Similarly, the "sneutrino D-term inflation" proposed in [661] assumed the sneutrino to be the inflaton. The superpotential is given by:

$$W = \frac{\lambda}{M_{\rm P}} N_R^2 \Phi_+ \Phi_- + \lambda_\nu N_R H_u L + \frac{M_R}{2} N_R^2 \ , \tag{266}$$

where N_R is assumed to be the lightest right handed (s)neutrino, with $U(1)_R$ charge $+1$ and no $U(1)_\xi$ charge. Therefore, the tree level D-terms in the potential of Eq. (248) are not affected, though the additional couplings will affect the radiative correction, and therefore the dynamical properties of the model. Even with a minimal Kähler potential, inflation is found to be successful in the regime, $M_R^2 N_R \ll g_\xi^2 \xi^2$. The model predicts an almost scale-invariant power spectrum, $n_s \simeq 1$, and the constraint from the cosmic string tension is relaxed as compared to the standard case.

5. *F_D-term hybrid inflation*

There are also models where both F and D-terms are contributing to the inflationary potential. A mixture of the F- and D-term inflation was proposed by [662, 663], built as an extension to the NMSSM. The model is constructed in such a way that the inflaton field S involved in a F-term like superpotential also generates the μ term of the MSSM, and it is also coupled to the right-handed neutrinos, generating the Majorana mass scale.

The symmetries of the model are also extended to $G_{SM} \times U(1)_\xi$, the additional abelian factor allowing for the presence of a FI term. This subdominant contribution to the D-terms is employed to control the decay rate of superheavy fields such as the waterfall fields X_i and the inflaton field into gravitinos. In this model, the potential is dominated by the F-terms. The renormalizable superpotential for the F_D-terms hybrid model is given by:

$$W = \kappa\, S\, \left(X_1 X_2 - M^2\right) + \lambda\, S H_u H_d + \frac{\rho_{ij}}{2}\, S N_i N_j + h_{ij}^\nu L_i H_u N_j + W_{\rm MSSM}^{(\mu=0)} \ , \tag{267}$$

where $W_{\rm MSSM}^{(\mu=0)}$ denotes the MSSM superpotential without the μ-term, S is the SM-singlet inflaton superfield, N_i are the right-handed Majorana neutrinos and $X_{1,2}$ is a chiral multiplet pair with opposite charges under some $U(1)_\xi$ gauge group. Consequently, the D-term contribution to the scalar potential is given by: $V_D = (g^2/8)(|X_1|^2 - |X_2|^2 - \xi)^2$. The soft SUSY-breaking sector can be obtained from Eq. (267) and reads:

$$-\mathcal{L}_{\rm soft} = M_S^2 S^* S + \Big(\kappa A_\kappa S X_1 X_2 + \lambda A_\lambda S H_u H_d + \frac{\rho}{2} A_\rho S \widetilde{N}_i \widetilde{N}_i - \kappa a_S M^2 S + {\rm H.c.}\Big) \ , \tag{268}$$