have an hierarchy [122]:

$$\Gamma_{\rm d} \gg \Gamma_{\rm kin} > \Gamma_{\rm thr} \,. \tag{433}$$

The relative chemical equilibrium among different degrees of freedom is built through $2 \to 2$ annihilations in the $s-$channel with a rate $\sim \alpha^2 n/E^2 \ll \Gamma_{\rm thr}$. Hence composition of the reheat plasma will not change until full thermal equilibrium is achieved. This implies that the universe enters a long period of quasi-adiabatic evolution after the inflaton decay has completed. During this phase, the comoving number density and (average) energy of particles remain constant [97].

5. *Reheat temperature of the universe*

The temperature of the universe after it reaches full thermal equilibrium is referred to as the reheat temperature $T_{\rm R}$. In the case of MSSM, we therefore have [122, 123]:

$$T_{\rm R} \simeq (H_{\rm thr} M_{\rm P})^{1/2} \,, \tag{434}$$

where, depending on the details, $H_{\rm thr}$ is given by Eqs. (431) and (432). Since $H_{\rm thr} \ll \Gamma_{\rm d}$, the reheat temperature is generically much smaller in MSSM (or in a generic theory with gauge invariant flat directions) than the standard expression $T_{\rm R} \simeq (\Gamma_{\rm d} M_{\rm P})^{1/2}$, which is often used in the literature with an assumption that immediate thermalization occurs after the inflaton decay. Note that the reheat temperature depends very weakly on the inflaton decay rate, for instance Eq. (432) implies that $T_{\rm R} \propto \Gamma_{\rm d}^{1/4}$, while $T_{\rm R}$ is totally independent of $\Gamma_{\rm d}$ in Eq. (431). Regardless of how fast the inflaton decays, the universe will not thermalize until the $2 \to 3$ scatterings become efficient. A larger φ_0 results in slower thermalization and a lower reheat temperature, see the following table for some sample examples [98].

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[97] The decay of flat directions and their interactions with the reheat plasma are negligible before the universe fully thermalizes.

[98] If $H_{\rm thr} \geq \Gamma_{\rm d}$, the reheat temperature in such cases follows the standard expression: $T_{\rm R} \simeq (\Gamma_{\rm d} M_{\rm P})^{1/2}$. This will be the case if the flat direction VEV is sufficiently small at the time of the inflaton decay, and/or if the reheat plasma is not very dilute.