at short distances. Treating couplings as fields can be seen in other theories such as scalar–tensor theories (see references in [7]), but here couplings run because of quantization in a systematic manner, i.e. RG equation. This evolved constant parameter, i.e. running coupling constant, can change the behavior of gravitational phenomena like black holes [8], galaxy rotation [9], CMB and etc.

In this paper, we investigate the effects of the improvement of gravitational and cosmological constants on the Mukhanov–Sassaki equation (MSE). This equation describes the growth of gauge invariant quantities constructed from quantum perturbations of metric and the inflation scalar field. These perturbations are usually considered as the primary seeds for inhomogeneities of CMB and the structure formation. Therefore investigation of the effects of RG improved couplings on the MSE would be remarkable.

The next section is dedicated to a brief introduction of ERG and various improvement methods. Then the improved MSE (IMSE) would be derived in section III. In section IV, we obtain the solution of IMSE for two models, one with a scalar field responsible for the inflation, and one with a cosmological constant. Finally in section V, effects of this improvement on the power spectrum are studied.

It should be noted here that although here we are investigating the improvement of the cosmological power spectrum via the running coupling constants obtained from the asymptotic safe theory, there are other points of view to see the potential impact of renormalization in the power spectrum. For example see [10].

II Truncated ERG in asymptotically safe gravity

Truncated ERG is one of the several methods for probing non–Gaussian fixed points of gravity theory [4]. In this approach, by truncating the scale–dependent effective action $\Gamma_k[g_{\alpha\beta}]$ up to appropriate interaction terms, other non–effective interaction terms would be ignored. The evolution of these remaining gauge couplings, which cannot be eliminated by fields redefinition, is obtained from the exact renormalization group equation (ERGE). The trajectory of RG flow