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SPECTRAL ANALYSIS OF THE *Chandra* OBSERVATION OF THE CLUSTER OF GALAXIES A1795

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We present spatially-resolved X-ray spectroscopy of the central 300 h_{50}^{-1} kpc of the cooling flow cluster of galaxies Abell 1795 made with the *Chandra* observatory. The data for the inner ~ 150 kpc indicate the presence for a strong cooling flow with an integrated mass deposition rate of about 200 $M_{\odot}$ yr^{-1}. The plasma temperature rises moving outwards in the cluster by a factor of 2, whereas the metal abundance decreases from $0.54^{+0.06}_{-0.05}$ to $0.23^{+0.04}_{-0.07}$ times the solar abundance over the same radial range (1σ error-bar).

1 Introduction

Abell 1795 is a nearby (z =0.063) rich cD galaxy cluster with one of the more massive cooling flows known (Edge et al. 1992, Fabian et al. 1994, Briel & Henry 1996, Markevitch et al. 1998). Strong emission lines from the nebulae around the cD galaxy (Cowie et al. 1983) and excess in the blue optical light (Johnstone, Fabian & Nulsen 1987) probably due to the formation of massive stars also triggered from the central radio source 4C 26.42 (McNamara et al. 1996) support the scenario in which the central peak of cooler gas (Xu et al. 1998; Allen 2000) is evidence of a cooling flow (Fabian 1994).

The *Chandra* (Weisskopf et al. 2000) observation of A1795 (Fig. 1) is one of the Guarantee Time Targets of A.C. Fabian for studies of cooling flow galaxy clusters. The spatial analysis of the *Chandra* observation is presented elsewhere (Fabian et al. 2000). Here we discuss the 20 ksec exposure of the *Chandra* Back-Illuminated CCD done on December 1999 when the Focal Plane had a temperature of –110°.

2 Spectral analysis

We use both single–phase and multi–phase models, considering that we are mapping the central part of the cluster core. The single–phase model just assumes an emission from an optically–thin plasma (MEKAL –Kaastra 1992, Liedhal et al. 1995– in XSPEC v. 11.0.1 –Arnaud 1996) absorbed by a column density that we have left free to vary. The multi–phase model combines a thermal emission from the ambient gas with a continuous distribution of gas states represented by

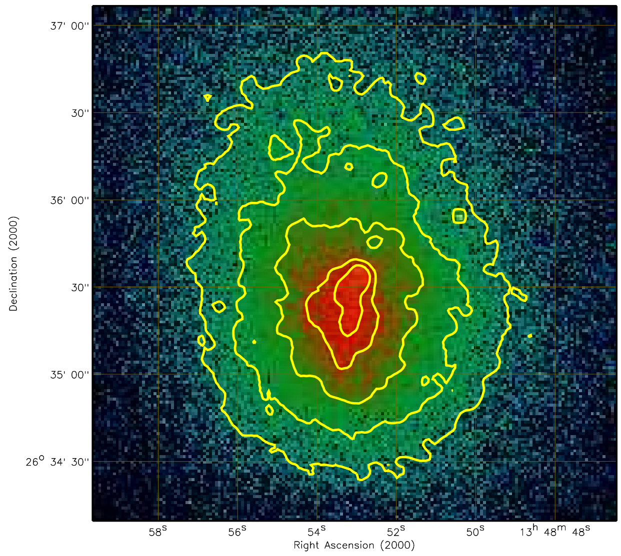

Figure 1: Smoothed image of the *Chandra* S3-CCD observation A1795.

a cooling–flow model written by R. Johnstone. The cooling–flow model is intrinsically absorbed by an uniformly distributed amount of hydrogen atoms per cm^2 at the cluster redshift that is left free to vary during the search for a minimum χ^2. The temperature and metallicity of the cooling–flow model are fixed to be equal to the ones of the thermal component.

The results of the spectral analysis are presented in Fig. 2 (an example of *Chandra* spectra are shown in Fig. 3).

The mass deposition rate within a given radius in the cluster cooling flow is estimated through the spectral fit of circular regions with a multi-phase model. The integrated values are remarkably in good agreement with the constraints available from the *ASCA* analysis in Allen et al. (2000). However, we are able for the first time to resolve spatially the profile of both $\dot{M}(<r)$ and $\Delta N_{\rm H}(<r)$.

3 Conclusions

The physical quantities constrained from the projected spectra need to be recovered to their 3-dimensional values to allow the study of the characteristics of the X-ray emitting plasma. Fitting a thermal model to a spectrum obtained collecting X-ray counts in rings provides, for each annulus, (i) an estimate for the Emission Integral, $EI = \int n_{\rm e} n_{\rm p} dV = 0.82 \int n_{\rm e}^2 dV$, through the normalization K of the model, $K = \frac{10^{-14}}{4 \pi d_{\rm ang}^2 (1+z)^2} EI$; (ii) a direct measurement of the emission-weighted gas temperature, $T_{\rm em}$, metal abundance, $Z_{\rm em}$, and luminosity, $L_{\rm ring}$.

From Kriss, Cioffi & Canizares (1983; see also McLaughlin 1999), the volume shell observed through each ring adopted in the spectral analysis can be evauluated and a matrix, $\mathbf{Vol} = \sum_{i,{\rm ring}} \sum_{j,{\rm shell}} Vol(i,j)$, built. The deprojected physical quantities (e.g. Figure 4) can be then obtained. At the moment, we are using these values to constrain the dark matter distribution in the central region of A1795 through the assumption that the X-ray emitting plasma is in hydrostatic equilibrium with the cluster potential.

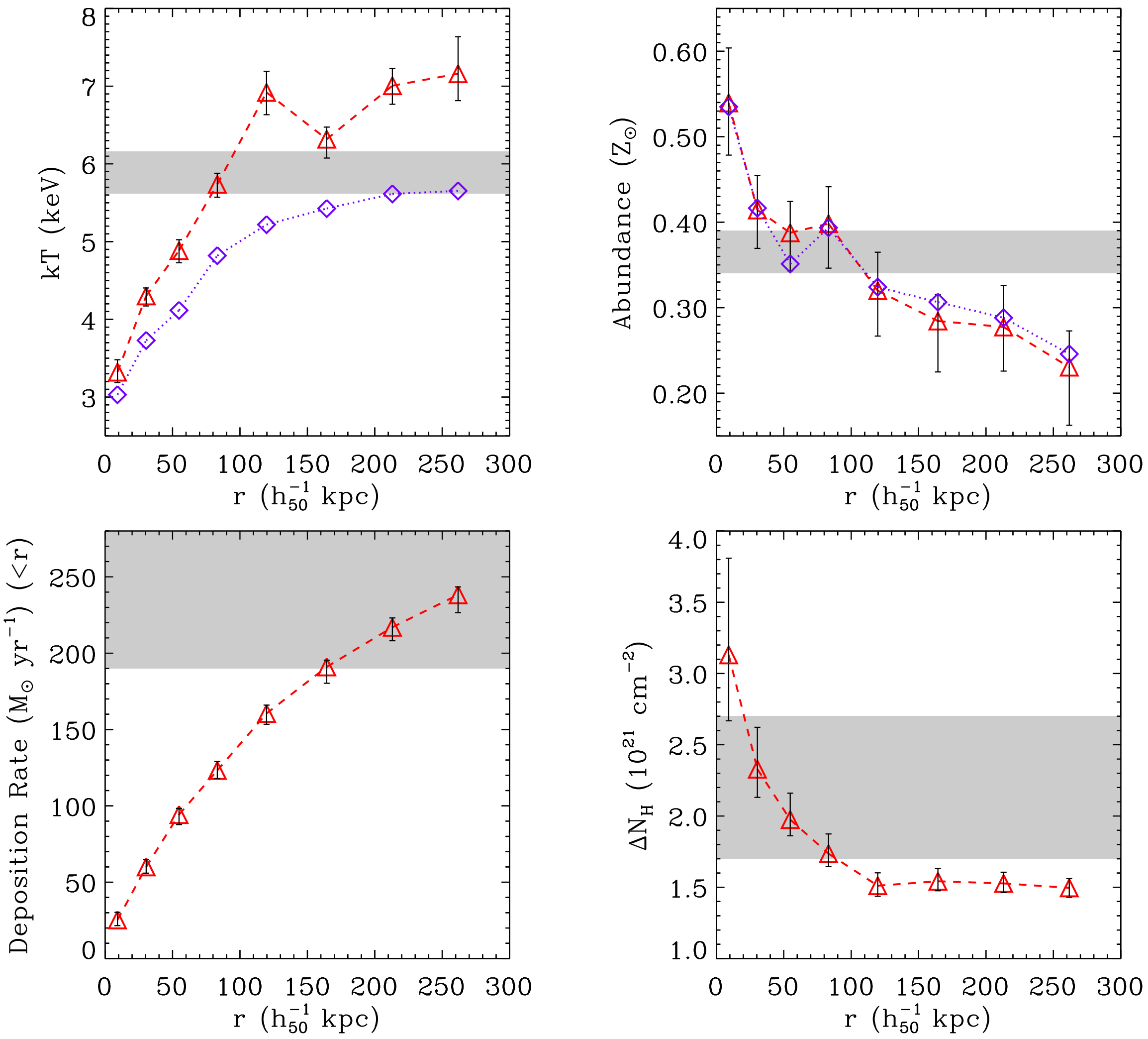

Figure 2: Best-fit spectral results applying a single MEKAL model plus an intrinsically absorbed cooling flow (*triangles*) and only a single MEKAL model (*diamonds*). The error bars are at 1σ level. The shaded regions represent the uncertainties at the 90 per cent level of confidence of the best-fit values from the *ASCA* analysis in Allen (2000).

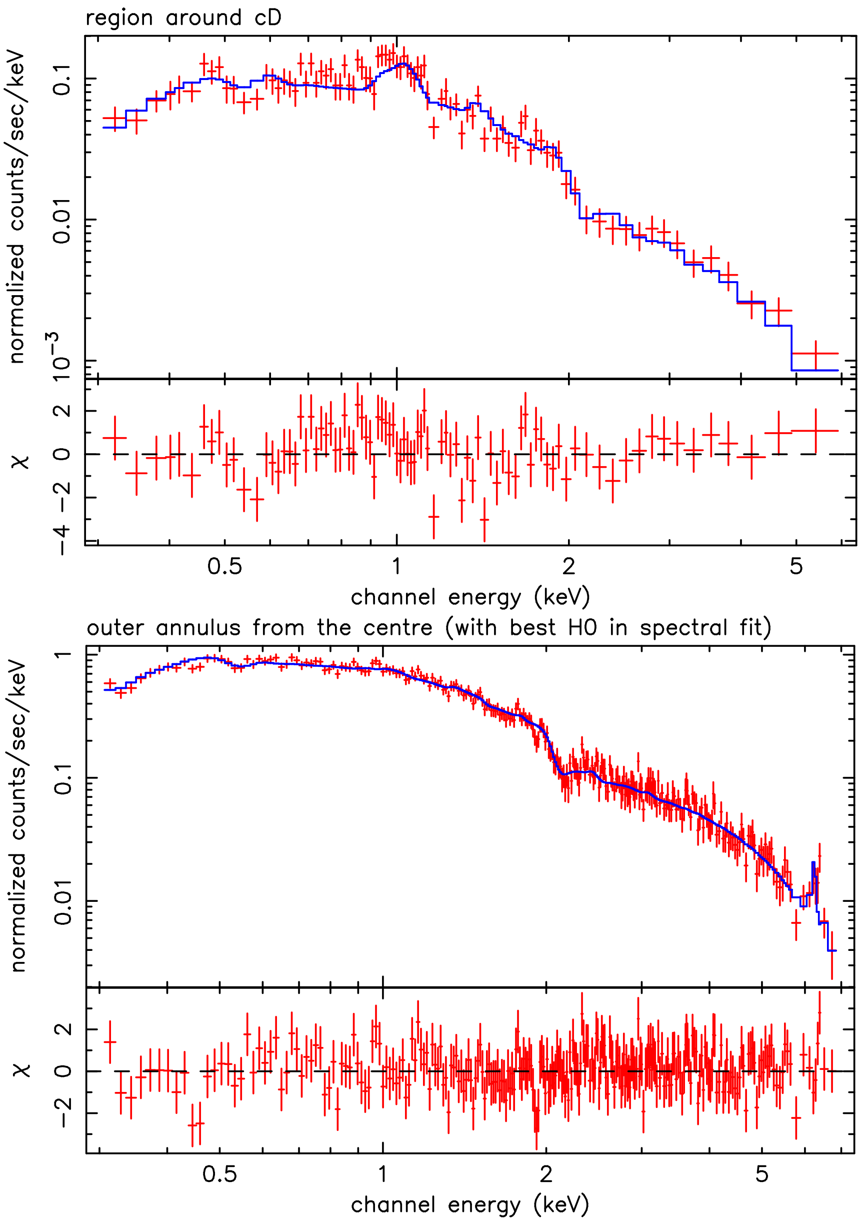

Figure 3: Examples of spectral fit of *Chandra* data in the range 0.3–7 keV for (left) the region around the cD galaxy (5 arcsec in radius) and (right) the outer annulus for which we obtain the best reduced χ^2.

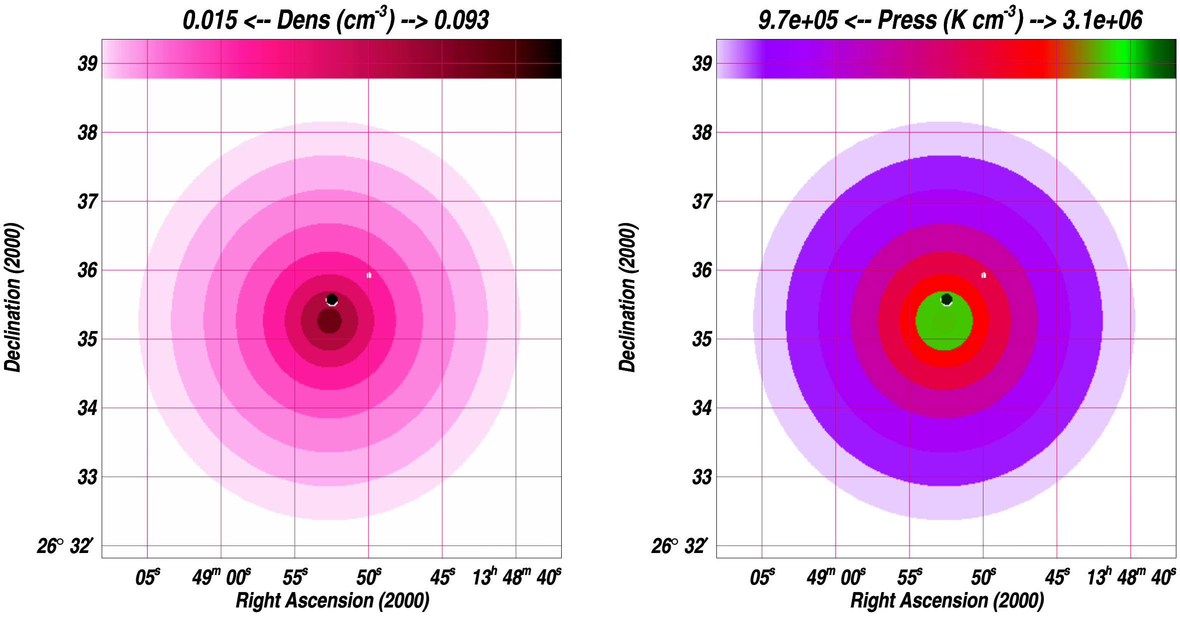

Figure 4: Deprojected results for the gas density (left) and pressure (right) when a single-phase plasma is considered. The title of each panel shows the colour code used and the range of values for that quantity.

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