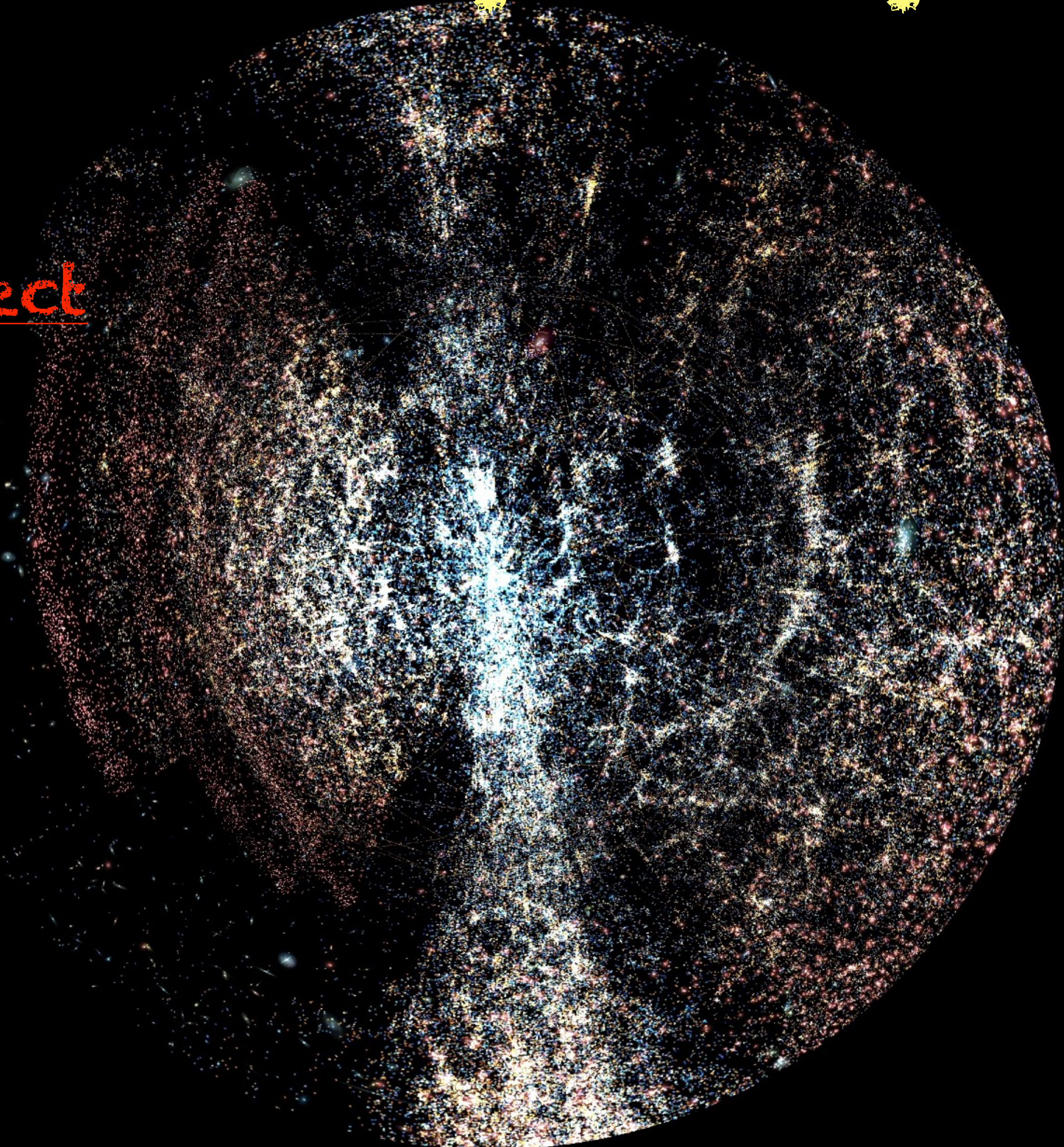
The Linear Point Standard Ruler with the Euclid galaxy survey



Euclid Standard Project

Euclid GC SWG
Additional Probes

(Lead/Secretary)
Stefano ANSELMI

GOALS of
Baryon Acoustic Oscillations (BAO) distances

- Constrain cosmological models (at the DE time)
- Consistency tests (e.g. tensions)

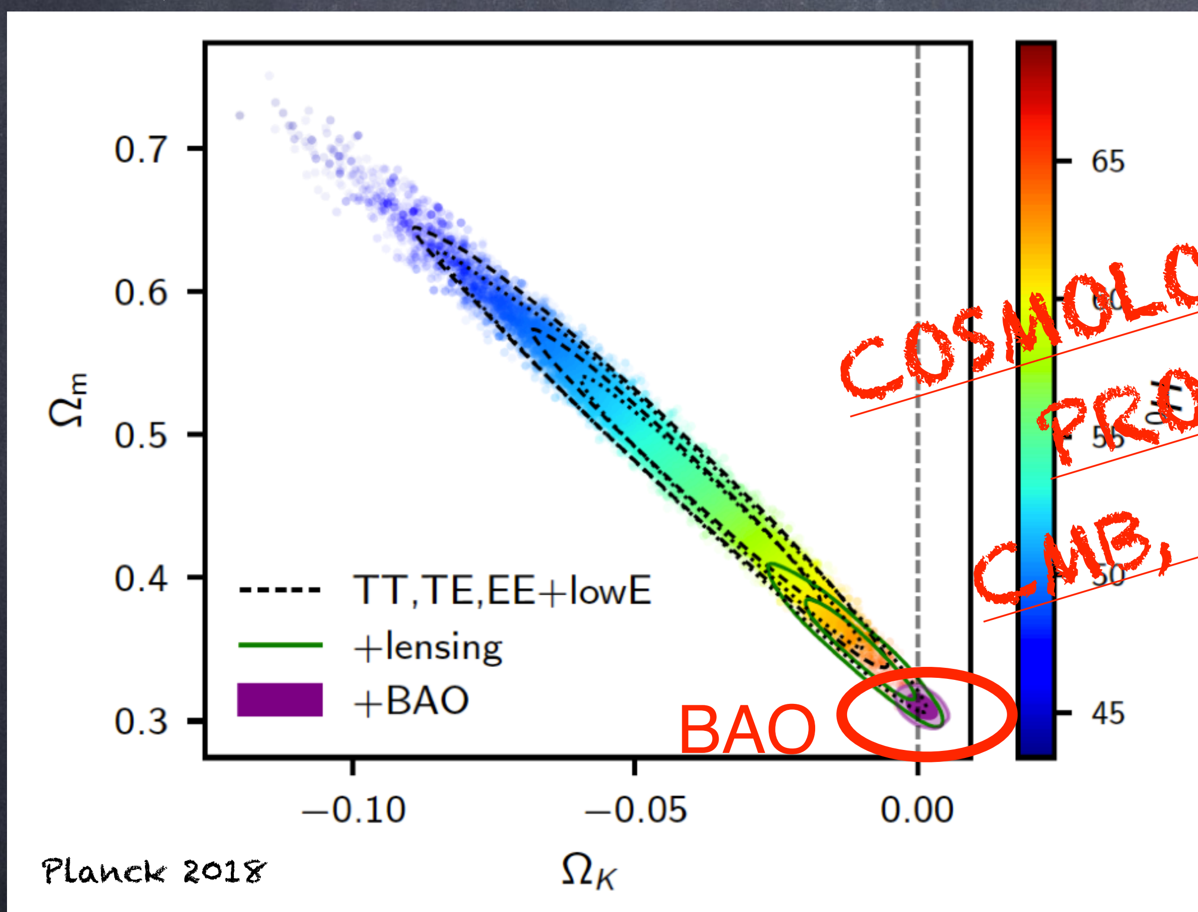
HOW

- BAO distances combined w/ other Cosmological observations.
  - Degeneracy among parameters are reduced.
- BAO distances alone (e.g. Dark Energy detection)

Late Universe Acceleration <-> Dark Energy

Probe Combination

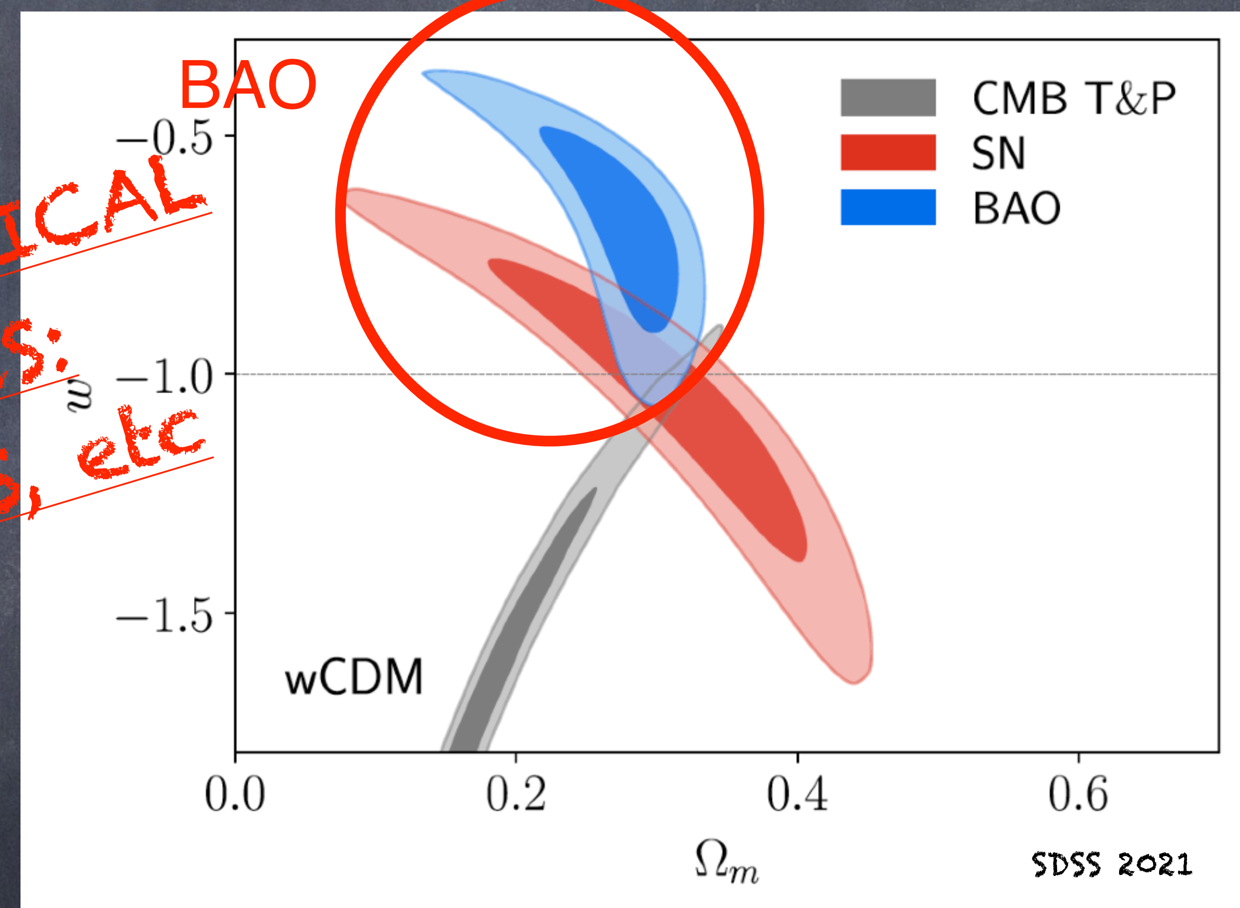
energy densities



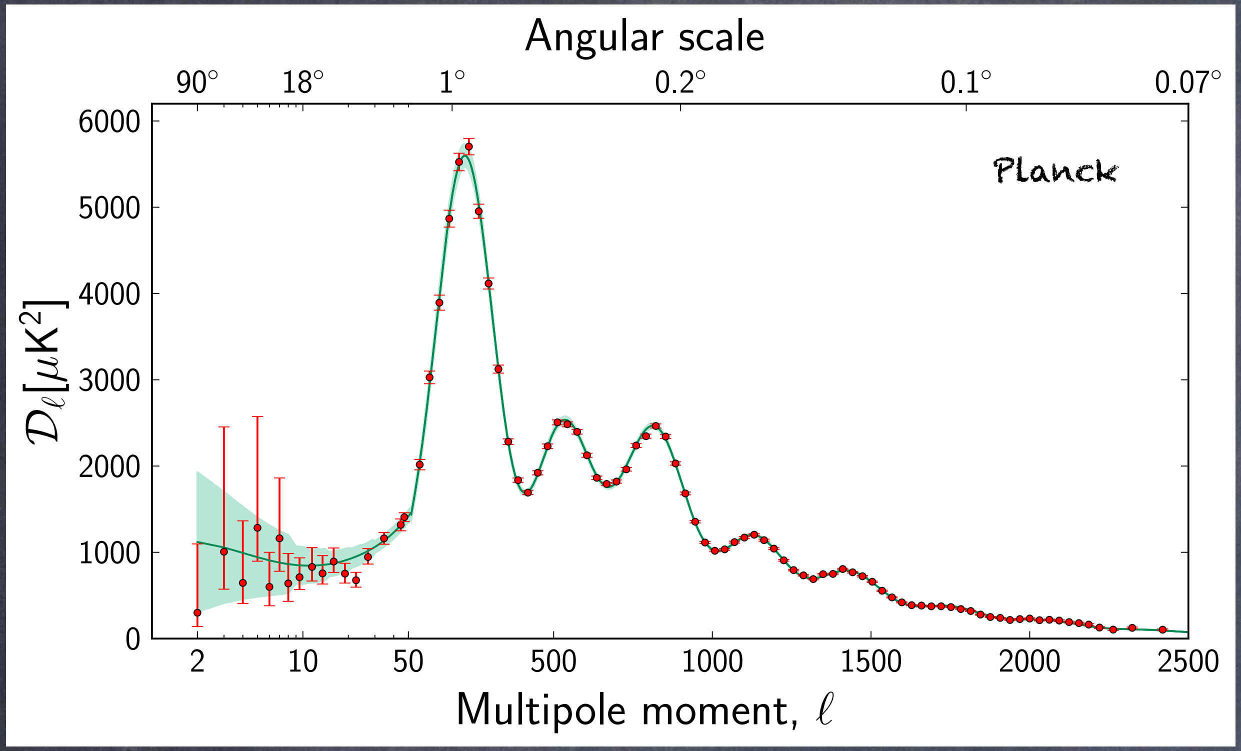
COSMOLOGICAL PROBES: CMB, LSS, etc

Different Probes

eq. state param. $P = \rho w$



Early times...

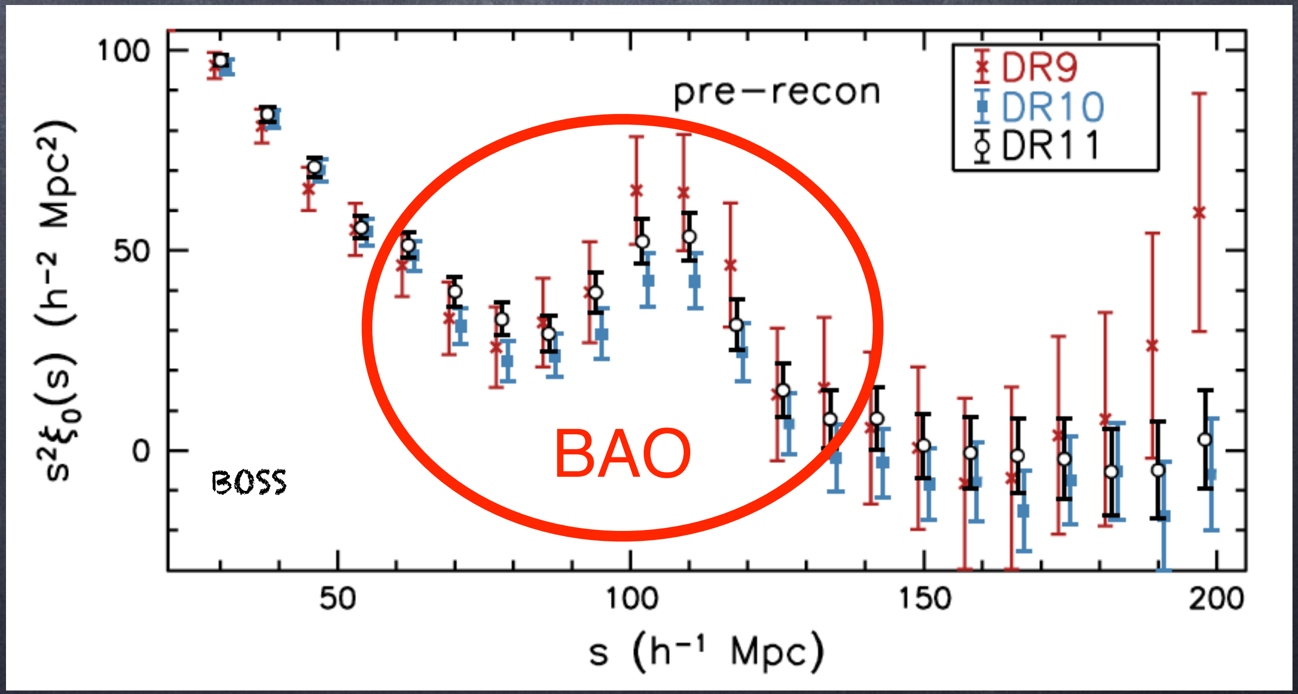


Initial fluctuations

temperature fluctuations in the CMB ($\delta T/T \sim 10^{-5}$)

...late times

Baryon acoustic oscillations in the galaxy Correlation Function



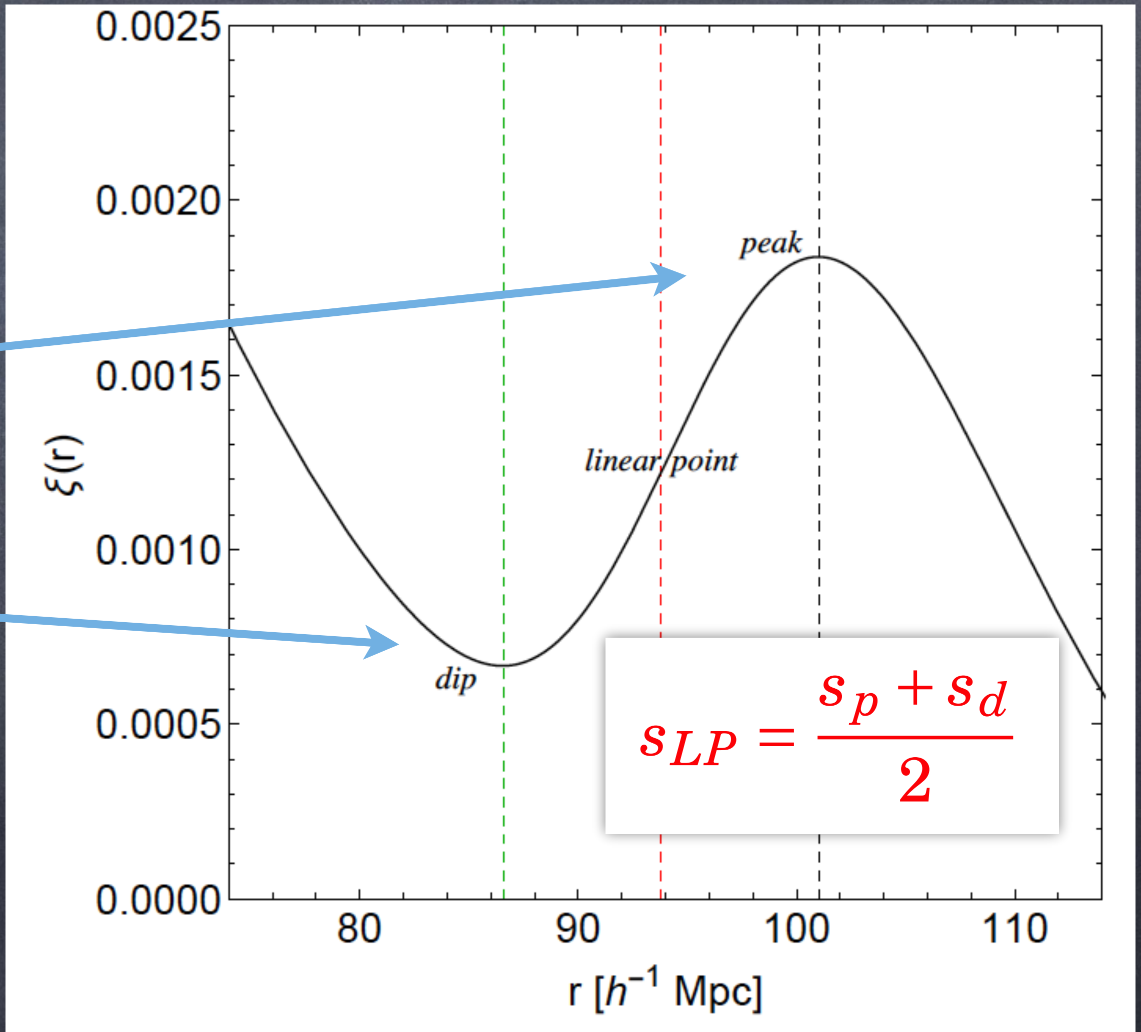
The Linear Point (BAO) standard ruler

S.A, Starkman, Sheth - MNRAS (2016)

Linear Point definition

- peak (s_p)
- dip (s_d)

- LINEAR POINT: s_{LP}
  (peak-dip middle point)



$$s_{LP} = \frac{s_p + s_d}{2}$$

Cosmological distances with the Linear Point

Relevant features

1) A geometrical point

2) Redshift independent at 0.5%, i.e linear

   Weakly sensitive to: Non-linear gravity, RSD, scale dep. bias

3) Cosmological Model Independent cosmological distances

4) Correlation-function Model independent cosm. distances

S.A, Starkman, Sheth - MNRAS (2016)

S.A, Starkman, Corasaniti, Sheth, Zehavi - PRL (2018)

S.A, Corasaniti, Sanchez, Starkman, Sheth, Zehavi - PRD (2019)

What is done

- Tested with N-body and Validated with SDSS galaxy mocks

S.A, Corasaniti, Starkman, Sheth, Zehavi - PRD (2018)

- Cosmological distances estimated from SDSS galaxy data

S.A, Starkman, Corasaniti, Sheth, Zehavi - PRL (2018)

- Accurate comparison with the sound horizon standard ruler

O'Dwyer, S.A, Starkman, Corasaniti, Sheth, Zehavi - PRD (2020)

- Standard ruler also for massive neutrino cosmologies; it constrains neutrino mass

Parimbelli, S. A, et al - JCAP (2021)

- Forecasts: Linear Point cosmic distances expected from Euclid, DESI, 4MOST, Roman, Subaru Prime Focus Spectrograph (PFS)

S.A., Starkman, Renzi - PRD (2023)

The Linear Point Standard Ruler with the Euclid galaxy survey

Standar Project OVERVIEW:

We will describe the validation procedure developed to estimate the linear point standard ruler from the clustering correlation function. We will identify the optimal setup to estimate the linear point. We will as well assess estimation uncertainties of the linear point standard ruler within the Euclid mission. To achieve these goals we will employ the Euclid Flagship simulation and large sets of mocks. We will finally apply the validated methodology to Euclid data.

FIRST GOAL:

estimate the Linear Point from the Euclid Flagship Simulation snapshots

Linear Point from Flagship Simulation snapshots

- Euclid Flagship I - halo snapshots

  - 2pcf measurements on Flagship I halo snapshots

  - Development of algorithms for large data-sets

  - Snapshots' redshift: $z = 0.9, 1.2, 1.5, 1.8$

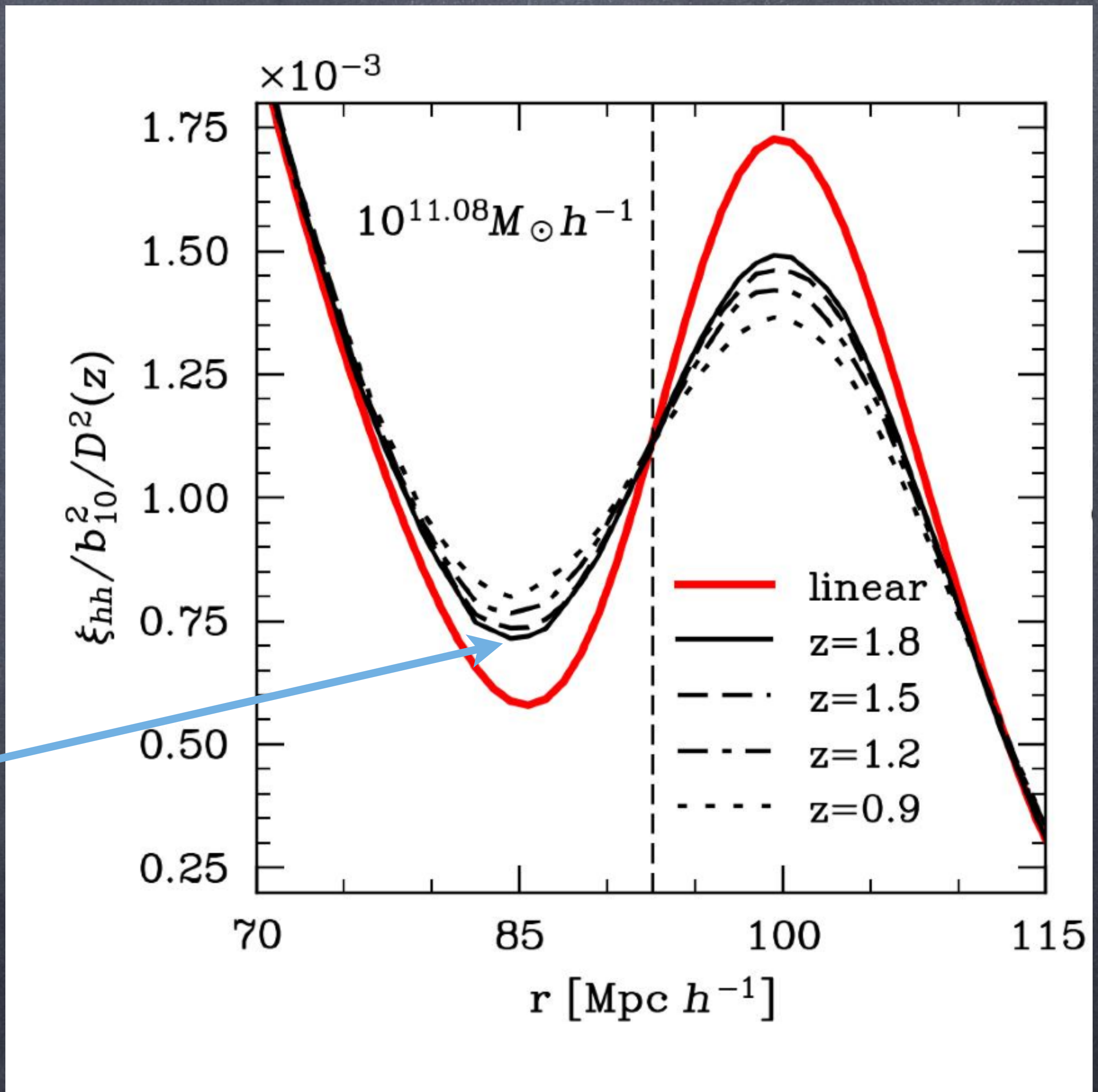
  - Different cuts in halo mass

  - 2pcf covariance: Gaussian recipe

EFFORT: Stefano Anselmi, Filippo Oppizzi, Alessandro Renzi, ………

example

- <u>Euclid Flagship I</u> – halo snapshots
  - Real space
  - Estimated 2pcf
  - First cut in halo mass



N-body 2pcf estimated points (connected by straight lines)

Linear Point estimation

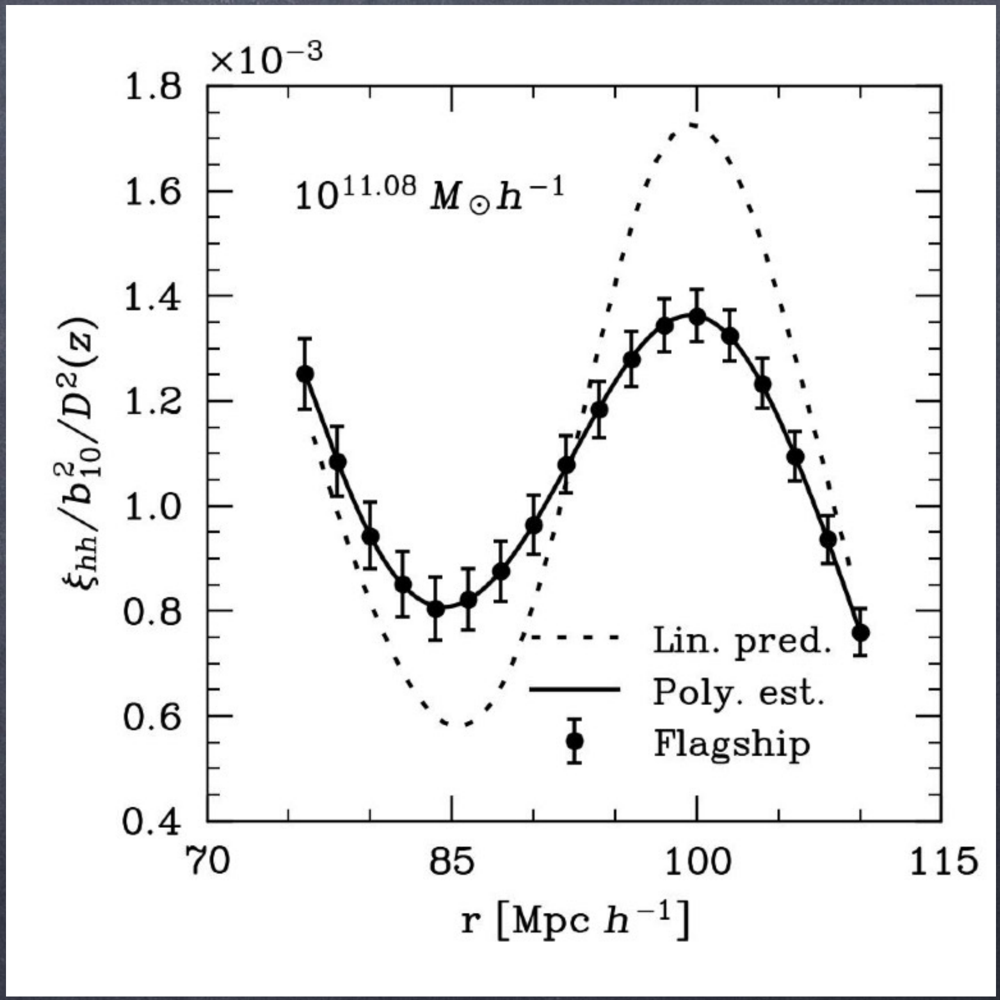
- Model-independent polynomial estimator

- For each redshift and mass cut:

  Validation procedure to obtain: unbiased and optimized estimator

- Uncertainties properly propagated

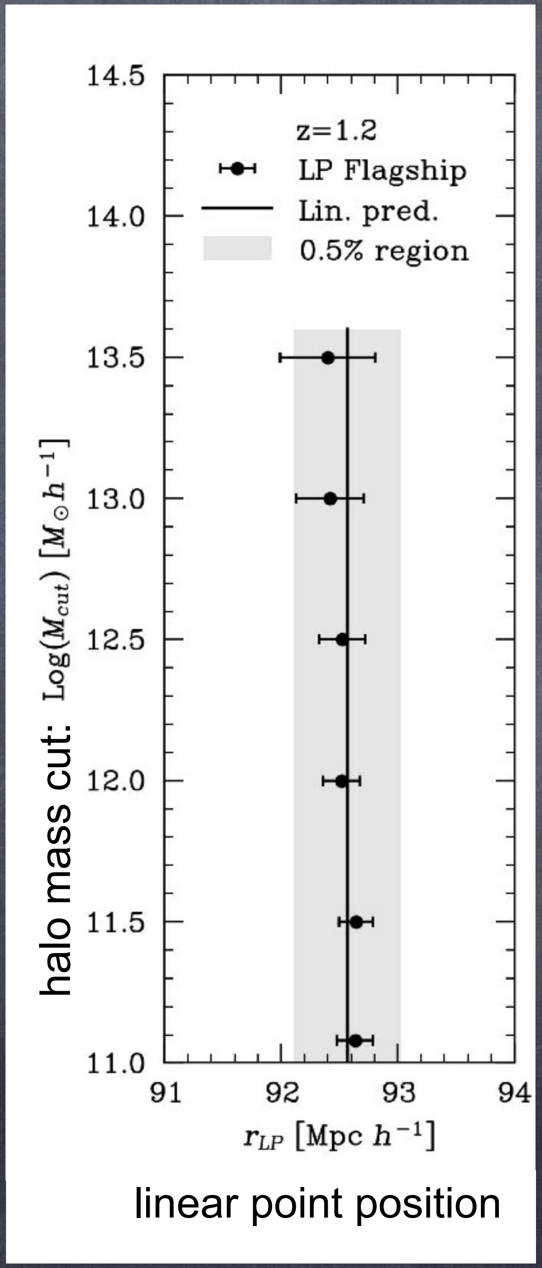
z = 0.9

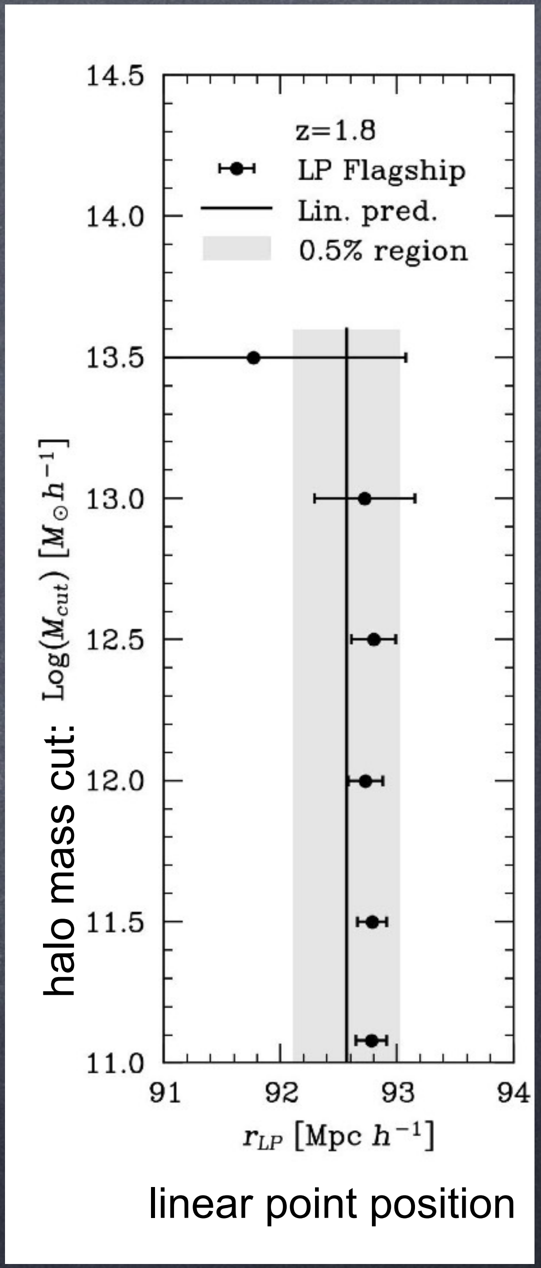


Linear Point estimation

- Results: Halos in Real space
  - Linear Point from Flagship
  - Agreement with linear pred.

- Ongoing
  - Halos:
    Redshift Space
  - Galaxies:
    Real Space
    Redshift Space
  - Expected Euclid errors
    scaling to Euclid volumes





Next Steps

- Euclid Flagship lightcone
  - Partial Sky coverage & irregular geometry
  - 2pcf Landy Szalay estimator
  - Redshift evolution
  - Magnitude cut
  - 2pcf covariance
  - GR effects
  - Redshift Bin optimization
  - ...
- Observational Systematics
  - Redshift error, purity & completeness
  - Noise/line interlopers
  - ...