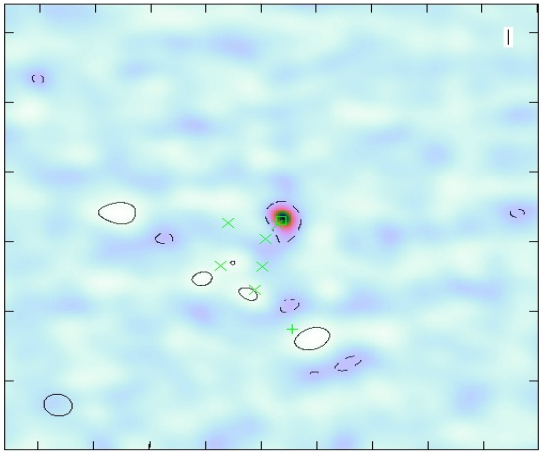
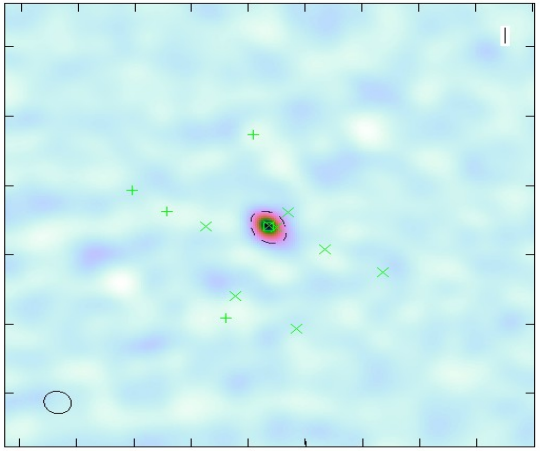
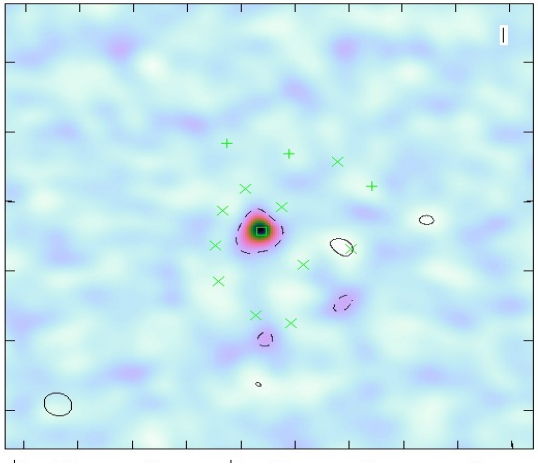
Probing the evolution of galaxy clusters using Sunyaev-Zel’dovich effect







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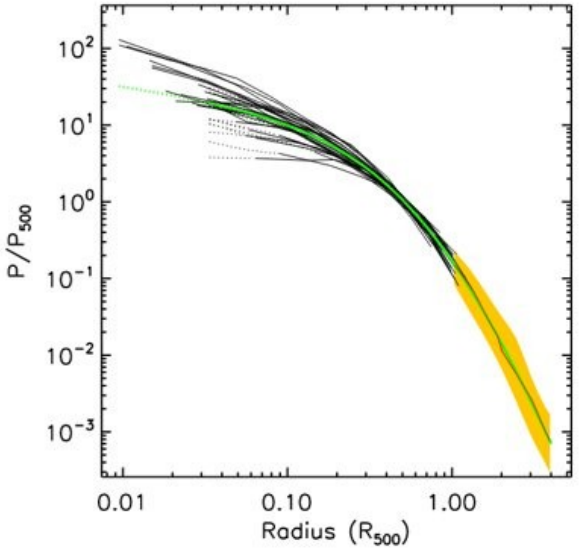
Universal Pressure Profile

Arnaud et al.(2010)

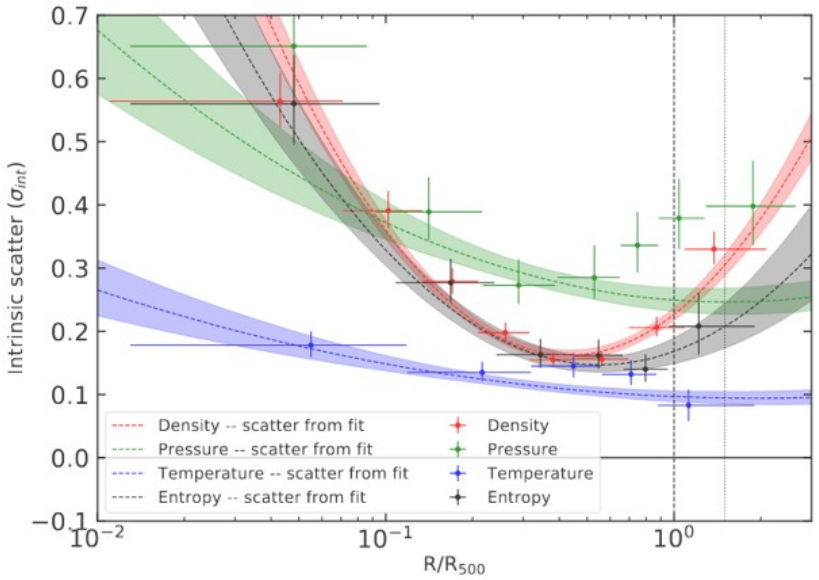
- $Y_{sz} \alpha \int Pdl$.
- Pressure profile eq. $p(x) = \frac{P_0}{(c_{500}x)^{\gamma}\,[1 + (c_{500}x)^{\alpha}]^{(\beta-\gamma)/\alpha}}$.
  - P_0 = normalised pressure
  - $x = R/R_{500}$
  - (α, β, γ) = GNFW shape parameters for cluster
  - c_{500} = concentration parameter



Arnaud M., Pratt G. W., Piffaretti R., Böhringer H., Croston J. H., Pointecouteau E., 2010, A&A, 517, A92. doi:10.1051/0004-6361/200913416

Scatter in various thermodynamic quantities

Ghirardini et al. (2019)



- Scatter computed using X-COP dataset from
  - XMM-Newton
  - Planck SZ data
- Pressure: extreme scatter
- Temperature: least scatter

Ghirardini V., Eckert D., Ettori S., Pointecouteau E., Molendi S., Gaspari M., Rossetti M., et al., 2019, A&A, 621, A41. doi:10.1051/0004-6361/201833325

My Research

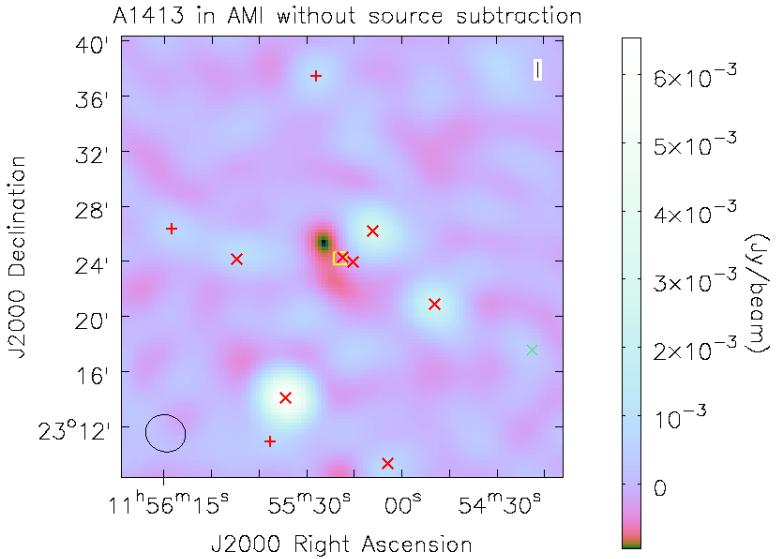
- Investigate intrinsic scatter in pressure profiles further
- Using SZ data from Planck telescope and Arcminute Microkelvin Interferometer (AMI)
- Look for deviations
- Investigate the same clusters for synchrotron emission using data from Murchinson Widefield Array (MWA)
- Find connections between synchrotron emission and deviations from average pressure profile (if any)

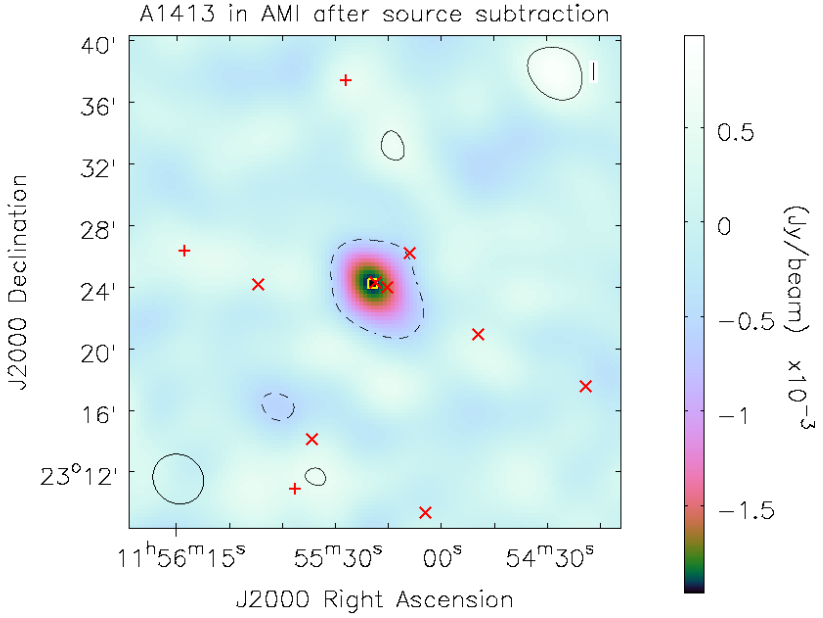
Cluster sample

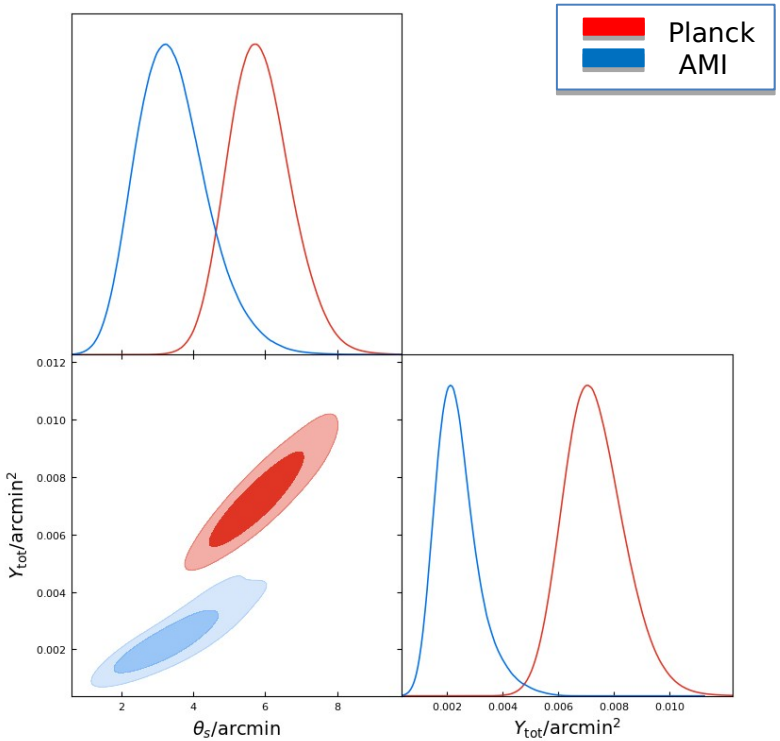
Abel	Planck identifier	Red shift
	PSZ2 G228.16+75.20	0.1761
ACO 1413	PSZ2 G228.16+75.20	0.143
	PSZ2 G213.39+80.59	0.559
ACO1489	PSZ2 G207.88+81.31	0.353
	PSZ2 G045.87+57.70	0.61
ACO 2259	PSZ2 G050.40+31.17	0.164
	PSZ2 G060.13+11.44	0.224
A 2409	PSZ2 G077.90-26.63	0.147
	PSZ2 G083.29-31.03	0.412


A1413 by SDSS
(optical)
z=0.143

Arcminute Microkelvin Interferometer (AMI) observations of A1413



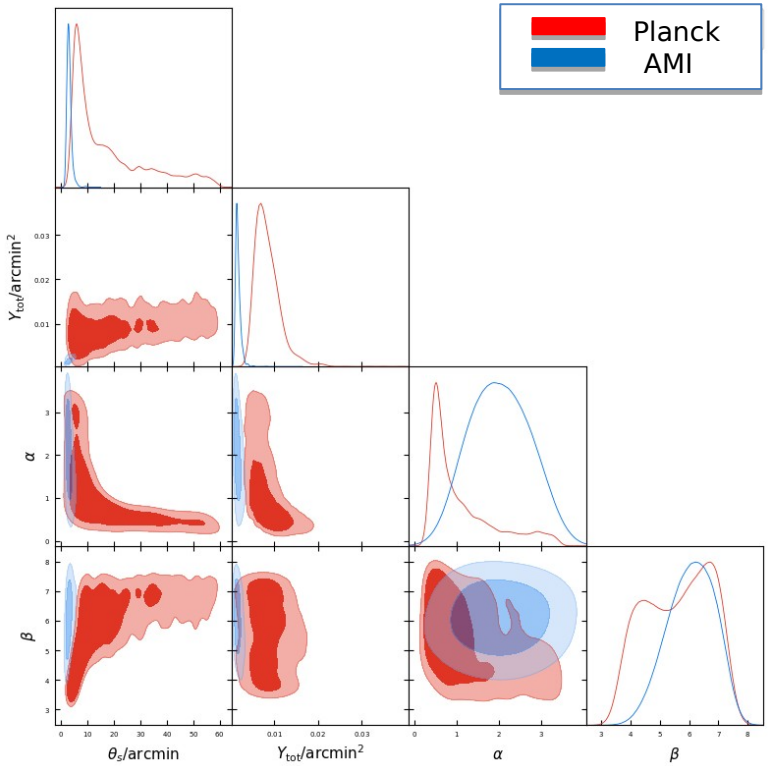




Bayesian analysis priors

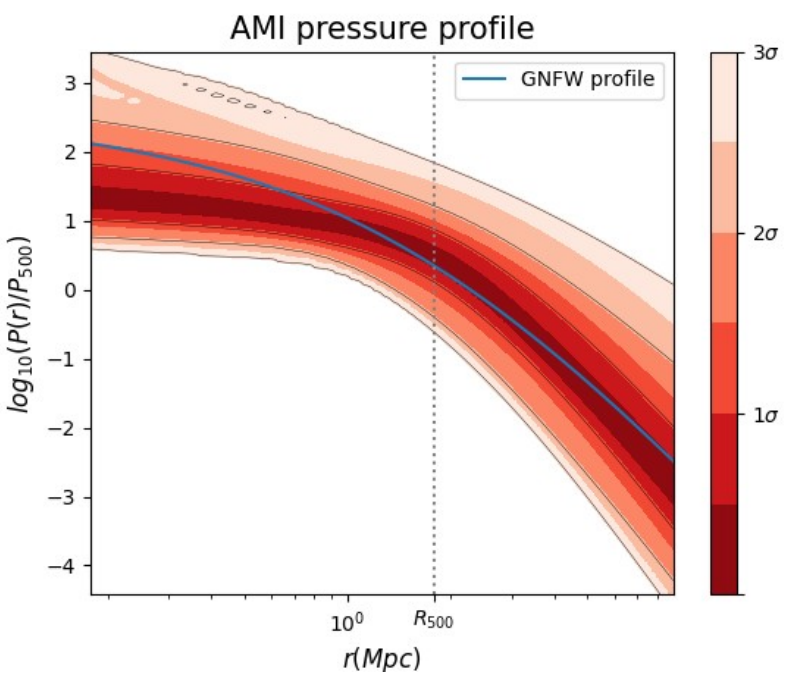
- θ_s = U[1.3 arcmin, 15 arcmin]
- Y_{tot}= U[0.00 arcmin^2, 0.02arcmin^2]
- $\alpha = \delta[\alpha_{model}]$ or U[0.1,3.5]
- $\beta = \delta[\beta_{model}]$ or U[3.5,7.5]
- $\gamma = \delta[\gamma_{model}]$

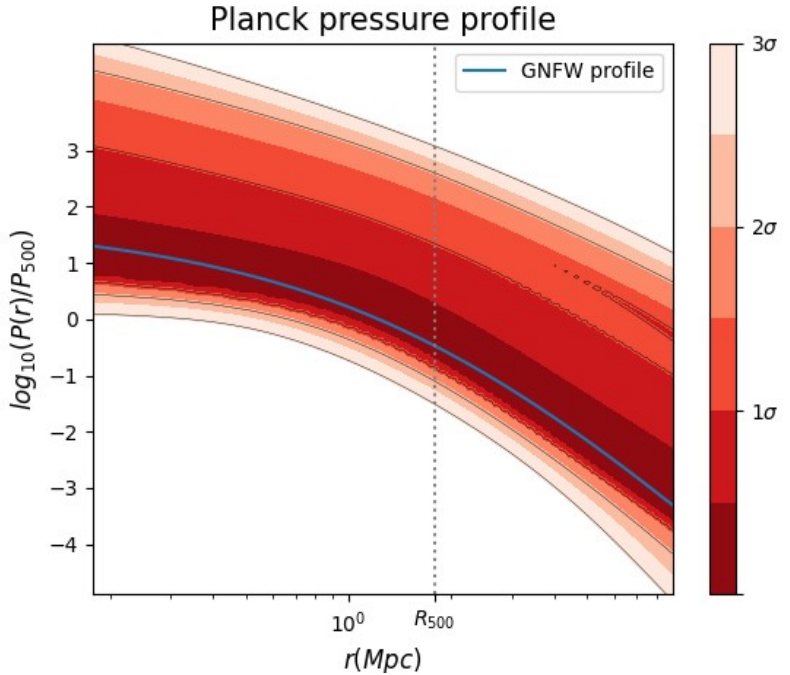
AMI-Planck analysis

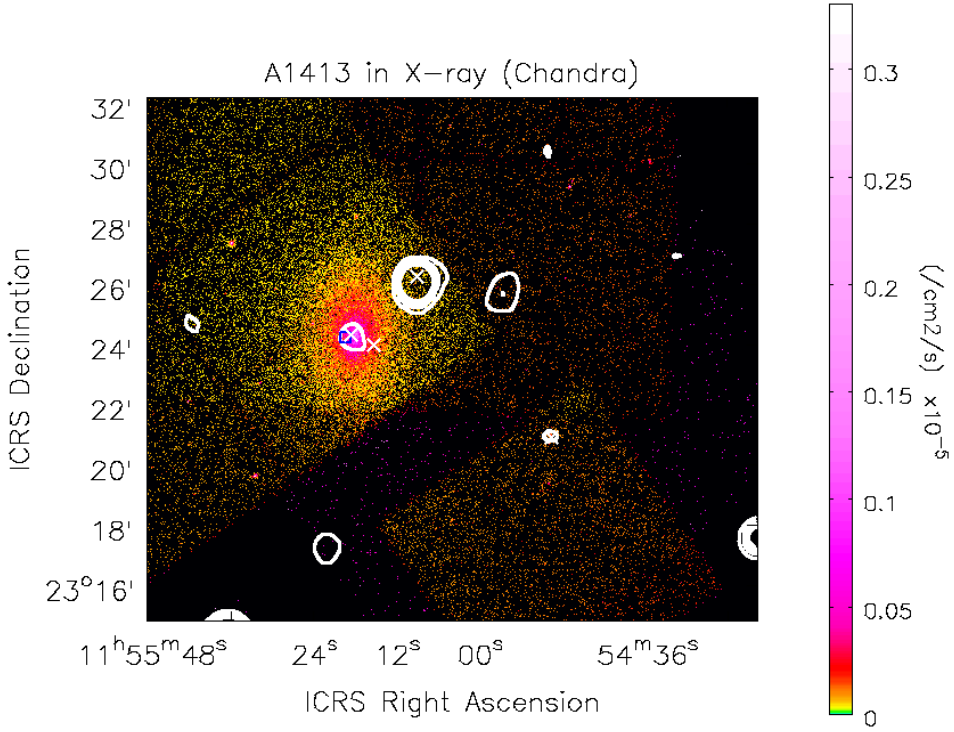


- Very small AMI and Planck constraints overlap.
- Joint AMI-Planck analysis in progress.

Pressure profile



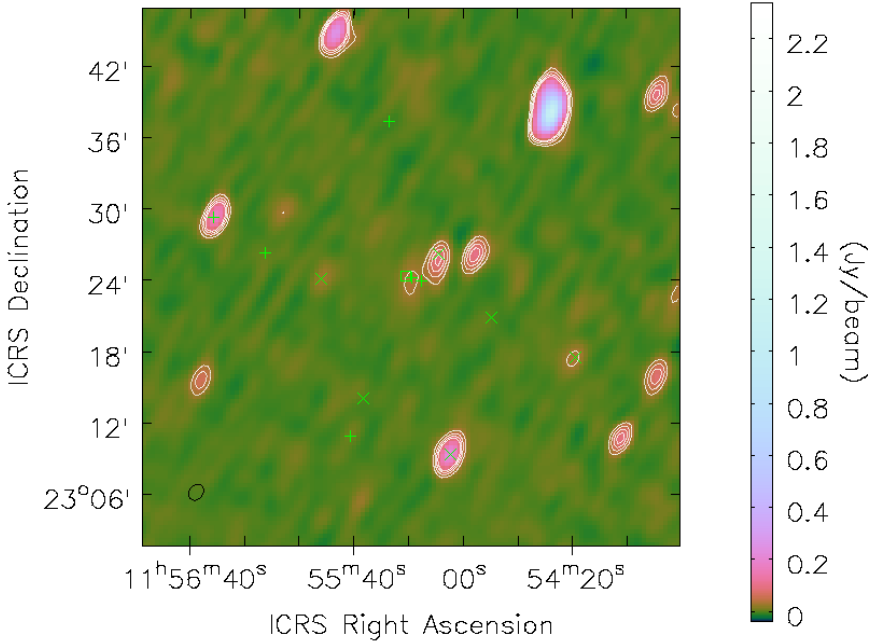


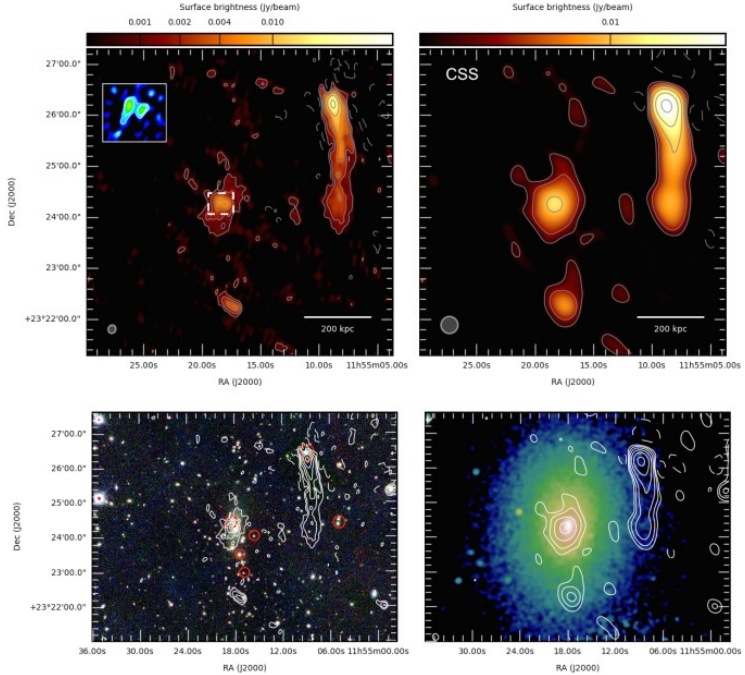


A1413:

- Image – Chandra
- White Contours – NVSS
- □ - AMI cluster center

MWA results and LOFAR survey





LOFAR image from: Savini F., Bonafede A., Br¨uggen M., Rafferty D., Shimwell T., Botteon A., Brunetti G., et al., 2019, A&A, 622, A24. doi:10.1051/0004-6361/201833882

Summary

- Literature: Relaxed cluster + mini halo. (Vikhlinin A et al (2005) doi:10.1086/431142, Govoni F. et al. (2009) doi:10.1051/0004-6361/200811180)
- AMI SZ centre and Chandra X-ray centre not overlapping.
- AMI pressure profile shows deviation from universal pressure profile.
- MWA observed a mini halo at 154MHz

Further...

- Complete the analyses for cluster sample
- Construct pressure profile
- Find deviations if any
- Look for synchrotron emission