Pressure profiles of galaxy cluster from SPT and Planck observations.

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ESA satellite mission launched in 2009.

Full sky maps of temperature and polarization with sub-Jansky sensitivity.

9 frequency bands from 30 to 857 GHz.

Resolution <10 arcmin.

1000+ cluster detected via the Sunyaev-Zeldovich effect (SZ).

South Pole Telescope

- 3 channels: 95, 150, 220 GHz, resolution 1.75 arcmin.
- 2500 square-degree survey at high galactic latitude.
- 677 clusters candidates:
  - Nearly mass limited ($M_{500} > 2 \times 10^{14} M_\odot$).
  - Maximum redshift: 1.7.
- It allows to probe the redshift evolution of the cluster structure.
- SPT is sensitive to inner regions, Planck to the peripheries.
We analyse a sub-sample of 6 clusters common to the SPT and CHEX-MATE catalogue. (arXiv:2010.11972)

We exploit the XMM data to validate our SZ pressure profile extraction algorithm.

The comparison with X-ray spectroscopic data provides a powerful benchmark.

We study the impact of sub-structure on the relation between SZ and X-ray profiles.
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Component separation: Planck


- Maps are high-pass filtered to remove large scale modes.
- 4 components fit:
  - Cluster SZ signal.
  - Primary CMB anisotropies.
  - Intracluster Dust Correction.
- Cluster template gNFW profile (Nagai et al. 2007) projected and convolved with the instrumental beams.
- The diffuse Components are recovered from the wavelets reconstruction of the 857GHz (Dust) and the 217GHz (CMB) channels.

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Component separation: SPT

- SPT maps are high-pass filtered due to the Filter Transfer Function.
- 220 GHz noise is very high.
- No significant dust contamination.
- To recover the background (CMB) in SPT we resort to a *Multiscale Internal Linear Combination*, including also the Planck 217GHz Channel.
- The weights minimize the CMB variance nulling the SZ component
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SPT-Planck Joint fit

We combine the cleaned maps in a joint fit of a gNFW profile.

We use the 95, 150 GHz SPT channels and the 100, 143, 353 GHz from Planck HFI.

Nagai profile with 3 free parameters:

1. Amplitude $P_0$.
2. 2 slopes: $\beta$ for $r>r_{500}$, $\gamma$ for $r<r_{500}$.
3. Intermediate slope and concentration fixed $\alpha=1.051$, $c_{500}=1.177$ (Arnaud et al., 2010).

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Profiles comparison

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- PSZ2G259.98-63.43 presents a slight deviation around $r_{500}$ probably explained by the irregular shape.
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Conclusion and future works

❖ We develop a complete set of tools to extract cluster pressure profiles from the joint analysis of Planck and SPT data.

❖ Combining the datasets allows us to fit the profile from the inner to the outermost regions of the clusters.

❖ We implemented two specific pipelines for the component separation on SPT and Planck.

❖ The comparison with XMM data on a pilot sample overlapping the CHEX-MATE catalogue shows good agreement between the X-ray and millimetre data.

❖ We investigate the impact of irregularities in the cluster shape to explain potential discrepancies.

❖ We will extend the analysis to a larger part of the SPT catalogue.
Thank You!

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