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The Effective Field Theory of Large Scale Structureat Three Loops

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We study the power spectrum of dark matter density fluctuations in the framework of the Effective Field Theory of Large Scale Structures (EFTofLSS) up to three loop orders. In principle, several counter-terms may be needed to handle the short-distance sensitivity in perturbation theory. However, we show that a small number of extra coefficients are sufficient to match numerical simulations with percent accuracy when a generic renormalization prescription is implemented (allowing for running of the individual counter-terms). We show that the level of accuracy increases with respect to the two loop results, up to $k \simeq 0.4\,h$~Mpc^{-1} at redshift $z = 0$, although the overall improvement is somewhat marginal. At the same time, we argue there is evidence that the behavior of the loop expansion in the EFTofLSS is typical of an asymptotic series, already on the brink of its maximum predictive power (at $z = 0$). Hence, the inclusion of higher orders will likely deteriorate the matching to data, even at moderate values of k. Part of the reason for this behavior is due to large contributions to the (renormalized) power spectrum at three loop order from mildly non-linear scales, even after the UV counter-terms are included. In conclusion, the EFTofLSS to three loop orders provides the best approximation to the (deterministic part of the) power spectrum in the weakly non-linear~regime at $z = 0$, and higher loops are not expected to improve our level of accuracy.

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