

SKA Science Book preparation

Cosmology continuum Focus Group

Co-leads: David Parkinson, Jinglan Zheng

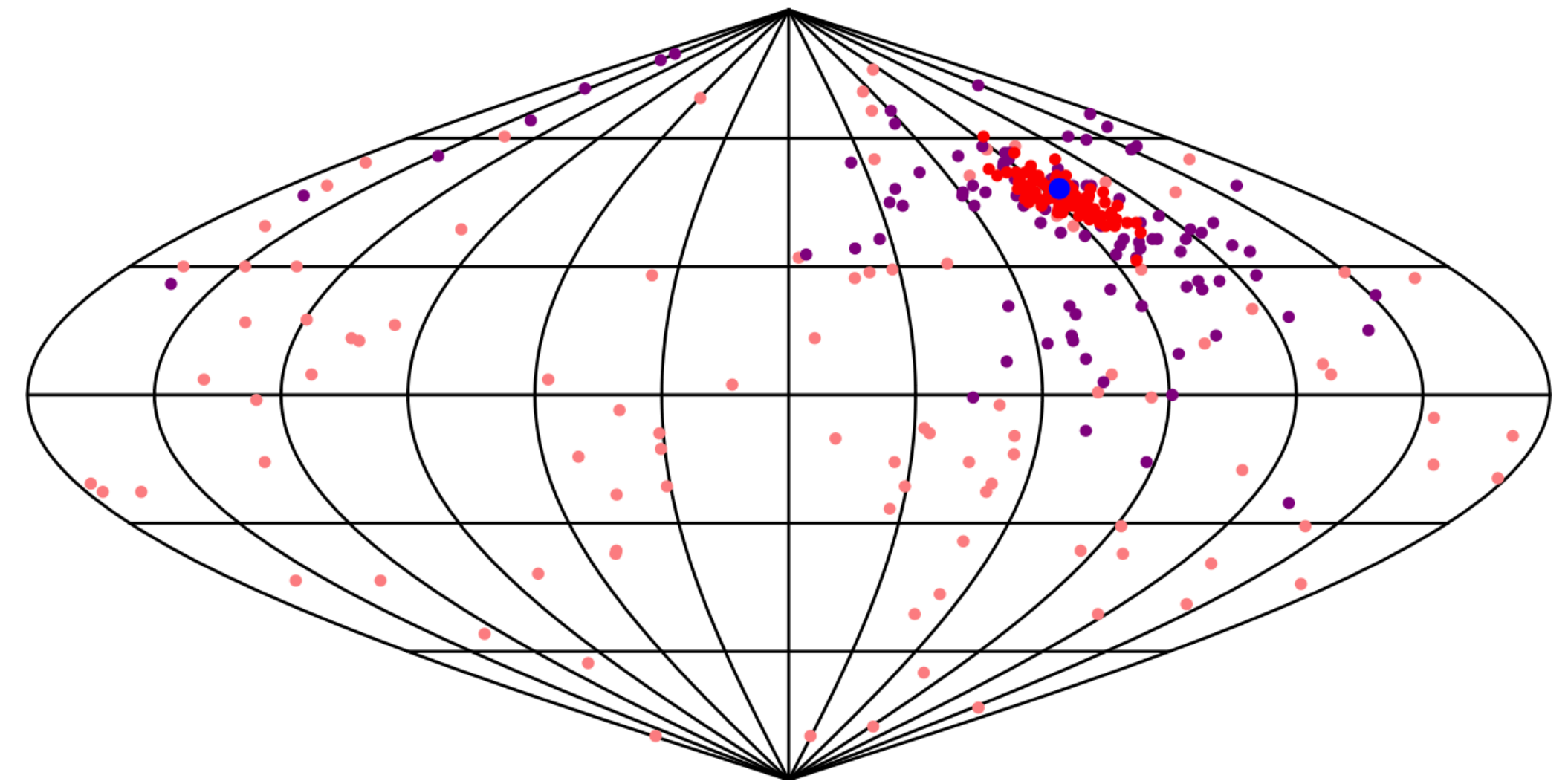
Jinglan Zheng 4, November SKA SWG 2024 @Nice, France

Cosmic matter dipole

Sebastian, Dominik , Jonah, David, Prabhakar

- cosmic matter dipole: a dipolar modulation of source counts across the sky → test of the Cosmological Principle (CP).
- forecast the high capability of the SKA to conclusively test the CP with radio observations

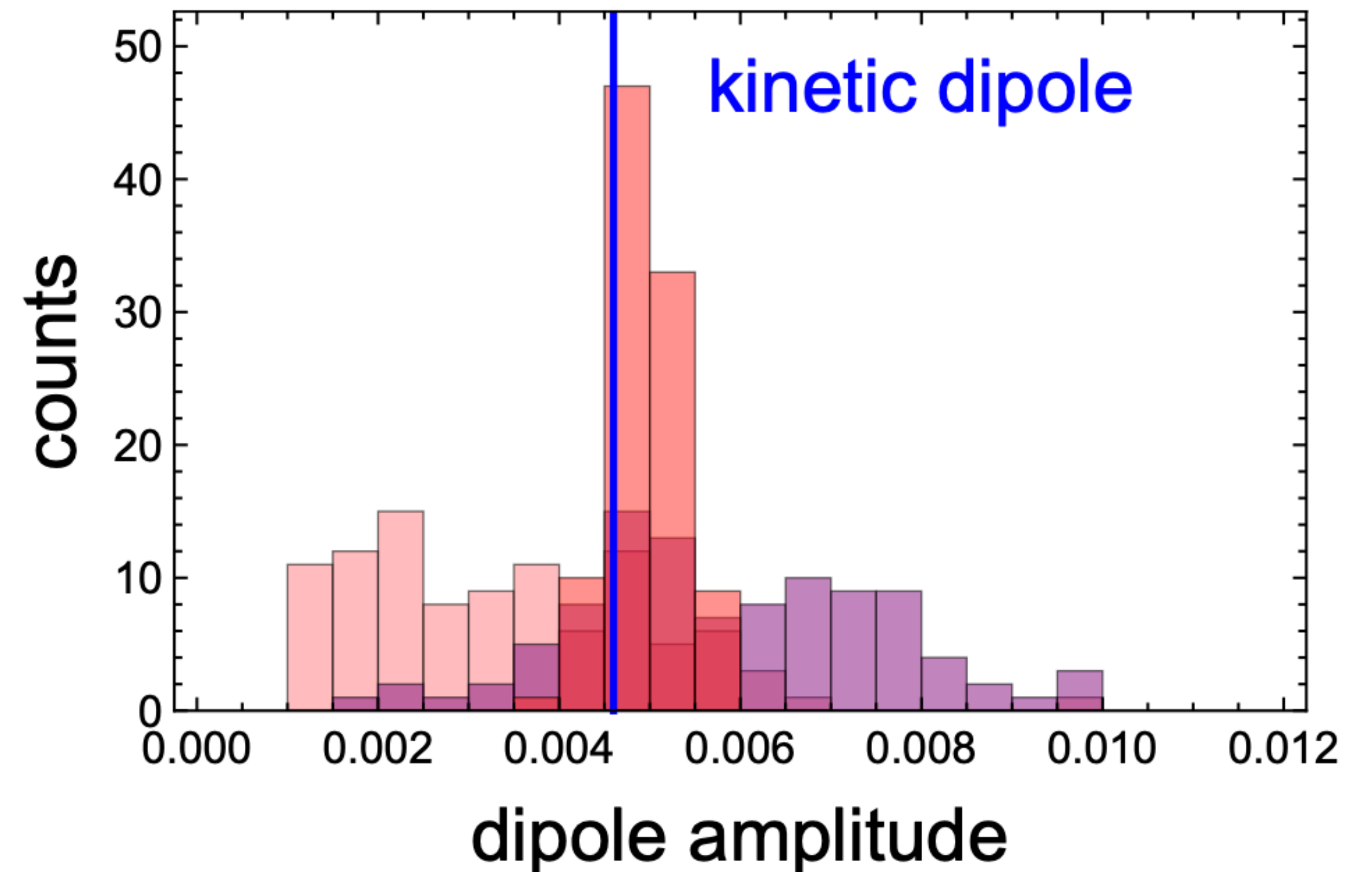
- CMB dipole
- structure dipole
- kinematic & structure dipole
- kinematic & structure dipole, w/o local structure



Red Book 2018

Cosmic matter dipole

- Using bespoke mock data we forecast the precision with which the SKA will be able to determine the matter dipole, including a quantification of known systematics.
- by utilising **photometric redshift estimates** the SKA will perform the first redshift measurements of the matter dipole in radio observations; simultaneously **measuring the low multipoles** (beyond just the dipole) of the projected matter field at different redshifts will further constrain ultra large-scale modes.



Red Book 2018

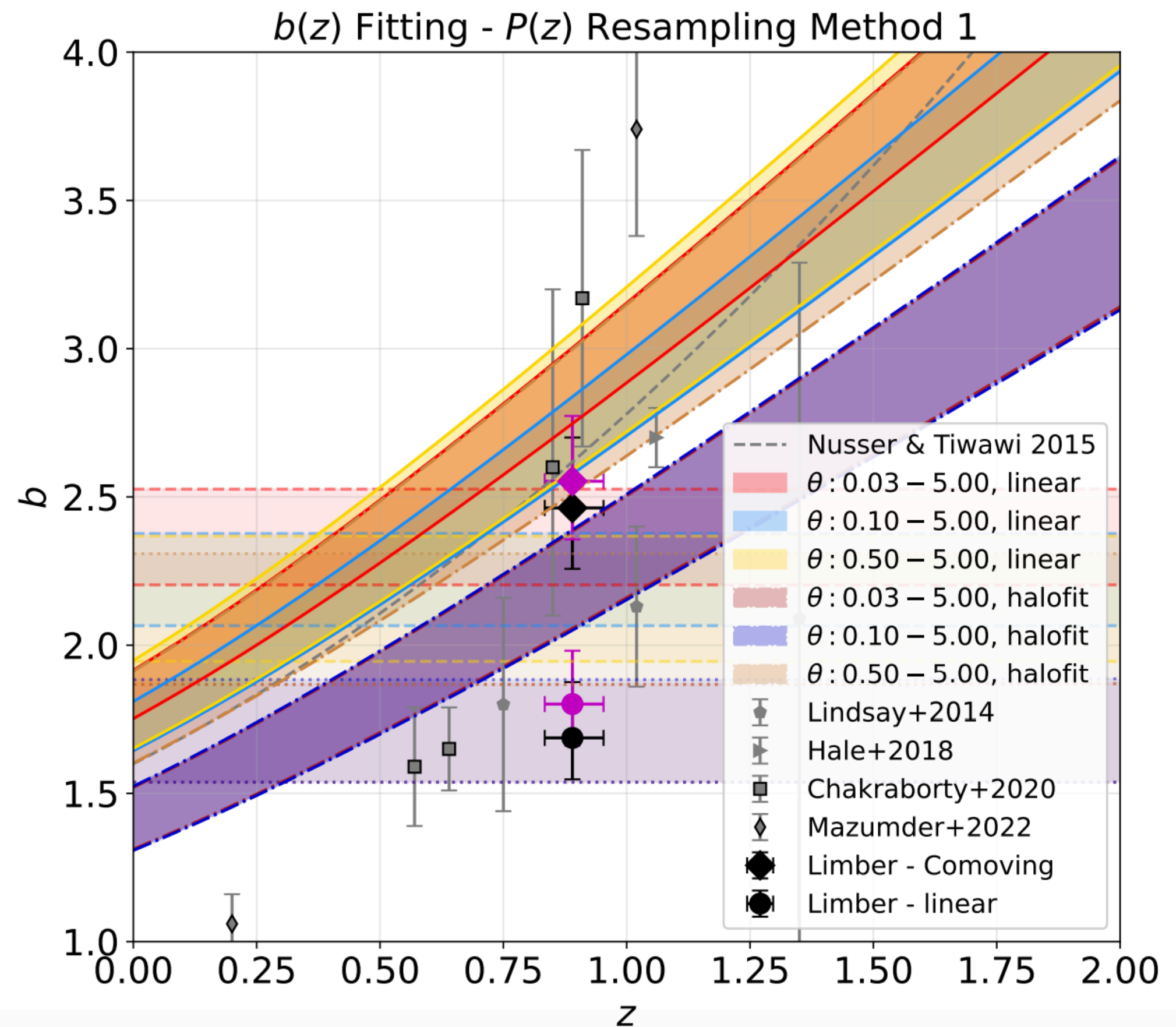
Cosmic Matter Dipole

- As per its higher sensitivity, the SKA will provide these high-precision measurements using SFGs, in addition to the previously measured AGN. And in synergy with HI intensity mapping, the kinematic dipole and its redshift dependence are too achievable targets for fundamental science with the SKA.
- tests of homogeneity will be possible with projected fields, constraining the fractal dimension of the cosmic web, providing a comprehensive array of tests of the Cosmological Principle.
- builds on a combined understanding of methodological studies as well as those applied to pathfinder data such as MeerKAT and Rapid Australian Square Kilometer Array Pathfinder Continuum Survey (RASC). As a baseline we forecast the capabilities of AA* and highlight advantages of AA4.

auto-correlation + calibrating

Jacobo, (Catherine), Prabhakar

- consider how SKA AA4 measurements of the angular auto-correlation functions of the radio catalogs for different flux cuts will allow us to improve our knowledge on radio populations so other cosmological analysis can significantly improve the determination of cosmological parameters.
- The calibration of these radio continuum populations through auto-correlations will enhance the cosmological probes that involve the cross-correlation of different observables. In particular, the SKA AA4 continuum sample can be used in correlations with CMB or weak lensing observables.



Hale et al 2023

Diffuse Galactic Foreground Emission

Sebastian, Dominik, ...

- large-scale spectro-polarimetric measurements at radio and microwave frequencies → CMB
 - CMB measurements require the removal of Galactic foreground radiation, where especially low-frequency diffuse emission poses a major challenge, in intensity and in polarisation.
- Building on a dedicated feasibility study with SKA-Mid [Basu et al. 1906.04788] we forecast SKA's capability to **constrain diffuse all-Stokes foregrounds** to ensure reliable extrapolation to relevant higher frequencies, with particular focus on Band 5 measurements with AA1 and AA2.
 - Synergies together with other low-frequency radio experiments (C-BASS, S-PASS, etc.)
 - Finally, these studies will also facilitate reconstructions of the Galactic magnetic field with vast applications across CMB and also Cosmic Ray science.

Testing cosmological principle

Pankaj Jain, Prabhakar Tiwari

- Current data from different cosmological observables shows two interesting deviations from the cosmological principle,
- (i) several indications of anisotropy associated with the CMB dipole, including an excess matter dipole amplitude
- (ii) Hemispherical anisotropy in the CMB which also seems to show a signature in the slope x of the $\log N$ - $\log S$ curve in matter flux distribution.
- Another very interesting set of observations indicate alignment of radio as well as optical polarizations from distant AGNs over large distance scales. The radio axis of these sources also show alignment over a certain distance scale. It has been suggested that this phenomenon may arise due to the presence of primordial magnetic field which is expected to show correlations over large spatial distances.

- probing (i) matter dipole using a modified statistical procedure to relate our local velocity to the extracted dipole
- (ii) anisotropy in the parameter x and tests of hemispherical anisotropy in matter power distribution using the SKA data and
- (iii) alignment of radio axis as well as polarizations over large distance scales.

Other

- primordial non-Gaussianity: Benedict, Chandra
- dark energy: David, Caroline
- x-correlations with CMB: Ian & Giulia, Marina, Chandra
- modifications of gravity: David, Caroline, Jinglan(BAO,RSD)
- Cross-correlations, synergies: Caroline, Jinglan