explicitly says that thorough (unlimited) division of the opposites does *not destroy* them; rather: 'Nor of the small is there a smallest, but always a smaller' (B3).

³⁸Sider writes 'a line segment is infinitely divisible, and yet has atomic parts: the points. A hunk of gunk does not even have atomic parts "at infinity"' (Sider, 'Van Inwagen and the Possibility of Gunk', 286).

³⁹As we learn from a thought experiment about a thorough sequence of cuts of a gunky item, in Hawthorne and Weatherson ('Chopping Up Gunk', 340).

⁴⁰The convergent collocation of the mixants does not entail that the mixants share parts.

the whole of the infinite spatial region occupied by the mixture. Its gunky constitution of unlimited smallness allows each opposite to be collocated with the other opposites at every region of the mixture, no matter how small. It is in this sense that in the Anaxagorean mixture *everything is in everything*, and *all things are together*: the opposites are *collocated* in the mixture.

PREPONDERANCE

Aristotle provides a helpful account of Anaxagoras's PP:

Things appear to differ from each other and are called by different names from one another based on what is most predominant in extent in the mixture of the infinitely many [components]. Nothing is purely or as a whole pale or dark or sweet or flesh or bone, but whatever each contains the most of is thought to be the nature of that thing.

(Phys. 187b2–6, translation here and following from Barnes *Aristotle*)

When an opposite is preponderant, or when it comes to be preponderant in a thing, it characterizes the thing, determining its profile of perceptible properties. A combination of preponderant opposites, such as 'the dense and the wet and the cold and the dark', can compose (*modulo* perception) into a type of thing such as earth (B15). So the metaphysical 'mechanism' in Anaxagoras's ontology of how properties are *present* in the world, and how they come to *characterize* entities is the following: opposites *are everywhere* in the world, in primitively unlimitedly small shares, being of primitively different kinds; *accumulation* of the shares of an opposite in some region of space, over and above properties opposite to it, gives rise to higher intensities of that opposite, making it perceptible as a characteristic in that region (e.g. getting colder).⁴¹ If various opposites become preponderant, and hence intense (evident) in some region, they may be perceived as composing a kind of stuff, such as earth.⁴²

⁴¹We can interpret preponderance as resulting in merely quantitative differences, that is, accumulation, rather than differences in intensity of an opposite. But what makes a difference for our discussion here, as we will presently see, is that both the quantitative and the intensity interpretations require a higher *density* of the opposite in the region.

⁴²I will not discuss here Anaxagoras's views of the composition of organisms. But about the composition of stuff, I would like to make a note regarding their extraction from mixtures. When milk comes out of flesh, the opposites that characterize milk aggregate in two ways: to *become predominant* over other opposites in flesh, and to *become perceptible*. They can become predominant before they become perceptible, but the milk we perceive is preponderant *modulo* perception. Milk and all other stuff in Anaxagoras are aggregations of opposites. In contemporary terms, Anaxagoras is an *extensional mereologist* with respect to stuff: a lump of stuff is not over and above its proper parts (except phenomenally for Anaxagoras); it is identical to its proper parts.

One would think that on this line of thinking something becomes larger by being augmented by the size of more shares of the large. But how can a thing acquire *more shares* of the opposite small, and yet become, not bigger by the addition, but *smaller*? In addressing this question, Anaxagoras breaks new ground in metaphysics.⁴³ He could not hold that something becomes smaller by *losing* shares of the small, since he needs a metaphysical mechanism that works for all opposites, not just for the small. But it would be paradoxical to say that something becomes smaller by *acquiring more* of the small. With his flair for paradoxes, Anaxagoras asserts the latter; but, I claim, gives it a special meaning that in fact avoids the paradox. The general metaphysical mechanism comes in the form of the PP, which is a *quantitative* principle. What then does more of the opposite do for the thing it is in? We know that the shares of the opposites are located in space. The movement of the shares (tropes) of opposites can result, according to Anaxagoras, in the accumulation or depletion of the shares in particular regions of space. My claim is that *the shares of the opposites are either portions of quality-stuff, or bundles of quality-degrees*. Where there is accumulation of shares of the hot in some location, the hot becomes perceptible there; where there is accumulation of the soft, softness becomes perceptible there; and where there is accumulation of the large or the small, largeness or smallness becomes perceptible there. In all cases of a preponderant opposite, the opposite becomes perceptible, by increase in intensity. This is why Anaxagoras does not face the paradox that Plato raised, of how the *addition* of the small could result in the thing becoming *smaller*. For Anaxagoras, *opposites behave like powers* of a thing, rather than like bricks in a thing, because their addition does not augment the constitution of a thing; rather, their addition renders the thing of a certain character. Increases and diminutions of the density of an opposite in a region result in the increase or diminution of the degree of the perceptibility of that opposite in that region. Understanding changes in the amount of shares of opposites as resulting in changes in the *degrees* of that opposite (and hence of its perceptibility), enables us to understand why Anaxagoras does not find it paradoxical that more of the small makes something smaller.⁴⁴

Do shares of equal size differ in intensity? When Anaxagoras says, ‘Nor of the small is there a smallest, but always a smaller’ (B3), does this apply only to the *size* of the shares of the opposites, or also to the *degree* of intensity of the opposites? Are they unlimitedly small in volume; or in intensity? Do these two factors vary independently of one another? How is the volume

⁴³This metaphysical problem will defeat Plato two generations later. See *Parmenides* 131d: ‘that to which the part of the small is added will be smaller, not greater, than before. That is impossible’.

⁴⁴In the *Phaedo* Plato dismisses the explanation that ‘the greater man is greater by a head, which is small, and [explains] that it is a monstrous thing that one is great by something that is small’ (101b).

of each share related to the degree of intensity of the opposite? We are presently envisaging what we might call a double mereology in Anaxagoras's system – a mereology of the size of the shares of opposites, and a mereology of the degrees of the shares of the opposites. I believe that Anaxagoras develops only *one* mereology, of the size of the shares of opposites; the shares are all unlimitedly small, and can cluster in different densities. But the mereology of the size of the shares of opposites can also account for the mereology of the intensities of opposites: shares of unlimitedly small size are unlimitedly small in the degree of intensity of the opposite. This is the base level of size and of intensity; increases in intensity take place through increases in the density of the opposite, according to the PP. Whereas one could imagine having shares of the same size of an opposite, but of different intensity, there is no indication of this in Anaxagoras's system.

Anaxagoras's mathematical 'bent' led him to base his ontology on *unlimited* smallness, namely, gunk. Anaxagoras belongs to the very first generation of cosmologists and mathematicians who investigated the concept of the infinite at its birth. Zeno of Elea, the disciple of Parmenides, generated the paradoxes of plurality and change, using infinite regress arguments.⁴⁵ This is also the time that the Pythagoreans, reportedly Hippasus of Metapontum (fifth-century BC), discovered the irrational numbers, whose specification requires infinitely many integers. And it is when Democritus calculated the volume of a cone and a pyramid using infinitely many planes. But can Anaxagoras's gunk ontology indeed explain composition, difference, and change of things through the principles of the Unlimited Smallness, and of the Preponderance of the opposites? The position I want to propose and defend is that Anaxagoras had mixed intuitions about *both*, a *countable* and an *uncountable infinity*, and that this conflation led him to combine Unlimited Smallness with Preponderance, which are incompatible.

Anaxagoras uses the principle of *quantitative preponderance* in order to have a way of explaining the *composition* of things, for example, into earth or flesh; of explaining that things have *different properties*, for example, that they are cold or dry; and of explaining *change* in things, for example, from being cold to being hot. Broadly speaking, his intuition is that the preponderance of a fundamental entity, namely an opposite (or combination of opposites), for instance, the preponderance of the hot over other opposites in a mixture, results in that mixture exhibiting that feature, namely being hot. Can gunk exhibit preponderance? Anaxagoras was familiar with examples of Aleph-0 infinity, for example, the infinity of the series of integers, but also with examples of Aleph-1 infinity, for example, from the

⁴⁵There has been controversy as to whether Anaxagoras responded to Zeno's arguments or vice versa. Palmer (*Parmenides and Presocratic Philosophy*) argues that Anaxagoras responded to Zeno, and I will follow this interpretation. Furthermore, Palmer (2009) and Raven (*Pythagoreans and Eleatics*) argue that there is evidence that Anaxagoras had a more sophisticated understanding of the infinite than Zeno (Palmer 2009, 245–6).

infinite divisibility of the continuum, from Zeno's paradoxes.⁴⁶ Aleph-0 infinities *do allow* for preponderance. For example, as Euclid showed, there are infinitely many prime numbers; yet, the Prime Number Theorem tells us that there are more prime numbers among the first 100 integers than among any other 100 integers.⁴⁷ So the infinity of the primes displays regions of *higher density* or *preponderance*, at the beginning of the infinite series. It would therefore not be unnatural for Anaxagoras to have intuitions about the possibility of preponderance in relation to infinity. But if the collocation of everything is to be explained through the unlimited smallness, namely the gunkiness of the opposites, and if their gunk is of Aleph-1 cardinality of parts, is such an infinity compatible with *variable density*? Is it possible for an opposite to be preponderant in relation to the other opposites in any region of space, in view of the fact that all the opposites are distributed gunk in every region of space? How can we think of the collocation of opposites? For Anaxagoras, all the opposites were primordially everywhere in his cosmic mixture, and the world as we know it was explained by the formation of preponderances of opposites in different regions. Each opposite, for example, the hot, was distributed everywhere in unlimitedly small tropes as divided gunk, which has the same density as do the points in a line. Such is the density of all the gunky parts of the compresent opposites in Anaxagoras's world. But, unlike non-gunky infinities (e.g. Aleph-0) which can vary in density, gunky density cannot increase, still remaining a gunky (Aleph-1) infinity. This was not clear to Anaxagoras, who could not sharply distinguish between Aleph-0 and Aleph-1 infinities, or their densities. So he thought that the PP was available to him to describe the difference in density of the Unlimitedly Small opposites in different regions; and so explain the variable degrees of perceptibility of opposites in these regions; and the consequent composition, difference, and change of things in the regions.⁴⁸

⁴⁶There is discussion in the literature about the evidence whether Democritus made the distinction between the two types of infinity. See Vita 'Democritus and geometric indivisibles'.

⁴⁷See Riemenschneider, 'Simple analytic proofs of some abstract versions'.

⁴⁸Let us assume per hypothesis (following Graham, 'Was Anaxagoras a Reductionist?') that Anaxagoras's ontology is built on fundamental opposites *and* fundamental stuff; instead of opposites only. The qualitative gunk interpretation I developed in this paper would then apply to this ontology as follows. The various kinds of opposites and kinds of stuff would exist in the primordial mixture as gunk, divided into parts of unlimited smallness. The vortex moves them around in the mixture generating preponderances such as of milk, of gold, of flesh, etc. These preponderances are phenomenally perceptible as such, that is, as milk or gold or flesh, etc. Preponderances of the opposites in the same regions of space result in such stuff being hot, or cold, or dry, etc. My preference for the interpretation that only the opposites are fundamental is the economy of the ontology, which Graham too, for instance, recognizes. There is also a second reason, which relates to the non-opposite properties. On my interpretation, all properties are opposites, for Anaxagoras. So, colour, for instance, consists in the opposites dark and light. But on Graham's interpretation, what he calls non-opposite properties, which are features of the primitive stuff and which become

In conclusion, as I understand Anaxagoras's ontology, he had intuitions about two aspects of infinity. First, their *unlimited smallness* makes thorough mixing of the opposites possible through their collocation. Second, their *variable density* explains difference of intensity and change of intensity of opposites. The result of the combination of these intuitions into a single system was a metaphysically novel and unique ontology of *property gunk*. With hindsight, we can give up the requirement for variable density of gunk and explore the explanatory possibilities of an ontology of property gunk, motivating research for the development of *power gunk ontologies*, which may offer novel solutions to: the problems of collocation; contact; containment; composition; constitution; mixing; and property-instantiation.

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perceptible features of phenomenal stuff (e.g. the colour of amber) through preponderance, are not entities in the Anaxagorean ontology. Such properties are not reified, nor are they reduced to the opposites, nor are they phenomenal. On the contrary, they are properties of the primitive stuff of the ontology, which can become properties of such stuff at the phenomenal level:

The phenomenal stuffs ... are ... mixtures in which a given element iterates its own properties at the phenomenal level; the properties of the phenomenal stuff are not a function of several primitive elements, but the expression of a single element.

(Graham, 'Was Anaxagoras a Reductionist?', 4)

Apart from the interpretative problem of distinguishing the type of property of opposites from the type of property of non-opposites in Anaxagoras, this additionally generates an explanatory problem and a metaphysical one. The explanatory problem is that we cannot explain, for instance, what it is that we are attributing to amber and on what basis we classify amber under yellow. Metaphysically, we cannot explain what it is for amber to have the same colour as the eyes of people suffering jaundice. In other words, we cannot explain what it is for amber to have a property, if properties are not reified in the ontology. But even if they are reified, and placed at the fundamental level, alongside fundamental stuff, a further problem arises as to how some primitive elements in the ontology (e.g. amber stuff) are made up of other primitive elements (yellow colour), although they are all of the same level of fundamentality in the ontology. Graham says:

The generic term 'quality' is itself potentially misleading if we import the Aristotelian baggage that a quality inheres in a substance; but we may use the term in a more neutral sense where it denotes what we call (in a non-technical sense) qualities without necessarily implying any particular ontological theory.

('Was Anaxagoras a Reductionist?', 2)

This comes with a certain cost, which on balance inclines me towards the only opposites reading of Anaxagoras's ontology.

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