

Inhomogeneity and the Curvature of the Spacelike Cosmos

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Abstract

In the Friedman Model of cosmology the spacelike universe is assumed to have constant sectional curvature so that locally it is curved like a sphere, Euclidean Space, or hyperbolic space. This assumption is justified if one assumes that it is a locally isotropic complete Riemannian manifold. That is, if one assumes that at every point $p \in M$, there is an $R > 0$ and a function F_p such that the length of the far side of a geodesic triangle with angle θ at p and adjacent sides of lengths $s, t < R$ is given by $F_p(\theta, s, t)$, then by Schur's Lemma, M has constant sectional curvature. Note that this F_p formula is like having a law of cosines.

Here we show that if the space is only locally "almost" isotropic in the sense which allows for both the weak and strong gravitational lensing that has been observed, then the space is close to a space of constant sectional curvature in the Gromov Hausdorff sense but not in a smooth sense. We also prove that the formulas for F_p are uniformly close to the corresponding formulas in a space with constant sectional curvature, thus allowing one to estimate the distance between stars using formulas based on the Friedman model.