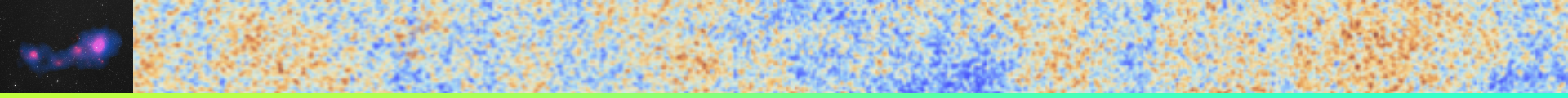


Hunting butterflies in the CMB: Probing large scale structures transverse velocities

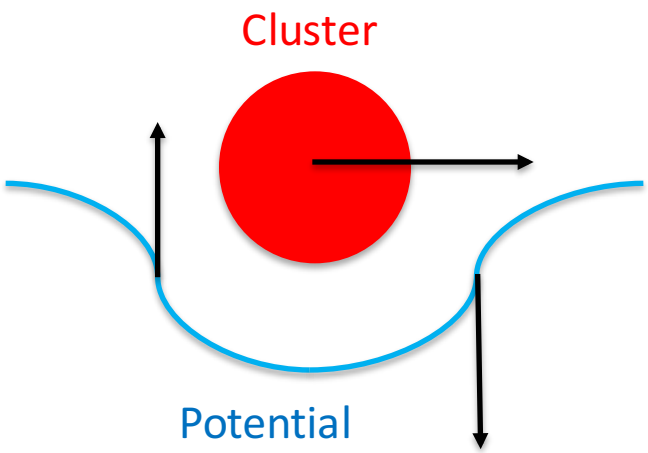
Guillaume Hurier

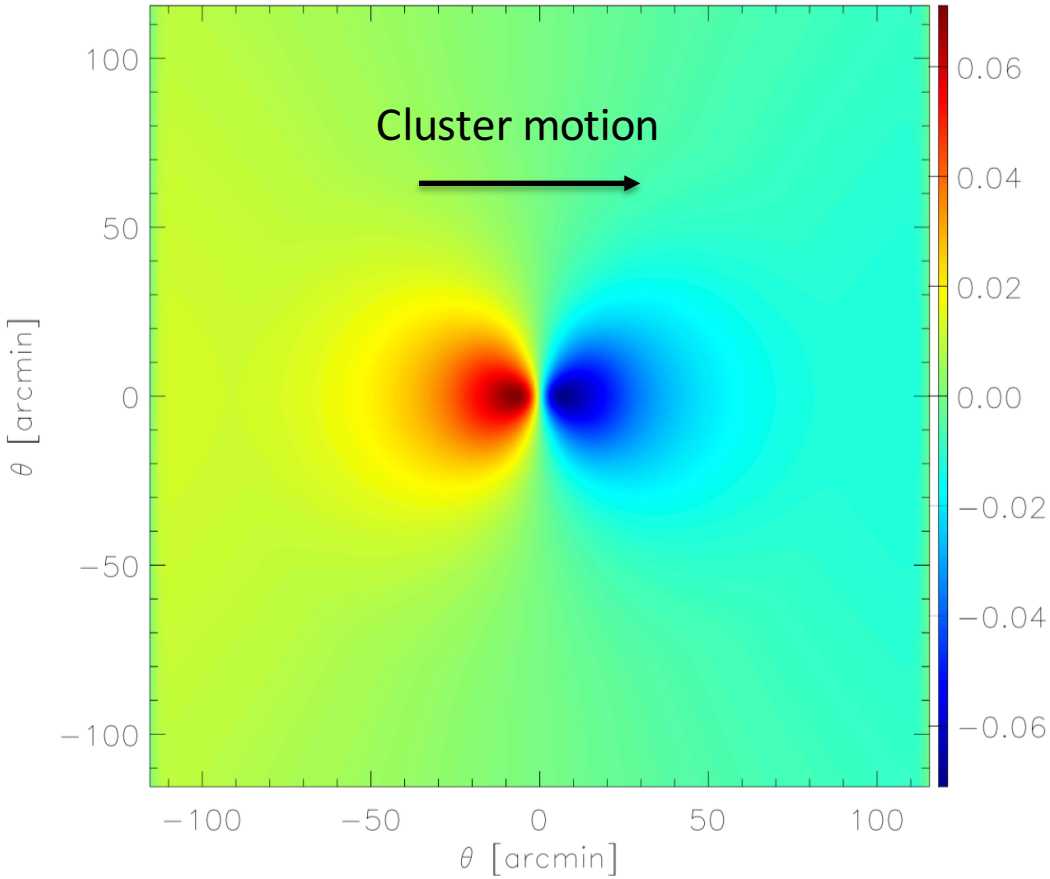
22/03/2019

CEFCA
Centro de Estudios de Física del Cosmos de Aragón

The effect

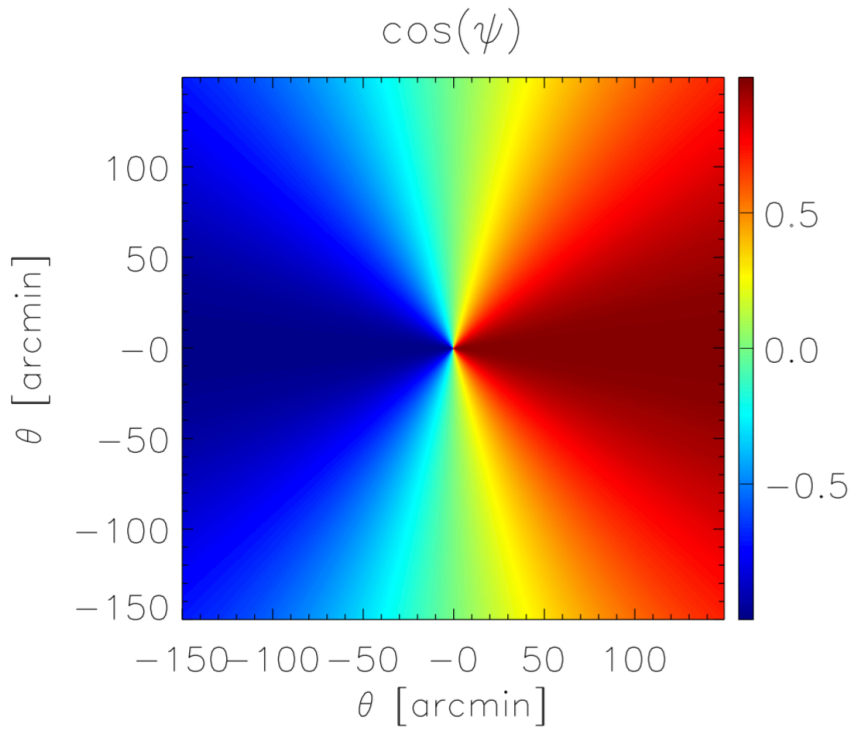
Faint dipolar anisotropies induced by gravitational potential time variation

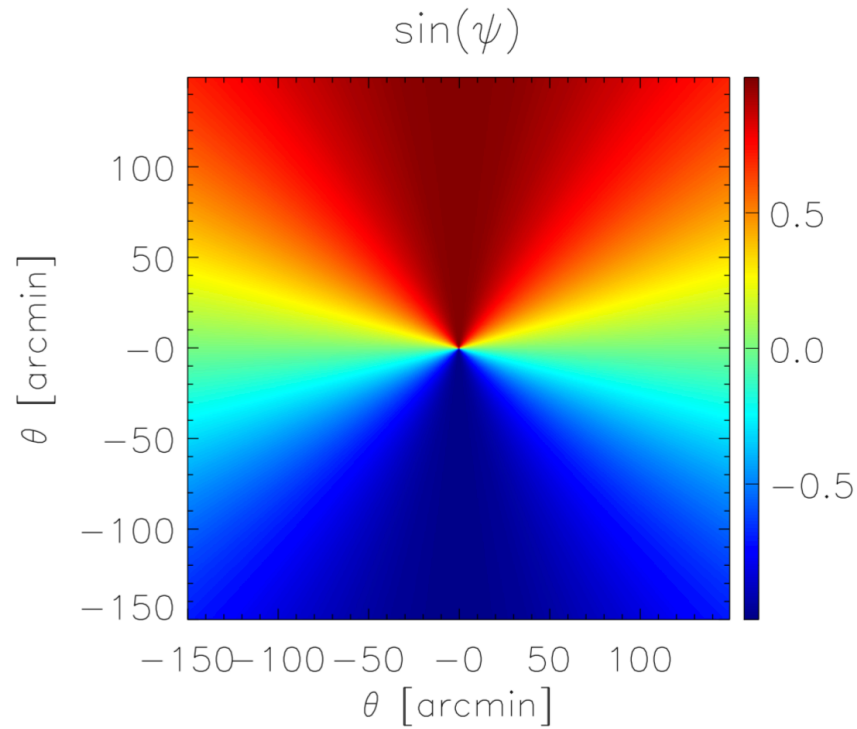




$$\frac{\Delta T_{\rm CMB}}{T_{\rm CMB}} = 2\frac{\beta_\perp}{D_{\rm A}}\cos(\psi)\int \frac{{\rm d}\phi}{{\rm d}\theta}{\rm d}l,$$

Dipolar profiles

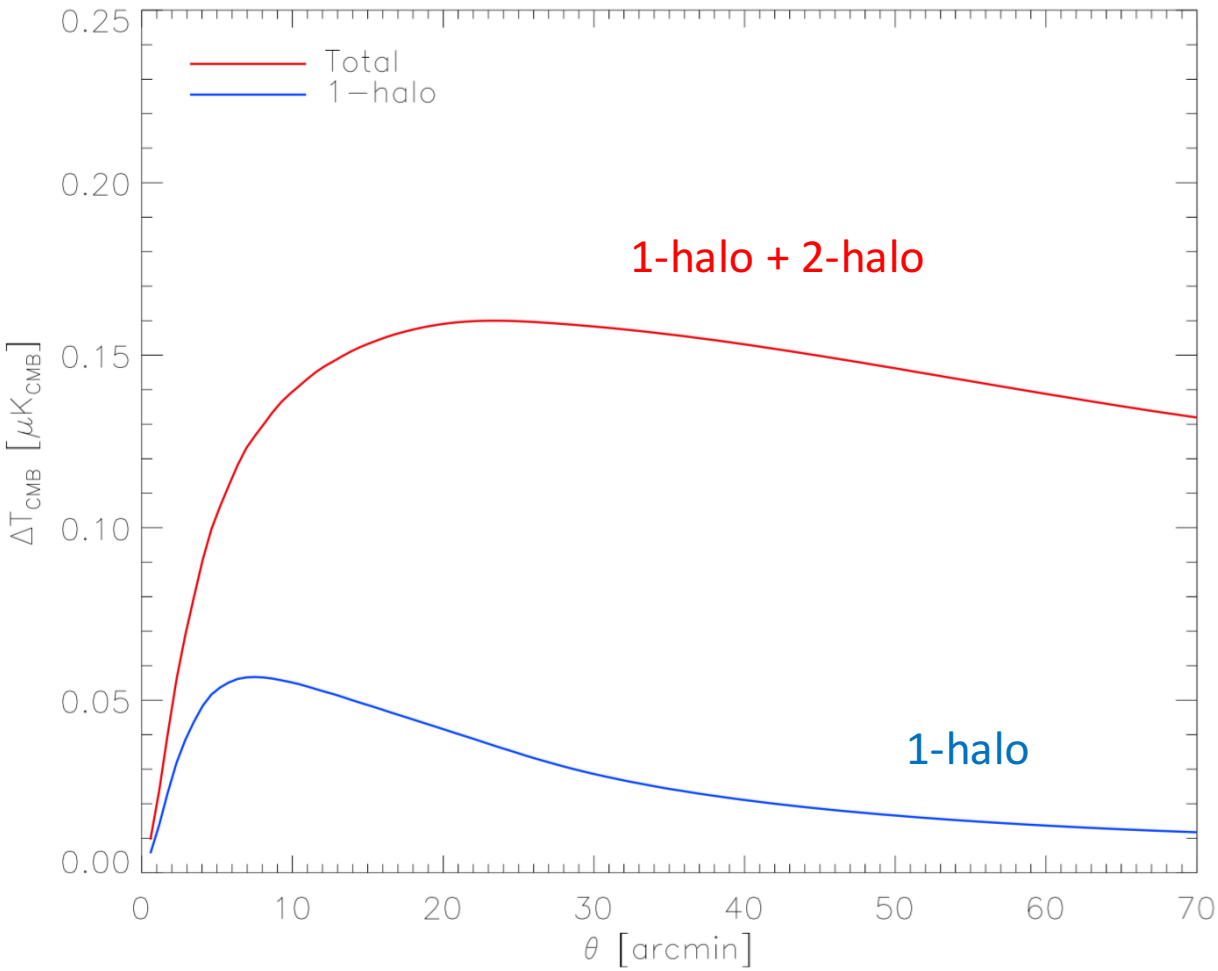




$$P_{\rm i}(\theta) = \frac{1}{2\pi\,\theta\,\Delta\theta}\int_0^{2\pi}\int_{\theta-\Delta\theta/2}^{\theta+\Delta\theta/2} \Delta T_{\rm CMB}(\theta,\psi)\,W_i(\psi)\,{\rm d}\Omega$$

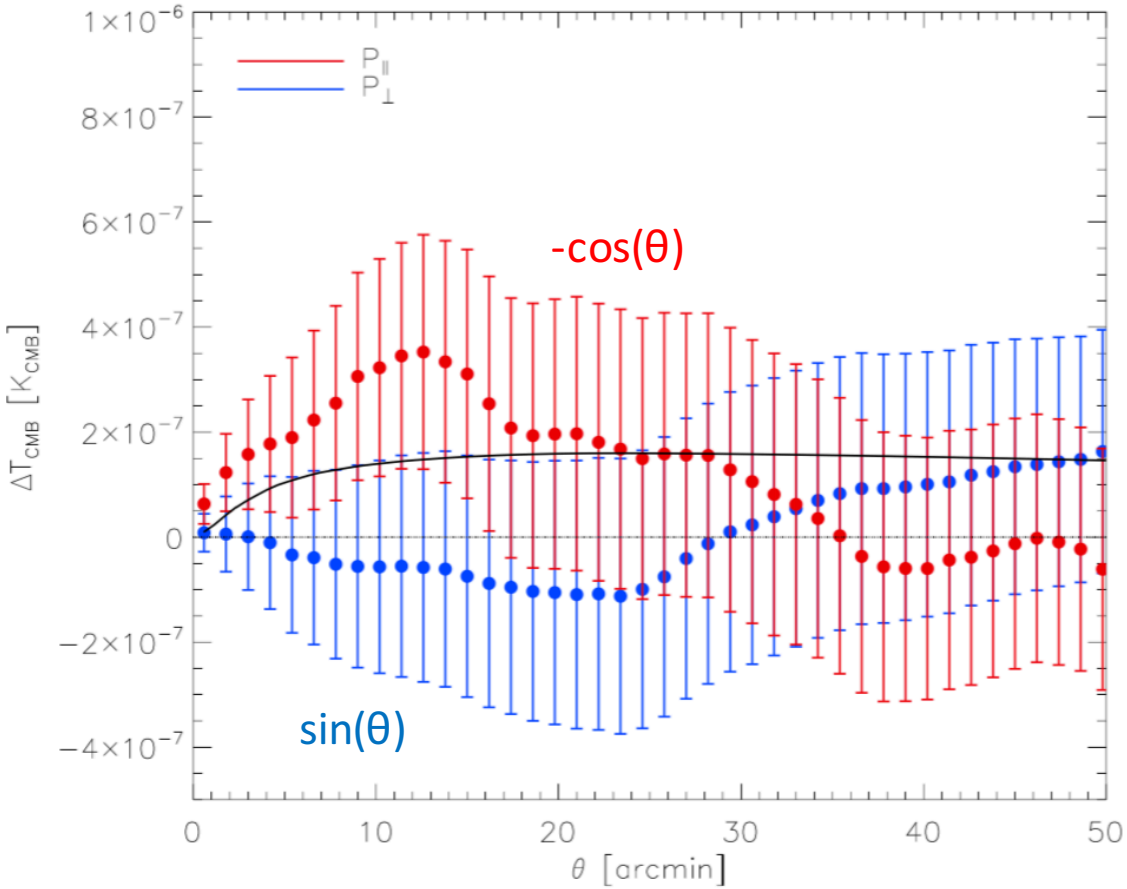
$$W = 1,$$
$$W_{\parallel} = -\cos(\psi),$$
$$W_{\perp} = \sin(\psi),$$
$$W_{+} = \cos(2\psi),$$
$$W_{\times} = \sin(2\psi),$$

Predicted stacked profile

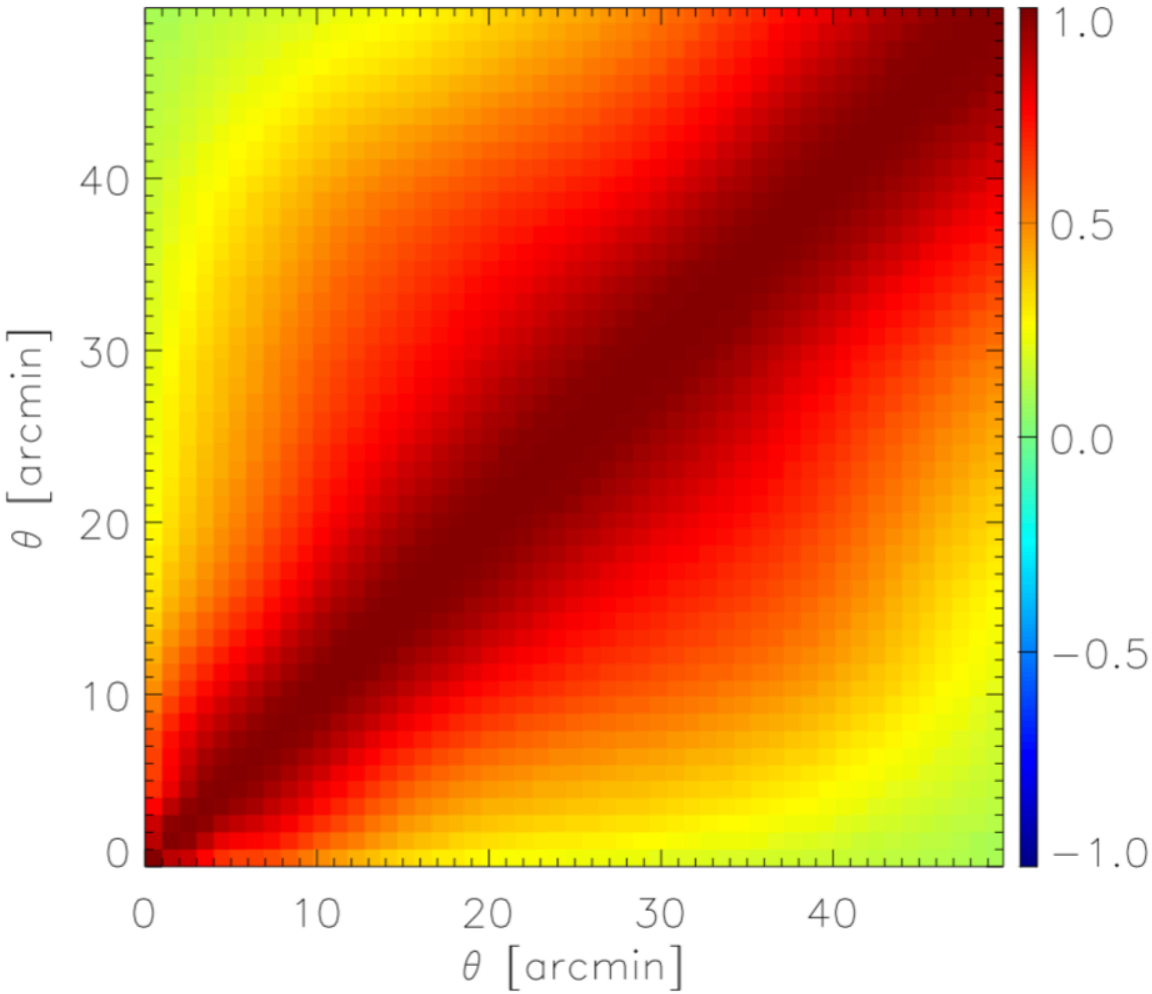


Planck x SDSS results

→ Velocity field inferred from SDSS DR13
→ Redmapper cluster catalog
→ CMB from Planck (NILC)

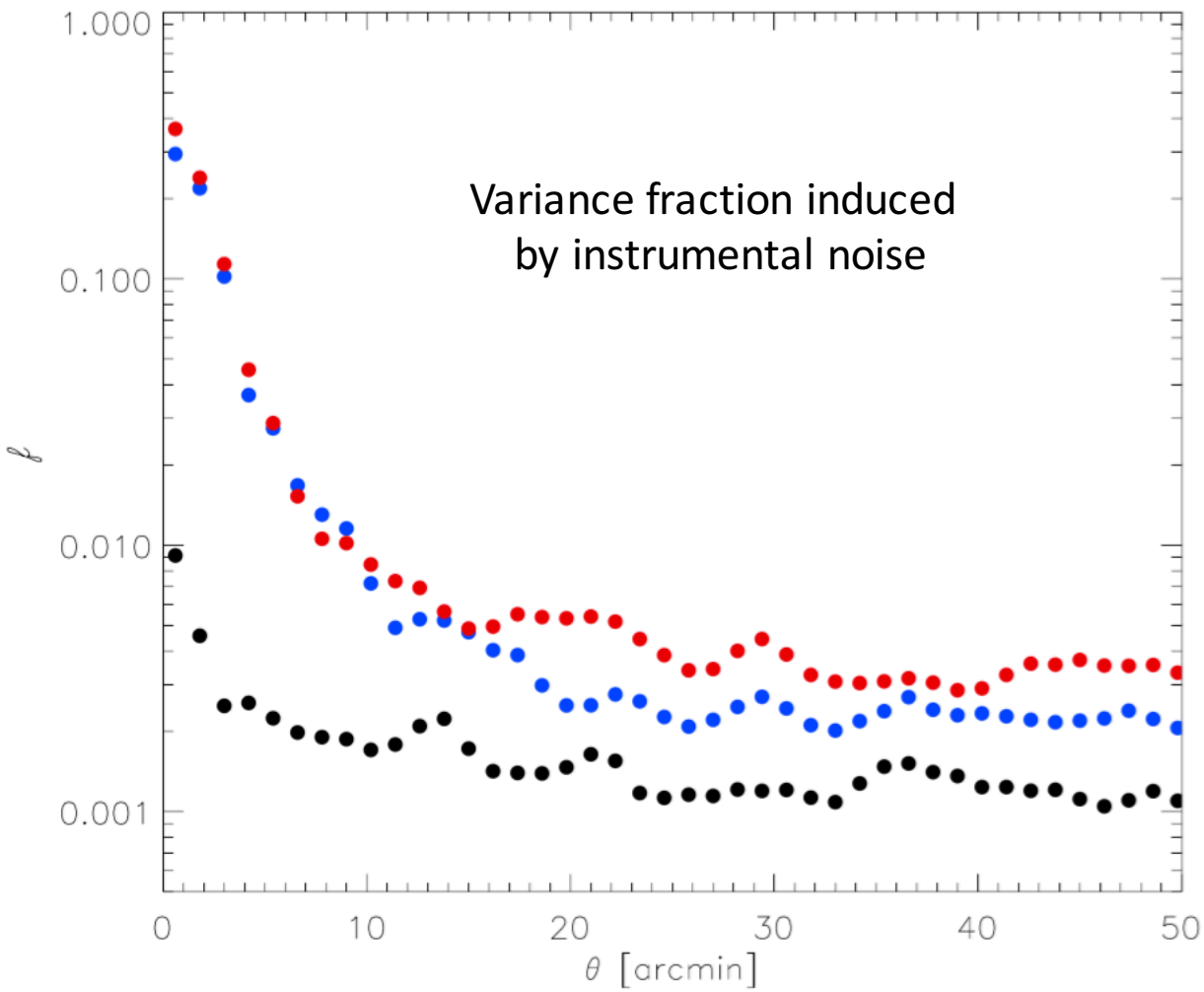


Correlation matrix



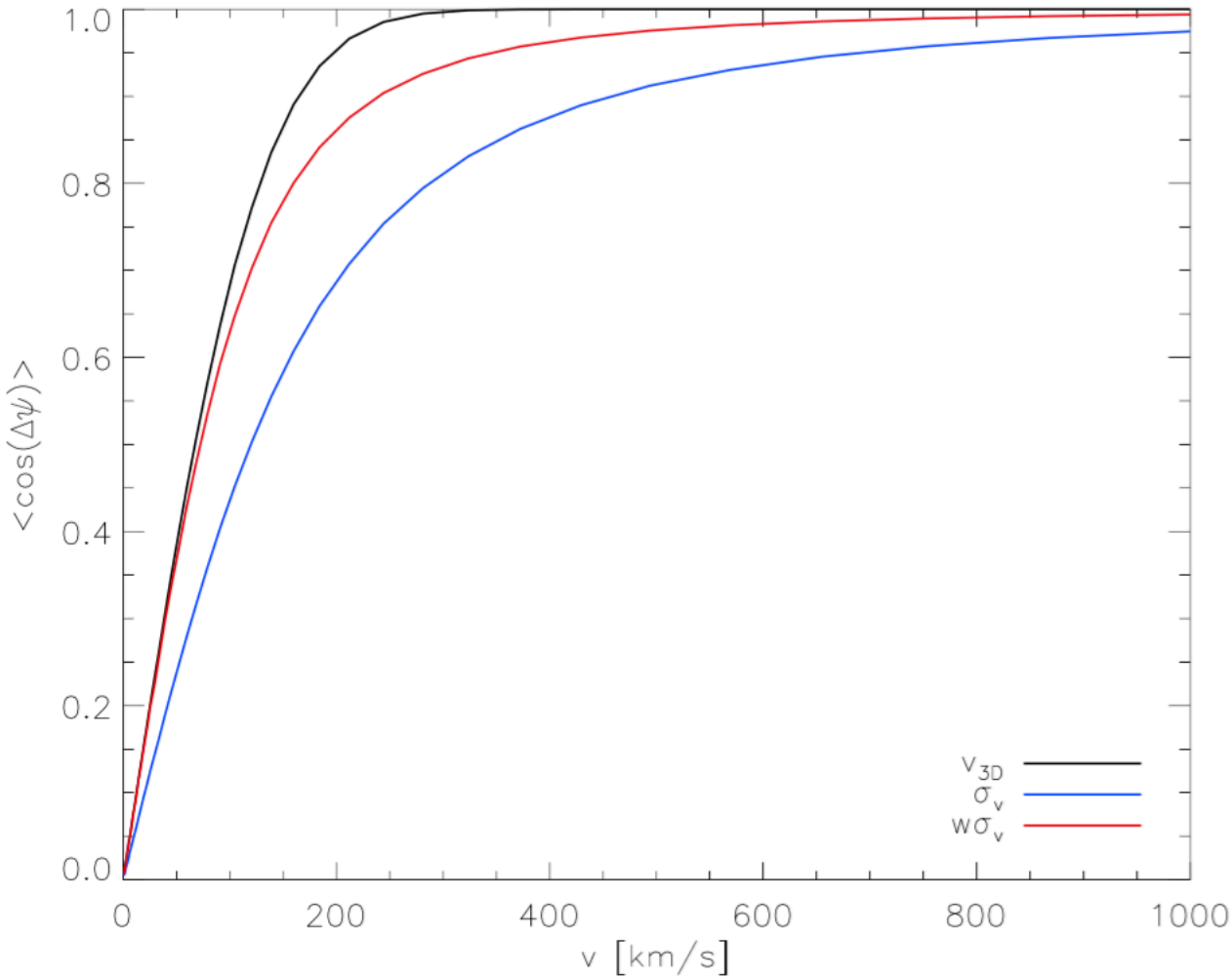
Uncertainty

Uncertainty Estimated from bootstrap and Monte-Carlo simulations



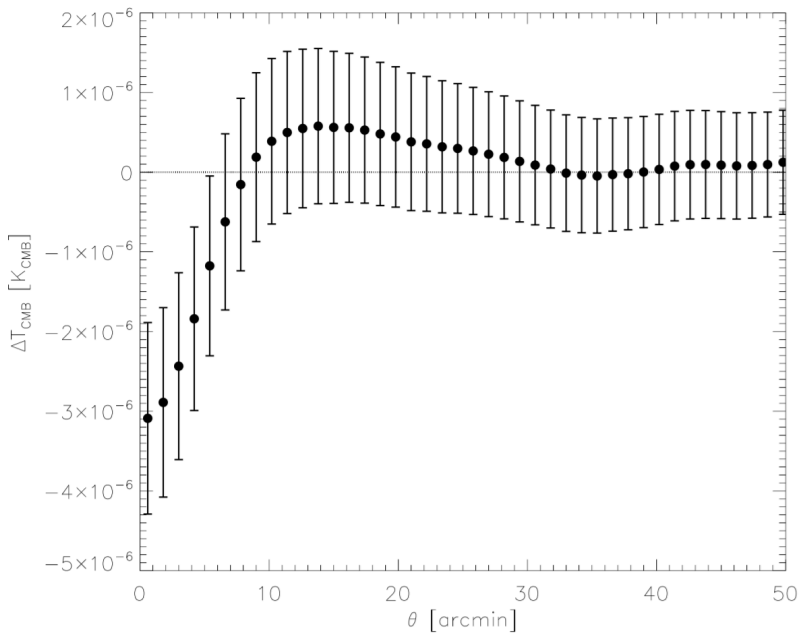
Velocity misalignement

For a 100 km/s gaussian error on the reconstructed velocity field

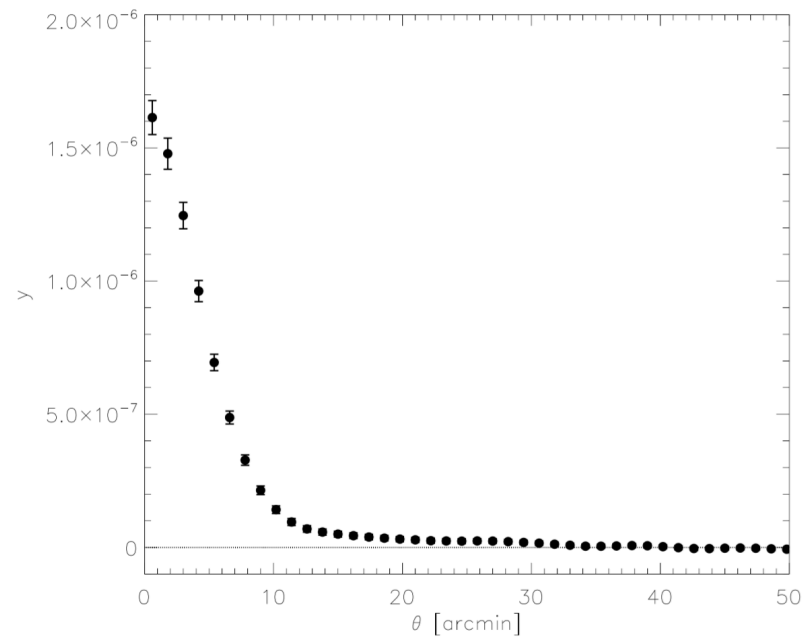


tSZ residuals in the CMB

CMB stacked profile
toward RedMapper clusters

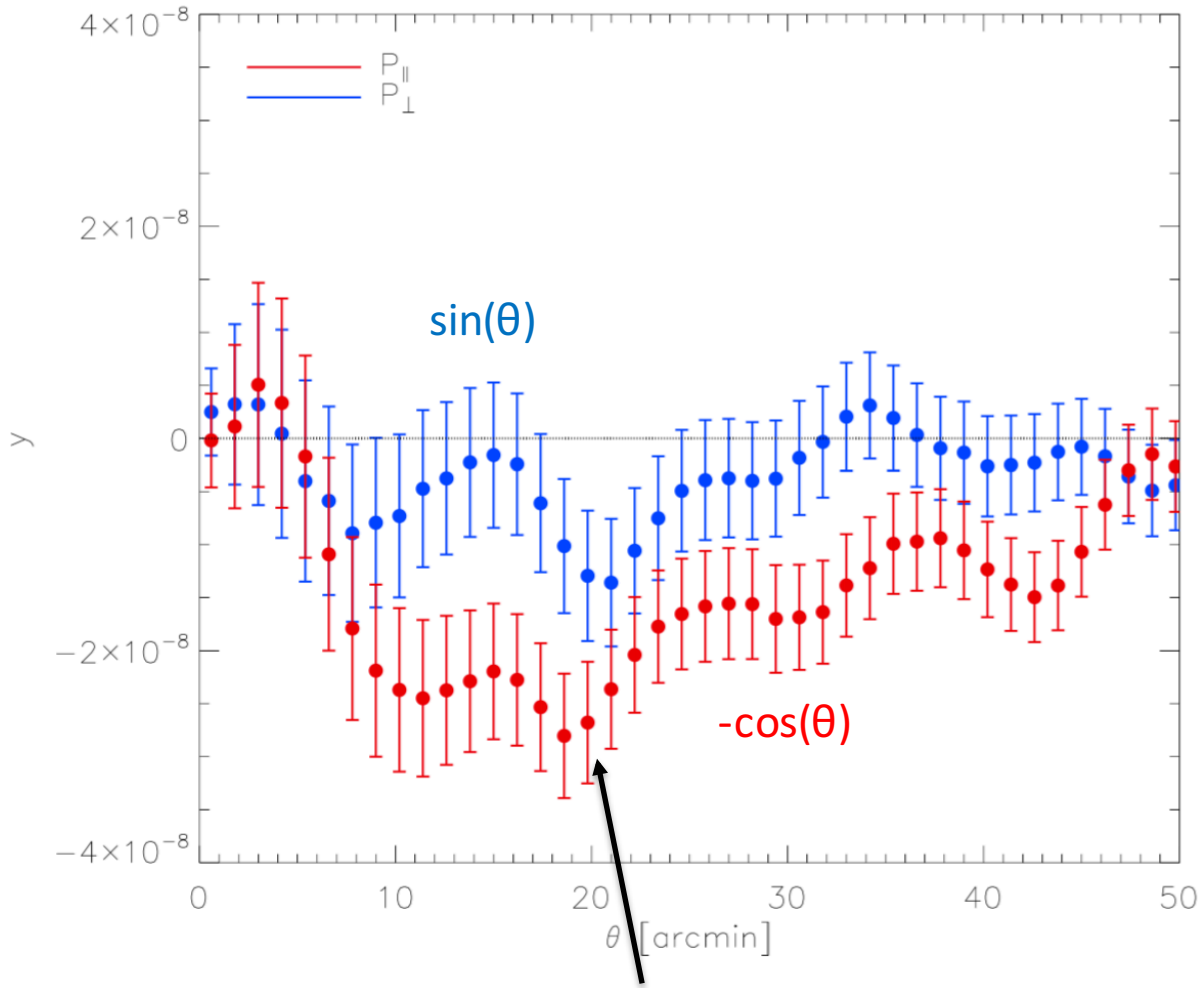


MILCA y-map stacked profile
toward RedMapper clusters



Leakage of ~2 K_{CMB}/y

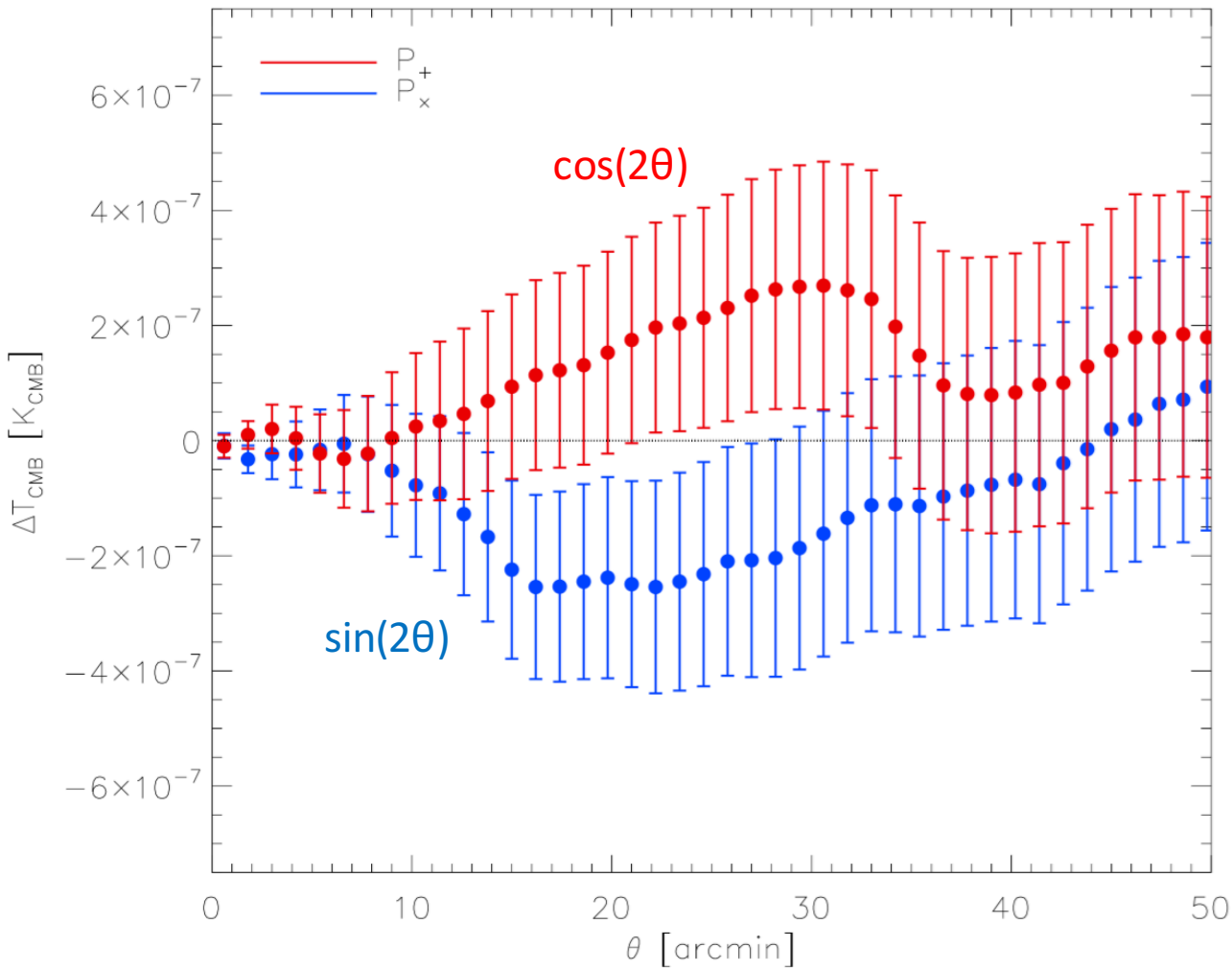
tSZ dipolar profile



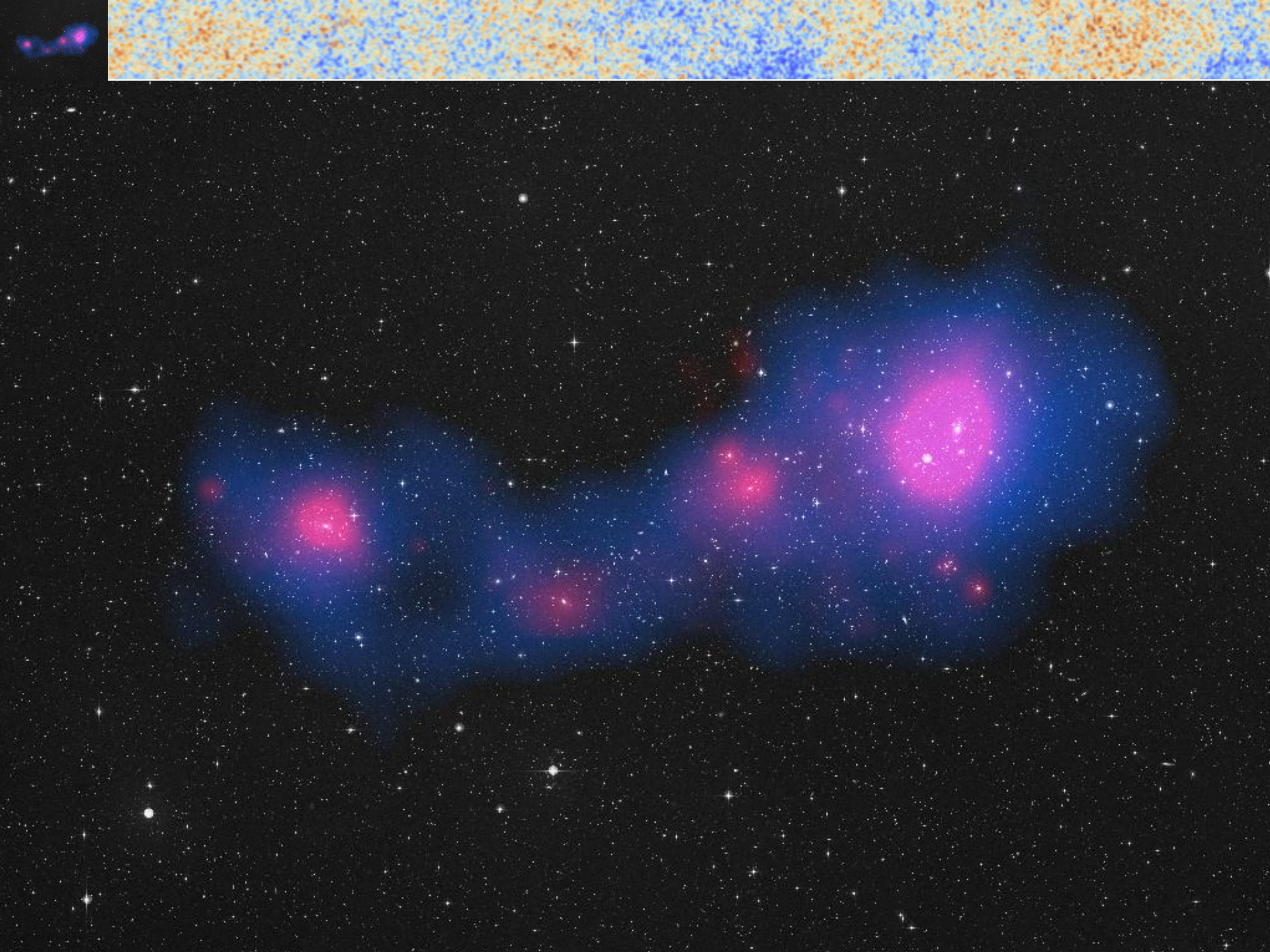
Cluster moving toward nearby matter overdensities

~0.5 10^{-7} K_{CMB} positive bias on CMB dipolar profil (20% of the measured signal)

CMB quadrupolar profile



Expectation for Euclid

Expected signal to noise considering identified cluster number density in the [0.2, 1.5] redshift range.
→ Euclid-Planck : 5 sigma (40% of the sky)

S/N potential improvement :
→ +20% cosmic variance limited
→ +15% for next gen CMB fullsky expériment (2' FWHM angular resolution)