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Contemporary status of inflation

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At the present state-of-the-art, the simplest inflationary models, based either on scalar fields in General Relativity or on modified f(R) gravity, which produce the best fit to all existing observational data, require only one dimensionless parameter taken from observations. These models include the pioneer $R + R^2$ one [1], the Higgs model, and the mixed R^2-Higgs model that has been shown to be effectively one-parameter, too [2]. They predict scale-free and close to scale-invariant power spectra of primordial scalar perturbations and gravitational waves generated during inflation. Their target prediction for the tensor-to-scalar ratio is $r = 3(1 - n_s)^2 = 0.004$. The difference between these models is in their post-inflationary behaviour which becomes especially interesting and complicated in the mixed R2-Higgs case [3,4]. Still future observations, in particular discovery of primordial black holes, may prove that the primordial scalar power spectrum has additional local peaks what requires at least two new parameters. I discuss mechanisms to produce such features including the recently proposed one which arise in many-field inflation with a large non-minimal kinetic term of an inflaton field leaving inflation before its end [5]. In this case, in addition to PBHs, small-scale secondary gravitational waves are generated, too. As for local non-scale-free features at cosmological scales, the present CMB data do not favor them, but are not able to exclude them completely [6].

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