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Anisotropic Superclustering of Cosmic Gas: an analysis with ACT+Planck and DES data

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The distribution of baryons in the cosmic web contains a wealth of cosmological and astrophysical information. In particular, measurements of the hot gas in anisotropic structures—such as filaments and superclusters—are important for the census of cosmic baryons. Such localized anisotropic measures can also provide cosmological information beyond two-point statistics and help to constrain models of baryonic feedback. Although hot gas is observable in CMB data through the the thermal Sunyaev-Zel'dovich (tSZ) effect, the signals from low-mass halos and unbound filament gas are weak, necessitating the use of stacking methods to boost signal-to-noise. By applying oriented stacking in selected regions of the cosmic web, we measure the anisotropic large-scale superclustering of thermal energy around galaxy clusters in tSZ maps from the Atacama Cosmology Telescope and Planck satellite. We compare with oriented measurements of galaxy density and weak lensing from Dark Energy Survey data. Our analysis probes the projected relationships between hot gas, galaxies, and the underlying matter density in filaments and superclusters. Comparisons to theory and simulations elucidate some of the successes and limitations of the current modelling of cosmic baryons.

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