

Carl Hoefer

On causal explanations of inertia in GR

Abstract

Recently some philosophers have argued that Einstein's General Relativity theory gives an explanation of the phenomena of inertia that is better than what classical physics offered, and perhaps should even be considered the *first reasonable* explanation provided by a physical theory. (The *explanandum* here includes not only the paths followed by force-free bodies, but also the motions of bodies subjected to an outside (non-gravitational) force, so-called "pseudo-forces" experienced by accelerating or rotating bodies, etc.) What is not clear is whether the explanations offered by GR should be considered *causal* explanations.

The trouble with this latter question is that in order to answer it, one may feel obliged first to take a stand on what causation, itself, is; and this is an apparently intractable problem. But one can take a different approach to the question, inspired by Chris Hitchcock's approach in "Of Humean Bondage", and look at the "stage-one" facts – the kinds of facts taken as *inputs* by philosophical theories of causation, in order to determine (stage two) an *output*, i.e., an answer to the question "Does/did X cause Y?" Stage-one facts include things like: is Y counterfactually dependent on X? Is there a Salmon-Dowe style causal process linking X and Y? Are instances of X always, in our world, followed by instances of Y? – and so forth. These facts tend to be relatively uncontroversial, and this is as true in the case of GR and inertial motion as it is in the case of Suzy stealing a bicycle. Hitchcock recommends that we adopt a pluralistic approach when talking about causation, recognizing that there are a number of distinct types of *causal* relation that can hold between events, properties, event-types, and so forth. Taking the Hitchcock approach, then, we can see that the explanations of inertial phenomena offered in GR are indeed causal, with counterfactual dependence being the type of causal relation that is most relevantly involved.

Moreover, strikingly, GR gives us causal relations between inertia-here and distant matter elsewhere; relations that would seem to amount to "instantaneous action at a distance"! I will explore what GR says about the determination of local inertial structure, and argue that the most plausible explanatory/causal story is indeed a non-local "action at a distance" one, as purely local explanatory stories are not plausible alternatives.