

Towards a non-Gaussian model of Redshift Space Distortions

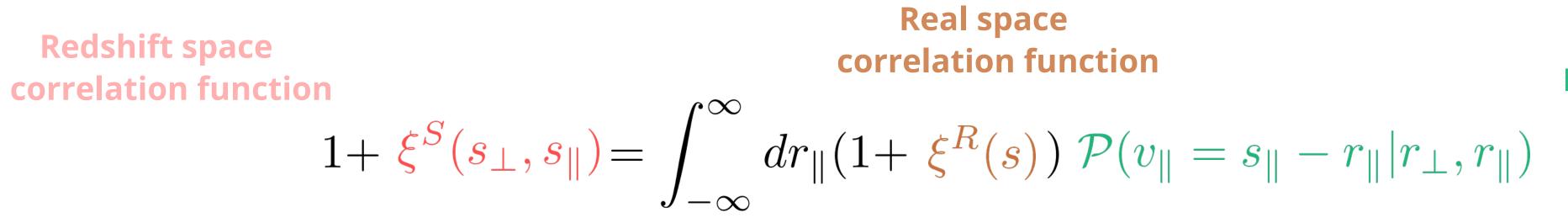
Carolina Cuesta-Lazaro, Alexander Eggemeier, Pauline Zarrouk, Carlton Baugh and Baojiu Li

carolina.cuesta-lazaro@durham.ac.uk

https://github.com/florpi

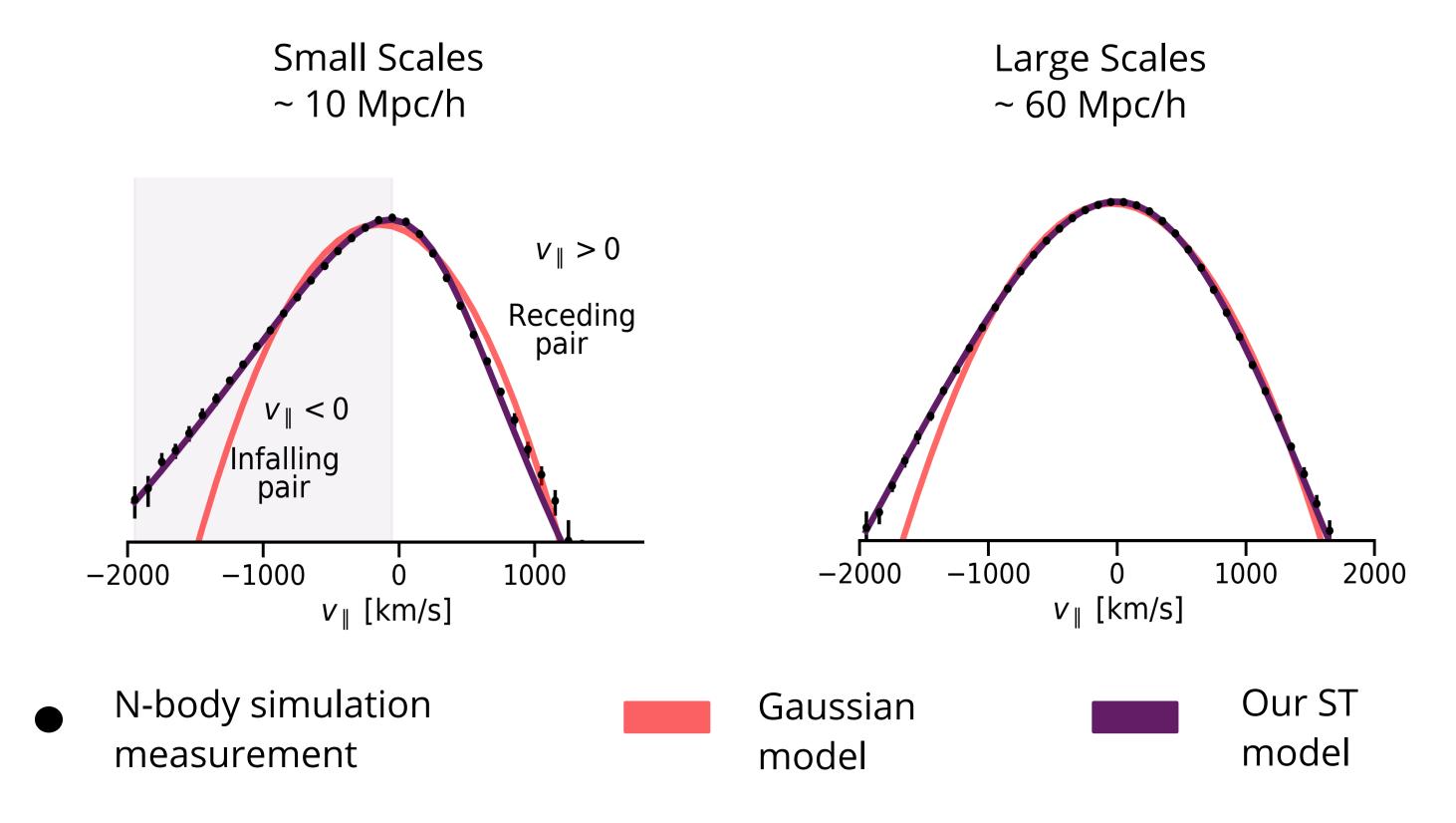
1. INTRODUCTION

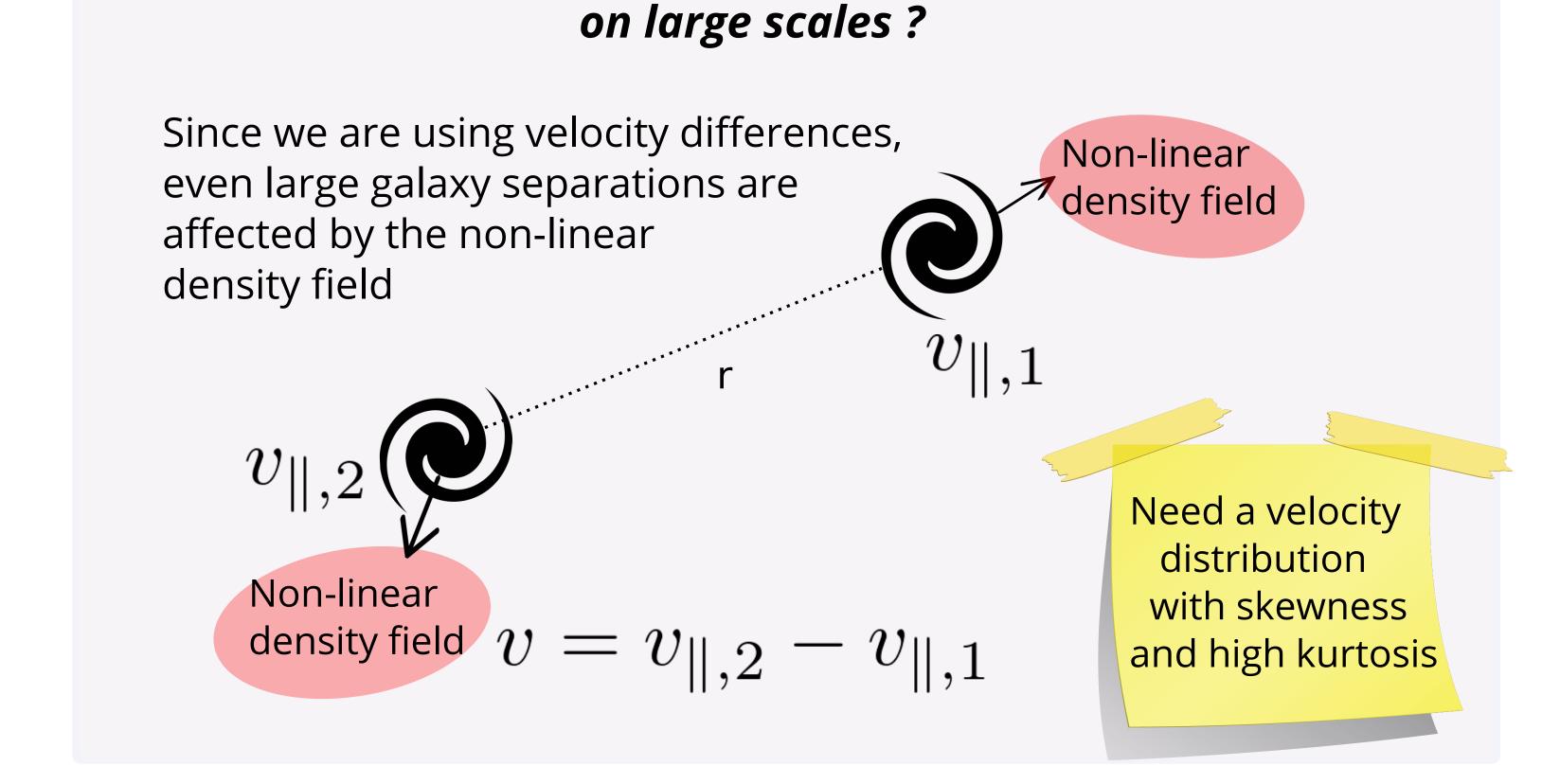
The peculiar motion of galaxies on an expanding background make the translation from redshifts to distances non-trivial, due to the additional Doppler effect. When we measure the clustering of galaxies without removing the effect of their motions, we are measuring a combination of their actual clustering and their pairwise velocity distribution [1],



Pairwise velocity distribution
Probability that a pair of galaxies
separated by r appears to
to be at a distance s

In the following figure, we show the pairwise velocity distribution measured on N-body simulations for different pair separations. The PDF is highly non-Gaussian, it shows both **skewness** and **heavy tails**.

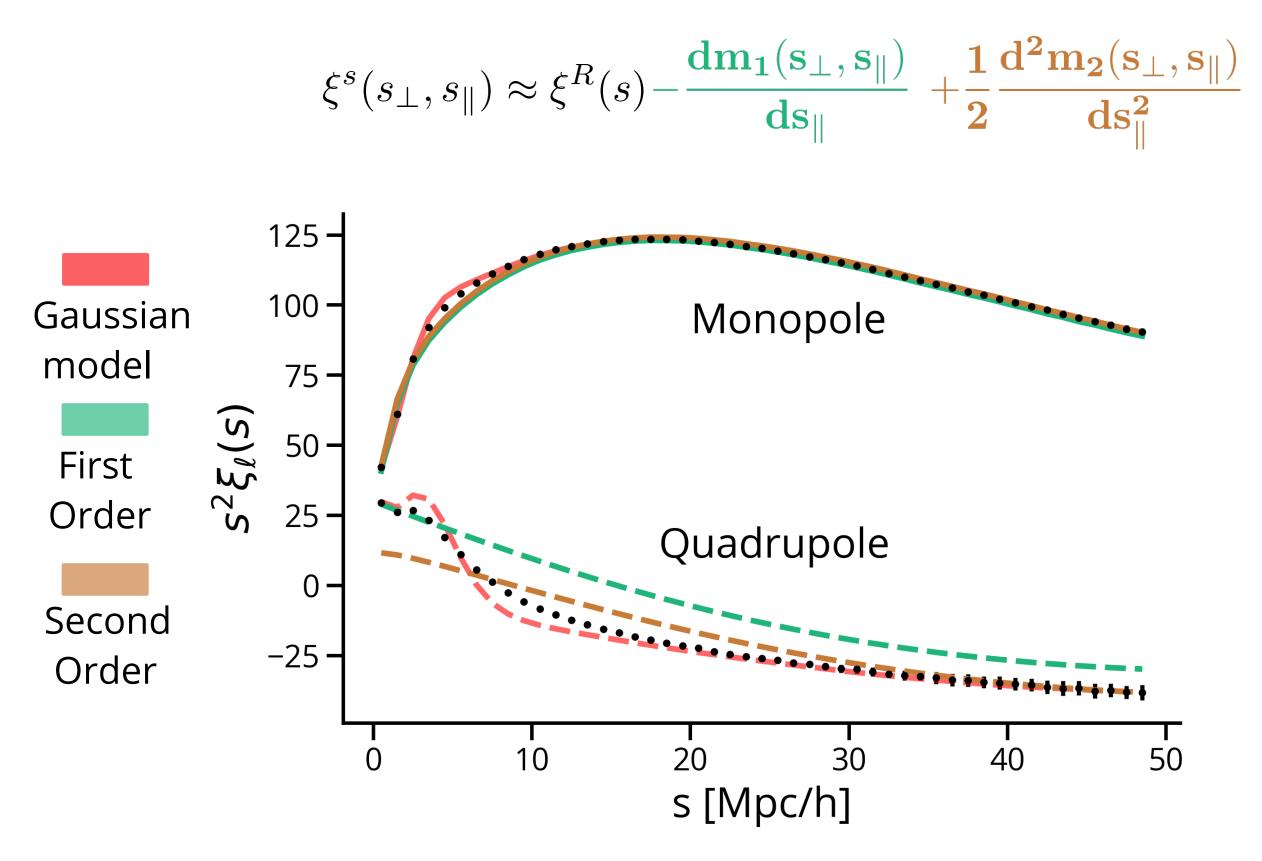




Why is the velocity distribution non-Gaussian

2. THE GAUSSIAN MODEL

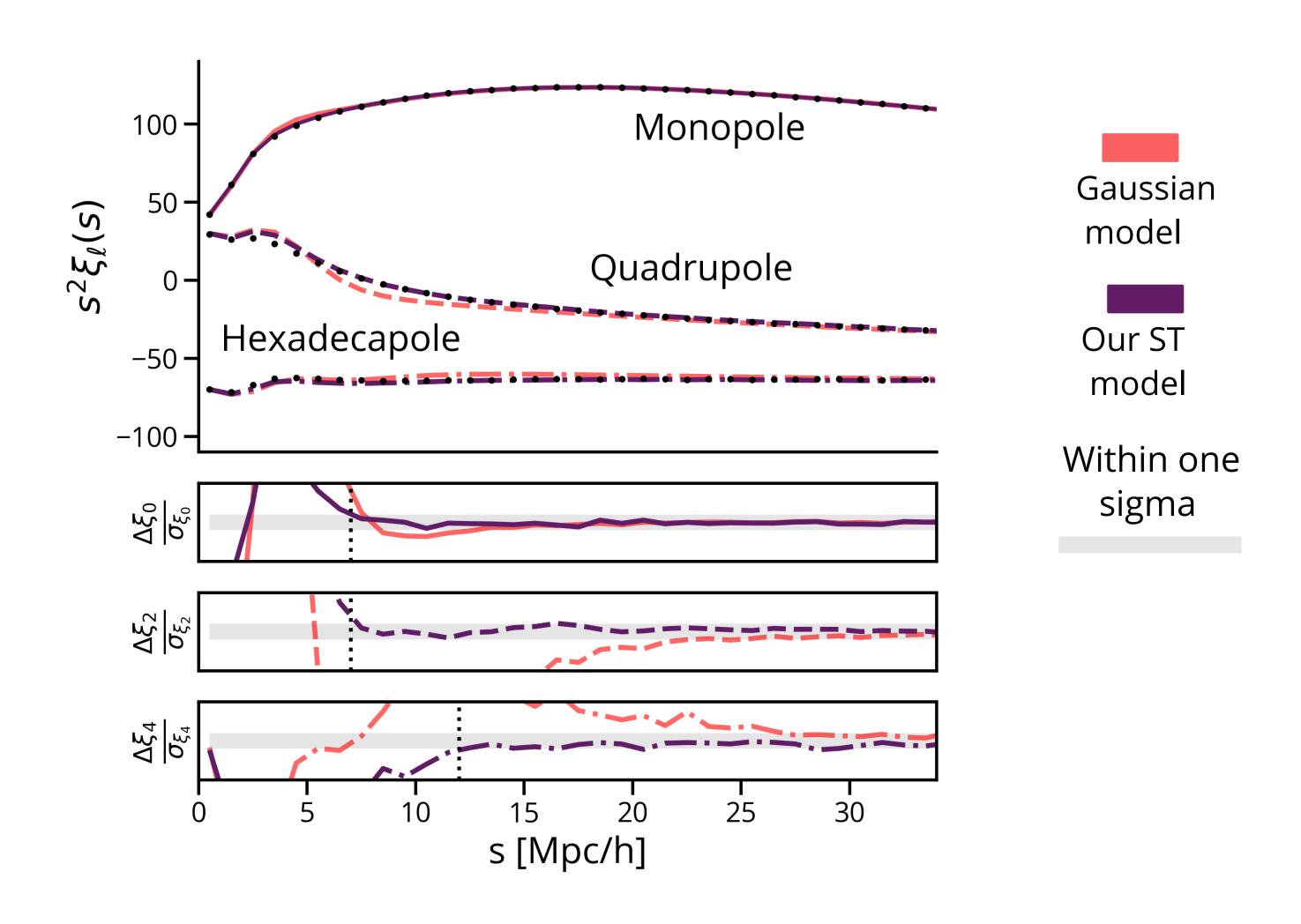
- State-of-the-art models approximate the pairwise velocity distribution by a Gaussian [2], [3].
- These models can reproduce the monopole and quadrupole up to scales of about 30 Mpc/h. But if we have shown that the PDF is strongly non-Gaussian, why does the Gaussian model work so well?
- We can Taylor expand the integral over the pairwise velocity distribution up to second order, which can in turn be written as an expansion in terms of its first two moments, the mean m_1 and the dispersion m_2 ,



• **Any** distribution with the right first two moments reproduces the redshift space clustering up to quasi linear scales. The actual pairwise velocity distribution is strongly non-Gaussian.

3. ADDING SKEWNESS AND TAILS

- On small scales, where statistical errors are the smallest, the accuracy of the Gaussian model degrades very quickly.
- To improve on it, we need to model the pairwise distribution with a PDF that produces higher-order moments. In particular, non-zero skewness and high kurtosis.
- The *Skewed Student-t (ST)* [4] distribution has exactly these properties. We find its parameters by matching its first four moments to the ones measured in the simulation.



4. CONCLUSIONS

- Including non-Gaussian features in the velocity pairwise distribution improves the modelling of the redshift space monople and quadrupole to within 1% up to scales of 10 Mpc/h.
- The ultimate success of the model relies on the prediction of the pairwise velocity moments. Further work needs to be done to predict these from theory within the required accuracy.