A World of Fields

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Abstract:

Trope ontology is exposed and confronted with the question where one trope ends and another begins. It is argued that tropes do not have determinate boundaries, it is arbitrary how tropes are carved up. An ontology, which I call field ontology, is proposed which takes this into account. The material world consists of a certain number of fields, each of which is extended over all of space. It is shown how field ontology can also tackle the problem of determinable properties and the problem of completeness of things.

Socrates said to Phaedrus that it would be good if one were able to carve up everything at its natural joints. (Plato, *Phaedrus* 265e) One should not carve up things like a bad cook who destroys the limbs when he carves up the beast because he does not carve it at its natural joints. The philosophical question here is how the material world is to be divided up into particulars. Which portions of reality are really particulars? Is the mereological sum of a table plus a book that is lying on the table really a particular? Or isn't it rather the case that the book is a particular, the table is a particular, but the sum of the table plus the book is not really a particular? The question is whether there is one true way of dividing reality, or whether there are several ways of dividing reality which are equally adequate, or whether any way of dividing reality is as adequate as any other.

This question about how to divide reality not only concerns concrete entities such as books and tables, but also abstract entities, i.e. ontically incomplete entities, such as the individual density of this table and the individual density of this book. In contemporary ontology individual properties, such as the individual density of this table, are commonly called *tropes*. In a trope ontology the question arises how tropes are to be divided up into particular tropes. Where does one trope end and another begin? Where does, for example, the density of the book end and the density of the table begin? Where is the boundary between the density trope of the book and the density trope of the table? In this essay I shall argue that tropes do not have definite and nonarbitrary boundaries. This will take me to an ontology in which the basic entities are edgeless and extended over all of space – I call these entities "fields".

To start with, I shall expound a version of trope ontology which I consider to be the strongest. I shall then confront this ontology with the question how tropes are to be divided up into particular tropes and whether tropes have definite and nonarbitrary boundaries. I shall conclude that tropes do not have such boundaries and that we should therefore rethink trope ontology. Field ontology, which I shall propose as an

ontology which does justice to the fact that tropes do not have definite boundaries, is a promising model of the ontic structures of the physical world. I shall try to develop field ontology in some detail and show how it can tackle some central problems of ontology such as the problem of determinable properties and a problem which I call the problem of completeness of things.

Trope ontology

The fact that two things can have the same property made many philosophers believe that properties are universals, i.e. entities which can be instantiated by several particular things. According to this view, which is called realism, a thing has a certain property by instantiating a certain universal. It is assumed that particulars and universals are entities of two different categories, and that a usual thing, e.g. a particular stone, is a particular which stands in the relation of instantiation to certain universals. (Though it is sometimes denied that instantiation is really a relation (cf. Armstrong 1978, p. 108)). An apple which has the density 1,5 g/cm^3 has this density because it stands in the relation of instantiation to the universal which we may call "being 1,5 g/cm^3". A certain pear may have the same density, and in this case the pear instantiates the universal of being 1,5 g/cm^3 too. Two things have a property in common if they instantiate the same universal.[1]

I have argued elsewhere[2] that an ontology with universals faces several serious difficulties and that we should better look for an ontology with-

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[1] In recent years this ontology has been developed in detail and defended by David Armstrong; see his 1978, 1989 and 1997. See also Fales 1990, Bigelow & Pargetter 1990, Lowe 1994, and Smith 1997. For an up to date introduction to the current debate about properties see Oliver 1996.

[2] See my *Dinge und Eigenschaften,* forthcoming. See also Campbell 1990, pp. 6-17.

out universals. Realism has a strong rival: trope ontology, according to which properties are particulars which may resemble each other. Trope ontology has been developed and defended in the Anglo-Saxon tradition by, for example, Donald Williams (1953), Keith Campbell (1990), Peter Simons (1994), John Bacon (1995), D.W. Mertz (1996), and Arda Denkel (1996). David Armstrong, though he prefers realism to trope ontology, gave the trope ontology a great boost by recognising the strengths of this ontology in his *Universals: An Opinionated Introduction* (1989, ch. 6). However, tropes are by no means a discovery of Anglo-Saxon philosophy. Edmund Husserl held an ontology with tropes, which he called "moments", and Roman Ingarden developed a trope ontology in detail in his mammoth treatise *The Controversy About the Existence of the World,* published 1947 in Polish, especially in vol. II/1 (1965). Aristotle and most medieval philosophers also held the existence of tropes. I refrain from discussing here the various versions of realism and the various versions of trope ontology. Instead, I shall outline how trope ontology is best construed in my view. I shall restrict my considerations here to material entities, i.e. to non-living, extended entities, which are in space and time, have mass, density etc., such as stones, apples or stars. My reason for this is that I do not want to presuppose that organisms[3], persons, God or numbers have the same ontic structure as non-living material entities.

Why do we say that things have properties? Why do we distinguish between things and their properties? Things are complex. We can not only distinguish between spatial parts of a thing, e.g. the egg yolk and the egg white of a particular egg, but also between aspects, between properties of a thing, such as the mass and the charge of a particular stone. Using Edmund Husserl's (*III. Logical Investigation,* §17) and

[3] Peter van Inwagen (1990, *Material Beings,* Ithaca: Cornell UP) for example holds that organisms have a different ontic status than e.g. tables. He even claims that "there are no tables or chairs or any other visible objects except living organisms". (1990, p. 1)

Donald Williams' (1953, p. 6 and 1986, p. 3) terminology we may call the former kind of parts *concrete parts* of a thing and the latter kind of parts, the properties, *abstract parts* of a thing. Assume that a certain thing T is at a region R such that no part of T is not within R and that nothing in R is not a part of T. R is the position of T, T occupies R, and T is the whole content of R. A concrete part of T then is a thing which is the whole content of a certain subregion R' of R. If a particular egg is at the spatial region R then the egg yolk of the egg is a concrete part of it because it is the whole content of the region R', where R' is the region at which the egg yoke is and R' is a subregion of R.

We can say that an entity is concrete if it is the whole content of a certain spatial region. An entity is abstract if it is not the whole content of the spatial region it occupies. P is an abstract part of the concrete entity T if P is an abstract entity and P is contained by the same region as T. The egg yolk of an egg is a concrete entity and it is a concrete part of the egg. The density of the egg is an abstract entity and it is an abstract part of the egg. *Tropes* are properties of a thing conceived of as abstract parts of the thing and as particulars. The tropes of a thing are as much a particular (as opposed to being a universal) as the thing is a particular. Different tropes of a thing exist in the same region together, they coexist or, to use Russell's term, they are compresent.

But why do we and how can we distinguish between different properties, tropes, of a thing? The reason for this is that different properties bestow different causal powers upon the thing. Due to its mass the moon is attracted by the sun (by gravitational force), whereas the temperature of the moon, for example, is irrelevant for the gravitational force between the moon and the sun. It is the heat of the hot-plate which makes the water boiling, whereas the mass or the charge of the hot-plate is irrelevant for this. Certain properties of a thing make it that the thing has certain effects upon our senses and let it behave in certain ways in certain experiments. We can distinguish between different properties of a thing by distinguishing between different causal powers the thing has.

I introduced the notion of an abstract entity as something which is not the whole content of the region it occupies, and I said that tropes are abstract entities. Williams and Campbell, however, hold that a trope of a thing could as well exist without the other tropes of the thing. The density trope and the temperature trope of a stone, for example, as a matter of fact coexist, but they could as well exist without each other, every trope could exist isolated. Campbell (1990, p. 21) writes: "We can take the tropes to be the basic primary items. It is *a matter of fact,* and not of metaphysical necessity, that tropes commonly occur in compresent groups." He allows explicitly for isolated tropes: "In trope theory, individual, isolated tropes, compresent with nothing, are admitted as possibilities." (1990, p. 59) If one holds this view one cannot characterise tropes as abstract entities as I introduced the notion of an abstract entity. Williams and Campbell give a slightly different meaning to the term 'astract'. They hold that an abstract entity is an entity for which it is *possible* – but not necessary, as I said – that there is another entity at the very same position. According to Williams and Campbell, abstract entities are entities of which there can be more than one at the same place and time.[4] With this terminology they can still call their tropes abstract although they believe that tropes can be the whole content of a certain region.

However, I do not believe that there can be isolated, lonely tropes. Could the density of a stone exist without the other properties of the stone? Can there be a density without being together with some mass

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[4] This usage of the word 'abstract' can be found in Williams 1986, p. 3 (cf. his 1956, p. 5 and pp.14f), Armstrong 1978a, 121f, and Campbell 1990, p. 3. Williams, however, uses 'abstract' sometimes ambiguously. On the one hand he writes "abstract entities differ from concreta in that many of them can and do occupy the same plime" (1986, p. 3) – I take it that this means that it is only essential for an abstract entity in this sense that they *can* occupy the same plime as another entity –, but on the other hand he says that a concrete entity is one which "exhausts or is the whole content" of a certain space-time region. His terminology would be more coherent if he said that a concrete entity is an entity which cannot be at the same position as another entity.

and some temperature? Could it happen that we find on some planet something which is a naked density trope, not coexisting with a temperature trope and many more tropes? I do not know how to argue that this is impossible, but I suggest that we should rely on our modal intuitions in this case. I can think of no better examples of impossibilities than the impossibility of there being an isolated trope. We refer to a single trope and we come to recognise a single trope only by an act of abstraction. When we observe a thing we can draw our attention to a certain aspect of the thing by leaving aside other aspects of the thing. But we always observe complete things consisting of many tropes, we never observe isolated tropes. I suggest that before we have not observed an isolated trope we should not assume that there could be isolated tropes.[5]

To say that a trope could not exist alone without the other tropes is to say that it is in its existence in a certain sense dependent on the other tropes of the thing of which it is a trope. Roman Ingarden calls the kind of existential dependence in question "existential non-self-sufficiency"[6] ("Seinsunselbständigkeit") (cf. Ingarden 1964, § 14). An entity x is non-self-sufficient upon an entity y if x cannot exist except by coexisting with y in a single whole (i.e. a complete thing) or coexisting with another entity z, which is a member of a certain class of entities which includes y. We can explicate the notion of a "single whole" ("Einheit eines Ganzen") by stating that entities exist in a single whole when they occupy the same region of space (at the same time). The density trope of a certain stone for example is non-self-sufficient upon the temperature trope of that stone because it cannot exist without a temperature trope, i.e. without a trope of the class of temperature tropes, of which the temperature trope

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[5] This position is, contra Williams and Campbell, also held by Simons (1994, p. 559) and Denkel (1996, p. 16f).

[6] This translation is suggested by Peter Simons (1982, "The Formalisation of Husserl's Theory of Wholes and Parts", *Parts and Moments,* ed. Barry Smith, Munich: Philosophia, p. 135).

the stone actually has is a member. Ingarden says in this case, where the density trope requires some temperature trope but not a particular one, that the density trope is ambiguously non-self-sufficient upon the temperature trope.

My view that tropes are non-self-sufficient has a further advantage, because the non-self-sufficiency of tropes explains what binds tropes which constitute a thing together. Michael LaBossiere (1994) for example has argued that a bundle-of-tropes view, according to which a thing is nothing but a bundle of compresent tropes, cannot explain what binds tropes together, and therefore one should accept a trope-substrata view, according to which tropes are borne by substrata. If things were bundles of tropes, he argues, there would have to be binding tropes which serve to bind the tropes of a thing together. But then the question would arise what binds the binding tropes, because if the tropes of a thing need to be bound together and if binding tropes are tropes then the binding tropes must also be bound. He concludes that one should prefer a trope-substrata view, where substrata, which unlike tropes need not to be bound, serve to bind the tropes of a thing. But if the tropes of a thing are non-self-sufficient upon each other – as for example in Roman Ingarden's ontology – this solves the problem of binding tropes. The tropes of a thing are held together by their mutual existential dependence upon each other – no extra binding entity is required.

There are two facts about things of which an ontology has to give an account: First, things have various aspects, i.e. things have properties. Secondly, two things can have the same property. Trope ontology does justice to the fact that things have various properties by assuming, as described, that a thing consists of many tropes. But how does trope ontology explain how two things can have the same property? The answer is that tropes can resemble each other in degrees between no resemblance and exact resemblance. Resemblance between tropes is not to be analysed in terms of having some entity in common. Resemblance is not analysable. If a particular apple and a particular pear both have the mass

0,5 kg, then it is true to say that they have the same mass because the mass trope of the apple and the mass trope of the pear resemble each other exactly. The mass trope of that apple resembles the mass trope of that pear to a maximal degree, and it resembles it to a higher degree than it resembles the mass trope of a pear with the mass 0,4 kg. All mass tropes resemble each other to a higher or lesser degree. This is how they are ordered and why they form a continuous spectrum, such that we can attribute numerical values to them.

Note that it is primarily tropes that resemble each other. Whole things – concrete entities – resemble each other only if tropes of them resemble each other. This is important because otherwise the problem of co-extension and the problem of imperfect community would arise which both arise for a more deflationary resemblance theory which tries to deny properties at all and which claims that for a thing to have a certain property is for it just to belong to a certain class of things which resemble each other. Such classes are called similarity circles.[7] The problem of coextension arises because the similarity circles of two properties can be identical. All animals with a heart have a kidney and all animals with a kidney have a heart, hence the similarity circles for 'having a heart' and 'having a kidney' are identical – although certainly the properties of 'having a heart' and of 'having a kidney' are two different properties. If having a certain property for a thing were nothing but for it to belong to a certain similarity circle, then the properties of 'having a heart' and of 'having a kidney' would be identical. But they are not, therefore for a thing to have a certain property does not just consist in its belonging to a certain similarity circle. This problem does not arise for trope ontology because the having-a-heart tropes – let us assume only for the sake of the argument that there are such tropes – form one similarity circle and

[7] Rudolf Carnap, in *Der Logische Aufbau der Welt* (1927), tried to construct properties as similarity circles of particulars. Cf. Campbell 1990, p. 33 on the problem of coextension and the problem of imperfect community.

the having-a-kidney tropes form another similarity circle. The having-a-heart tropes are distinct from the having-a-kidney tropes, and none of the former resembles one of the latter.

The problem of imperfect community may be demonstrated by the following example. A leaf resembles a greenfinch, and the greenfinch resembles a sparrow. These three things, together with many other things, form a similarity circle. But there is not a single property which corresponds to this similarity circle. This problem arises because things are complex and resemble each other in various aspects. It does not arise for trope ontology because according to trope ontology it is the colour trope of the leaf and the colour trope of the greenfinch that resemble each other, and it is the being-a-bird trope of the greenfinch and the being-a-bird trope of the sparrow that resemble each other. Certainly, the colour trope of the leaf does not resemble the being-a-bird trope of the sparrow. The problem of imperfect community does not arise for trope ontology because trope ontology does justice to the fact that things are complex, i.e. that things have many aspects.

I should point out that this account of resemblance between things has a remarkable advantage over the account that is given by realism. The fact that two things can have the same property is explained by realism by the assumption that there are entities, universals, which are such that they can be instantiated by more than one thing. The difficulty with realism now is that this explanation can only be applied for cases where things have *exactly* the same property, but it fails for cases where things have not exactly the same property but they have similar properties. An apple with the mass 0,31 kg has not the same mass as a pear with the mass 0,32 kg but still the apple and the pear resemble each other in their mass. This resemblance cannot be explained in terms of two things instantiating the same property. So what account can the realist give? It seems as though he also has to appeal to some primitive resemblance, in this case primitive resemblance between universals. But if we have to accept primitive resemblance anyway, why not explain all resemblance

in terms of primitive resemblance? For a trope theory with primitive resemblance as I proposed it resemblance between things with exactly the same mass and resemblance between things with similar mass is both to be explained in terms of primitive resemblance between tropes.

To summarise, I think trope ontology is best construed as follows: Things, such as stones or eggs, are complexes of tropes, i.e. of individual property instances. The tropes of a thing are non-self-sufficient upon each other, i.e. a single trope could not exist but needs to coexist with other tropes, together with which it constitutes a concrete thing. Tropes resemble each other more or less closely. This resemblance is unanalysable. Concrete things resemble each other if tropes of these things resemble each other.

The problem of the boundaries of tropes

Having given an outline of how trope ontology is best construed I now want to turn to the question how the material world is to be divided up into particulars. More exactly, I want to investigate how tropes are to divided up into particular tropes. This question arises for trope ontology because tropes are supposed to be spatial entities, and they are supposed to have boundaries. Assume there is a pot with water and there is an egg in the water. Which temperature tropes are there in the pot? We would like to say that there is the temperature trope of the egg. There is probably also the temperature trope of the water. If we accept that there are these two tropes we may ask: Where is the boundary between these two tropes? What is the boundary of the temperature trope of the egg? Where does one trope end and where does another trope begin? Is there *one true way* of dividing up tropes? Do tropes have definite boundaries? Do the boundaries of tropes coincide with the boundaries we ascribe to concrete objects, such as eggs and stones? These are questions, I think, trope ontology should be able to answer. In what follows I shall first

mention two answers to these questions that claim that tropes do have definite boundaries and that it is not arbitrary how tropes are carved up. However, I will not accept these answers. After considering these answers I shall present a theory according to which it is arbitrary how tropes are carved up. I will call that theory "field theory". Finally, I will argue that this theory can tackle the problem of determinable properties and the problem of completeness of objects.

The first theory that I want to consider that claims that tropes have determinate boundaries is *trope-substance ontology*. According to such an ontology, which is a rival to the trope ontology which I proposed above, every genuine thing has a substance, an essential kernel, an essential nucleus. This is supposed to be something like the ontic centre of the thing, and it is that, which is the bearer of the tropes. Roman Ingarden calls it the "constitutive nature" of the object. Arda Denkel calls it the "particular essential nature". If one accepts such a bearer of tropes one can claim that it determines the boundaries of the tropes. According to this view, a trope has its boundary where the substance has its boundary. The substance bestows its boundary upon the trope. In our case of an egg in a pot with water that means that the boundary of the temperature trope of the egg is identical with the boundary of the substance of the egg. However, although I cannot argue the case here[8] I shall assume that trope-substance ontology is false and that a physical object does not have an essential kernel. Here I mention only that in trope-substance ontology the problem is only postponed. The question where the boundaries of tropes are is answered, but then the question arises where the boundaries of substances are.

The second theory that I want to consider that claims that tropes have determinate boundaries is to be expounded as follows. Let us assume that the temperature of the egg is 21°C and the temperature of the water

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[8] For arguments against substance ontology see my *Dinge und Eigenschaften,* forthcoming.

is 22°C. The egg and the water have different determinate tropes of the same determinable property. The determinable is temperature, and the different determinates are 21 or 22°C respectively. The temperature trope of the egg and the temperature trope of the water are *two* tropes, according to this view, because they are different determinates. One may assume that one determinate trope *a* ends where a determinate trope *b* begins which is incompatible with *a* because *a* and *b* belong to the same determinable but *a* is a different determinate from *b*. The boundaries of a trope of the type '21°C' are where tropes of other temperatures, for example 22°C, begin. Let us call this view the theory of determinate tropes.

According to this view the boundaries of tropes will not always coincide with the boundaries we ascribe to concrete objects such as eggs. If, for example, in our pot the egg *as well* as the water had the temperature 21°C, there would be, according to this theory, *just one* temperature trope for the *two* concrete objects, the egg and the water. If, on the other hand, the egg yolk had the temperature 22°C, and the egg white as well as the water had the temperature 21°C, then there would be two temperature tropes in the pot, but the boundary between the two tropes would not coincide with the boundary between the two concrete objects as we usually conceive of them, i.e. between the egg and the water.

According to this view the physical world consists of tropes, each of which is extended in a certain region of space. They may overlap each other, may be disjoint, or one may be ingredient of another. A determinate trope has a boundary where a trope of another determinate of the same determinable begins. The surface of a concrete object would be where boundaries of several tropes coincide, but there would also be tropes which overlap the concrete object.

The biggest problem for this account is that apparently there are not such sharp discontinuities between tropes. If the egg has 21°C and the water has 22°C then it will not be the case that the discontinuity of the

temperatures determines a boundary between the two regions. Rather, there will be a continuous transition from the region with 21°C to the region with 22°C. Here it is true what Leibniz said: "Natura non facit saltus" – nature does not make leaps. But if transitions between regions with different determinates of the same determinable are continuous, then the difference of the determinates cannot determine definite boundaries between tropes. Hence the theory of determinate tropes is false.

There is a phenomenon about material entities, of which we may expect an ontology to give an account, which I want to call the *completeness* of material entities.[9] I have argued already above that an isolated trope cannot exist. A single density trope for example cannot exist. But which tropes needs a density trope to be combined with so that this complex of tropes can exist? There are certain limitations as to what combination of properties a concrete entity can have. Not every combination of properties, of tropes, can exist, only some sets of tropes can coexist and constitute a thing. For example, an object having all the properties of a particular egg *except*, for example, temperature cannot exist. An existing extended object cannot lack, for example, charge or density. Without density or charge it would be ontically incomplete. Only ontically complete objects can exist.

It seems as though every concrete material entity has one determinate property for each of a certain set of determinables. Every concrete entity is in this sense complete. Every concrete material object has a density, a charge, a mass etc. However, the theory of determinate tropes seems to allow for any combination of tropes in a given place. It leaves at least unexplained why a concrete material object may not fail to have, e.g., a charge or a density.

How many temperature tropes are there now in the pot with the water and the egg? I have argued that the distribution of temperature in the

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[9] See Ingarden 1965, p. 67 and Campbell 1990, p. 153 about completeness of an object.

pot does not determine how many temperature tropes there are. The transitions between regions with different temperatures are probably continuous, and therefore we cannot find out how the temperature in the pot is to be carved up just by measuring the temperature in the different regions. As the search for objective determinate boundaries of tropes is unsuccessful we may assume that there are no such boundaries. From an ontological point of view it is arbitrary how tropes are carved up. One may conceive of the temperature of the egg as one trope, but one may also conceive of the temperature of the egg yolk as one trope and of the temperature of the egg-white as *another* trope. There is not ontologically privileged way of carving up tropes, because there are no objective boundaries of tropes to be discovered. It is up to our choice how we divide the temperature in the pot up. There are infinitely many possibilities how to divide up tropes and we can do it according to our interests. If we want to say something about the egg compared to the water we can speak about the temperature of the egg as compared to the temperature of the water, even if the egg and the water have exactly the same temperature. But this does not mean that there is a determinate boundary between the temperature trope of the egg and the temperature trope of the water which would determine that the temperature tropes in the pot are to be counted in one way rather than in some other way. We can refer to the temperature in any region, and any region of temperature is equally legitimately to be conceived of as a temperature trope.

Jonathan Lowe argues that an objection against trope ontology can be made out of this. He thinks that if something is really to be an *object* in the strict sense then it must be an entity possessing determinate identity conditions. In our example this would mean that there must be a "fact of the matter" as to whether or not the temperature trope of the water is identical with the temperature trope of the egg, and it must be an objective fact which is the right way of dividing up of tropes.

> [An object's individual] color, say, is not "itself" an object, somehow related to the object of which it is the color. If it were an object, it would have determi-

nate identity conditions, and yet it does not appear that it can have these. Supposing the colored object to be uniformly colored, it makes doubtful sense to ask whether "the color" of its top half is *numerically identical* with "the color" of its bottom half, or whether either or both of these is identical with "the color" of the whole object. Certainly, these questions cannot apparently be answered in a nonarbitrary and principled way. (Lowe 1995, 512f)

I agree with Lowe that carving up tropes cannot be done in a nonarbitrary and principled way. But I deny that therefore tropes may not properly be called "objects". If one wants to one can conceive of the color of the top half of an apple and the color of the bottom half of the apple as two different tropes. In this case it does make sense to ask whether the former is numerically identical with the latter. The answer is that they are not numerically identical, they don't even overlap.

Lowe's claim that objects must have determinate identity conditions probably entails that objects must have determinate boundaries and that it must be determinate how they are to be counted. There must be a true answer to the question how many temperature tropes there are in the pot with the water and the egg. Lowe would be right if there were entities with determinate identity conditions and determinate boundaries. If there were such entities it would be appropriate to take them to be objects in the strict sense, whereas tropes, which do not have determinate identity conditions, should be taken to be only objects in the loose sense. But it is likely that the carving up of all material entities is an arbitrary matter.

Fields

If this is true, if tropes do not have definite boundaries we should perhaps rethink our trope-ontology. According to a standard trope ontology a concrete entity, such as an egg, is a bundle of tropes, such as a temperature, a density, a charge, etc. According to this view the material

world is the totality of all these single tropes. But if, as I have suggested, these tropes do not have definite boundaries, then that suggests *that they are carved out of something*. And that is what I want to propose now: I want to propose an ontology with entities, of which Common Sense tropes, such as the temperature trope of an egg, are *subdivisions*. Such an approach has been proposed by Keith Campbell (1990, ch. 6), and what I present now will be to a great extent along the lines of his theory.

I do not deny that there are entities such as the temperature trope of an egg, but I think such entities are not the most basic material entities. Such middle-sized every day tropes are not "the primary constituents of this or any possible word, the very alphabet of being" (Williams 1953, p 7) as Donald Williams thinks. I suggest that the basic entities of the material world are unbounded and are such that it is arbitrary how they are carved up. They are unbounded in the same way as space is unbounded. For such an entity there is no area of which it is objectively – and not just depending on someone's decision – true that all points on the one side of that area are within the entity and all points on the other side of that area are not within the entity. Furthermore, any portion (i.e. spatial subdivision) of such an entity is equally legitimately to be conceived of as an object as any other. I call these basic entities *fields*. A field is extended over all of space. There may be more than one field. I say then that the fields are *superimposed*. The physical world consists of a certain number of superimposed fields, each of which is extended over total space.

A field can have different *intensities* (or "strenghts") in different regions. That means that there are variations of a field, and a field may be in different regions in different variations. Different regions of a field are more or less *similar* in intensity, in case of maximal similarity they have exactly the same intensity. A field may be present in different regions in varying strengths. I quote Keith Campbell's description of fields:

> Taking our clue from space-time itself, we now propose that all the basic tropes are partless and edgeless in the ways that space is, and that they change only in space-time's innocent way. All basic tropes are space-filling fields, each one of them distributes some quantity, in perhaps varying intensities, across all of space-time. (Campbell 1990, p. 146)

Now, the assumption that fields have different intensities in different regions allows us to conceive of a particle, e.g. a lepton or a boson, as "a zone in which several fields all sharply increase their intensity". As macroscopic objects are composed of elementary particles, and particles are regions of high field intensity, we may say that things are certain configurations of field strengths in a certain region.

Everywhere in space there are the same fields present. Fields do not have holes, only regions of low intensity. The world is not the sum of things between which there is nothing. There is – as far as we know – no empty space. It is recognised in physics that in regions of space which were thought to be empty there is so-called interstellar matter.

Which fields are there? It is a task of *physics* to discover which fields there actually are, but we may speculate (following Keith Campbell) that there is one field for every one of the fundamental forces recognised in contemporary physics. That would mean that there are four fields: gravitation, electromagnetism, weak and strong nuclear forces.

But what then about temperature, charge or density, which obviously are properties? If there is no temperature field or no density field, as I have just proposed, what account can we give of these properties then? What we need to show here in defence of field ontology is that there are ways how such properties can be traced back to field intensities. Not only any subdivision of a field may be conceptualised as one trope, we may also conceptualise a certain combination of certain intensities of certain fields as one trope. Obviously, we usually do not conceptualise electromagnetism as a property. Usually we conceptualise temperature or density or anything like that as properties. These Common Sense

tropes, I suggest, can be traced back to combinations of certain field strengths. I shall indicate three ways how this might work for different properties. First, some properties may be to be traced back to certain changes of field intensity. Temperature, for example, is, according to kinetic-gas-theory, average kinetic energy of molecules; temperature is to be traced back to movement of molecules. Molecules according to field ontology, are zones of high intensity of several fields. Movement of molecules is therefore change of field strengths. So, kinetic energy of molecules can be traced back to change of field strengths, hence temperature can be traced back to combinations of field strengths.

Secondly, some properties may be to be traced back to certain constant field intensities. A property E may be at a position P if and only if at P field L has intensity *a*, field M has intensity *b*, and field N has intensity *c*. (L, M, and N may be the only fields there are, or there may be other fields besides L, M, and N.) It would be intuitively reasonable if density were a property like that. What the density at a certain position is, in other words how much matter there is at a position or what the intensity of matter is at a position, depends on certain field intensities at that position.[10]

Thirdly, a property may be to be traced back to the integral of the intensity of one or several fields in a certain region. Mass might be an example of such a property. Mass is never mass at a certain point but always mass in a certain region, e.g. the region that is occupied by a stone. The mass in a region R is to be traced back to the volume integral (dV=dxdydz) of the density in R. Let us assume for the sake of illustration that there is a density field, whose intensity I call ρ. The mass M in region R (e.g. the mass of a stone in region R) is:

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[10] Campbell (1990, p. 146) considers whether there is a *matter* field. "Matter is not either fully present or completely absent; it is present with more or less intensity across all space-time." If there is a matter field then the intensity of the matter field at a position corresponds to the density at that position.

$$M(R) = \iiint_R \rho(x, y, z)dxdydz = \iiint_R \rho dV$$

I think that these examples justify the hope that common-sense properties can be traced back to combinations of field strengths.

I shall now confront field ontology with two central problems of ontology: the problem of determinables and the problem of completeness of things.

The problem of determinables

There are classes of single properties which exhibit a strong unity. A thing's having 1,1 g/cm³ and a thing's having 1,2 g/cm³ are closely related to each other. They are both *determinates* of the same *determinable*, 'having 1,1 g/cm³' is a determinate property (or "singular" property), 'having a density' is a determinable property (or "generic" property). Examples of other determinable properties are, e.g., temperature, mass, charge etc. But what does the unity of determinates of the same determinable consist in? Every ontology has to offer an account of determinable properties, and I think field ontology does quite well here. Evan Fales (1990, p. 227) and David Armstrong (1978b, p. 116), both realists, list five (putative) facts which any adequate theory of determinables must explain:

(1) The determinates of a determinable all have something in common, they form a unity. (E.g., all the determinate densities, 1,1 g/cm³, 1,2 g/cm³, and so forth, belong in some sense together.)

(2) At the same time they differ in that very respect (e.g. two different densities differ in density).

(3) Determinates of one determinable exhibit a resemblance order. (E.g., densities are ordered so that we can refer to them as '1,1 g/cm³', '1,2 g/cm³', and so forth.)

(4) Determinates of one determinable form a set-of-incompatibles. (E.g. no thing can wholly have at the same time the density 1,1 g/cm³ *and* the density 1,2 g/cm³.)

(5) If and only if a thing has a determinable property it necessarily also has the determinable to which the determinate belongs.

Field ontology offers an ontic structure which is parallel to the determinable-determinate structure. The connection between field and field strength corresponds to the connection between determinable and determinate property. For the sake of simplicity let us assume that density were a field. We can then say that the field corresponds to the determinable property and the field strength corresponds to the determinate property. There is a density at a certain position if the density field is at that position. Which density there is at that position depends on which intensity the field has at that position. If there is a density field at all, then this field is at every position, and has a certain intensity there, because a field is extended over all of space. In general terms, a determinable property G is at a position and at every position if the G-field, or the field or fields on which G is based, exists. A certain determinate of G is at a certain position if the G-field or the fields on which G is based have certain intensities. We can now explain the facts mentioned above as follows:

Ad 1: The determinates of one determinable form a unity because they are intensities of the same field. Densities have in common that they are different intensities of the density field. What density a certain thing has depends on what intensity the relevant field has in the region the thing occupies. All densities depend on the intensity of that field in the relevant region. If we talk about the density of a thing we talk about the intensity of the density field rather than the intensity of some other field. When we talk about the density of some thing we always talk about the intensity of the same field.

Ad 2: Different determinates of a determinable differ in that they are *different* intensities of the same field. If one thing has a density of 1 g/cm³ and another thing has a density of 2 g/cm³, then these two tropes are subdivisions of the same field, which are similar but not exactly similar.

Ad 3: The determinates of one and the same determinable exhibit a resemblance order because different positions of a field are more or less similar. The intensities of a field form a continuous spectrum. Assume D1, D2, and D3 are subdivisions of a field, say they are the density tropes of three things. If D1 is more similar to D2 than to D3, and if D3 is more similar to D2 than to D1, then the three tropes are ordered due to their resemblance in the order D1-D2-D3.

Ad 4: Two different determinates of one and the same determinable are incompatible with one another because a field cannot have two different intensities at one and the same position.

Ad 5: A thing cannot have a determinable property without having a determinate of it because a field cannot be in a region without having any intensity. A field is extended over all of space, it is in every region, and if a field is in a region then it has an intensity in this region.

The problem of completeness of things

I claimed above that there are certain limitations as to what combination of properties a concrete entity can have. The question then we are confronted with is why not every combination of tropes can exist. Why is it impossible that there is a thing which has all the properties the stone in front of me has except its density and which has no other density instead? If the stone in front of me is just a bundle of tropes – a density trope, a charge trope, a temperature trope etc. – why should it not be

possible to take one of those tropes away, as it is possible to remove a single twig from a bundle of brushwood?

I think an ontology should entail that only certain combinations of properties exist, but this view is not widely acknowledged. I mentioned already above that Campbell holds that there could be a single trope, which does not coexist with other tropes. Erwin Tegtmeier (1992, p. 51) claims that already a single state of affairs, i.e. a thing's having a certain property, can exist without being combined with other states of affairs. That implies that there could be, for example, this stone's having 2 g/cm³ without there being this stone's having a certain temperature and charge. Armstrong holds the same view when he writes: "The individual must, I think, instantiate at least one monadic universal" (1997, p. 44), by which he implies that there could be an individual with just one property.

One reason for holding that any combination of properties can exist is that this view is entailed by a combinatorial theory of possibility. According to combinatorialism the world is a certain stock of entities which are combined in a certain way. These entities could or can be combined in *any* way. Every combination of the existing entities is possible. If one holds combinatorialism and a trope ontology one will hold that any tropes can coexist (cf. Campbell 1990, pp. 93-95). If one holds combinatorialism and that there are individuals and universals, as Armstrong does, then one will hold that an individual may have any properties. It can have more or less properties, and it can have any combination of properties. Armstrong defends combinatorialism and concludes that a thing can have any combination of properties.[11] However, following my modal intuitions I think that entities such as a single density or a thing having all the properties of the stone in front of me except density are absurd and cannot exist. Therefore, I think that an ontology should

[11] See Armstrong 1989, p. 118. See also Armstrong's defence of his theory of possibility in his 1989, *A Combinatorial Theory of Possibility,* Cambridge UP.

reflect this fact and explain why such entities are impossible. It is only by an act of abstraction that we can think of an object as losing a determinate property without being replaced by another determinate of the same determinable. The properties of a thing are mutually dependent; only a complete object is capable of independent existence. Roman Ingarden has pointed out that the dependence of a concrete object on its determinate properties is an ambiguous dependence. An object that has the determinate property T_1 requires exactly one property T_i from the set of those determinate properties $\{T_1,..., T_n\}$ that belong to a certain determinable, but it is not determined which property from that set it requires.[12] Furthermore, there seems to be a certain set of determinables such that every thing, every subdivision of the material world, has exactly one determinate belonging to it. Every thing has a density, a charge etc.

This is explained by field ontology as follows: In any region of the physical world there are the same fields present. A field cannot be removed from the world, and there cannot be a hole in a field. At every place there has to be exactly one intensity of each of the fields the physical world consists of. This explains why there is – arguably – a certain set of determinables that is such that every object has to have exactly one determinate of each of the ranges of determinates that belong to these determinables. Thus, it is not arbitrary how many tropes a physical object – a region of the material world – consists of.

A trope ontology which assumes that middle-sized tropes, such as the density of a certain apple, are the basic entities of the material world could also claim that there is a set of determinables that is such that every object has to have exactly one determinate of each of the ranges of determinates that belong to these determinables, but it could not explain

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[12] See Ingarden 1965, p. 89. Ingarden distinguishes various kinds of ontological dependence. The dependence of an object on its tropes he calls 'vieldeutige Seinsunselbständigkeit' (ambiguous existential non-self-sufficiency).

why, it would not make perspicuous what the uniform structure of the world consists in. But shouldn't we expect that there is an explanation for the fact that there is the same structure of matter all over the universe? Field ontology offers such an explanation. It offers a simple model of the structure of the material world, which does justice to the uniform structure of the universe. The world consists of fields, a field is extended over all of space, hence there are the same fields everywhere.

Concluding remarks

According to field ontology the ontic structure of the world does not exactly correlate to the structure of our conception of the world and to the structure of language. Field ontology is, in Peter Strawson's term, a revisionary ontology. It is an attempt to describe the ontic structure of the world. It is not a description of our thoughts about the world, and it does not assume that the structures of our thinking about the world are exactly parallel to the ontic structures of the world. According to more traditional ontologies we can read off from how we speak about and conceive of the world what the ontic structures of the world are. If one starts from this assumption one is likely to end up with substance ontology, which is parallel to the subject-predicate structure of our language. However, the fact that we can carve up the world in different, apparently equally legitimate ways should make us sceptical that our divisions of the world into particulars depict ontic structures of the world. Field ontology is an attempt to do justice to this fact and to provide an ontological description of the world, i.e. of the stuff *of which* we can conceive in the way we do. I claim that a world which consists of fields looks like our world and is such that there can be portions of matter (subregions of the fields) of which we can conceive of as middle-sized things such as tables and eggs. If physics would confirm an Aristotelian Common Sense ontology according to which there is a table here and a bed over

there one meter away from it and there is nothing in between, then we should accept this ontology. But there is something in between, and physics has discovered structures of the world which are everywhere and which are everywhere the same, be it within this table, between this table and the bed, or between the sun and the moon. Field ontology does justice to the fact that there is the same structure everywhere by claiming that the world consists of fields which are extended over all of space, and it does justice to the fact that the world is different in different regions by claiming that fields have different intensities in different regions.

Is the world the totality of things? This seems to be obviously true, but we should be careful how we spell this claim out. It is not true, I have argued, that the material world is the totality of single things, substances, with a definite size each of which is somewhere in space and between which there is nothing. I have suggested that we better describe the world ontologically not as the totality of things or particles but rather as consisting of fields which are extended over all of space. *A priori* we may be inclined to think that the world consists of permanently existent particles, but we should be sceptical about this. David Bohm, in his *The Undivided Universe: An ontological interpretation of quantum theory* (1993), takes it to be a result of modern physics that the concept of a particle is to be questioned:

> As it is well known the concept of a permanently existent particle is not consistent with this theory [of relativity]. But rather it is the point event in space-time that is the basic concept. In principle all structures have to be understood as forms in a generalised field which is a function of all the space-time points. In this sort of theory a particle has to be treated either as a singularity in the field, or as a stable pulse of finite extent. The field from each centre decreases with the distance, but it never goes to zero. Therefore ultimately the fields of all the particles will merge to form a single structure that is an unbroken whole. (Bohm & Hiley 1993, *The Undivided Universe,* p. 352)

It seems that there are good reasons to believe that fields should have a future in ontology.[13]

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