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XMM–NEWTON observation of Abell 1835 : temperature, mass and gas mass fraction profiles

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Abstract. We present a study of Abell 1835 based on observation of the EPIC cameras aboard XMM–NEWTON. We find a temperature profile up to 1.8 Mpc which is basically flat outside the cooling flow region. Fitting a β-model and assuming hydrostatic equilibrium allow us to determine a gas mass fraction of $0.18\,h_{50}^{-1.5}$ at 70% of the virial radius.

1. Introduction

Abell 1835 is a medium distant (z∼0.25) galaxy cluster which was observed during June 2000 with XMM–NEWTON. We concentrate on EPIC–MOS2 and –PN cameras. The study of Abell 1835 using RGS spectrometer was made by Peterson et al. (2001). We use the remarkable spatial and spectral resolution of XMM–NEWTON to determine the temperature, mass and gas mass fraction profiles with unprecedented accuracy.

2. Imaging

In order to estimate the gas mass, we use the β-model : $S(r) = S_0(1 + (r/r_c)^2)^{-3\beta+0.5}$. Figure 1 shows the cluster in the 0.3 to 3 keV energy band. From the data we calculate S. And its fit give us : $\beta = 0.704 \pm 0.005$ and $r_c = 202.3 \pm 7.1$ kpc (68% confidence level).

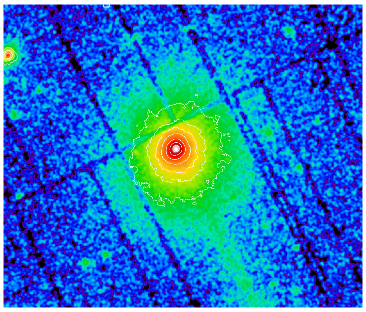

Figure 1. 0.3–3 keV MOS2+PN image of Abell 1835 filtered with a Gaussian.

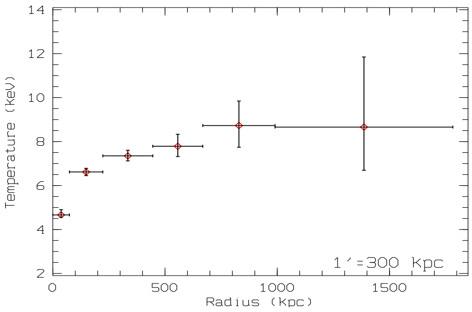

Figure 2. Temperature profile derived from a combined MOS2+PN fit.

3. Temperature profile

All the spectra we use for temperature estimates are vignetting corrected (see Arnaud et al. 2001) and background corrected (see Majerowicz et al. 2001). We fit with a Mekal code associated with a photo electric absorption fixed at the galactic value of $2.24 \times 10^{20}\,\mathrm{cm}^{-2}$. Figure 2 shows the resulting temperature profile up to 1.8 Mpc from the cluster center. We confirm a temperature drop towards the center of the cluster which is generally associated with a cooling flow (Allen et al 1996). Outside the cooling flow region the temperature profile is flat with a mean value of 8.2 keV.

4. Mass profiles

To calculate the gas mass profile, we use the β-model fit parameters (section 2). Figure 3 shows the corresponding results. The hydrostatic equation and the Monte–Carlo method by Neumann & Böhringer (1995) are used to estimate the gravitational mass (see figure 3). At a radius of 1.7 Mpc ($0.7\,r_{200}$), $\mathrm{M_{gas}} = 2.56 \pm 0.08 \times 10^{14}\,\mathrm{M_\odot}$ and $\mathrm{M_{tot}} = 1.40 \pm 0.21 \times 10^{15}\,\mathrm{M_\odot}$.

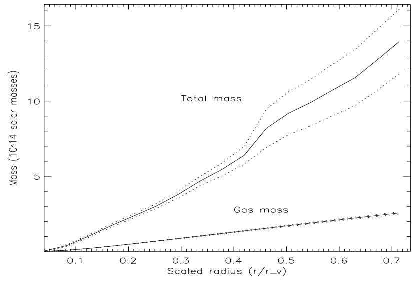

Figure 3. Mass profiles.

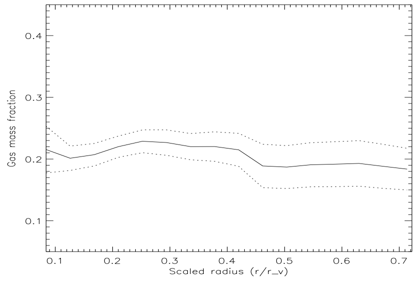

Figure 4. Gas mass fraction profile.

From this two mass calculations, we are able to estimate the gas mass fraction f_b (figure 4) at $0.183 \pm 0.034\,h_{50}^{-1.5}$ (68%). Extrapolating our found f_b throughout the Universe (White et al. 1993) with recent result on Ω_b (Burles et al. 2001) based on primordial nucleosynthesis, we find $\Omega_m = 0.43 \pm 0.10 h_{50}^{-0.5}$ (68%). It is an upper limit since we do not account for other baryon contributions.

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