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The flow of time as a selection rule in general relativity

The Lorentz-covariance of special-relativistic formulae expresses the special (or restricted) principle of relativity, stating that all fundamental laws of nature have the same form in all inertial frames of reference. As a consequence of this principle, the theorem of corresponding states holds. According to it, if a physical phenomenon is possible, then every transformation from the Poincaré group, interpreted actively, generates from its description in a given inertial frame a description of a possible phenomenon in this frame.

All transformations from the Poincaré group are isometries of special-relativistic space-time. In other words, the space-time pseudo-metrics is an absolute element of the structure of such space-time. The matter is otherwise in general-relativistic space-time, where the pseudo-metrics is a dynamic element. There is consent that, in general, transformations from the group of covariance of general-relativistic laws do not allow for active interpretation. Thus, one might conclude that no generalization of the theorem of corresponding states seems to hold. On the other hand, it would be a clear exaggeration to say that general covariance has no physical content. The truth lies most probably somewhere in between.

If the above conjecture is right, then, after all, some analogue of the theorem of corresponding states must hold, but it cannot go so far as to make active interpretation of all transformations from the covariance group possible. However, such restriction is not inherent in general-relativistic laws, but comes from outside. This would mean that generally covariant laws are in a definite sense too general. In particular, Einstein equations have too many solutions. Thus, some selection rule is needed, which would help in eliminating non-physical solutions.

The special theory allows for two interpretations: Minkowskian and Lorentzian. Only the latter is compatible with the notion of the flow of time, or temporal becoming. There are strong ontological reasons for treating this notion seriously. Thus, it would be quite natural to demand that all physically significant cosmological models should allow for Lorentzian interpretation. This kind of model should either contain some absolute relation of simultaneity that is necessary for temporal becoming, or at least allow for supplying its space-time structure with such relation. This restriction would eliminate, e.g., monsters like the (in)famous Gödel's model.

The seemingly most natural candidate for this kind of absolute simultaneity is the synchronicity in the cosmic time. Thus, one might object that realistic cosmological models do not contain cosmic time, because of containing singularities. However, it is by no means obvious that „true" time must be identical with the cosmic time. On the contrary, in some models, e.g., in Milne's model, the cosmic time clearly does not coincide with „true" time, since the clocks of fundamental observers undergo time dilation depending on their absolute motions. This opens the possibility that there might be „true" time even in the absence of cosmic time.