Outskirts of Galaxy Clusters: Intense Life in the Suburbs
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Temperature and metallicity maps in cool core clusters of galaxies

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1. Observation and data analysis

We have analized XMM-Newton data of A2199, a nearby ($z = 0.030$), relaxed, rich cluster of galaxies, whose X-ray emission is strongly peaked on the central galaxy, NGC6166, suggesting the existence of a cluster cool core (Peres *et al.* 1998).
The background subtraction is performed using an observation characterized by features similar to those of the A2199 observation. We have selected, in the XMM-Newton archive, a field observation presenting the following properites:
• duration of about 90 ksec;
• performed with the same filter as the A2199 observation;
• characterized by a galactic HI column density and a soft X-ray background, the latter being calculated from the ROSAT All-Sky survey diffuse background maps, which differ from those of the A2199 observation ($N_H = 8.7 \times 10^{19}$ cm^{-2}, $R_{45} = 208.2 \times 10^{-6}$ cts/arcmin^2) by 3% and 30% respectively.

We have accumulated spectra from 9 concentric annuli, out to 12 arcmin, centered on the X-ray emission peak and have fit them with a single temperature model (mekal * wabs model in XSPEC) in the $1.5 - 10.0$ keV spectral band, well suited for temperature measurements in the range $kT \sim [3, 5]$ keV.

We have then deprojected the radial profiles using the technique described in Ettori *et al.* (2002).

2. Results

2.1. *Projected profiles*

Here we present the projected profiles of temperature and iron abundance (Fig. 1) plotted together with Chandra and BeppoSAX profiles derived from Johnstone *et al.* (2002) and De Grandi & Molendi (2001, 2002).

While the temperature profiles derived from XMM-Newton and Chandra data show a remarkable agreement, the comparison between BeppoSAX and our data points toward a systematic difference of about 10%, already noted in the Coma cluster: 0.8 keV on a temperature of 8.2 keV (De Grandi & Molendi, 2002).

There is a clear difference in the abundance profiles of XMM-Newton and Chandra. This difference could be due to the proximity of the $Fe - K_\alpha$ line at 6.7 keV, used to mesure the metallicity, to the spectral upper limit in Johnstone *et al.*'s analysis (7.0 keV).

2.2. *Deprojected profiles*

We have deprojected radial profiles using the method indicated by Ettori *et al.* (2002), obtaining three-dimensional profiles for temperature, abundance (see Fig. 2), electron density (n_e), emissivity (ϵ), cooling time (t_{cool}), pressure (see Fig. 3 left panel), entropy, gravitational mass, iron mass and iron mass excess (see Fig. 3 right panel).

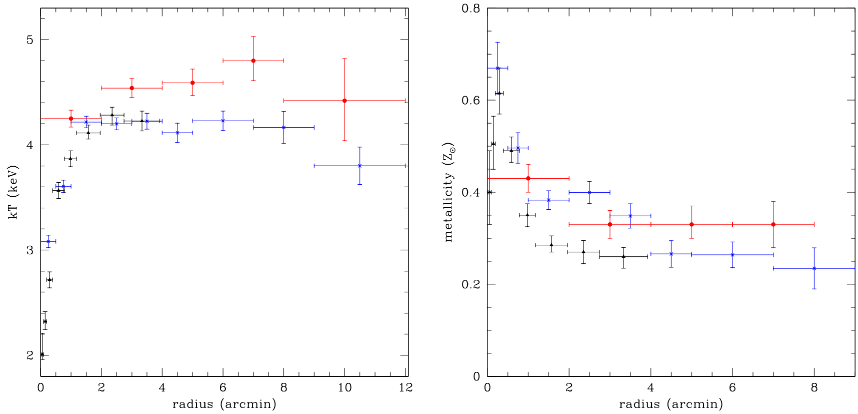

Figure 1. Temperature (left) and iron abundance (right) projected profiles: blue, red and black points are, respectively, for XMM-Newton, BeppoSAX and Chandra data.

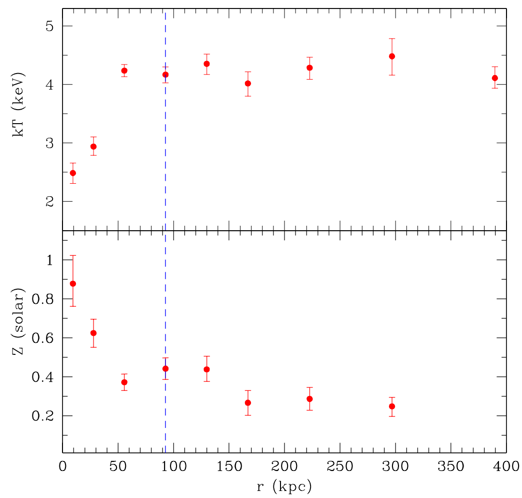

Figure 2. Temperature and iron abundance deprojected profiles.

The radius within which the temperature (abundance) profile decreases (increases) is about a factor of 2 smaller than the cooling radius, estimated from the t_{cool} profile. The value of r_{cool} is about 95 kpc, in good agreement with previous estimates by Perez *et al.* (1998) and Johnstone *et al.* (2002).

The total iron mass excess is 6.3×10^8 $M_\odot$, a factor of 2 smaller than previously estimated in De Grandi *et al.* (2003) with BeppoSAX data. The discrepancy could be due to the differences between the projected metallicity profiles (see Fig. 1).

References

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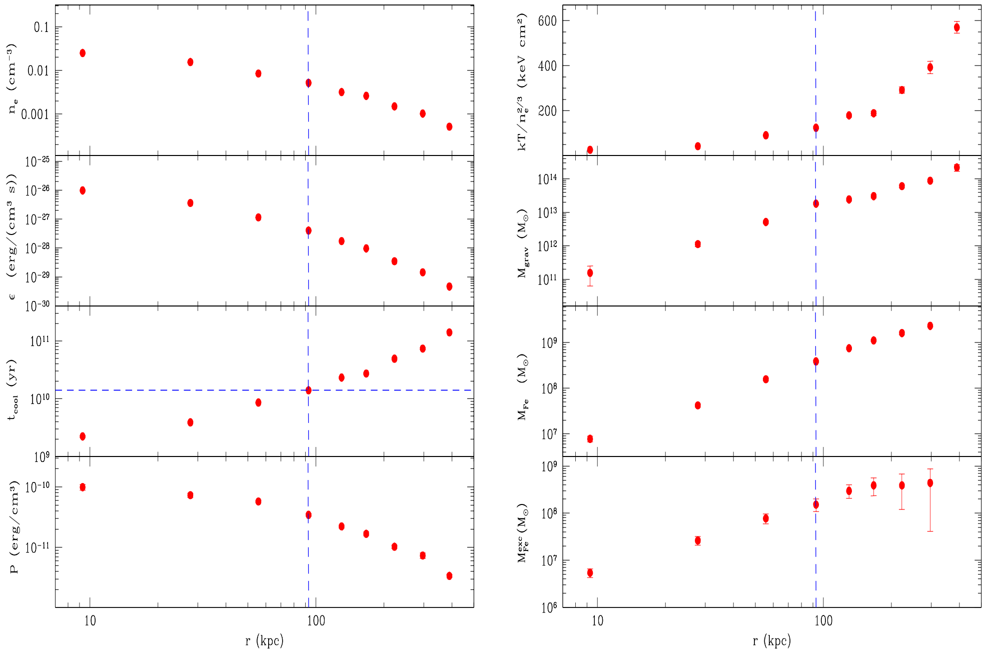

Figure 3. Deprojectd quantities of A2199: n_e, ϵ, t_{cool}, P in the left panel, entropy (defined as $kT/n_e^{2/3}$), M_{grav}, M_{Fe} and M_{Fe}^{exc} in the right panel.

Ettori S. *et al.* 2002 A&A **391** 841
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