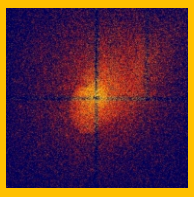
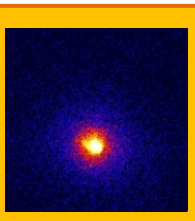


X-RAY MORPHOLOGY AND COOL CORE STATE IN GALAXY CLUSTERS



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The dominant mechanism invoked to explain the bimodality between Cool Core (CC) and Non Cool Core (NCC) objects relates the presence or absence of a CC to the recent merging history of the cluster. We tested this hypothesis on a sample of 100 local clusters observed with Chandra finding a clear correlation between an indicator of the thermodynamical CC state (central entropy) with several morphological indicators (Center Shift, Concentration Parameter and Cuspiness). Since these indicators can be easily measured also with poor quality data, we suggest to use them to identify relaxed CC objects for cosmological studies.

SAMPLE SELECTION

The starting point of our sample is the ACCEPT Database [1], which provides the central entropy parameter for 241 clusters observed by Chandra. For **99 clusters** (mostly at $z > 1$) we calculated the Concentration Parameter (defined as the ratio SB($r < 100$ kpc)/SB($r > 500$ kpc) [2]) and Centroid Shift within 500 kpc with our own analysis of Chandra images. We also used tabulated values of the Cuspiness parameter [3] for **69 clusters** within ACCEPT.

CORRELATION TESTS

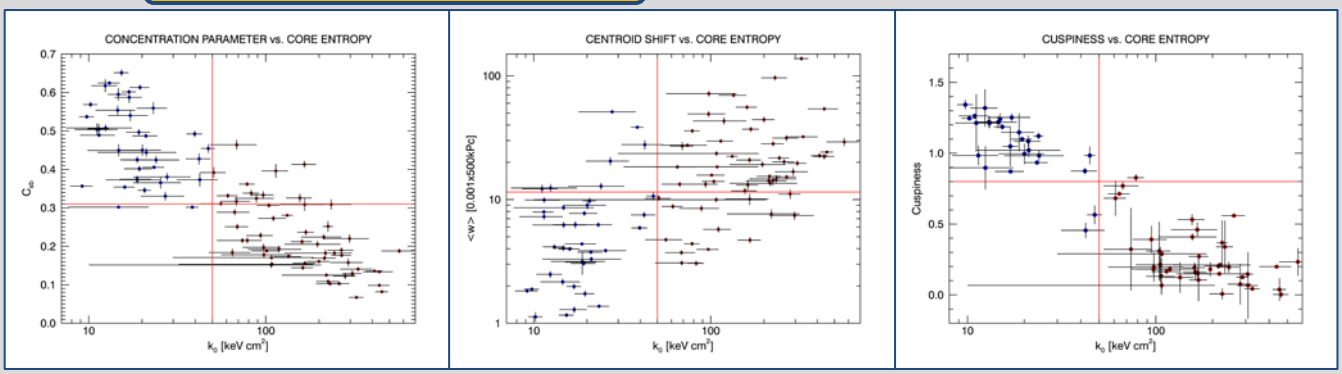

Fig.1: The three morphological indicators plotted VS the core entropy for each one of the clusters studied. The horizontal and vertical red line represent the values chosen to discriminate respectively CC/NCC and morphologically relaxed/disturbed clusters

For each one of the two samples (69 and 99 clusters) we performed **Kendall and Spearman correlation tests** to estimate quantitatively the correlation between the morphological and the thermodynamical state. The results obtained from the Spearman test are as follows (Kendall test provides consistent results):

- Concentration Parameter VS Entropy: ρ=-0.861; Probability of Null hypothesis: 3.4×10^{-30}
- Centroid Shift VS Entropy: ρ=+0.657; Probability of Null hypothesis: 1.6×10^{-13}
- Cuspiness VS Entropy: ρ=-0.868; Probability of Null hypothesis: 5.2×10^{-22}

Are COOL CORE clusters RELAXED?

From our results we can assert that CC clusters can generally be considered relaxed with a good degree of accuracy. In our sample about 95% of CC clusters is also classified as relaxed both by Concentration Parameter and Cuspiness. The percentage is 83% if we the Centroid Shift as morphological parameter.

Are RELAXED clusters COOL CORE?

We also tried to identify which morphological indicator is best suited for the identification of CC clusters by calculating the percentage of CC clusters between those classified as relaxed. Using Cuspiness, 96% of the relaxed is also CC. As for Concentration Parameter, the percentage is 76% which increases to 94% if we chose 0.4 as threshold value for this parameter.

RESULTS

We found evidence of strong correlation between relaxed morphological state and Cool Core thermodynamical state. This fact supports the hypothesis that cool cores are found in morphologically relaxed clusters and that their absence can be related to recent mergers.

From our studies, it emerges that **Cuspiness and Concentration Parameter can be used to identify Cool Core clusters** with a good accuracy. Centroid Shift is in this sense less accurate, since about 1/3 of the clusters classified as relaxed are NCC, likely because of projection effects.

REFERENCES

1. Cavagnolo *et al.* 2009, ApJS 182, 12
2. Cassano *et al.* 2010, ApJL, 721, L82
3. Maughan *et al.* 2012, MNRAS, 421, 1583

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