What Mirrors the Mirror? Space-Time Structure as an Abstract Entity

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Abstract.

In recent years a growing number of philosophers of physics have defended a structuralist approach to the nature of space-time although critical voices have also been heard. Among the proponents of structural space-time realism one finds Dorato (2000) and Lusanna and Pauri (2007). Dorato concludes his paper by saying:

"[S]tructural spacetime realism remains as the only clear option, rejecting on the one hand the heavy metaphysical baggage of a substantival spacetime, and on other, the instrumentalist ploy of relationism, incapable of taking into account the explanatory role of geometrical laws and the causal potency of spacetime regarded as a property of the gravitational field."

However there are antagonists to this view, like Pooley (2006) who says in the beginning of his paper:

"The main thesis of this paper is that, whatever the interpretative difficulties of generally covariant spacetime physics are, they do not support or suggest structural realism."

I agree with Pooley, though I think that his own proposal of sophisticated substantivalism is not the right direction to go.

In the first part of my talk I try to show that structural spacetime realism is not a very feasible position as a response to the failure of substantivalism. In general, I think that structural realism suffers from a confusion of mathematical model and physical reality. According to an ontic structural realist, who focuses on structure rather than content, theories represent concrete structures, which means that a scientific theory is true or false with respect to some concrete relations and structures in nature. But how can we assign a truth value to a mathematical equation in virtue of actually existing structures if we understand its meaning in virtue of knowledge of abstract objects and relations? The structure of a theory does not correspond directly to some real structure but to the structure of some models which constitute the interpretation of the theory; i.e., a mathematical expression is structurally coherent with its models, and one of them may then be isomorphic with a real

structure. It remains a puzzle at least to me how we can understand a theory's structure by having access to the abstract structure of the models.

Indeed, nothing is wrong in seeking physical interpretations of mathematical structures. But such work should not be done by indiscriminately indentifying mathematical structures and physical reality. The proper way of physically interpreting a mathematical structure is by setting up constraints in virtue of assigning an empirical or experimental content to the model. If this is granted, there will not be much physical space-time structure left apart from that of the associated gravitational field.

In the second part I will therefore argue in favour of a kind of non-reductive relationism according to which space-time supervenes on fields and matter but as an abstract object. My claim is that like any other abstract entity space-time existentially depends on concrete physical entities such as fields and objects, but that it possesses abstract properties which are irreducible to concrete physical properties.

Dorato, Mauro (2000), "Substantivalism relationalism, and Structural Spacetime Realism," in *Foundations of Physics*, 30, 1605-1628

Lusanna, Luca and Mauro Pauri (2007), "Explaining Leibniz-equivalence as Difference of Non-inertial Appearances: Dis-solution of the Hole Argument and Physical Individuation of Point-events," in

Pooley, Oliver (2006), ´'Points, Particles, and Structural Realism," in Rickles, S. French & Staatsi (eds.) *The Structural Foundations of Quantum Gravity*, Oxford University Press.