DOES INFLATIONARY PARTICLE PRODUCTION SUGGEST A LOW-DENSITY FLAT UNIVERSE ?

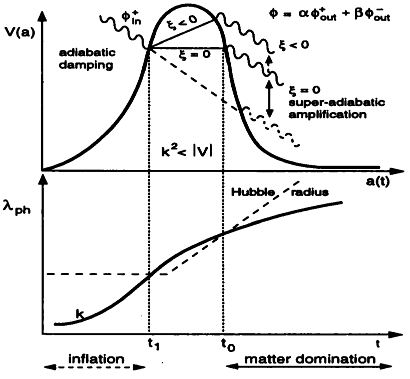
Varun Sahni[1] and Salman Habib[2]

[1]Inter-University Centre for Astronomy & Astrophysics, Post Bag 4, Pune 411007, India [2]T-8, Theoretical Division, MS B285, Los Alamos National Laboratory, Los Alamos, New Mexico 87545

In a FRW Universe a massless nonminimally coupled scalar field satisfies the Klein-Gordon equation $[\Box + \xi R]\Phi = 0$, $\Phi_k = (2\pi)^{-3/2}\chi_k(\eta)\, e^{-i\vec{k}\cdot\vec{x}}/a$

$$\ddot{\chi}_k + [k^2 - (1-6\xi)\ddot{a}/a]\chi_k = 0 \tag{1}$$

which closely resembles the one dimensional Schrödinger equation, $\psi'' + (E - V(x))\psi = 0$, the role of the "potential barrier" $V(x)$ being played by the 'barrier in conformal time' $V(\eta) = (1-6\xi)\ddot{a}/a$. The form of $V(\eta)$ is shown below assuming Inflation is followed by a matter/radiation dominated epoch and $\xi < 1/6$.



The process of super-adiabatic amplification of zero-point fluctuations resulting in particle production is illustarted in Fig. 1. The amplitude of modes having wavelengths smaller than the Hubble radius decreases conformally with the expansion of the Universe, whereas larger-than Hubble radius modes freeze (if $\xi = 0$) or grow with time ($\xi < 0$). As a result, modes with $\xi \leq 0$ have their amplitude super-adiabatically amplified on re-entering the Hubble radius after Inflation.

Negative values of ξ enhance long range power in the vacuum expectation value of the energy-momentum tensor $\langle T_{\mu\nu}\rangle$. For ultra-light fields ($m/H \sim 1$) the resulting energy density of created particles behaves like an *effective cosmological constant* and can exceed the conventional matter density at late times leading generically to $\Omega_m < 1$.

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