LoCuSS: The Sunyaev-Zel'dovich Effect and Weak Lensing Mass Scaling Relation

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We present the first weak-lensing-based scaling relation between galaxy cluster mass, M_wl, and integrated Compton parameter Y_sph. Observations of 18 galaxy clusters at z~0.2 were obtained with the Subaru 8.2-m telescope and the Sunyaev-Zel'dovich Array. The M_wl-Y_sph scaling relations, measured at Delta=500, 1000, and 2500 rho_c, are consistent in slope and normalization with previous results derived under the assumption of hydrostatic equilibrium (HSE). We find an intrinsic scatter in M_wl at fixed Y_sph of 20%, larger than both previous measurements of M_HSE-Y_sph scatter as well as the scatter in true mass at fixed Y_sph found in simulations. Moreover, the scatter in our lensing-based scaling relations is morphology dependent, with 30-40% larger M_wl for undisturbed compared to disturbed clusters at the same Y_sph at r_500. Further examination suggests that the segregation may be explained by the inability of our spherical lens models to faithfully describe the three-dimensional structure of the clusters, in particular, the structure along the line-of-sight. We find that the ellipticity of the brightest cluster galaxy, a proxy for halo orientation, correlates well with the offset in mass from the mean scaling relation, which supports this picture. This provides empirical evidence that line-of-sight projection effects are an important systematic uncertainty in lensing-based scaling relations.

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