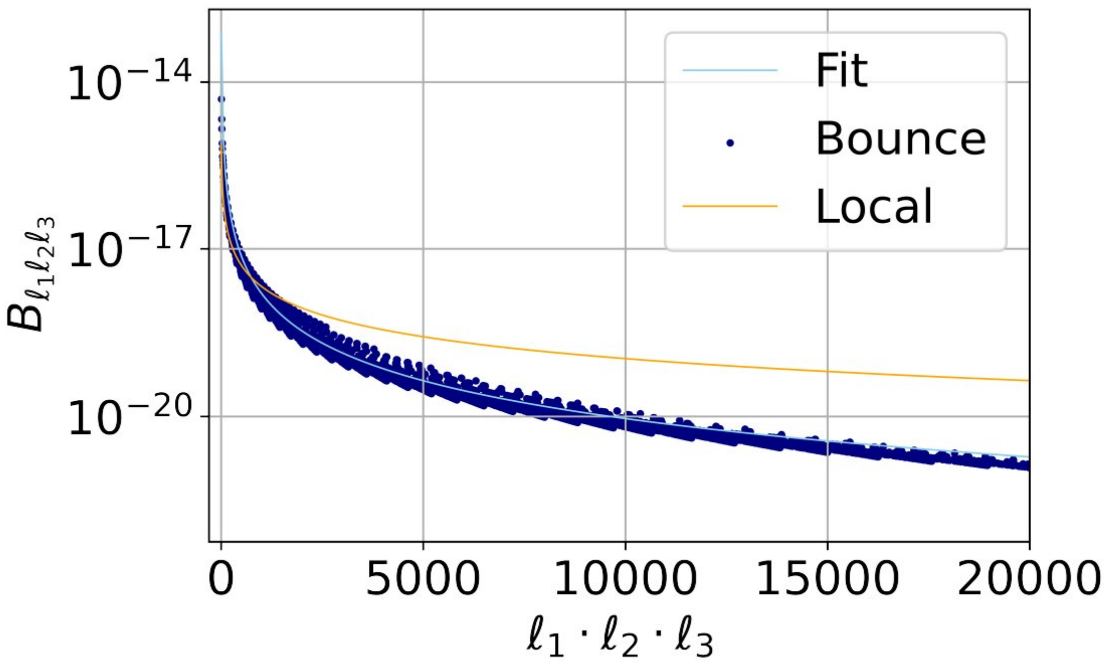
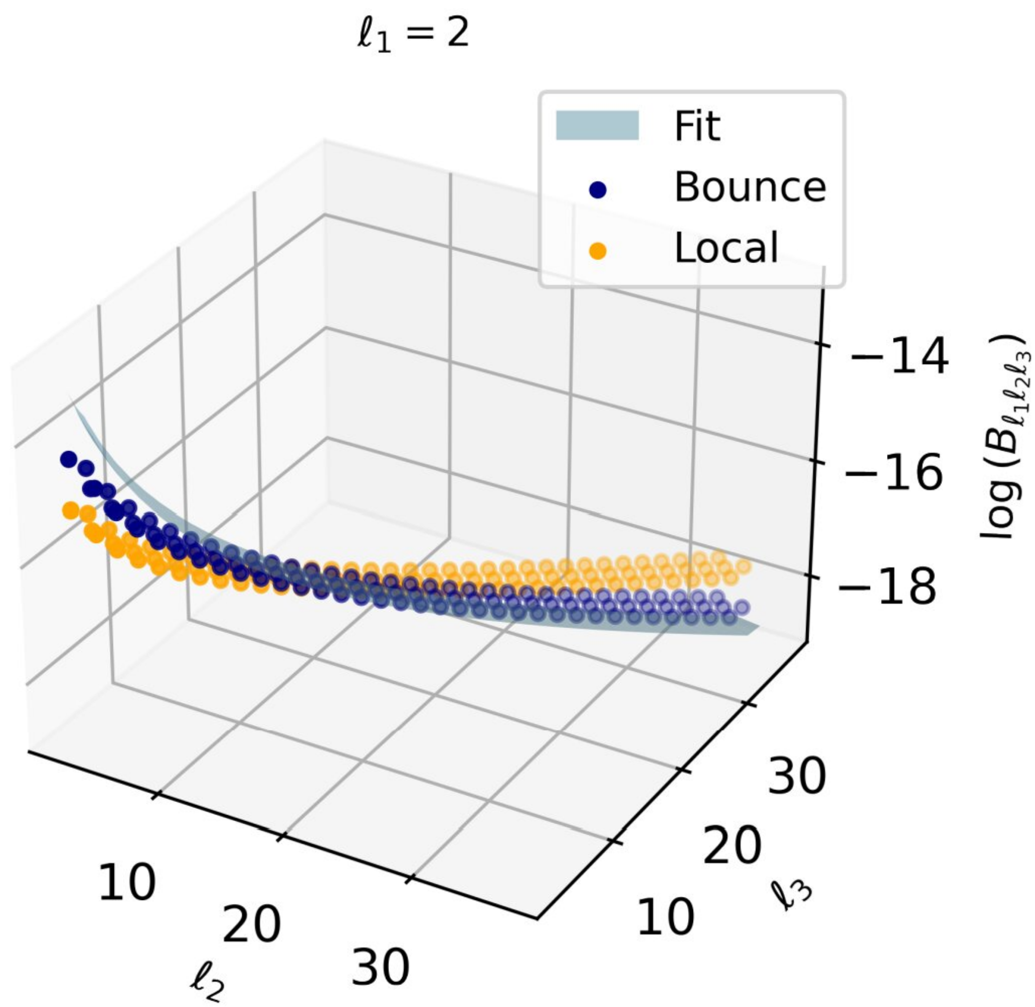
Deriving a general expression for the bispectrum in cosmologies rules out most bouncing models

May 30 2023, by Bob Yirka


Fit
Bounce
Local
10^{-14}
10^{-17}
10^{-20}
$B_{\ell_1\ell_2\ell_3}$
0
5000
10000
15000
20000
$\ell_1 \cdot \ell_2 \cdot \ell_3$


$\ell_1 = 2$
Fit
Bounce
Local
−14
−16
−18
$\log(B_{\ell_1\ell_2\ell_3})$
10
20
30
ℓ_2
10
20
30
ℓ_3

Top panel: The bouncing bispectrum computed with the numerical transfer functions (blue dots), fit to the bispectrum obtained in [23] (cyan) and the local bispectrum (yellow), for q = −0.7 (multiplication by fNL included). The bispectrum is plotted as a function of the product $L \equiv l_1 l_2 l_3$, which allows plotting all values of the 3D bispectrum in a 2D plot, at the price of having multiple (l_1, l_2,l_3) configurations corresponding to the same value of the product L. Bottom panel : The same bispectrum for $l_1 = 2$ fixed as a function of l_2 and l_3, compared to the local bispectrum with the same value for fNL. Only values of l_i which satisfy the triangle inequality are plotted. The fitting formula is indicated as a cyan surface. Credit: *arXiv* (2022). DOI: 10.48550/arxiv.2212.05977

A team of cosmologists from the University of Paris-Saclay, CNRS/IN2P3, Jagiellonian University and the University of Geneva derived a general expression for the bispectrum in bouncing cosmologies and then compared the results with Planck data, finding that it rules out most bouncing models. In their study, reported in the journal *Physical Review Letters*, the group derived measures of the non-Gaussianity of the primordial fluctuations generated during inflation in the early universe.

Because the beginning of the universe, if there was one, was so long ago, and because so little evidence has survived to this point in time, cosmologists and astrophysicists have trouble settling on a theory to describe the means by which the universe likely got its start. But they have settled on two main possibilities: that the whole thing started with a big bang, or that there was a bounce.

The first idea suggests that there was a single moment in time when a gigantic explosion occurred, releasing the components that evolved to become what is now the universe. The second idea suggests that the big bang idea is not feasible because it proposes that the universe emerged from nothing—proponents of the bouncing theory suggest there was a prior universe that collapsed and then expanded again.

Most bouncing theories suggest this could have happened repeatedly, perhaps an infinite number of times. Currently there are many more scientists behind the big bang theory.

In this new effort, the research team took a look at the bispectrum—a measure of the non-Gaussianity of primordial fluctuations generated during inflation—or put another way, the means by which different parts of the universe should have interacted under a bouncing scenario.

Notably, the bispectrum would not be included in images of the cosmic microwave background as it exists today, but as the researchers on this effort note, it should show up in frequencies in the early universe. And that was where the researchers put their focus. They derived expressions for it under a bouncing scenario and then compared the results with previously derived Planck data. They found the bispectrum to be highly constrained and therefore ruled out bouncing models with a 95% confidence level.

More information: Bartjan van Tent et al, Constraining the Bispectrum from Bouncing Cosmologies with Planck, *Physical Review Letters* (2023). DOI: 10.1103/PhysRevLett.130.191002

On *arXiv*: doi.org/10.48550/arXiv.2212.05977