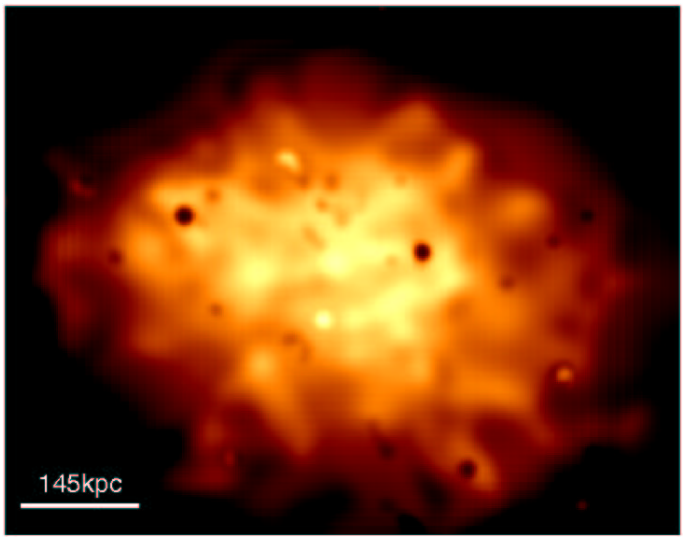
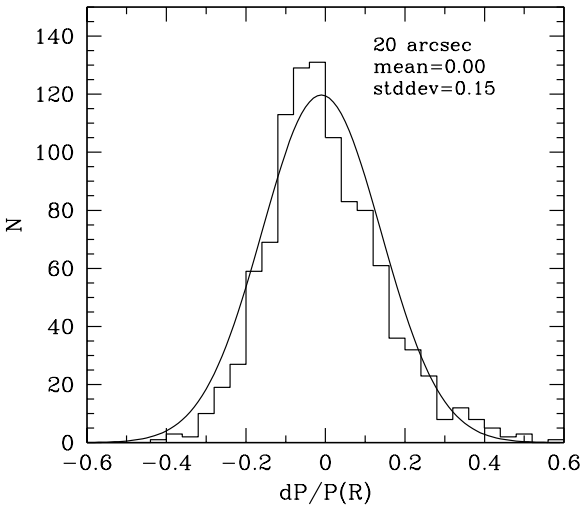
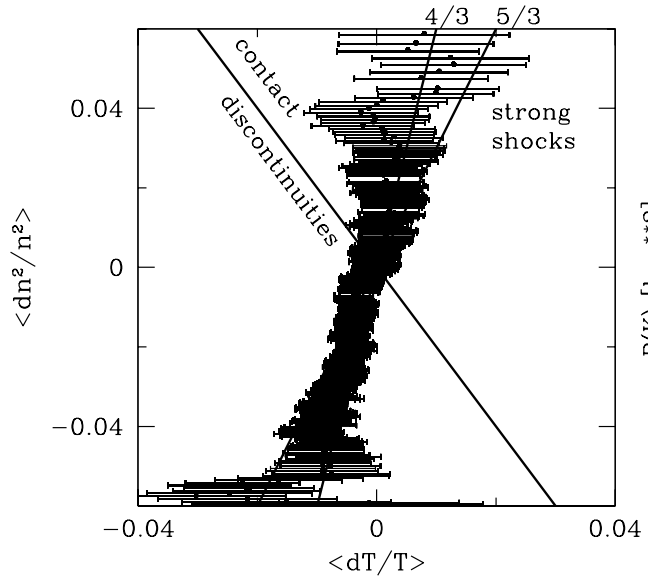
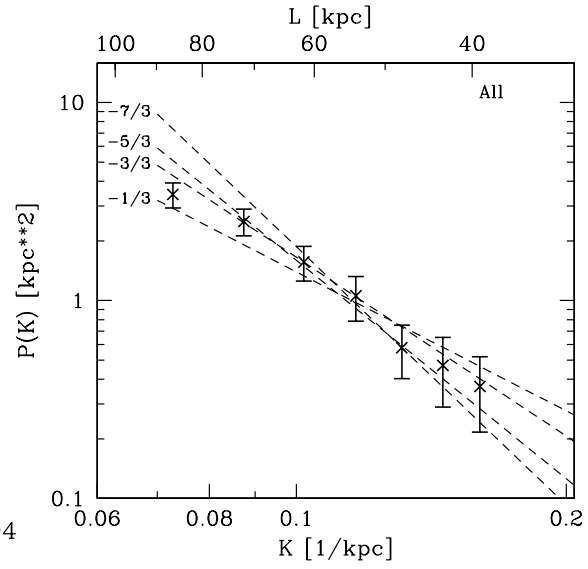
Probing Turbulence in the Coma Galaxy Cluster

Spatially-resolved gas pressure maps of the Coma galaxy cluster are obtained from a mosaic of XMM-Newton observations in the scale range between a resolution of 20 kpc and an extent of 2.8 Mpc. A Fourier analysis of the data reveals (for the first time) the presence of a scale-invariant pressure fluctuation spectrum in the range between 40 and 90 kpc and is found to be well described by a projected Kolmogorov/Oboukhov (KO) -type turbulence spectrum. Deprojection and integration of the spectrum yields the lower limit of ~ 10 percent of the total intracluster medium pressure in turbulent form. The results also provide observational constraints on the viscosity of the gas. Projected pressure maps (upper left) are used for the analyses to minimize the effects of contact discontinuities and strong shocks. The Gaussianity of the normalized residual pressure fluctuations (upper right) and the correlations between relative density and temperature gradients close to the adiabatic value (lower left) give further evidence for a turbulent intracluster medium in the center of Coma. The power spectrum is well fit by projected KO spectra with reasonable slopes (lower right). Simulations show that a 100 ks pointing with the XRS instrument onboard the Astro-E2 satellite (to be launched Feb. 2005) will enable us to confirm the presence of a turbulent plasma ($\sigma_v \geq 100$ km/s) as a significant kinetic Doppler broadening of the line widths of the Fe K-line complex in excess to thermal broadening.









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