

Another look at general covariance and the equivalence of reference frames

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Abstract

In his general theory of relativity (GR) Einstein sought to generalize the special-relativistic equivalence of inertial frames to a principle according to which all frames of reference are equivalent. He claimed to have achieved this aim through the general covariance of the equations of GR. There is broad consensus among philosophers of relativity that Einstein was mistaken in this. That equations can be made to look the same in different frames certainly does not imply in general that such frames are physically equivalent. We shall argue, however, that Einstein's position is tenable. The equivalence of arbitrary frames in GR should not be equated with relativity of arbitrary motion, though. There certainly are observable differences between reference frames in GR (differences in the way particles move and fields evolve). The core of our defense of Einstein's position will be to argue that such differences should be seen as fact-like rather than law-like in GR. By contrast, in classical mechanics and in special relativity (SR) the differences between inertial systems and accelerated systems have a law-like status. The fact-like character of the differences between frames in GR justifies regarding them as equivalent in the same sense as inertial frames in SR.

Keywords: General covariance; equivalence; relativity; reference frames

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