

How to be a realist about relativistic spacetime without believing in magical explanations: The Dynamical Approach?

Recent discussion about the status of Minkowski spacetime in Special Relativity, fuelled by the publication of Harvy Brown's *Physical Relativity*, is primarily presented as a dispute about the arrow of explanation in SR. The dynamical approach, advocated by Brown (and originally by Oliver Pooley), would defend that in the explanation of relativistic effects, like length contraction, the arrow goes from the symmetries of the laws to the mentioned effects, with Minkowski spacetime being relegated to be a codification of the general structure of the phenomena (phenomena that are consequence of the invariance properties of the dynamical laws). On the contrary, the, let us call it, kinematical approach, defends a more standard view that places Minkowski spacetime as part of the *explanans* of these effects. If, then, one takes into account that such effects must be consequence of the laws, this means that the arrow of explanation goes from the symmetries of the spacetime structure to the symmetries of laws. Janssen (2008) is a clear presentation of the dispute in this terms and a defence of the kinematical approach.

On the other hand, it seems clear from the beginning that this dispute also has, perhaps primarily according to some (see Norton (2008)), an ontological dimension. Presented from this other angle, the now called constructivist intends to reduce spacetime structures to mere properties of matter; on the opposite side, the realist defends the autonomous existence of spacetime and the adaptation of matter laws to the geometrical constraints of such an entity. Norton forcefully argues that the constructivist, to be consistent, must provide full construction of spacetime structures from matter laws and that such a project either fails, as it must assume spacetime notions from the start, or it must accept an extreme form of operationalism.

The first aim of this paper is to argue that both ways of presenting the discussion, insofar as they are understood as mutually exclusive, are incomplete. The claim may seem obvious to some, as one may think that, in general, discussions about explanation always hide some ontological assumptions and that claims about ontological priority are only meaningful in an explanatory context. Whether this is the case or not in general, it is not usually considered so in the present discussion – Janssen for instance explicitly states that claims about the arrow of explanation in SR are ontologically neutral – and, I claim, this is fatal for the characterisation of the two sides of the dispute. I will argue this by showing, first, that the most promising strategy for providing an account of the explanation of relativistic effects in which Minkowski spacetime participates in the *explanans* is one that conceptualises the situation as an instance of some kind of formal or geometrical explanation. Then, I will argue that such a scheme does not allow to distinguishing between the two positions (the dynamical and the kinematical approaches) unless one introduces considerations about ontology.

Conversely, if one looks at the dispute coming from the side of ontology, a defence of the realist approach will never be complete unless one provides an account of why the symmetries of the matter laws must replicate those of the spacetime metric. This can be read indicating that an

ontological perspective that does not incorporate issues somehow related to explanation will appear as arbitrary.

Where does this leave us? I will defend, this is the second objective of the paper, that one can combine successfully the two dimensions in a coherent proposal. In a sense, this can be seen as giving response to Norton's challenge for the constructivist: to provide an alternative to the realist position. My take is that this can be done – at least if the realist position is understood, as Norton presents it, as defending the independent existence of a spacetime entity – but that this involves making explicit some of the spacetime assumptions of the construction instead of deriving the full spacetime from non-spatiotemporal laws. That this deserves to be thought as, in any sense, close to the dynamical approach has to do with understanding some of the spacetime assumptions as necessary conditions for the formulation of any matter law. Completion of the full project would involve stating the minimal spacetime assumptions that enter into the formulation of any dynamical law, providing a justification for them, and showing how in different theories different spacetime structures are completed.

My aim here is much more modest than attempting at fulfilling such a project. I will just show how, in the case of Minkowski spacetime in SR, one can identify some primitive spatiotemporal elements as well as some conventionalist ones as necessary for its construction starting from the matter laws. And I will argue that taking this into account provides an understanding of Minkowski metric that allows a satisfactory answer to the question about explanation in SR: it solves the main problem for the naïf realist position – namely, to account for the equality between dynamical and spacetime symmetries – and it provides a framework in which to explain the Lorentz invariance of matter laws.

Finally, I will also suggest how this project can be translated to the general relativistic context and how this sheds light on the interpretation of Einstein's Principle of Equivalence.

References

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