Lecture 4. Interactions of systems. Epilogue, future develpments

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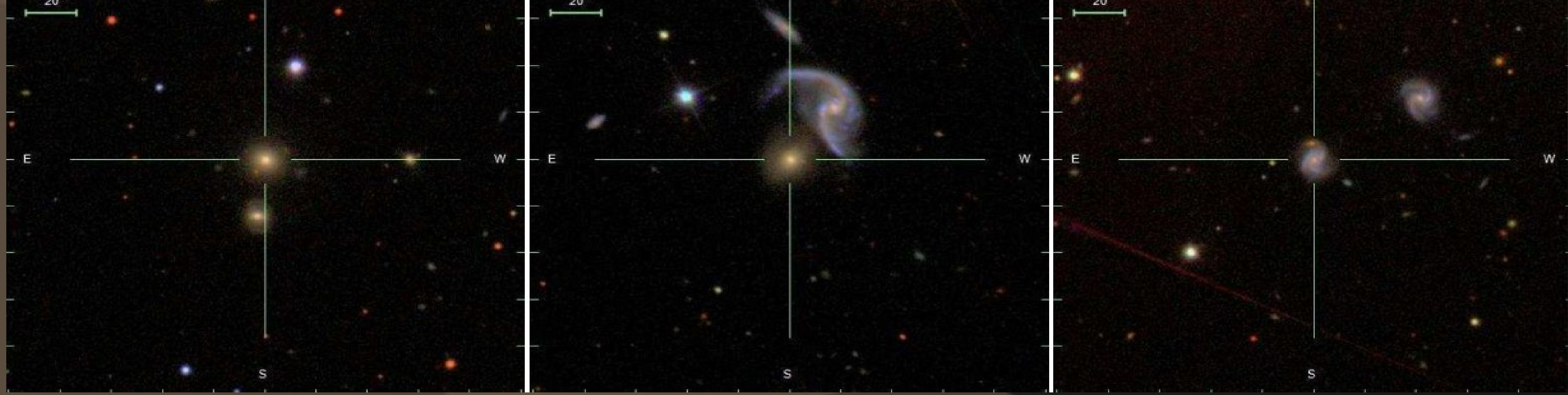
Espirito Santo, September 2022

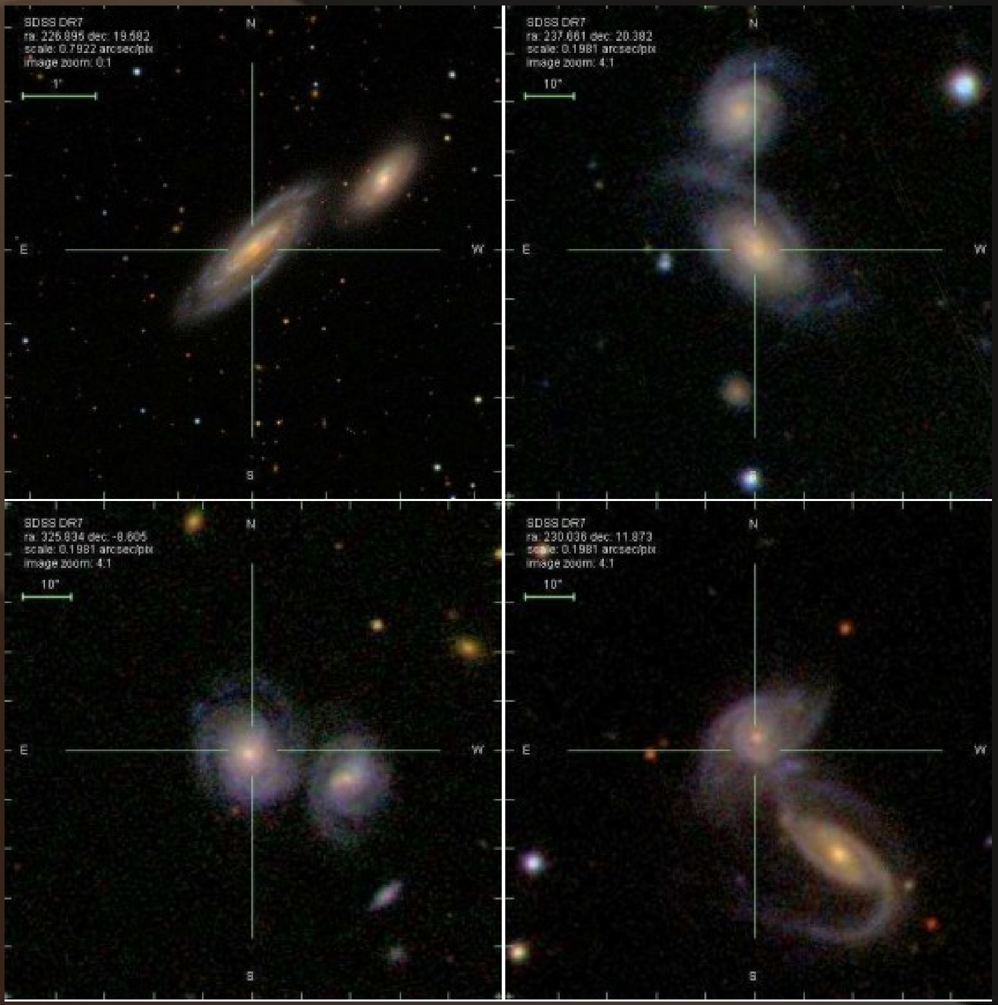
Interacting pairs of galaxies

- Galaxy pairs are interesting and particular systems from the dynamical point of view (link with a two body problem)
- In observations the effects of the interaction can be separated from those of the secular evolution.
- Can provide further constraints to simulations
- Galaxy interactions may also be used to test model predictions and observations.



Tidal features

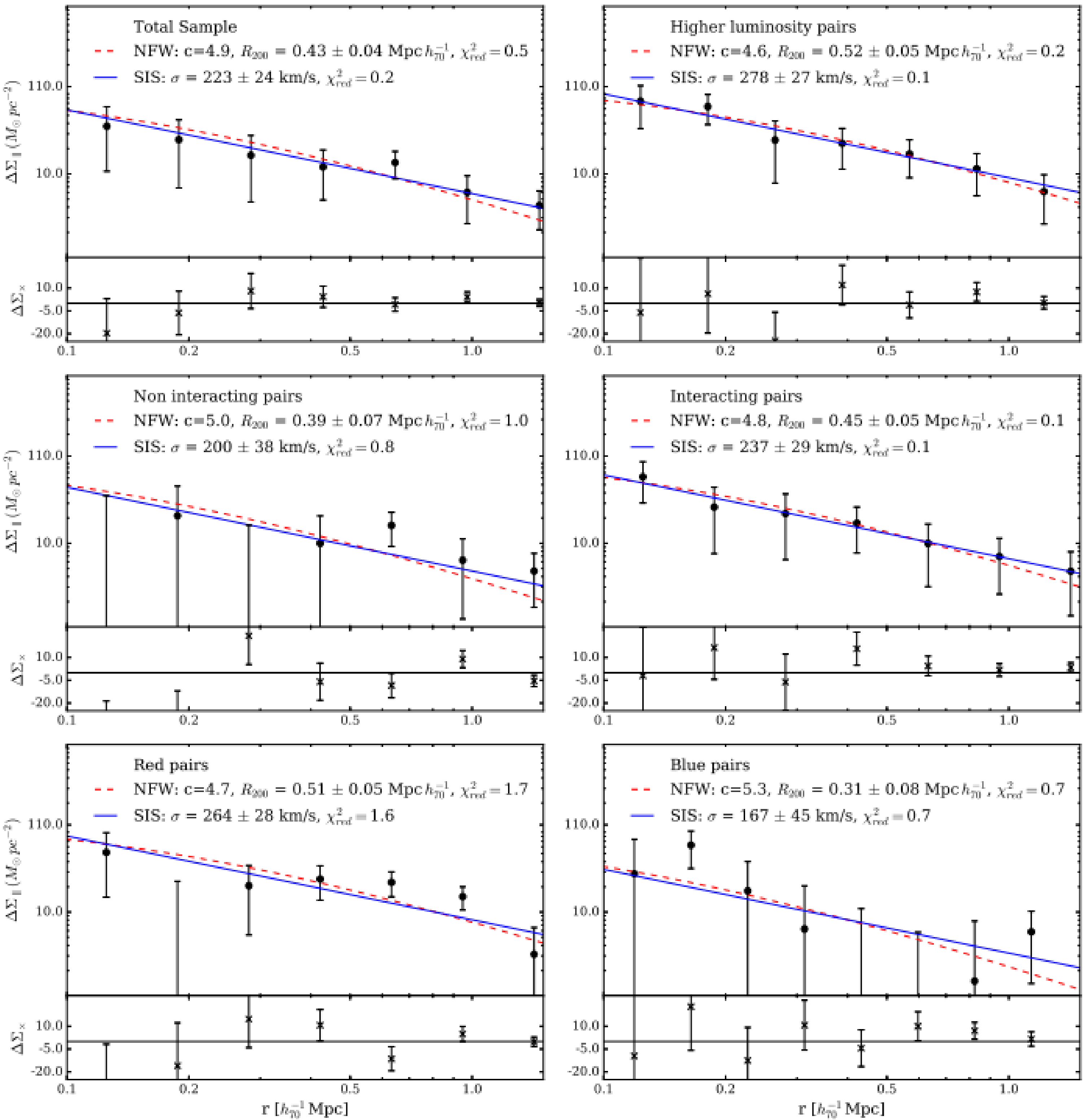
Excess of star formation



Sol Alonso, et al. 06-16, and in progress

WL studies of galaxy Pairs

- Galaxy interactions can be though as the low energy counterpart of bullet-type clusters



Gonzalez E. et al. 2020

WL M/L ratios of pairs

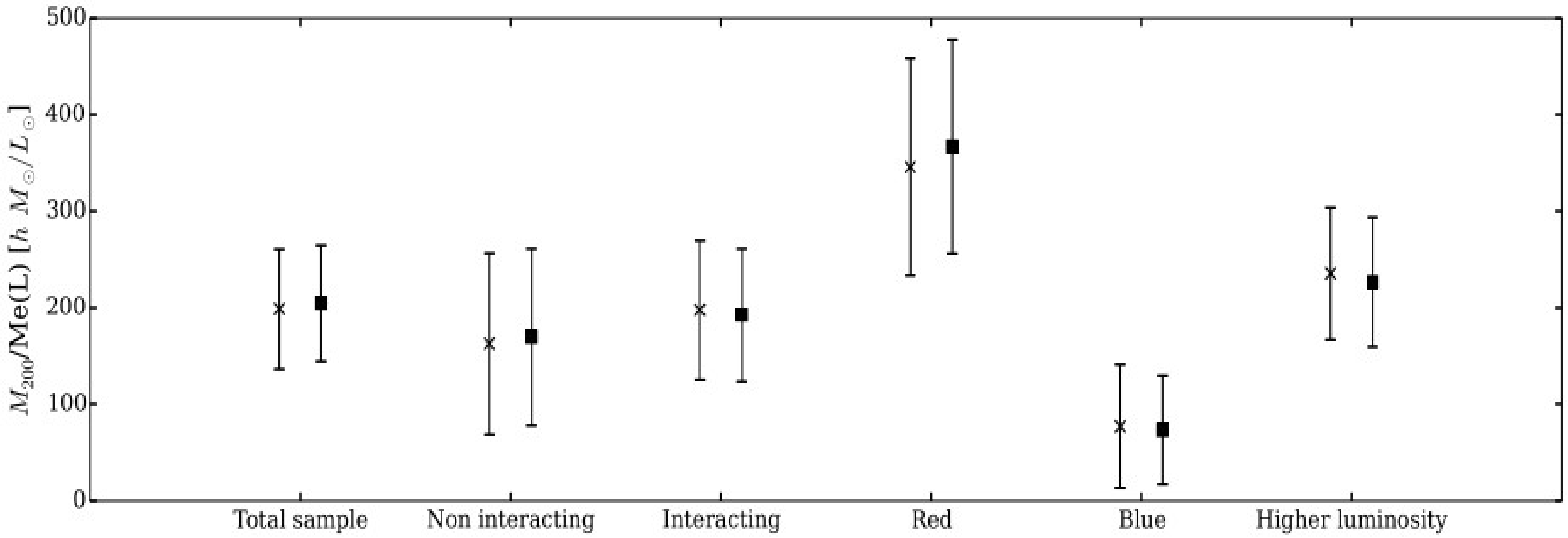


Fig. 4. Mass to light ratios for the analyzed samples. Masses are the M_{200} derived according to the lensing analysis, considering SIS (crosses) and NFW (squares) models. Luminosity is computed according to r−band absolute magnitudes, adopting the median of the luminosity distribution for each sample.

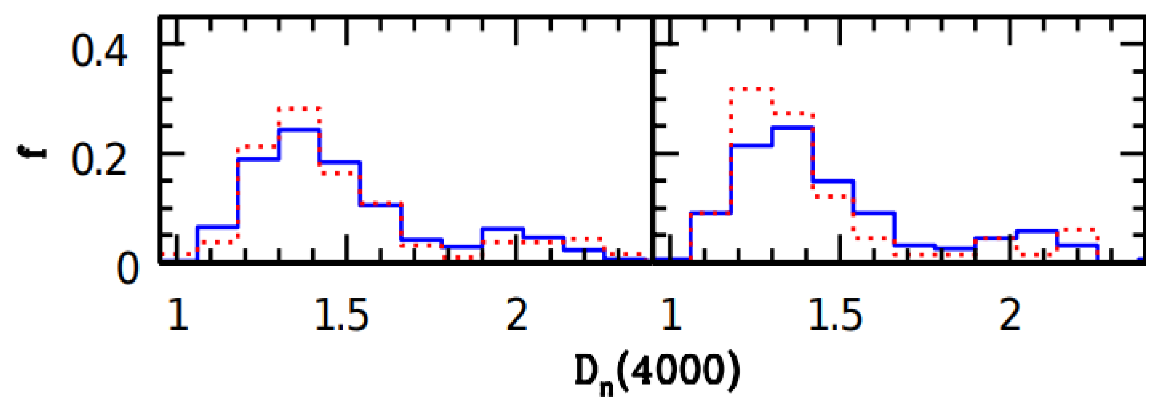
More to do on WL in pairs

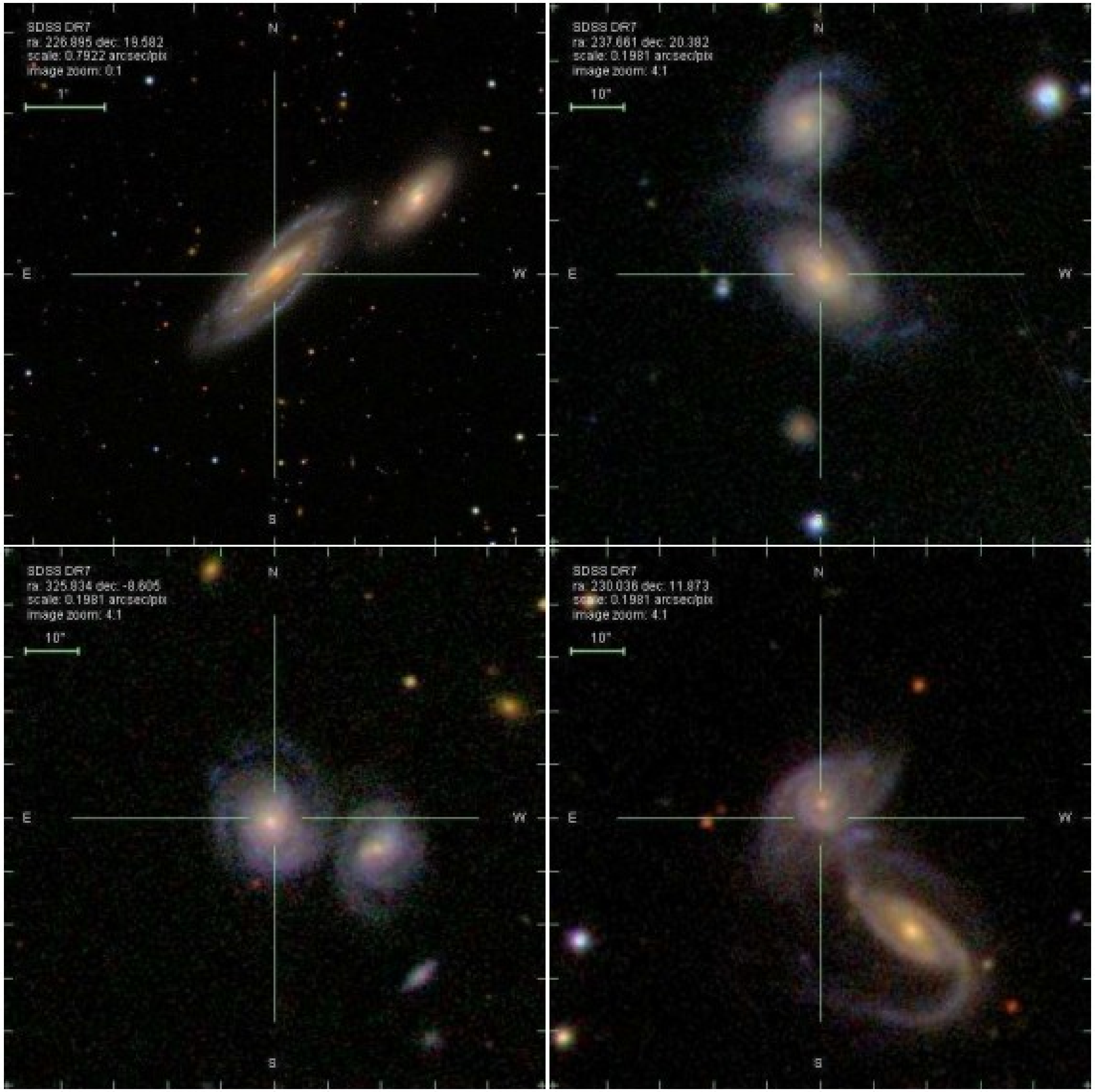
New WL work, may provide further information on halo shapes and orientations wrt galaxies.

Also, redshift-space distortions and other statistical measures can shed light on the dynamics of interactions

Statistical measures of Galay - Galaxy interactions

- Low energy interactions: galaxy-galaxy (as compared to cluster collisions)
- More to learn on DM/astrophysics
- Dependence on relative velocities, spins, etc.
- We report an excess of co-rotating (65%) vs counter-rotating pairs (35%)





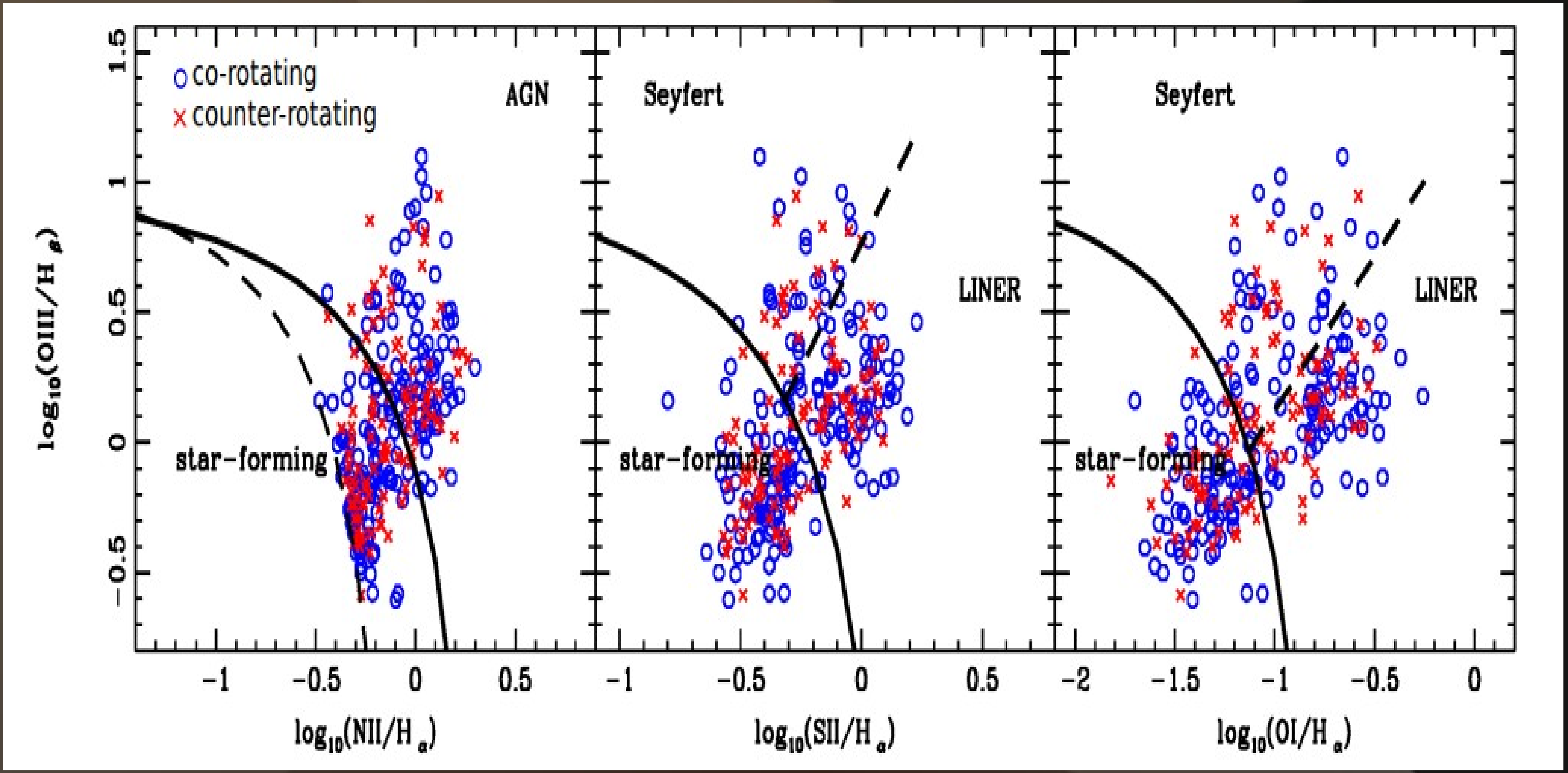
Co-rotating vs counter-rotating pairs

AGN activity is also enhanced in interacting pairs

- Excess of co-rotating vs counter rotating pairs

  do not seem to be associated to different type of AGN

AGN – galaxy interactions



Mesa et al.’18

Exploration of SFR-AGN-interactions effects are important and promising

- Work in progress with new catalogs of galaxies and infrared selection of AGN

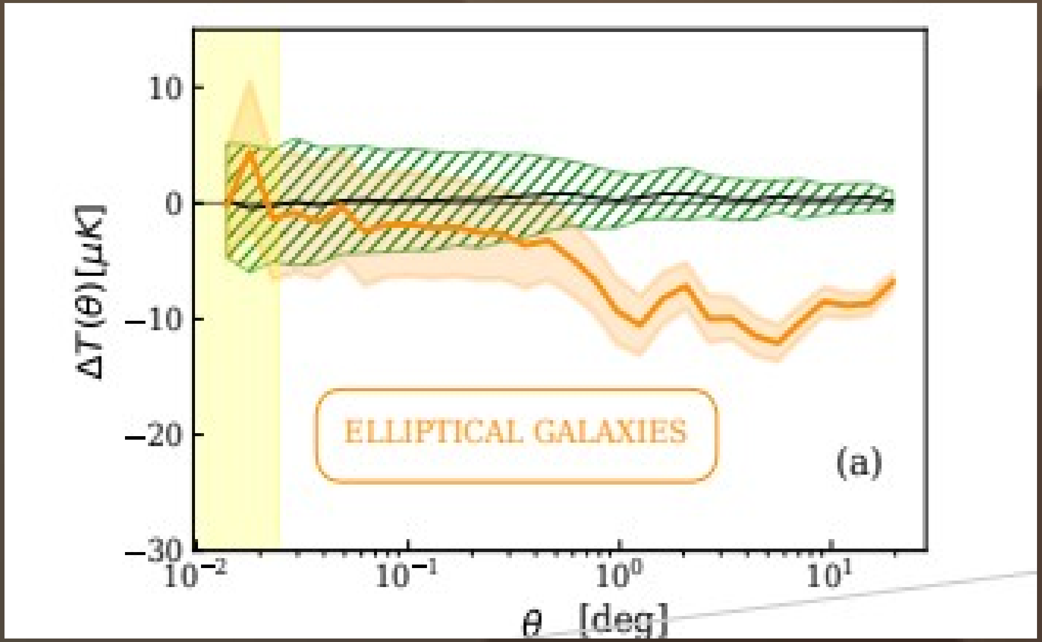
CMB

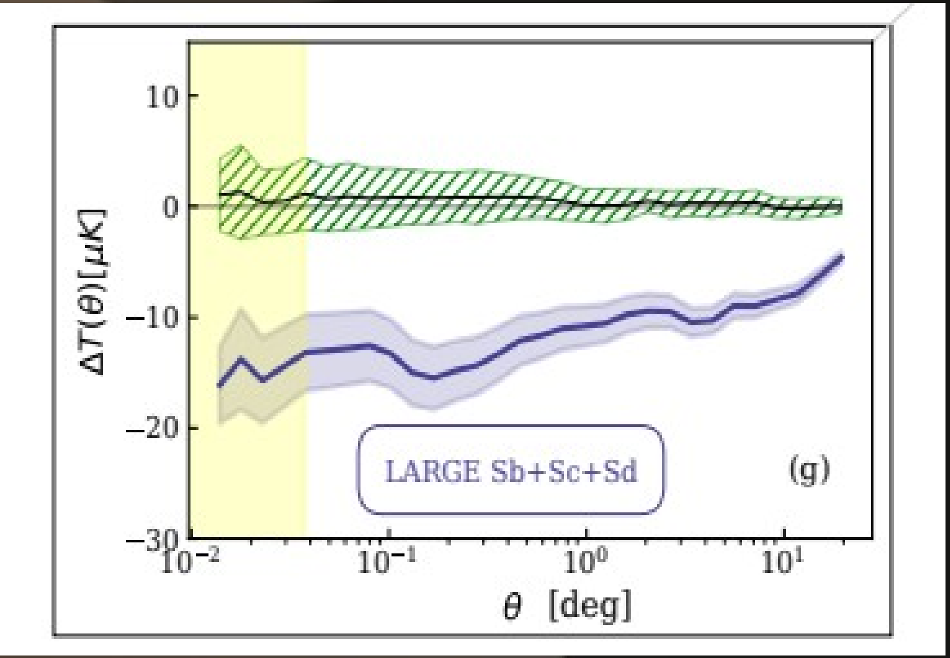
- Given the several uncertainties present in galaxy data: biases, callibration issues, correlated errors, etc., it is worth to consider possible CMB systematics as well.

- Serendipitous detection of foregrounds in CMB data

when searching for possible Kinematic SZ effect by stacking spirals with same sense of rotation…

Heliana Luparello et al. 2022

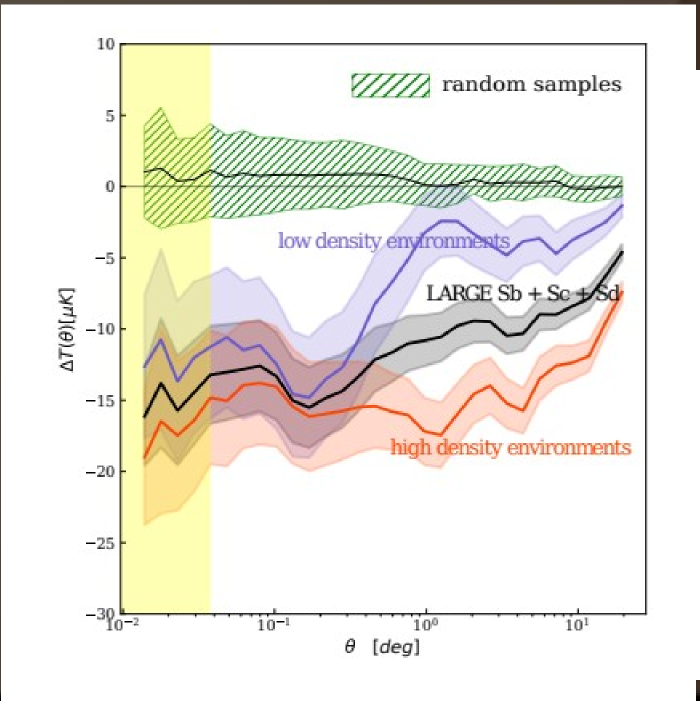




Temperature decrement mostly due to late spirals, ellipticals inherit the large scale effect from clustering

Foregrounds are small compared to CMB fluctuations

- Still they may be relevant for astrophysics



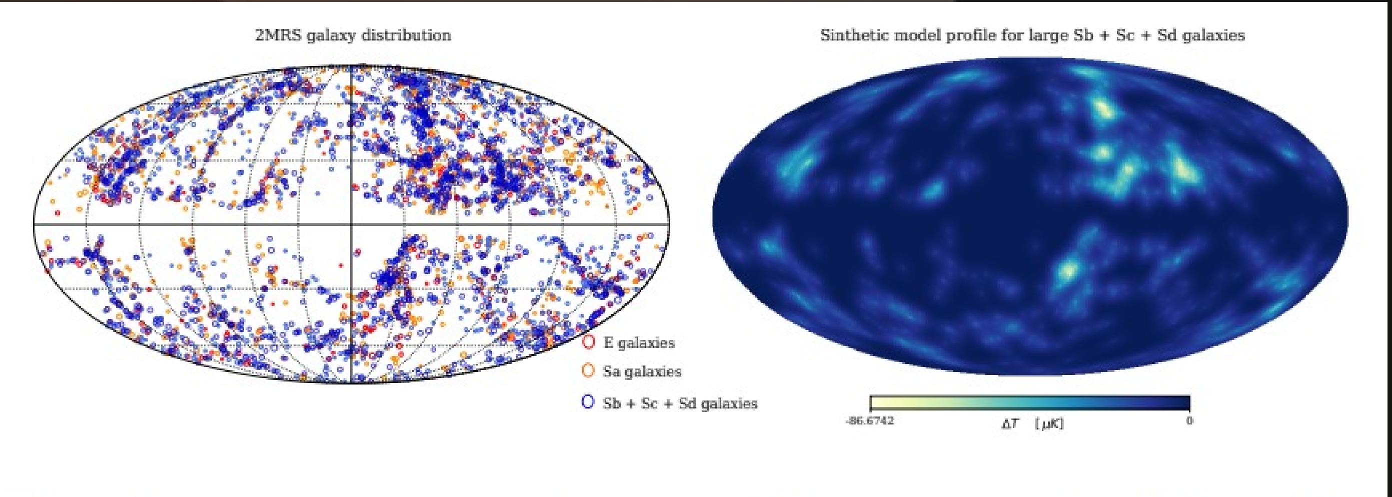
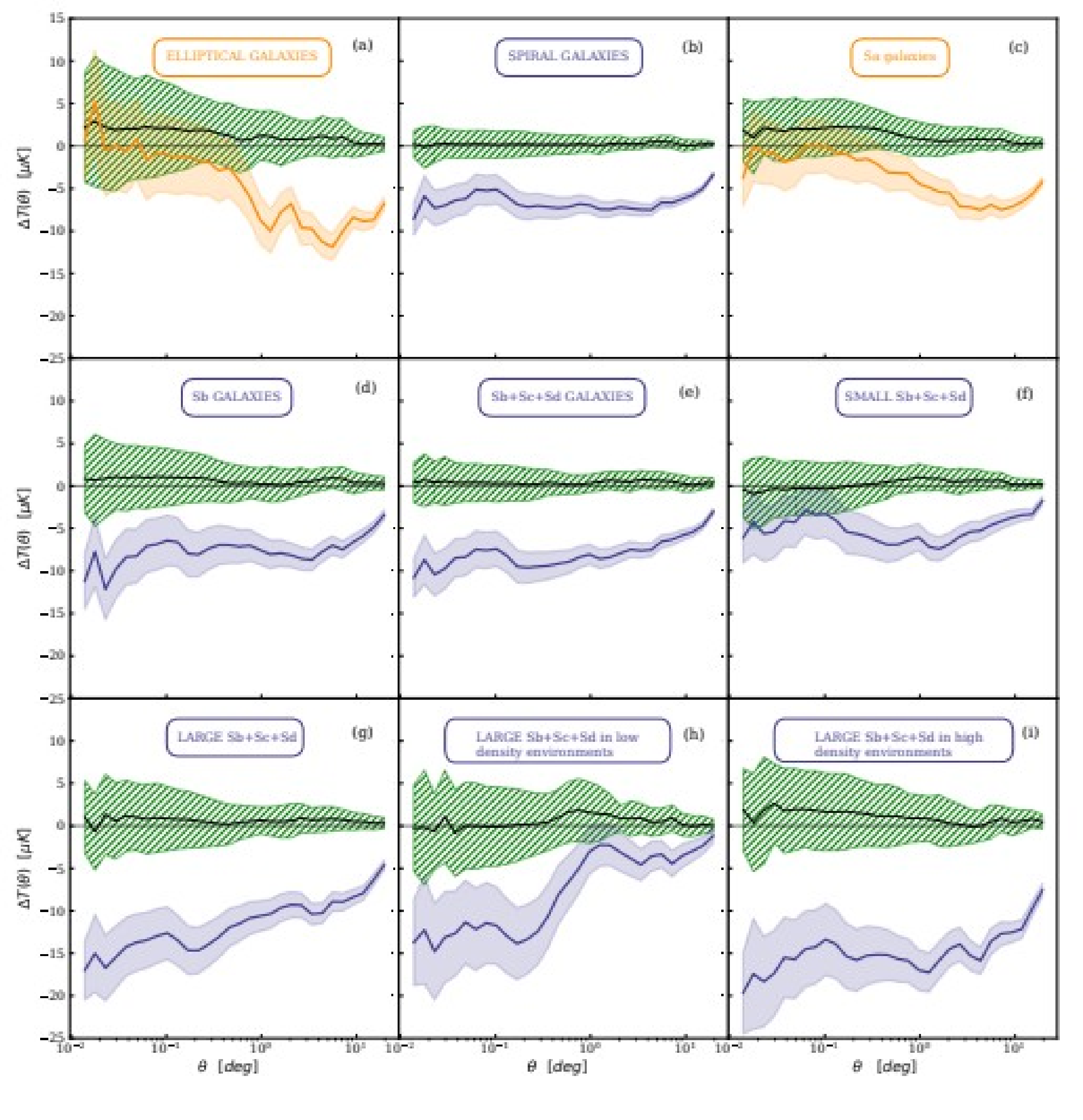


Figure 4. Galaxy distribution and synthetic map. Left panel: Distribution of galaxies from 2MRS in the range $cz < 4500$ km s^{-1}, classified according to their morphological type. Right panel: Synthetic foreground map of ΔT, obtained by assigning the profile described in Section 4.2 to the sample of large (radii>8.5 Kpc) Sb +Sc + Sd galaxies.

Consistency in WMAP and Planck Subtraction of SZ effect makes no changes



- Even if they would not affect systematically Planck predictions, they could alliviate tensions in parameters if uncertainties are raised

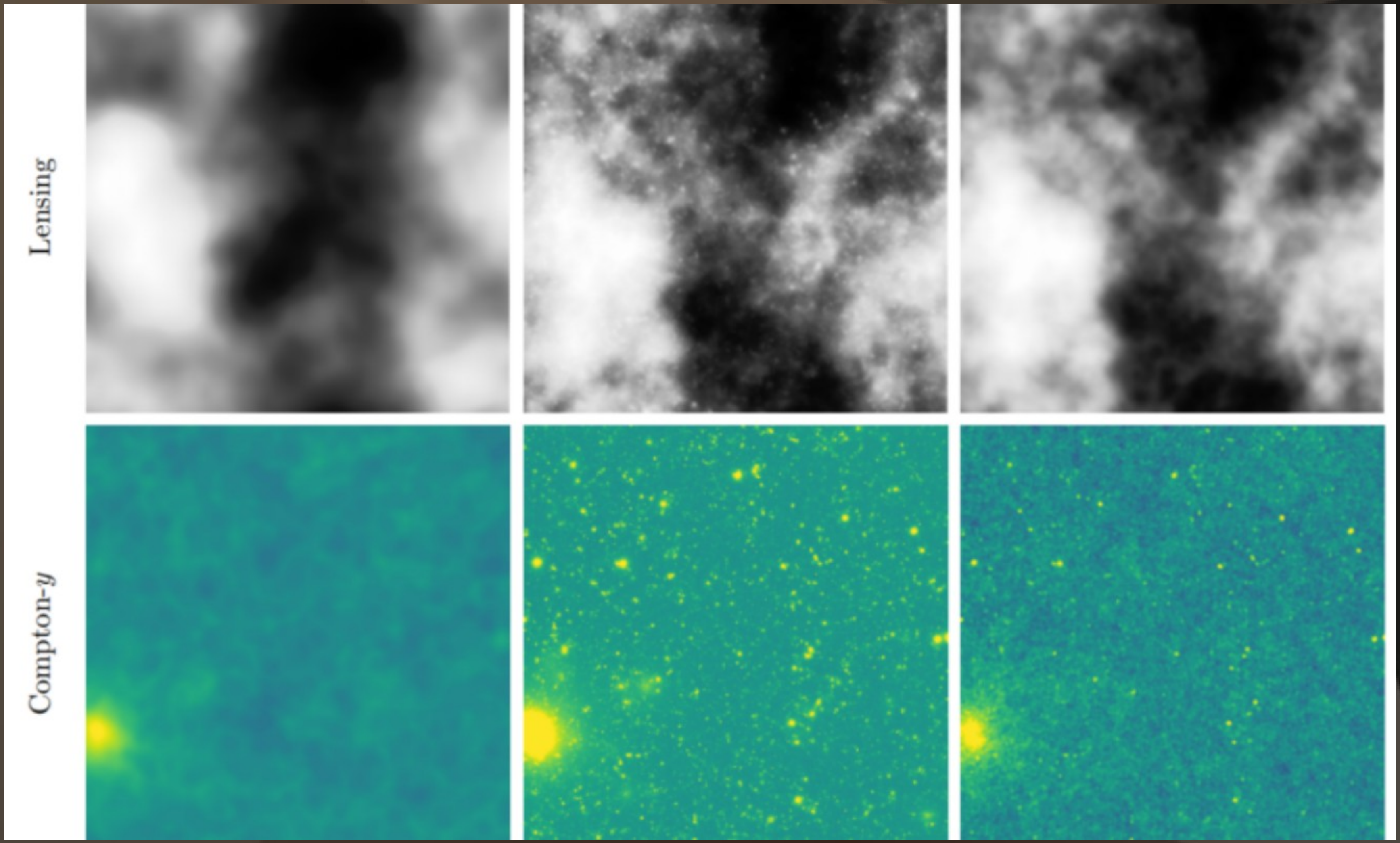
Work in progress shows that the spectrum at high l may also be marginally affected.

Around bright nearby galaxies (within ½ degree aprox.), temperature fluctuations are systematically lower than elsewhere by 2 muK.

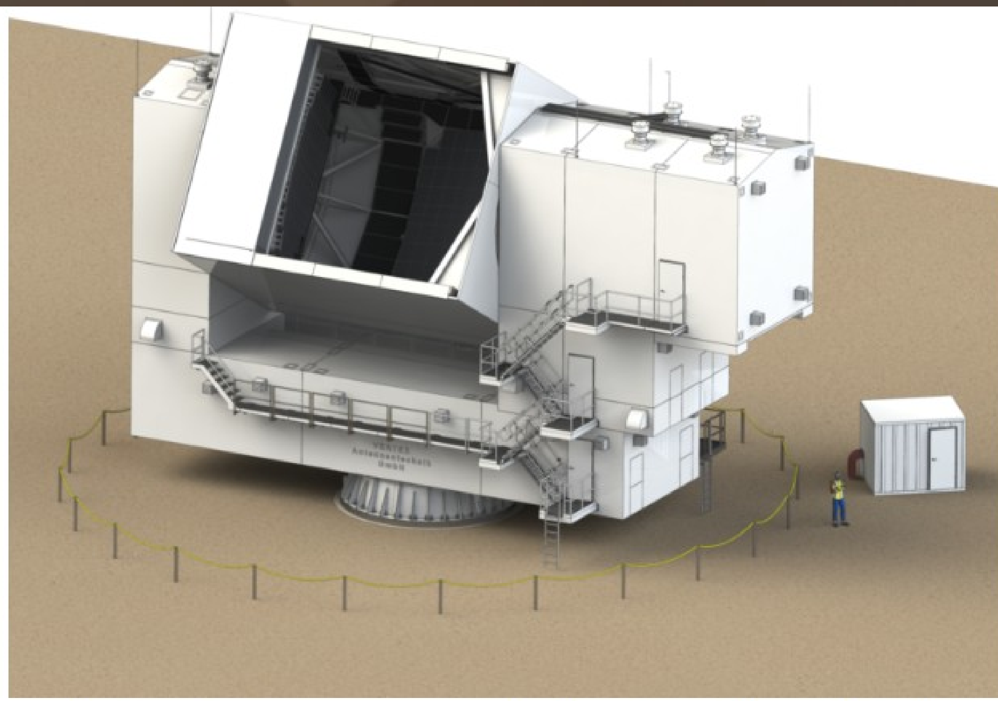
The physical origin of these two effects are unknown, work in progress..

New developments in CMB studies
CMB S4

Planck Real Sky Simulation CMB-S4



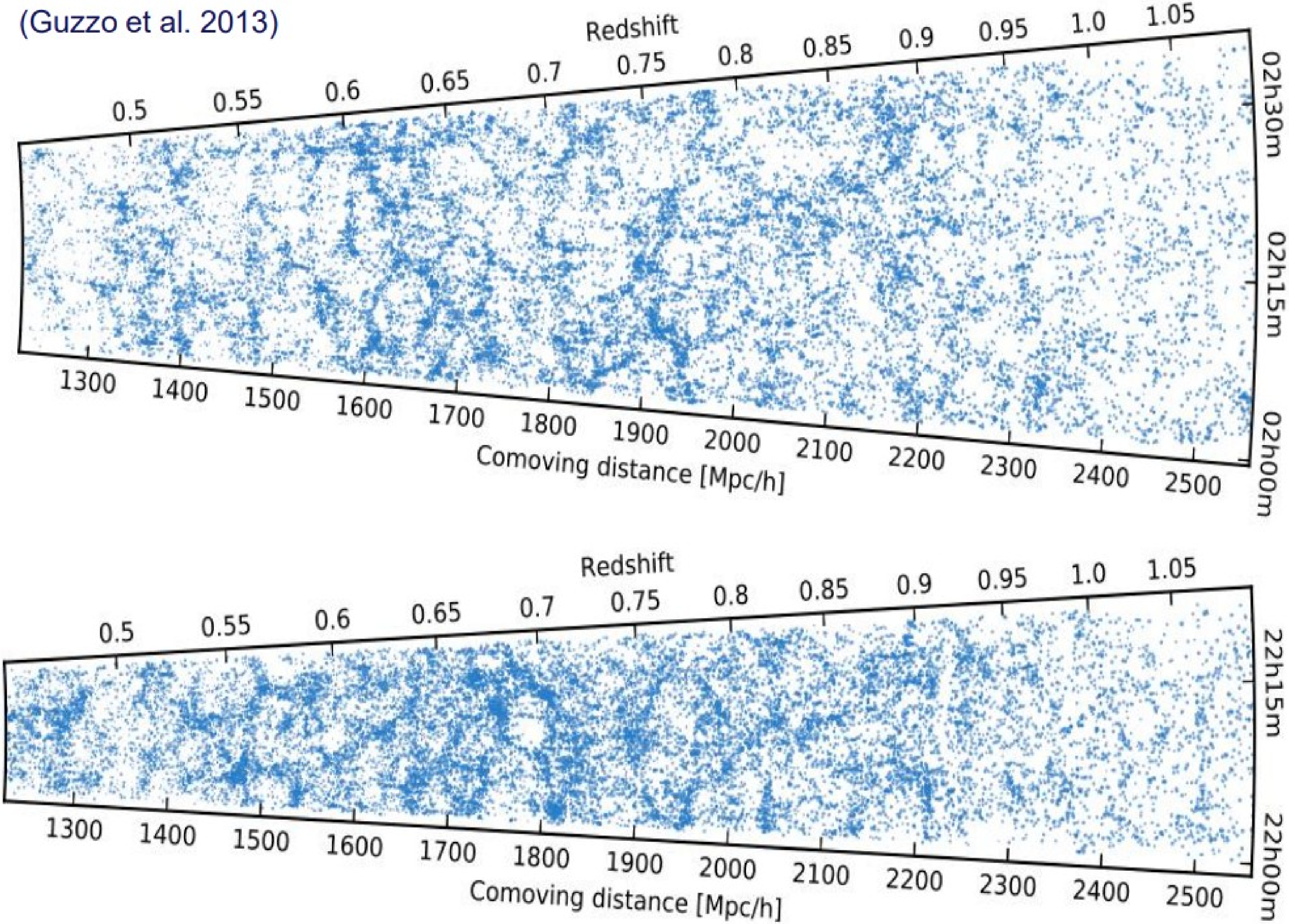
Understanding signal and noise at high l

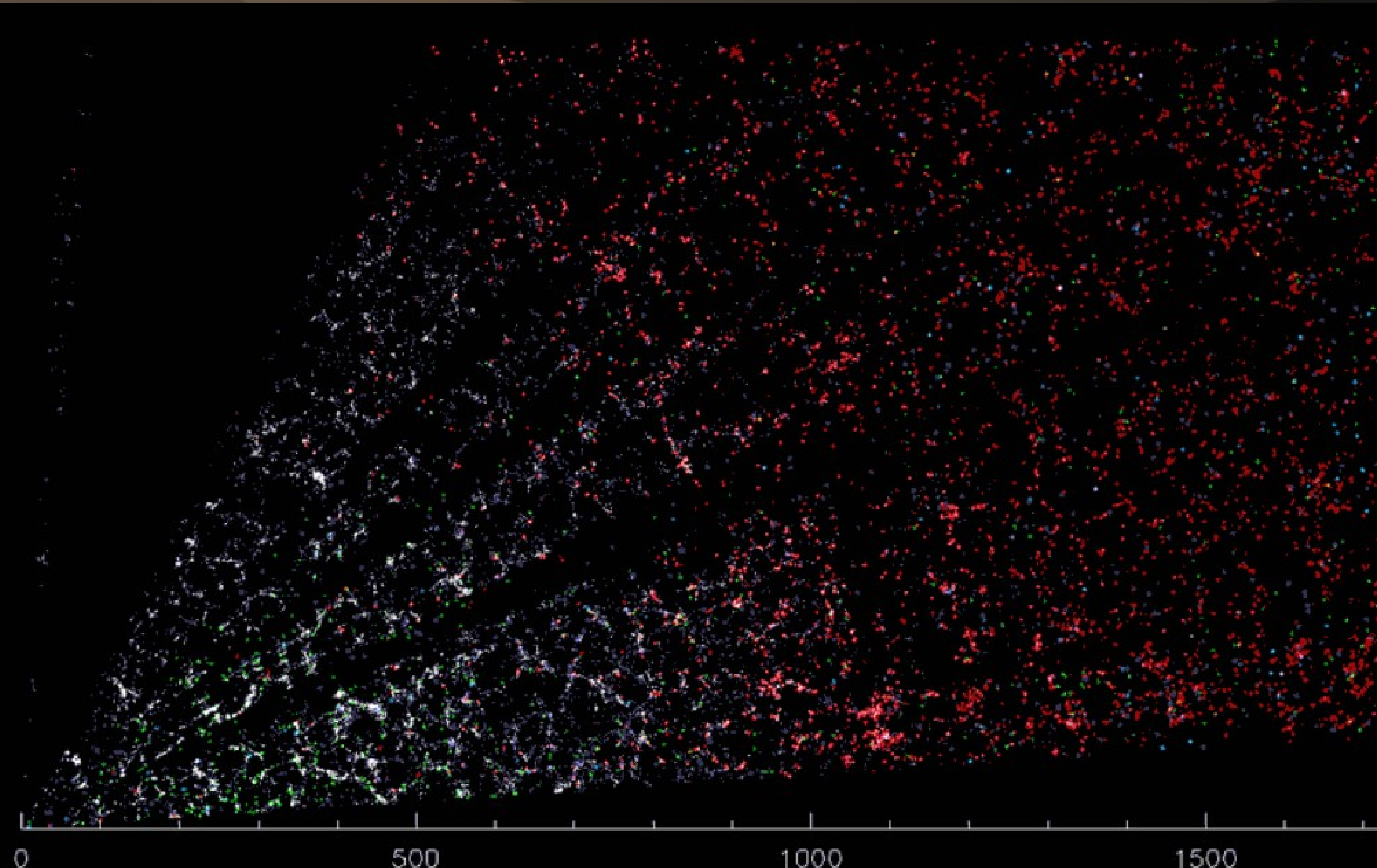


The Cross-Dragone telescope design to be deployed in Chile.

Ongoing and future surveys

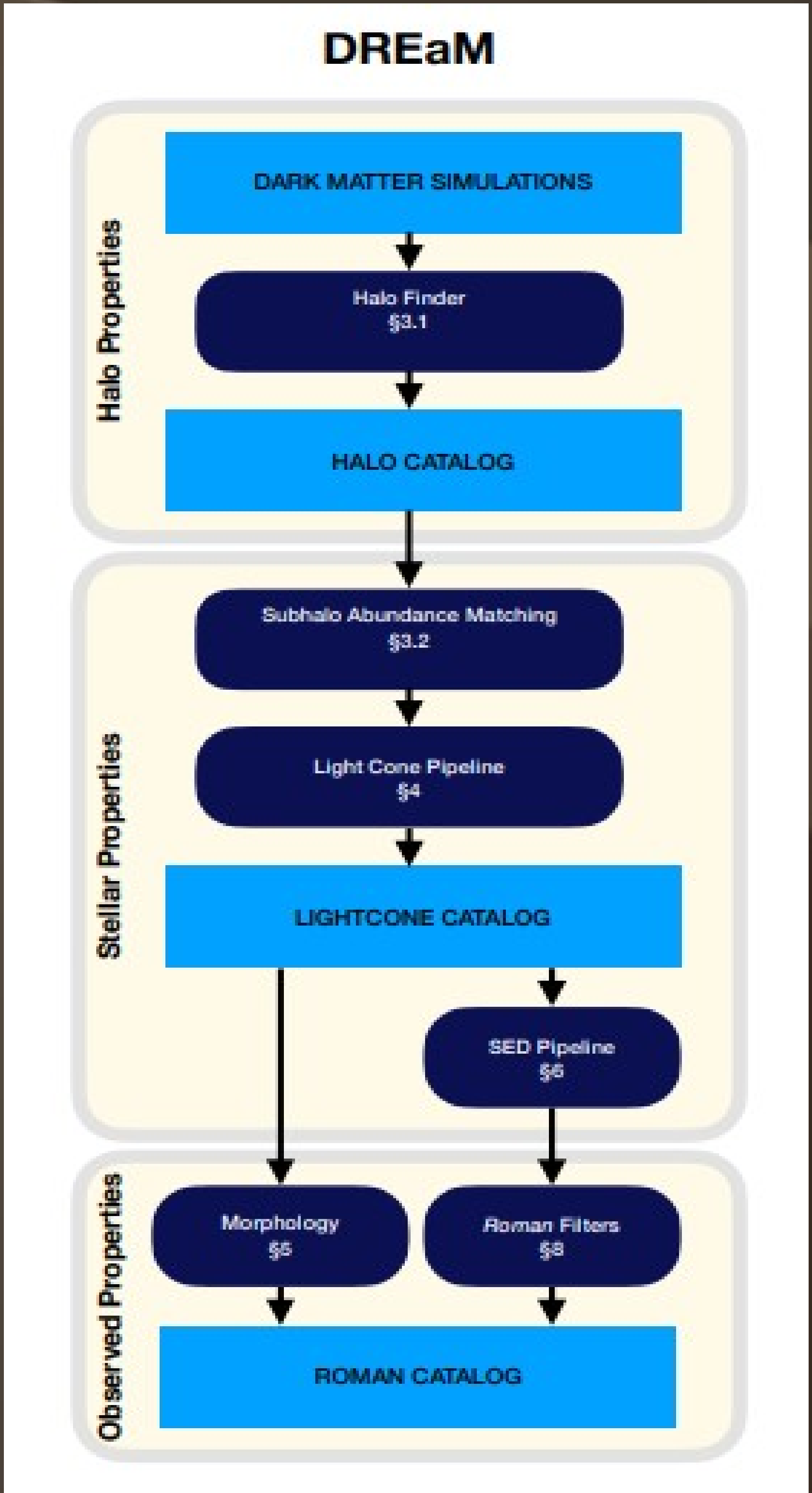
(Guzzo et al. 2013)





0
500
1000
1500

Preparing for the future with accurate mock catalogs



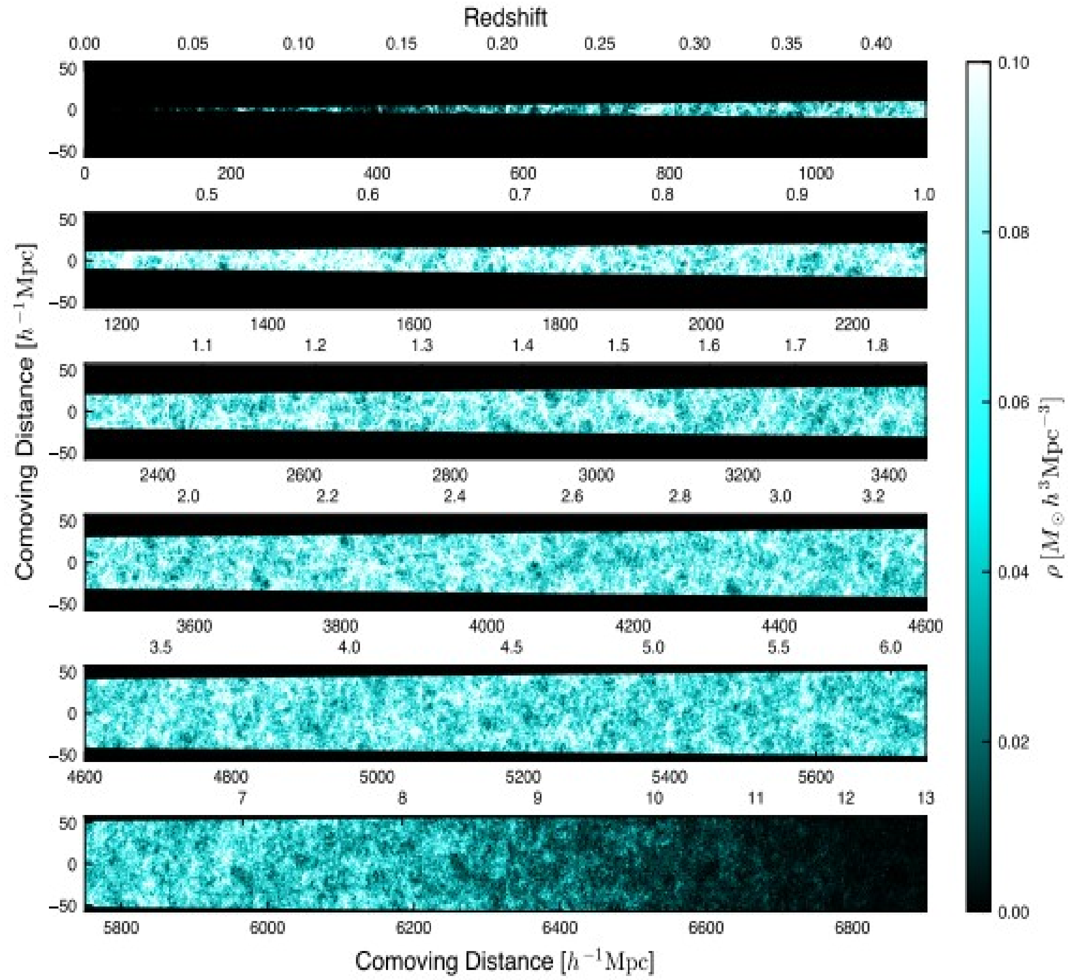


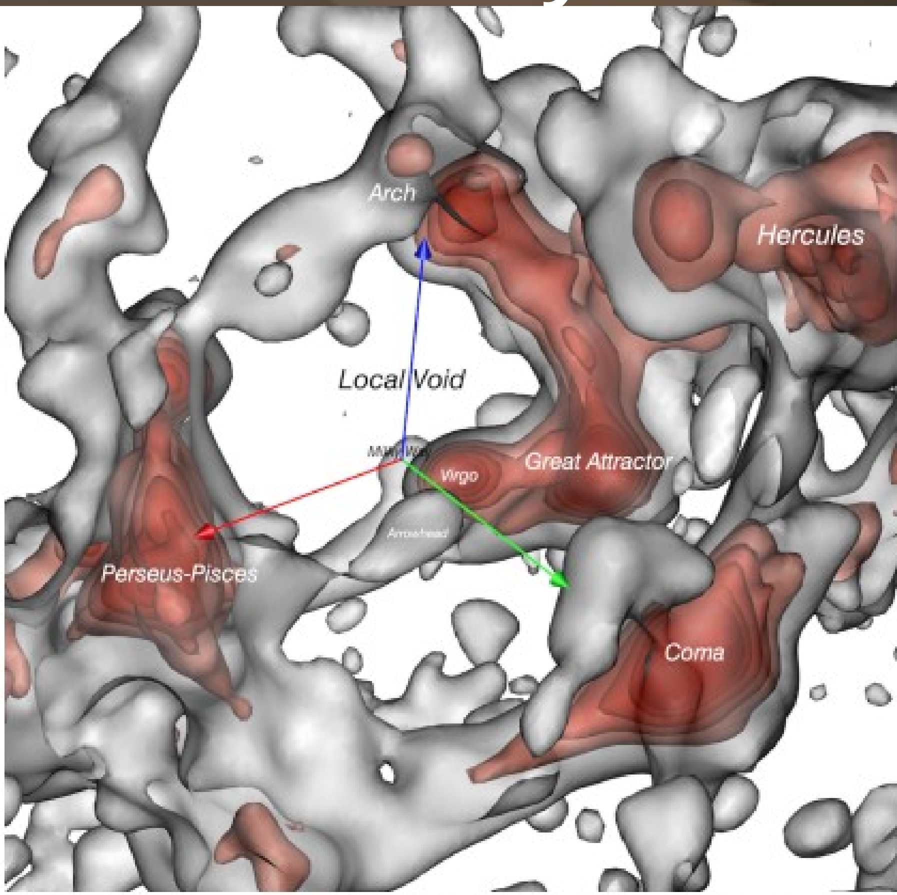
Figure 4. Mass density of galaxies in survey volume, with a field of view of 1 deg^2. The x-axis shows the cosmological redshift (top) and the comoving distance (bottom). We have plotted 10 tiled boxes in each row, for a total of 60 boxes to reach the desired redshift range. This figure demonstrates the depth and distribution of galaxies of a 1 deg^2 UDF.

Inprovement in redshift independent distance estimates with reasonable uncertainties and widely available

What can we learn from the closest cosmic void ?

- Many issues related to faint galaxies: internal and global dynamics, structure within the local void, etc.
- Just considerd all the studies developed in Virgo and other nearby clusters!

Tully et al. Cosmicflows-3



ure 1. Overview of the structure surrounding the Local Void. Isosurfaces of density are inferred from the velocity
tructed from the Wiener Filter treatment of Cosmicflows distances, with the densest peaks in red and less dense filar
vey. The Milky Way is at the origin of the colored arrows, 5,000 km s^{-1} in length, oriented in the frame of superga
dinates (red toward +SGX, green toward +SGY, blue toward +SGZ). The Local Void fills the empty region abov
y Way in this plot. This view inward from a location at positive values of SGX, SGY, and SGZ will be referred to a
ence orientation.

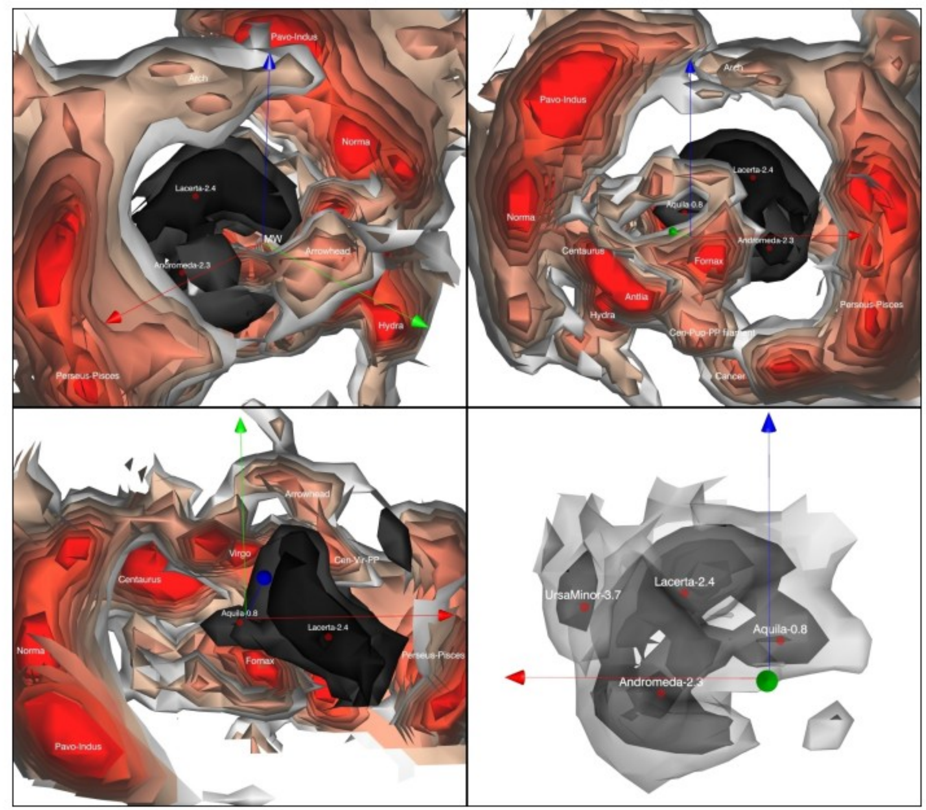


Figure 2. The heart of the Local Void. The deepest parts of the void are mapped by surfaces of density −1.1 (black) and −0.7 (dark grey). Local minima are located by red dots and given names. Contours in shades of light grey and red illustrate surrounding high density structures. The Milky Way is at the origin of the red, green, blue directional arrows. The same scene is shown from multiple vantage points. The reference viewing direction in the upper left panel is from positive values of all 3 coordinates (video frame time: 02:01). At upper right, the scene has been rotated around to almost in from the negative SGY axis (02:25). Then at lower left, the view is in from very near to the positive SGZ axis. In this latter case, a foreground clip at SGZ=+3000 km s^{-1} has removed the Arch to give an unrestricted view of the void (02:32). In the lower right panel, the Local Void contours are shown alone, looking in from positive SGY (02:42).

Also consider the outcome of more high energy interactions, clusters / groups

Extreme objects may change all predictions !

- New Gordo type clusters

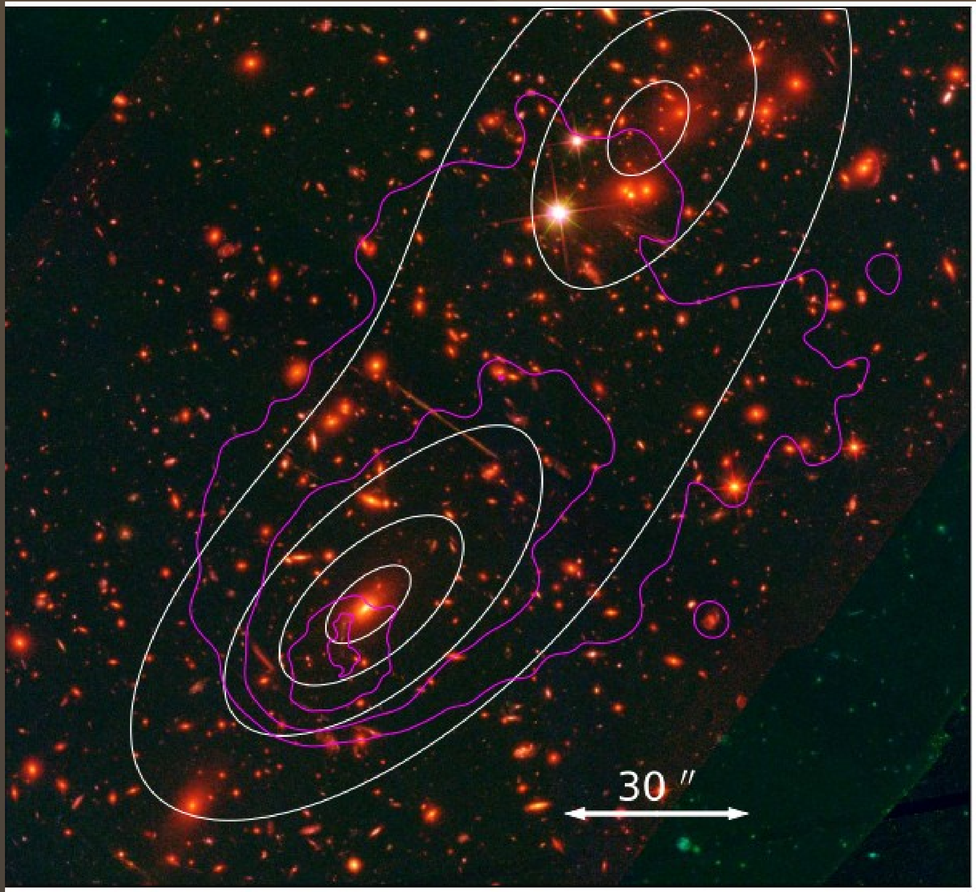


Fig. 3. ACT0102 X-ray emission and mass distribution overlaid on the *HST* colour image (same as in Figure 1). The magenta lines show the *Chandra* X-ray surface brightness isophotes and the white lines represent the projected total mass isocontours of the smooth component from our best-fit strong lensing model.

Caminha et al. 2022

Asencio et al.2021

Summing up LSS lessons/issues/concerns

- Nice agreement with the local volume

  (Sibelius simulations, 2022) can be achieved, but consider excess of high mass clusters.
- Rare massive colliding cluster pairs at high redshifts ~1, too large relative velocities of 2500 km/s
- Explore the galaxy power spectrum at larger distances,beyond 180 Mpc

Summing up LSS lessons/issues/concerns

- Need to understand foregrounds in CMB
- LS velocity flows
- LS alignments wrt galaxy and ICL, lensing and halo shapes
- Cosmology with Cosmic Voids

- Muito obrigado !!