Stellar to gas mass ratio in rich clusters of galaxies

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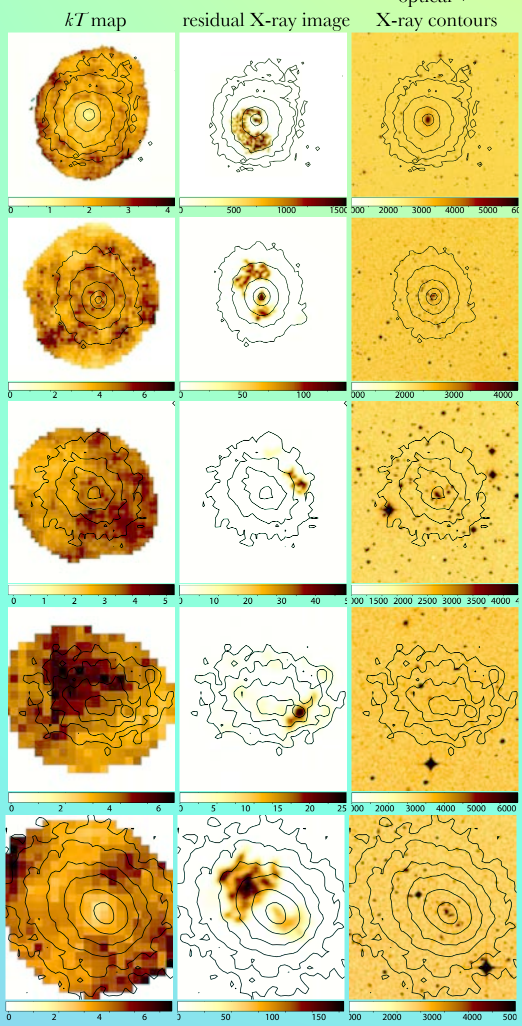
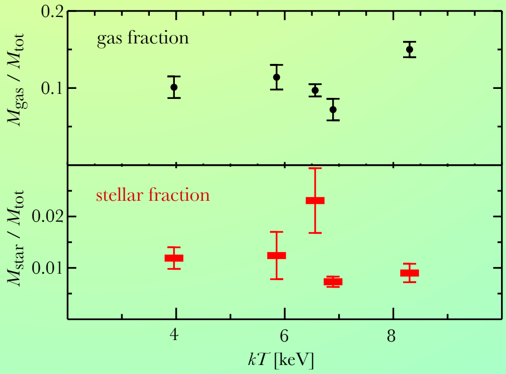
The baryonic component in galaxy clusters may be divided in two main classes: the diffuse X-ray emitting intracluster gas and the stars, mainly in galaxies. In this work, we have analyzed 5 galaxy clusters using both XMM-*Newton* and optical SDSS and CFHT data in order to estimate the contribution of stars (in galaxies mainly, but also in the stars responsible for the diffuse intracluster light) to the total baryon mass and how this correlates to the physical properties of the cluster. We find that the stellar-to-gas mass ratio within r_{500}, is anti-correlated with the intra-cluster gas temperature, ranging from 14% to 6% while the temperature varies from 4.0 to 8.3 keV. This suggests that less massive, colder clusters are more prolific star forming environments than massive hot clusters.

The Sample



Temperature maps, substructure maps and optical image overlaid with X-ray contours for A496, A1689, A2050, A2631 and A2667.

Cluster	R.A (J2000)	DEC (J2000)	z	d_L (h_{70}^{-1} Mpc)	nH ($10^{20} cm^{-2}$)	$< kT >$ (keV)	r_{500} (h_{70}^{-1} kpc)
A496	04 33 37.1	-13 14 46	0.033	144.902	4.45	3.96 ± 0.023	1480
A1689	13 11 34.2	-01 21 56	0.1823	888.870	1.84	8.34 ± 0.32	2172
A2050	15 16 21.6	+00 05 59	0.1183	551.167	4.67	5.85 ± 0.11	1785
A2631	23 37 39.7	+00 17 37	0.273	1393.23	3.82	6.89 ± 0.34	2153
A2667	23 51 47.1	-26 00 18	0.23	1146.59	1.64	6.56 ± 0.13	1976

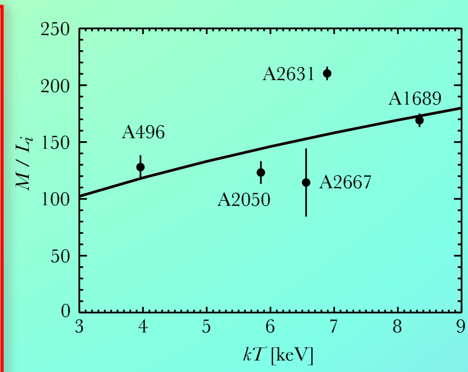


Gas and total stellar mass ratio as a function of intra-cluster gas temperature. The black points represent the gas fraction while the red ones are the stellar fraction. The stellar mass were computed using both stars in galaxies (through the luminosity function) and the ICL contribution. The total mass is derived assuming hydrostatic equilibrium.

We combined X-ray with optical analysis to study the baryon content (stellar, intracluster stars and gas component) of five Abell clusters. Our results are robust because of data homogeneity processing, a careful treatment of stellar mass-to-light ratio to early and late-type galaxies and the use of XMM-*Newton* data to estimate the gas mass. We computed the stellar and the gas masses within the same radius.

We also computed substructure maps (following the method of Andrade-Santos 2008, in prep.) and temperature maps (using Durret et al. 2004 technique) for each cluster. These maps allow us to characterize the dynamical state for our cluster

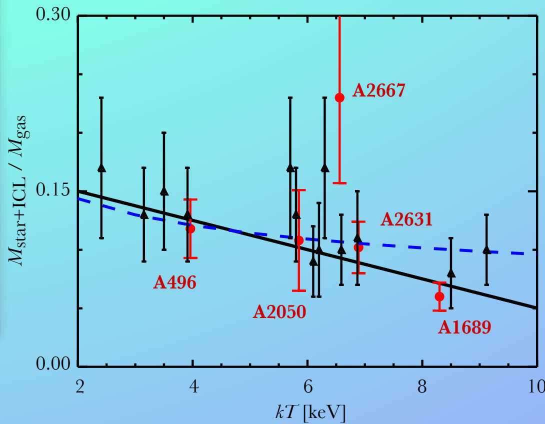
From optical data we derived total luminosity and the late-type fraction to calculate stellar masses. We assumed a reasonable contribution of the ICL to the total luminosity (following Gonzales et al. 2007).



Total mass to luminosity ratio in the *i*-band. The curve corresponds to our best fit: $M/L = 58\,(kT)^{0.5}$ [solar units].

We confirmed here, using a different technique, early findings by David, Forman & Jones (1990), Lin, Mohr & Stanford (2003), Gonzales et al. (2007) to the dependence of the stellar-to-gas mass with the temperature.

We showed here that, for this sample of clusters, the efficiency of galaxy formation can vary from 6% to 14% proving that star formation efficiency depends on the environment as hydrodynamical simulation performed by Springel & Hernquist (2003) suggested. Massive clusters are hostile environments to star formation.

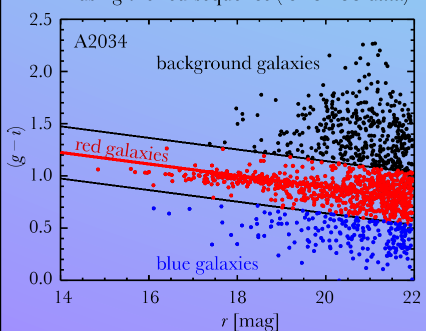


Ratio $M_{ICL+star}/M_{gas}$ as a function of temperature for A496, A1689, A2050, A2631 and A2667 (redpoints). Our best fit,

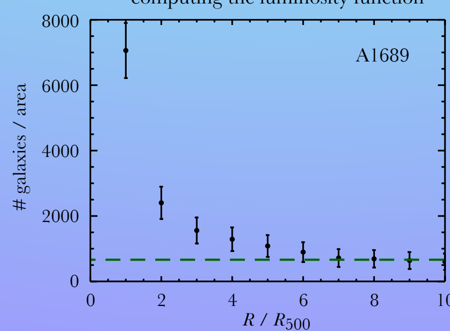
$$\frac{M_{star}}{M_{gas}} = 0.18 - 0.012\left(\frac{T_{gas}}{1\mathrm{keV}}\right),$$

is represented by the solid line. Black points were obtained from Lin et al. (2003) and the blue dot-dashed line was their best fit ($M_{star}/M_{gas}\, kT^{0.23}$).

Cluster galaxy member selection using the red-sequence (for SDSS data)



Background estimation for computing the luminosity function



Refs.:Laganá et al. (2008) A&A in press (arXiv:0804.1102); Laganá (2008) Thesis, IAG/Universidade de São Paulo

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