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Cancellation of quantum corrections on the soft curvature perturbations

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We study the cancellation of quantum corrections on the superhorizon curvature perturbations from sub-horizon physics beyond the single-clock inflation from the viewpoint of the cosmological soft theorem. As an example, we focus on the transient ultra-slow-roll inflation scenario and compute the one-loop quantum corrections to the power spectrum of curvature perturbations taking into account nontrivial surface terms in the action. We find that Maldacena's consistency relation is satisfied and guarantees the cancellation of contributions from the short-scale modes. As a corollary, primordial black hole production in single-field inflation scenarios is not excluded by perturbativity breakdown even for the sharp transition case in contrast to some recent claims in the literature. We also comment on the relation between the tadpole diagram in the in-in formalism and the shift of the elapsed time in the stochastic-δN formalism. We find our argument is not directly generalisable to the tensor perturbations.

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