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BISPECTRUM ALIASING IN COSMOLOGICAL N-BODY SIMULATIONS

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We use numerical simulations to study the aliasing effect particularly on the bispectrum estimation. By contrasting the D20 scaling function against the classical mass assignment schemes, we got a smallest aliasing contribution obtained by the D20 function.

Different statistical methods are used to infer the properties of the large scale cosmic density distribution. The matter power spectrum is the most common statistical measure of gravitational clustering. Its importance arises from the fact that, for a gaussian random field, the power spectrum describes completely its statistical properties. However, a complete description for a non-gaussian distribution, which can emerge from non-linear processes, requires the use of higher order correlation functions. The bispectrum, has emerged as a standard probe of non-gaussianities in the large scale structure. The bispectrum is the lowest order indicator of non-Gaussinity in the primordial density field, which allows to constraint inflationary models and can give information about non-linear processes.

For computational efficiency, it is common to use Fast Fourier Transforms to get different Fourier space statistics, making the interpolation of the density field in a cartesian grid mandatory. This is done via a mass assignment scheme (MAS), which is a convolution of the density field with a window function. The finite sampling of the convolved density field introduces an additional effect known as "aliasing", which is significant near to the Nyquist wavenumber and has to be corrected for a precise estimation.

In this work we use numerical simulations to study the effect of the MAS on the estimation of the power spectrum and, mainly, the bispectrum. The effect of the aliasing on the power spectrum and bispectrum is estimated numerically in order to measure its impact on the final statistics. We show comparisons of different MAS in the power spectrum and bispectrum and conclude that using the standard cloud in cell method results in a strongly biased

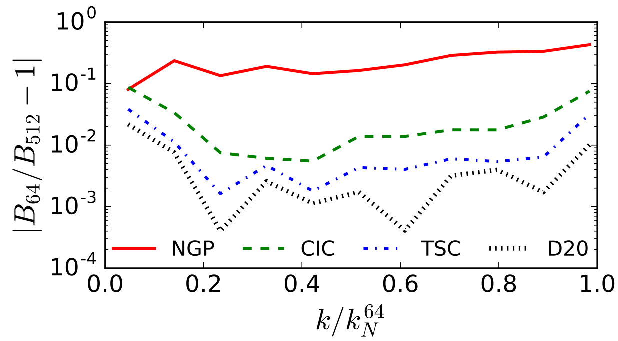

Fig. 1. Fractional deviation of $B(k_{123})$ for a grid of 64^3 cells, where the aliasing effect is relevant for $k \sim k_N^{64}$, against a grid of 512^3 cells, where the effect of a aliasing is negligible at the same wavenumber range.

bispectrum (close to 60%) for values close the Nyquist wavenumber. On the other hand, the triangular shaped cloud and Daubechies scaling function schemes show the best performance with the minimum aliasing effect with relative small deviations (40% and 14% respectively). We found that a MAS in the form of a Daubechies wavelet scaling function that is meant to produce an almost negligible aliasing on the power spectrum produces a very small aliasing effect on the bispectrum. Finally, we present an analytic form for the aliasing of the bispectrum independent of the MAS that in general provides a way to estimate the effect of aliasing on bispectrum estimates. This result is important, since in the current age of percent precision cosmology, accurate estimators of power spectrum and bispectrum are a mandatory tool to probe the cosmic mass density field. It is worth to mention that this is one of the first works studying systematically this effect on the bispectrum.

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