ASCA OBSERVATIONS OF THREE GRAVITATIONAL LENSING CLUSTERS OF GALAXIES; CL0500-24, CL2244-02, AND A370

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Abstract. We determined the X-ray temperatures of three gravitational lensing clusters, CL0500-24, CL2244-02, and A370, and obtained significant constraints on the surface brightness profile assuming the β-model and the King model profiles. The mass of the cluster estimated from these X-ray data is by a factor of two to three smaller than the mass estimated from lens models for two of the clusters.

It is suggested by several authors that the X-ray measurements gives systematically smaller masses than the lens masses (e.g. [1]). In order to estimate mass from X-ray observations, both the X-ray temperature and the X-ray surface-brightness profile are necessary. However, these quantities have been directly measured only for a limited number of lensing clusters. With ASCA we have determined the X-ray temperatures and constrained the surface-brightness profile of three lensing clusters. The results of spectral fits, spatial fits and mass estimates are summarized in Tables 1, 2, and 3. For the two of the clusters, CL0500-24 and A370, the X-ray masses were found to be significantly smaller than the mass estimated from lensing models. The discrepancy is statistically significant and by factor of two to three. On the other hand consistent X-ray and lensing masses were obtained for CL2244-02. We suggest that the major cause of mass discrepancy is in the substructures of the two clusters. The results are presented in [2] in more detail.

References

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TABLE 1.   Results of Spectral Fits

Cluster	$N_H[\text{cm}^{-2}]$[†]	$kT[\text{keV}]$	$L_X(2-10)[\text{erg/s}]$	Abundance	χ^2 (dof)
CL0500-24	2.6×10^{20}	7.2(5.4–10.9)	1.7×10^{44}	< 1.5	24.7 (26)
CL2244-02	4.8×10^{20}	6.5(5.2–8.3)	1.3×10^{44}	< 0.2	72.2 (58)
A370	3.1×10^{20}	6.6(5.7–7.7)	8.3×10^{44}	0.3 ± 0.2	118.4 (124)

[†] N_H is fixed at the galactic value. The quoted errors correspond to a single parameter error at 90% confidence.

TABLE 2.   Results of β model fits

Cluster	β-model profile			King-model profile	
	β	$r_c[\text{Mpc}]$[†]	χ^2 (dof)	$r_1[\text{Mpc}]$[†]	χ^2 (dof)
CL0500-24	0.9 (0.6–1,4)	0.41 (0.17–0.62)	61.9 (43)	0.44 (0.34–0.58)	63.9 (44)
CL2244-02	0.30 ± 0.05	< 0.10	72.1 (45)	1.3 (0.9–1.5)	90.0 (46)
A370	0.95 (0.6–1.7)	0.48 (0.26–0.86)	42.9 (45)	0.52 (0.41–0.60)	44.2 (46)

[†]1 arc minute corresponds to 0.342, 0.348, and 0.373 Mpc for CL0500-24, CL2244-02, and A370, respectively for the Cosmological parameters of $\Omega_0 = 1, \Lambda = 0$, and $H_0 = 50$ km/sec/Mpc.

TABLE 3.   Comparison of Projected Mass of Clusters inside the arc radius

Cluster	θ_{arc}/r_{arc} ["/Mpc]	X-ray Mass [$\times10^{13} M_\odot$]		Lens Mass [$\times10^{13} M_\odot$]	
		β-model	King-model	Spherical	Detailed [ref]
CL0500-24	22/0.13	4.0 (2.6–8.4)	3.8 (2.3–7.5)	13	13 [3]
CL2244-02	9.9/0.057	1.6 (0.9–2.3)	0.27 (0.18–0.46)	2.1	1.5 [4]
A370	25/0.16	5.0 (3.9–7.2)	4.7 (3.6–6.80)	26	17 [5]