XMM-Newton image of A2142 (Rossetti et al 2013)

# Beyond the (cool) cores: large scale sloshing in the ICM

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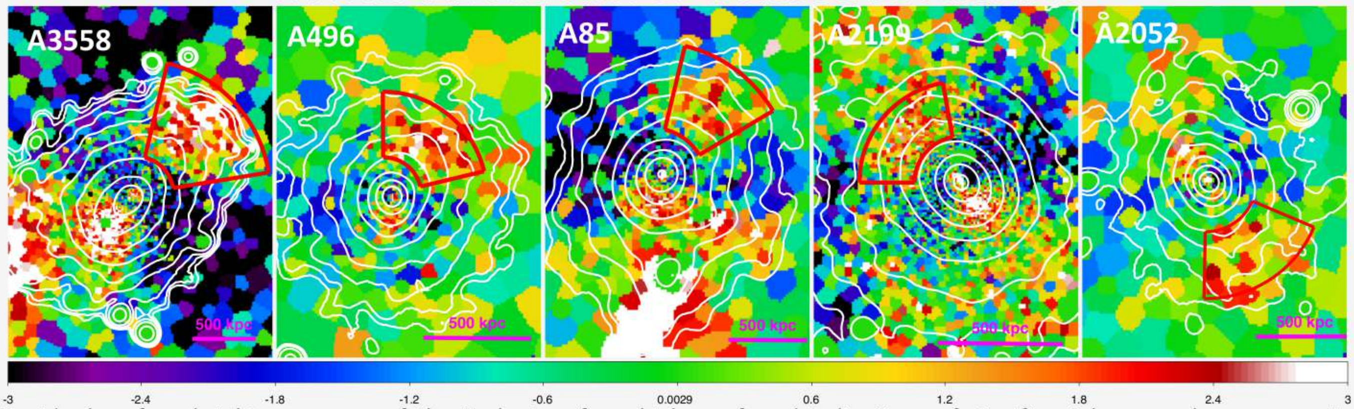
## A PUZZLING MPC-SCALE COLD FRONT IN A2142

One of the most important results in the last 15 years in the astrophysics of galaxy clusters has been the discovery of cold fronts, which appear to be almost ubiquitous in galaxy clusters. In most systems, they are likely due to the relative motion, or sloshing, of the low entropy gas of the cluster cool core with respect to the outer gas following an off-axis minor mergers.
Up to a few years ago, sloshing cold fronts were believed to be confined in the innermost regions of cool core clusters, where the entropy profiles are steep (Ghizzardi et al. 2010). Recently, sloshing features have been detected at larger radii (200-400 kpc, in A2052, Blanton et al 2011, A496 Roediger et al 2012, and A2029, Paterno-Mahler 2013) and in two cases cold fronts were detected up to 0.7-1 Mpc (Perseus, Simionescu et al 2012, A2142 Rossetti et al 2013). In particular **the record-breaking cold front, at 1 Mpc from the center, in A2142 appears as a striking sharp edge** in the high resolution XMM-Newton image.
Hydrodynamical simulations have played a major role in our understanding of cold fronts and of the sloshing phenomenon and they predicted the large scale asymmetries found in the observations (Roediger et al, 2012, 2013). However, simulated fronts in clusters outskirts are usually not steep and easily destroyed by Kelvin-Helmholtz instabilities and conduction because of the weak magnetic field which cannot develop an efficient magnetic draping (ZuHone et al 2011, 2013).
Thus the presence of a sharp front at 1 Mpc from the center, stable over a linear scale of 1.2 Mpc, challenges our understanding of the sloshing phenomenon and of the microphysics of the ICM.

## THE QUESTION:

Is this Mpc-scale cold front an **unique feature** which can be explained by a peculiar merging history of A2142 or large scale cold fronts are a **common feature** of galaxy clusters, just like their small scale counterparts, and they went unobserved so far because high resolution observations concentrated mainly in the central regions?

## A SYSTEMATIC SEARCH OF LARGE SCALE SLOSHING




*Residual surface brightness maps of the 5 clusters for which we found indications of significant large scale excesses. To produce these maps we divide adaptively binned ROSAT PSPC images by the azimuthal (or elliptical) average surface brightness The red sectors highligt the large scale excesses. X-ray isophotes are overlaid.*

We started a systematic search for large scale excesses and discontinuities mining the entire ROSAT/PSPC archive. Thanks to its large field of view and low background level, this instrument has proven very powerful to probe the surface brightness distribution in the faint regions of clusters outskirts (e.g. Eckert et al. 2012) and its moderate spatial resolution has been sufficient as well to detect the surface brightness jumps in A2142 and Perseus. Using residual maps and profiles in sectors, and focusing only on known sloshing clusters**, we found five systems (A3558, A496, A85, A2052 and A2199)**, besides A2142 and Perseus, where we have significant indications of large scale residuals extending beyond 400 kpc from the center (Fig.1, upper panels). We investigated the surface brightness profiles in these excess regions: the quality of the data is sufficient to exclude prominent edges as the cold front in A2142 but not smaller discontinuities (i.e. jumps $n_{in}/n_{out} < 1.6$, using a projected spherical density broken power-law model). We need the larger effective area and superior resolution of XMM-Newton to nail down the possible large scale cold fronts in these systems: a program to observe these features has been approved in A013 and the first observations will be performed soon.

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