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Newtonian regime and topology: consequence for the role of spatial curvature in cosmology

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The standard model of cosmology currently allows for three types of geometries (or topologies) for our Universe (Euclidean, spherical or hyperbolic), each of these types corresponding to a set of different (multiconnected)-topologies. Among these geometries, Newton's theory of gravity is only defined on the Euclidean one. Still, extending the validity of this theory to the other two cases (called a non-Euclidean Newtonian theory), with the aim that this should constitute the limit of a relativistic theory of gravity, could provide a strong theoretical tool to probe large scale effects of global topology. We will see that Einstein's equation is actually incompatible with such a theory. Therefore this equation must be modified in the hypothesis where we require the relativistic theory describing our Universe to be compatible with the presence of a Newtonian regime in any topology. I will present such a modification which is based on Rosen's bi-metric theory. Its main consequence is that the expansion law of a homogeneous and isotropic solution no longer features the spatial curvature (i.e. $\Omega = 1,\ \forall \Omega_k$), asking for a reevaluation of that curvature from cosmological data.

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