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Commentary

Particle Physics Inflation Models in Current Scenarios

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DESCRIPTION

Inflation models are compared with observation on the assumption that the curvature perturbation is generated from the vacuum fluctuation of the inflation field. The focus is on single field models with canonical kinetic terms, classified as small, medium and large field according to the variation of the inflation field while cosmological scales leave the horizon. Small field models are constructed according to the usual paradigm for beyond standard model physics.

This theory models of inflation, and of their predictions for the primordial density perturbation that is thought to be the origin of structure in the universe. It contains mini reviews of the relevant observational cosmology, of elementary field theory and of super symmetry that may be of interest in their own right. The spectral index, specifying the scale dependence of the spectrum of the curvature perturbation, will be a powerful discriminator between models, when it is measured by Planck with accuracy. The usual formula for n is derived, as well as its less familiar extension to the case of a multi-component inflation; in both cases the key ingredient is the separate evolution of causally disconnected regions of the universe. Primordial gravitational waves will be an even more powerful discriminator if they are observed, since most models of inflation predict that they are completely negligible. We treat in detail the new wave of models, which are firmly rooted in modern particle theory and have super symmetry as a crucial ingredient. The review is addressed to both astrophysicists and particle physicists, and each section is fairly homogeneous regarding the assumed background knowledge.

Since inflation or curveting energy density creates all matter, it is important to understand the process of reheating and preheating into the relevant degrees of freedom required for the success of big bang nucleo synthesis. We discuss two distinct classes of models, one where inflation and curveting belong to the hidden sector, which are coupled to the standard model gauge sector very weakly. There is another class of models of inflation and curveting, which are embedded within Minimal Super symmetric Standard Model (MSSM) gauge group and beyond, and whose origins lie within gauge invariant combinations of super symmetric quarks and leptons. Their masses and couplings are all well motivated from low energy physics; therefore such models provide us with a unique opportunity that they can be verified/falsified by the CMB data and also by the future collider and non-collider based experiments. We then briefly discuss the stringy origin of inflation, alternative cosmological scenarios, and bouncing universes. The non-minimal coupling parameter between gravity and the Higgs field must then be very large, yielding some new cosmological consequences for the early universe and new constraints on the Higgs mass. As an outcome, new inflation is only possible for very special initial conditions producing first a short contraction era after which an inflationary expansion automatically follows; a chaotic inflationary scenario is successfully achieved. The contrast of density perturbations required to explain the seed of astronomic structures are obtained for very large values of the Higgs mass, otherwise the perturbations have small amplitude; in any case, the spectral index of scalar perturbations agrees with the observed one. The combination of two theories of particle physics into a single framework to describe all interactions of subatomic particles, except those due to gravity. The two components of the standard model are electroweak theory, which describes interactions via the electromagnetic and weak forces, and quantum chromo dynamics, the theory of the strong nuclear force. Both these theories are gauge field theories, which describe the interactions between particles in terms of the exchange of intermediary messenger particles that have one unit of intrinsic angular momentum, or spin. Everyday matter is built from the members of the lightest generation: The up and down quarks that make up the protons and neutrons of atomic nuclei; the electron that orbits within atoms and participates in binding atoms together to make molecules and more complex structures; and the electron neutrino that plays a role in radioactivity and so influences the stability of matter. Heavier types of quark and lepton have been discovered in studies of high energy particle interactions, both at scientific laboratories with particle accelerators and in the natural reactions of high energy cosmic ray particles in the atmosphere.

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