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On the Soft Limit of the Large Scale Structure Power Spectrum: UV Dependence

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We derive a non-perturbative equation for the large scale structure power spectrum of long-wavelength modes. We use an operator product expansion together with relations between the three-point function and power spectrum in the soft limit. The resulting equation encodes the coupling to ultraviolet (UV) modes in two time-dependent coefficients, which may be obtained from
response functions to (anisotropic) parameters, such as spatial curvature, in a modified cosmology. We argue that both depend weakly on fluctuations deep in the UV. As a byproduct, this implies that the renormalized leading order coefficient(s) in the effective field theory (EFT) of large scale structures receive most of their contribution from modes close to the non-linear scale. Consequently, the UV dependence found in explicit computations within standard perturbation theory stems mostly from counter-term(s). We confront a simplified version of our non-perturbative equation against existent numerical simulations, and find good agreement within the expected uncertainties. Our approach can in principle be used to precisely infer the relevance of the leading order EFT coefficient(s) using small volume simulations in an 'anisotropic separate universe' framework. Our results suggest that the importance of these coefficient(s) is a $\sim 10\%$ effect, and plausibly smaller.

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