Chandra Observations of the Galaxy Cluster MACSJ1423.8+2404

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ABSTRACT
We present an analysis of a 130 ks Chandra observation of galaxy cluster MACSJ1423. At a redshift of 0.54, this is the most distant massive cooling-flow cluster known. We derive azimuthally averaged, deprojected temperature, metallicity and density profiles, and find a gas mass fraction in agreement with previous work by Allen et al. (2004). The Navarro, Frenk and White (NFW) model provides an acceptable fit to the mass profile; a generalized NFW model was also explored, but did not provide a better fit. A singular isothermal sphere mass model is strongly ruled out. We also present two-dimensional maps of projected temperature, entropy and pressure which, beyond the innermost core, do not indicate any significant deviations from spherically symmetric equilibrium. Finally, we use deep, multi-color Subaru SuprimeCam imaging to measure the cluster mass using weak-lensing techniques, for comparison with the X-ray results.

X-RAY MASS ANALYSIS
Our data consist of ACIS-I and ACIS-S images of MACSJ1423 [1], with exposures of 15 and 113 ks, respectively. Spectra were extracted from concentric circular annuli and geometrically deprojected to produce the azimuthally averaged temperature and metallicity profiles shown below. The temperature profile, combined with the surface brightness profile (not shown) were used to measure the mass distribution of the cluster. In the first case, the mass profile was modelled using a Navarro, Frenk and White (NFW) profile [2,3],

\[ \rho_{\text{NFW}}(r) = \frac{\rho_s}{(r/r_s)(1+r/r_s)^2} \]

which provides a good description of the data. The constraints on the NFW scale radius \( r_s \) and velocity dispersion \( \sigma_v \), as well as the corresponding constraints on the gas fraction profile, are shown below. These results are all in good agreement with previous work [4]. Note: the effective velocity dispersion is simply related to the concentration parameter \( c \) by \( \sigma_v = c r_s H(z) \).

ALTERNATIVE MASS MODELS
- Singular isothermal sphere – This model, in which the mass enclosed is directly proportional to radius, provides a statistically unacceptable fit, with \( \chi^2=47.8 \) (5 DOF).
- Generalized NFW – The NFW model can be made more flexible by allowing the slope at small radii to vary [5]:

\[ \rho_{\text{GNFW}}(r) = \frac{\rho_s}{(r/r_s)(1+r/r_c)^2} \]

The addition of this new parameter weakens the constraints on the scale radius and velocity dispersion (or concentration parameter) as expected. For MACS1423, the best fitting inner slope remains consistent with the NFW value, \( \beta=1 \).

SPECTRAL MAPPING
An adaptive binning technique [6] was employed to produce high-resolution thermodynamic maps of the cluster. (For more information, see the poster of E. Million, also in this session.) The results do not show any significant deviation from hydrostatic equilibrium.

SUBARU AND KECK DATA
We obtained multicolor images of the cluster using Subaru and spectra of member galaxies using Keck. The redshift distribution of the spectroscopically observed galaxies is shown below, and can be used to estimate the galaxy velocity dispersion.

REFERENCES:

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