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Testing the distance-duality relation to probe the morphology of galaxy clusters

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Abstract. Aiming at comparing different morphological models of galaxy clusters, we use two new methods to construct a cosmological-model-independent test of the distance-duality (DD) relation. The luminosity distances come from the Union2 compilation of Type Ia supernovae. The angular-diameter distances are given by the two cluster models of De Filippis *et al.* and Bonamente *et al.* The advantage of our new methods is that they can lead to reduced statistical errors. The morphologies of the cluster models are mainly focused on a comparison between the elliptical and spherical β models. The spherical β model is divided into two groups, in terms of different reduction methods of angular-diameter distances, i.e. the conservative and corrected spherical β models. Our results show that the DD relation is consistent with the elliptical β model at the 1σ confidence level (CL) for both methods, whereas for almost all spherical β-model parameterizations the DD relation can only be accommodated at the 3σ CL, particularly for the conservative spherical β model. To minimize systematic uncertainties, we also apply the test to the overlap sample, i.e. to the same set of clusters modeled by both De Filippis *et al.* and Bonamente *et al.* The DD relation is compatible with the elliptically modeled overlap sample at the 1σ CL; however, for most parameterizations the DD relation cannot be accommodated even at the 3σ CL by any of the two spherical β models. Therefore, it is reasonable that the marked triaxial ellipsoidal model is a better geometric hypothesis describing the structure of galaxy clusters than the spherical β model if the DD relation is valid for cosmological observations.

Keywords. cosmic background radiation, cosmology: observations, distance scale, galaxies: clusters: general, X-rays: galaxies: clusters