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Challenging LCDM and the isotropy of the local Universe with galaxy clusters

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The hypothesis that the late Universe is isotropic and homogeneous is a cornerstone of the standard cosmological model. The cosmic expansion rate H0 (i.e. Hubble constant) is assumed to be spatially constant, while coherent matter flow motions (bulk flows) are believed to be negligible at cosmic scales. Any deviation from this consensus can put the validity of the standard cosmological model under question. Scaling relations of galaxy clusters are a powerful probe of cosmic isotropy. By measuring many different cluster properties (that do or do not depend on cosmology), several scaling relations with different cosmological sensitivities can be built. Nearly independent tests of cosmic isotropy and large bulk flows are then feasible. We use up to 570 clusters with measured properties at X-ray, microwave, and infrared wavelengths to construct ten different cluster scaling relations and test the isotropy of the local Universe. Through rigorous and robust tests and by combining all available information, we detect an apparent 9% spatial variation in the local H0, at a >5.5 sigma level. The observed anisotropy has a nearly dipole form. Alternatively, our findings could also be attributed to a 900 km/s cluster bulk flow, which seems to extend out to at least 500 Mpc. Both of these scenarios strongly challenge LCDM. Future tests with more distant clusters and new cluster measurements will provide further insights on these exciting findings.

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