Rotational kSZ effect

in groups and clusters from the MACSIS & BAHAMAS simulations

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Hydrodynamic simulations
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CLUSTER DYNAMICS THROUGH SZ

\[ y_{\text{ksz}} = \int_{\text{LoS}} \sigma_T n_e n \cdot \beta_p \, dl \]

Radial velocity field

**See** Porciani+02

**HOW DOES ANGULAR MOMENTUM ORIGINATE IN THE UNIVERSE?**

- Baxter+19

- Porciani+02

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Cluster dynamics through SZ

Baxter+19

Betti+07

Altamura+19

Baldi+18

data

best fit

data

best fit

$\theta_{\text{los}}$: 0°
McCarthy+17 / Barnes+17

BAHAMAS: 400 $h^{-1}$ Mpc volume $\rightarrow$ large statistics (20k objects)

MACSIS: 390 zooms from a 3.2 Gpc volume $\rightarrow$ high-mass clusters
• Check angular momenta alignment $L_i, L_j \ (i \neq j)$
• Check angular momenta – bulk velocity alignment $v_i, L_j$
• Check bulk velocity alignment $v_i, v_j \ (i \neq j)$
\[ \Delta \theta (L_{stars}, L_{gas}) \]

If this is 180 deg, then it’s a bullet cluster

\[ \Delta \theta (L, v) \]
ASIDE: what about morphology?

Bett+07

BAHAMAS®

\( z = 1.00 \)

\( R_{\text{spatial}} = R_{\text{iso}} \)

\( \theta_{\text{major}} \) [degrees]

\( \theta_{\text{minor}} \) [degrees]

\( \theta_{\text{intermediate}} \) [degrees]

\( M_{\text{spatial}} \) [M\(_{\odot}\)]
• Stacking kSZ maps after de-rotation

• Mass and redshift dependence
• Halo model fit (beta / gNFW)
• Sample selection++
Thanks for listening!

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