The Mass Function of an X-Ray Flux-Limited Sample of Galaxy Clusters, Preliminary Results

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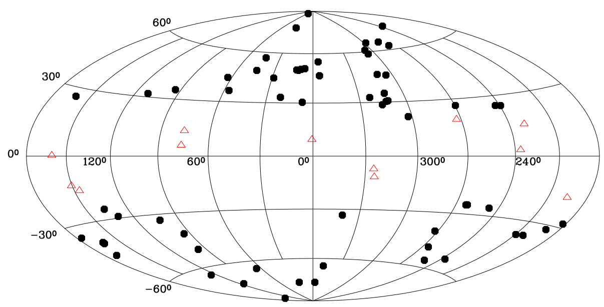
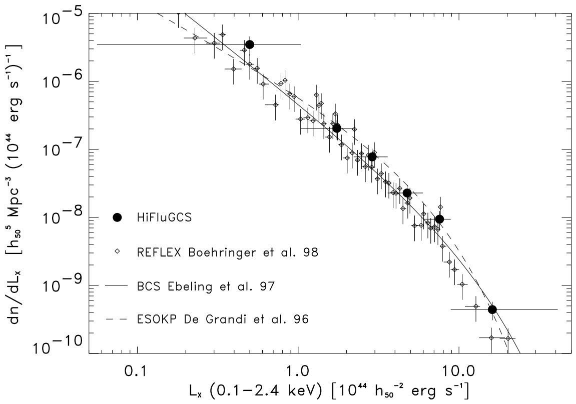
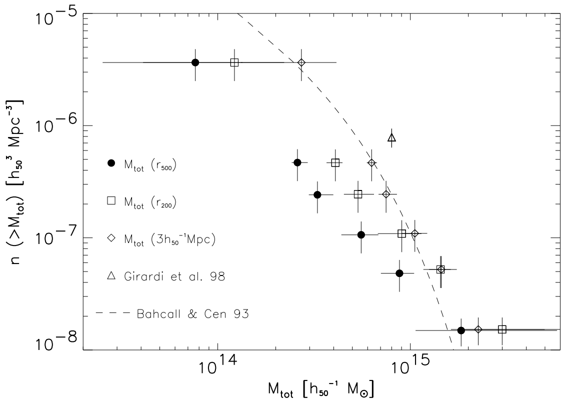
Introduction: Distribution functions of physical parameters of galaxy clusters can place important constraints on cosmological scenarios. Comparison with analytical or numerical calculations can yield, e. g., the amplitude of the initial density fluctuations. The most important quantity to be compared to models is the gravitational mass of the clusters.

The Sample: Completeness of a cluster sample is essential for the construction of the mass function. We are in the process of creating a purely X-ray selected sample of high flux clusters by analysing the ROSAT All-Sky Survey (RASS) using an extent criterium. Up to now the sample (called HiFluGCS) consists of clusters compiled from RASS-based cluster surveys of high completeness (REFLEX, NORAS, Böhringer et al. in prep.) with a flux limit much deeper as the one adopted here ($f_{\rm X}(0.1\text{–}2.4\,{\rm keV}) \geq 2.0 \cdot 10^{-11}\,{\rm erg/s/cm^2}$). Also other published cluster catalogs have been checked. Exclusion of the galactic band leaves us with a sky coverage of roughly 2/3 of the sky. HiFluGCS now consists of 63 clusters.







Upper left: Distribution of the clusters in galactic coordinates. Red triangles indicate clusters whose positions lie in the direction of the Milky Way and are therefore not included in HiFluGCS.
Upper right: X-ray luminosity function.
Lower right: Cumulative gravitational mass function. The symbols correspond to different definitions for the outer boundaries of the clusters. For comparison with previous determinations the masses determined within a fixed radius are plotted.

The Masses: With the ASCA and ROSAT pointed observations (POBS) high quality data are now available for many of the clusters in HiFluGCS. The gravitational mass ($M_{\rm tot}$) has been determined individually for each cluster in a homogeneous way using mainly higher exposure POBS. Fitting a standard β-model to the surface brightness profile of the X-ray emitting intracluster gas (ICM) gives the ICM density profile. Using then the hydrostatic equation we have determined $M_{\rm tot}$-profiles assuming isothermality of the ICM. To assure validity of the hydrostatic equilibrium and to treat clusters of different size in a uniform manner we have determined $M_{\rm tot}$ of the clusters at the radius r_{500} (r_{200}) where the mean total density equals 500 (200) times the critical density.

Conclusions: The derived luminosity function agrees well with previous determinations. The mass function differs from previous determinations in particular towards smaller masses. The main reason is the difference in the adopted outer boundary of the clusters. We suggest to use a radius dependent on the mean density, since for approximately self similar clusters the characteristic radius scales as $r_{\rm char} \propto {M_{\rm tot}}^{1/3}$.
Integration of the mass function yields the matter density bound in clusters $\rho_{\rm bound}$. Relative to the critical density we find $\rho_{\rm bound} = 1.0\%$ (1.6%) for clusters with masses $\geq\ 2.5 \cdot 10^{13} h_{50}^{-1} {\rm M}_\odot$ $(4.1 \cdot 10^{13} h_{50}^{-1} {\rm M}_\odot)$. Thus only a small fraction of the total mass in the Universe is bound in clusters.