Séminaire master Structures et relations en philosophie médiévale

et en philosophie des sciences contemporaines

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Objets et relations en philosophie contemporaine

Michael Esfeld, 18 octobre 2011

1) Trois distinctions au sujet des propriétés

- universals / particulars (tropes, modes): realism / nominalism

note: if there are qualitatively identical tokens of fundamental physical properties (e.g. mass, charge), you don't need universals to account for ressemblance, and universals cannot account for the numerical plurality of property tokens anyway.

- intrinsic / relations, relational: atomism / holism, structural realism (4 and 5 below)
- pure qualities, categorical / dispositions, powers: Humeanism / dispositional essentialism (6 below)

2) Trois théories du rapport entre objets et propriétés

- objects as bare particulars (primitive thisness, haecceity): Locke

objection: haecceitism leads to situations (possible worlds) that are indiscernible, but nonetheless different, since they differ in the bare particulars that instantiate the properties in question.

- objects as bundles of properties: Leibniz, Hume

note: makes physical sense only on the field view (handout for next week); furthermore, not clear whether objects could be conceived as bundles of relations

- properties as the modes (= the ways of being) of objects: Spinoza, Heil. There thus are objects, but objects and their properties (including relations) are given « at once », there being no ontological distinction between them, only a conceptual distinction.

3) Trois théories au sujet de l'identité des objets

adapted from Esfeld and Lam (2011), p. 144:

(a) The fundamental physical objects are equipped with an intrinsic identity: each fundamental physical object has intrinsic properties, that is, possesses properties that are independent of whether the object is alone or accompanied by other objects. These properties are furthermore such that they distinguish each object from all the other objects that there are in the world (Aristotle, Leibniz).

(b) The fundamental physical objects are not equipped with an intrinsic identity: they have (or at least can have) intrinsic properties, but no fundamental physical object has intrinsic properties that distinguish it from all the other fundamental physical objects. However, there are – asymmetric – relations that provide for identity conditions in that they distinguish each fundamental physical object from all the other ones. Time instants in Galilean space-time can serve to illustrate this situation: there are no intrinsic properties that distinguish each time instant from all the other ones. But the irreflexive and asymmetric relation "earlier than" does so.

(c) Neither intrinsic properties nor relations provide for identity conditions of the fundamental physical objects: two or more fundamental physical objects can have all the same intrinsic properties and stand in the same relations. If you take the formalism of

quantum theory literally, you can come to the conclusion that quantum systems are such objects, but it is difficult to say the least to spell out an ontology along these lines: How can two objects have an identical position (same position distribution) and yet be two objects?

4) Cinq théories du rapport entre objets et relations

adapted from Esfeld and Lam (2011), pp. 145-147:

(1) There are only objects, but no non-supervenient relations. Objects have only intrinsic properties. All physical relations are reduced to the intrinsic properties of objects in the sense that they strongly supervene on them. Suppose that mass is an intrinsic property of objects. Relations such as being heavier than, being lighter than, having the same mass as then supervene on the masses that objects have each independently of one another. If one sets out to account for what there is in the world, it suffices to mention the intrinsic properties; the relations then come for free. The intrinsic properties furthermore equip the objects with an intrinsic identity: there is at least one intrinsic property of each object by means of which it is distinct from all the other objects in the world. Leibniz proposes such a radical atomistic conception in his *Monadology* (1714), Ockham apparently did so before him.

This conception faces serious objections. At least spatio-temporal relations are generally admitted as being non-supervenient relations, even in classical physics. As is well known, Leibniz puts forward a good argument against spatio-temporal relations existing independently of matter in his correspondence with Newton-Clarke, but he by no means succeeds in showing spatio-temporal relations to supervene on intrinsic properties of objects.

(2) There are non-supervenient relations among objects – such as spatio-temporal relations –, but there is an ontological primacy of the objects (relata) over the relations (and thus over the structures they are part of) in the following sense: the objects are equipped with an intrinsic identity independently of the relations in which they stand and thus independently of the other objects that happen to be in the world. Relations are irrelevant as far as the identity of the objects is concerned.

Admitting non-supervenient relations among objects whose identity does not depend on these relations is the standard way in traditional metaphysics to conceive the relationship between objects and relations. David Lewis' thesis of Humean supervenience can be regarded as the most famous example of such an atomistic position within contemporary metaphysics: Lewis recognizes spatio-temporal relations as being non-supervenient relations that hold the world together. However, these relations do not contribute to the identity of the fundamental material objects. That identity is constituted by fundamental physical, intrinsic properties occurring at space-time points.

(3) There are relations as well as objects standing in the relations without there being any ontological priority between them. This view has to accept as a primitive that there is a numerical diversity of objects. Their numerical diversity is neither grounded in relations, nor is it grounded in intrinsic properties (since these do not constitute identity conditions for objects). Nonetheless, there is no question of haecceitism here. This conception has been developed as "moderate structural realism" in Esfeld (2004) and Esfeld and Lam (2008).

(4) Relations are ontologically primary and objects are ontologically secondary in the sense that they derive their existence from the relations in which they stand and thus from the structures they are part of. Objects are mere nodes within structures. The relations bear all the

ontological weight: objects are literally constituted by the relations in which they stand. To the extent that this view recognizes intrinsic properties, it has to reconstruct them on the basis of relations as well (see notably Ladyman and Ross 2007, chapter 2 to 4).

(5) There are only relations and no objects, thus no relata, in the domain of fundamental physics. There are only objectless structures in the sense of networks of relations without relata (French and Ladyman 2003).

Assessment: (1), (4) and (5) are not intelligible. (2) and (3) are the serious contenders. They are best conceived in terms of relations and intrinsic properties being the ways of being (modes) of objects.

5) Le réalisme structural

Physical structure: network of concrete relations among objects without these objects possessing an intrinsic identity, that is, an identity which is independent of the relations in which they stand.

6) Le réalisme structural et la modalité

- properties as pure qualities: quidditism objection. There are possible worlds that are indiscernible, but nonetheless different, since they differ in the pure qualities that play the nomological and causal roles instantiated in them (cf. the objection against haecceitism above).
- Structures cannot be pure qualities: the nomological role it plays is essential for a given structure. The decisive question then is: Is the nomological role of structures also a causal role?

Argument for affirmative reply: only if the structures are causal do they explain the phenomena (causal explanation)

Objection: spatio-temporal relations are the foremost example of irreducible relations (structures), but these are not causal.

Reply: (a) Space-time is no longer conceived as a passive background in general relativity theory. The spatio-temporal, metrical relations are gravitational relations and thus causal: they set matter in motion. (b) Such a view may already apply also to Newtonian mechanics if conceived along the lines of the holism paradigm (see handout for next week).

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Holisme et réalisme structural en philosophie des sciences

Michael Esfeld, 25 octobre 2011

1) Le paradigme atomiste

- matter in motion

Newton, *Opticks*, question 31:

> "… it seems probable to me, that God in the Beginning form'd Matter in solid, massy, hard, impenetrable, moveable Particles …; no ordinary Power being able to divide what God himself made one in the first Creation. … the Changes of corporeal Things are to be placed only in the various Separations and new Associations and motions of these permanent Particles."

- particles (atoms) located in space, forces to account for their acceleration
- the Leibnizian twist: spatio and temporal relations among particles, instead of space and time as substances; forces as properties of the particles (dispositions, causal theory of properties)
- the great advantage of this view: it makes the macroscopic world as we experience it intelligible
- the great problem for Newton: gravitation as action at a distance

Newton to Bentley, 25 Feb. 1692:

> "That gravity should be innate inherent & essential to matter so that one body may act upon another at a distance through a vacuum without the mediation of anything else by & through which their action or force may be conveyed from one to another is to me so great an absurdity that I believe no man who has in philosophical matters any competent faculty of thinking can ever fall into it."

- The field solution (Maxwell's theory of electromagnetism 1860): particles as sources of fields; local propagation of effects, thus upper limit of velocity with which effects can propagate

2) Le paradigme des champs

Einstein, in the special and then the general theory of relativity (1905, 1916) draws the consequences from the field solution. He poses the velocity of light as absolute (the same in any reference frame), and he endorses from Galilean and Newtonian physics the axiom that all reference frames are equivalent. The conjunction of these two axioms has radical metaphysical consequences, giving rise to what I would like to call the field paradigm by contrast to the atomism paradigm:

a) *no global time*: The spatial as well as the temporal distances between events are relative to a reference frame. Consequently, there is no global, unequivocal temporal order of events. Space and time are unified in four-dimensional space-time.

b) *no temporal becoming*: All what there is in space-time simply exists (block universe). Consequently, there is no temporal becoming. This view is incompatible with the production theory of causation (causation consisting in bringing something into existence), which is implied by the causal theory of properties (dispositional essentialism).

c) *event instead of particle ontology*: What there is in space-time are events instead of particles. There is no matter in motion, literally speaking. Persisting objects are construed as sequences of events with similar properties (perdurance instead of endurance). Motion and change are construed as variation in the properties instantiated at space-time points. This view suggests *super-substantivalism*: fields are not inserted in space-time, but properties of space-time points or regions. All there is in the universe are literally speaking properties of space-time points or regions.

3) Le paradigme holiste

Quantum physics implies that Einstein's field paradigm is not correct, because quantum physics violates Bell's theorem. There are non-local correlations among macroscopic measurement events which cannot be accounted for on the basis of a common cause that propagates at most with the velocity of light. The violation of Bell's theorem contradicts Einstein's guiding principle in building the theories of special and general relativity according to which all the factors that contribute to determining what there is at a space-time point are situated in the past light-cone of that point. This is the famous *non-locality* of quantum physics: the probabilities for certain measurement outcomes to be obtained at a certain space-time point are not completely determined by what there is in the past light-cone of that point; events that occur at points separated by a space-like interval from that point contribute to determining the probabilities for what happens at that point.

Ontic structural realism (OSR) seeks to account for these correlations in terms of non-separability: quantum objects stand in relations of entanglement (superpositions of correlations, as described by the quantum formalism). There are no intrinsic properties on which these relations could supervene (although quantum objects may have intrinsic properties such as mass and charge). The relations of entanglement thus are non-supervenient relations in addition to (and independent of) the spatio-temporal relations. They are more important non-supervenient relations, since they concern the very characteristics of matter (Ladyman 1998, Esfeld 2004). However, this account is unsufficient for the following two reasons:

a) *the lack of a dynamics*: OSR provides for an ontology, telling us what there is, namely certain structures, but it does not provide for a dynamics, remaining silent on the temporal development of the structures that it poses. Saying that there is a single non-separable entity (a structure) does nothing to account for the non-local correlations between the separate measurement outcomes. More precisely, it is not explained how a local interaction with that single entity results in separate, non-locally correlated events, without action at a distance being involved.

b) *the lack of a primitive ontology*: OSR sets out a scheme for an ontology, rather than constituting a concrete ontology. Saying that there are certain structures does not tell us what the entities are that implement these structures. OSR therefore has to be supplemented with a primitive ontology – primitive, because the ontology cannot be derived from OSR (or the quantum formalism), but has to be posed as that what OSR (or the quantum formalism) refers to. There are good arguments (Esfeld 2011, Esfeld forthcoming) for maintaining that the only available cogent ontology for quantum mechanics that includes a dynamics which is able to account for the measurement outcomes consists in posing particles that always have a definite position, as does

Bohmian mechanics (Dürr and Teufel 2009). Thus conceived, quantum mechanics is a mechanics like Newtonian mechanics, being about matter in motion, that is, particles which move in space.

How do we get from here to a solution to the action at a distance problem? By getting from an ontology of structures to a non-local dynamics in the sense of a holistic dynamics. More precisely, (a) the position of any given particle at a time derives strictly speaking from the state of the whole universe at that time; consequently, the position of the particles is a relational property, and the particles' being absolutely discernible in virtue of their positions does not amount to an intrinsic identity; (b) the way in which the position of any given particle develops in time (its trajectory) is not locally, but globally determined, depending on the position of all the other particles in the universe.

Consequences / open issues:

- On this view, there are structures of spatial relations between particles and their development in time, these structures developing as a whole according to a certain law. What about forces then? The radical, but consequent move is to say that mass (gravity) and charge (electromagnetism) are not additional, fundamental and then intrinsic, dispositional properties, but secondary, being ways in which the spatial relations among particles develop in time (matter in motion). The spatial relations thus are the fundamental and only causal properties (dispositional essentialism). But how do we get from this fundamental ontology to a law that reproduces the predictions of quantum mechanics (and quantum field theory)?
- This view presupposes more space-time structure than does the field view. But how exactly does it abrogate the axioms of Einstein's theories of special and general relativity?

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