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Analytical model for non-thermal pressure in galaxy clusters

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I will present an analytical model we recently developed for intracluster non-thermal pressure in the virial region of relaxed clusters. The core of this model is a first-order differential equation describing the evolution of non-thermal velocity dispersion. This equation is based on insights gained from observations, numerical simulations, and theory of turbulence. It describes that the non-thermal energy is sourced, in a self-similar fashion, by the mass growth of clusters via mergers and accretion, and dissipates with a time scale determined by the turnover time of the largest turbulence eddies. Our model predicts a radial profile of non-thermal pressure for relaxed clusters. The non-thermal fraction increases with radius, redshift, and cluster mass, in agreement with numerical simulations. The radial dependence is due to a rapid increase of the dissipation time scale with radii, and the mass and redshift dependence comes from the mass growth history. Combing our model for the non-thermal fraction with the Komatsu-Seljak model for the total pressure, we obtain thermal pressure profiles, and compute the hydrostatic mass bias. We find typically 10% bias for the hydrostatic mass enclosed within r500.

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