X-ray and strong lensing mass estimates of MS2137.3

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1. Introduction

Galaxy clusters are powerful cosmological tools, providing we can obtain a reliable estimate of their masses. To this purpose, the most promising techniques are *X-ray and gravitational lensing analysis*, that allow to combine 2D and 3D constraints and to test different regions of clusters. A limit to the joint analysis is the consistent disagreement between these two kind of mass estimates, claimed by several works in literature. To unfold this issue, we aim to perform a **combined X-ray and lensing analysis for a set of massive clusters**, starting with the well-known lensing cluster MS2137.3-2353 (z=0.313), whose X-ray and strong lensing mass estimates are, up to now, contrasting.

2. The X-ray analysis

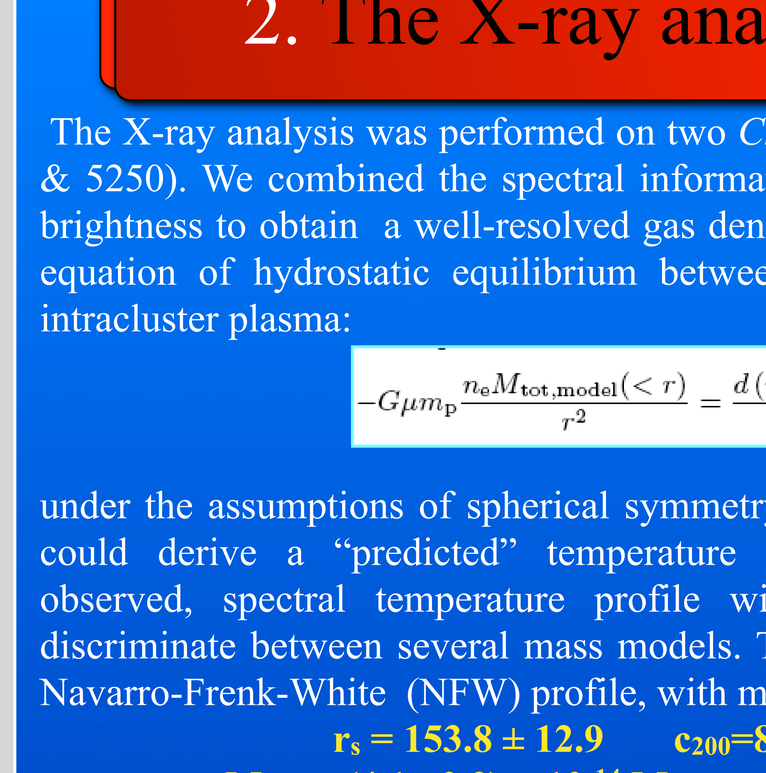
The X-ray analysis was performed on two *Chandra* datasets (Obs.ID 928 & 5250). We combined the spectral informations and the X-ray surface brightness to obtain a well-resolved gas density profile. By inverting the equation of hydrostatic equilibrium between the dark matter and the intracluster plasma:

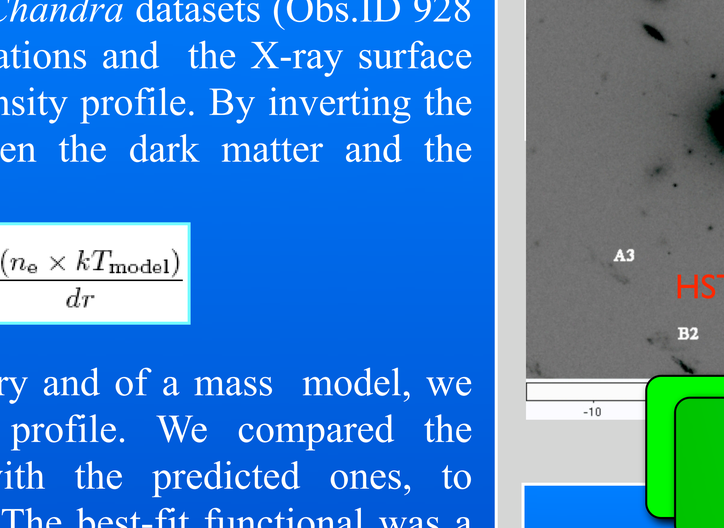
$$-G\mu m_{\rm p}\frac{n_{\rm e}M_{\rm tot,model}(<r)}{r^2}=\frac{d\,(n_{\rm e}\times kT_{\rm model})}{dr}$$

under the assumptions of spherical symmetry and of a mass model, we could derive a "predicted" temperature profile. We compared the observed, spectral temperature profile with the predicted ones, to discriminate between several mass models. The best-fit functional was a Navarro-Frenk-White (NFW) profile, with mass parameters:

$r_s = 153.8 \pm 12.9$ $\quad c_{200}=8.93 \pm 0.55$

$M_{200} = (4.1 \pm 0.3) \times 10^{14}\ M_\odot$ $\quad R_{200} = 1.37$ Mpc





3. The strong lensing analysis

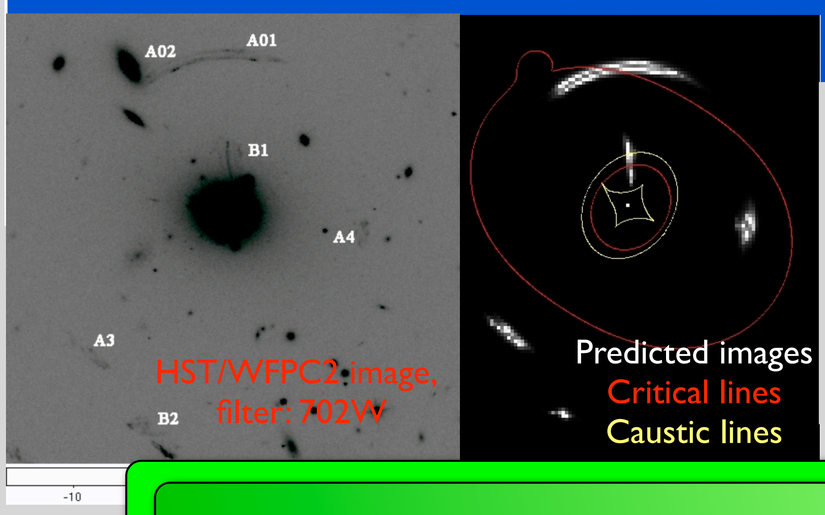
MS2137.3-2353 presents both a tangential and a radial arc -which was the first ever detected- arising from two lensed sources (system A & B in the image below, on the left) at z_s=1.501; the tangential and radial arcs allow to constrain the total mass enclosed and the mass distribution derivative, respectively. We performed a parametric strong lensing reconstruction of the cluster mass distribution exploiting the *Lenstool* code (available at http://www.oamp.fr/cosmology/lenstool/).

The best fit values for the NFW profile were:

$r_s = 144.0 \pm 30.3$ $\quad c_{200}=9.25 \pm 1.0$

$M_{200} = (3. \pm 0.7) \times 10^{14}\ M_\odot$ $\quad R_{200} = 1.33$ Mpc.

Our strong lensing analysis also highlights that a dark matter distribution slope shallower than the NFW one is preferred in the central region.



4. Conclusions

We have presented new X-ray and strong lensing mass measurements for the galaxy cluster MS2137.3-2353. Our mass profile estimates agree pretty well, leading to a mean value of the mass: $M_{200} \simeq 3.8 \pm 0.4 \times 10^{14}\ M_\odot$: this good agreement suggests that a combined X-ray/lensing analysis is a very effective approach to pinpoint the galaxy cluster masses.

References

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