

Light propagation and the average expansion rate in near-FRW universes

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We consider universes that are close to Friedmann-Robertson-Walker in the sense that metric perturbations, their time derivatives and first spatial derivatives are small, but second spatial derivatives are not constrained. We show that if we in addition assume that the observer four-velocity is close to its background value and close to the four-velocity which defines the hypersurface of averaging, the redshift and the average expansion rate remain close to the FRW case. However, this is not true for the angular diameter distance. The four-velocity assumption implies certain conditions on second derivatives of the metric and/or the matter content.

Comments: 27 pages, no figures. v2: Published version. Added references and clarifications, corrected a typo

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