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Rare events are non-perturbative.

In recent years, it has been noted that perturbative treatment of large fluctuations fails to make correct predictions, e.g., for the formation of primordial black holes. Some non-perturbative methods like stochastic formalism were introduced to explore the tail of distributions, resulting in exponential tails for probability distributions in some models when quantum kicks dominate the classical trajectory. We advocate that the \delta N formalism can be applied to non-perturbatively calculate the tail of the distribution of fluctuations. We study a model of single-field inflation in which the tail of the PDF decays more slowly than exponential. This may significantly enhance the probability of the formation of PBHs. Furthermore, we employ the non-linear \delta N formalism in a model of two-field ultra-slow-roll (USR) inflation. We show that the geometry of the surface of the end of USR phase in the field space plays a crucial role in the PDF of fluctuations. In particular, we illustrate how the geometrical properties of the boundary may lift the tail of PDF for curvature perturbation.

References:
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