Inflation, pre-inflation and post-inflationary heating in the R^2 and mixed R^2-Higgs models

Alexei A. Starobinsky

Landau Institute for Theoretical Physics RAS,
Moscow - Chernogolovka, Russia

Several new results on inflation and pre- and post-inflationary evolution of the Universe in the $R + R^2$ (Starobinsky) and the mixed R^2-Higgs models are presented. The $R + R^2$ model where R is the Ricci scalar, augmented by small one-loop quantum gravitational corrections, represents the pioneer inflationary model [1] which still remains viable. It contains only one adjustable parameter taken from observations, has a graceful exit from inflation and a natural mechanism for creation and heating of matter after its end, and produces a very good fit to existing observational data on the power spectrum of primordial scalar (adiabatic density) perturbations. More generally, all viable slow-roll inflationary models in $f(R)$ gravity should be close to this model over some range of R. It also represents a dynamical attractor for slow-rolling scalar fields strongly coupled to gravity, as well as for the mixed R^2-Higgs inflationary model [2]. We consider the inverse problem of reconstruction of inflationary models in $f(R)$ gravity using information on the power spectrum of scalar perturbations only, ambiguity in this procedure and how it can be fixed by some aesthetic assumptions on the absence of new physical scales during and after inflation. The forms of $f(R)$ for which exact constant-roll solutions generalizing slow-roll ones can be realized are found [3]. As follows from observational data on the primordial scalar (matter density) perturbation spectrum, running of the dimensionless coefficient in front of the R^2 term with curvature due to loop quantum-gravitational corrections is small and does not exceed a few percents [4]. The same refers to the $R \Box R$ correction considered perturbatively, without increasing the number of degrees of freedom [5]. Also studied is the problem of inflation formation from preceding generic classical curvature singularity, and which conditions are needed for this [6]. Some exact anisotropic solutions describing it are presented. Since this process is generic, too, for inflation to begin inside a patch including the observable part of the Universe, causal connection inside the whole patch is not necessary. However, it becomes obligatory for a graceful exit from inflation in order to have practically the same number of e-folds during inflation inside this patch. Finally, the possibility of violent particle production after the end of inflation in the mixed R^2-Higgs model is investigated [7].

References

[1] A. A. Starobinsky, *Phys. Lett. B* **91** (1980) 99–102.

[2] M. He, A. A. Starobinsky and J. Yokoyama, JCAP **1805**, 064 (2018) [arXiv:1804.00409].

[3] H. Motohashi and A. A. Starobinsky, Eur. Phys. J. C **77** (2017) 538 [arXiv:1704.08188].

[4] L.-H. Liu, T. Prokopec and A. A. Starobinsky, Phys. Rev. D **98**, 043505 (2018) [arXiv:1806.05407].

[5] A. R. R. Castellanos, F. Sobreira, I. L. Shapiro and A. A. Starobinsky, JCAP **1812**, 007 (2018) [arXiv:1810.07787].

[6] D. Müller, A. Ricciardone, A. A. Starobinsky and A. Toporensky, Eur. Phys. J. C **78** (2018) 311 [arXiv:1710.08753].

[7] M. He, R. Jinno, K. Kamada, S. C. Park, A. A. Starobinsky and J. Yokoyama, Phys. Lett. B **791**, 36 (2019) [arXiv:1812.10099].