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Understanding non-Gaussianity signatures in general relativity

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Possible departure from Gaussian statistics in cosmological perturbations can shed much light on the physics of their generation in the primordial Universe. Many of the forthcoming surveys of the large-scale structure with unprecedented survey volume aim at detecting these signatures. However, ignoring the "gauge artifacts" in general relativity that arise from the freedom to choose arbitrary space-time coordinates to describe the perturbed Universe can lead to incorrect interpretation on the observational consequences of these non-Gaussian signatures. I present two important examples of non-Gaussianity signatures. I show that in the "separate universes" formalism it can be clarified that they are strictly forbidden in canonical inflation scenarios involving only one scalar degree of freedom. One is a quadrupolar direction-dependence in the power spectrum of matter density, which is naively expected from a non-Gaussian correlation between a primordial gravitational wave of super-horizon wavelength and two density perturbations of shorter wavelengths. The other is a galaxy biasing that grows toward large scales, which is naively expected from nonlinearity in general relativity that couples a long-wavelength gravitational potential with two short-wavelength density fluctuations. Conversely, general models of single-field inflation can be falsified if it turns out that either of those signatures is actually observed.