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Magnetic field amplification in $f(R)$ theories of gravity

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Abstract. The inflationary amplification of magnetic field seeds for galaxies is discussed in the framework of the $f(R)$ theories of gravity, where $f(R)$ is of the form $f(R) \sim R^n$. The breaking of the conformal invariance necessary for the seeding of the primordial magnetic field from the vacuum is generated by means of the coupling of the electromagnetic field with curvature terms. We analyze the coupling of the electromagnetic field with the Riemann tensor, $F^{\alpha\beta}F^{\alpha'\beta'}R_{\alpha\beta\alpha'\beta'}$. We find that amplification of the magnetic field occurs during the reheating phase of evolution of the Universe. Estimates of the index n are derived by using the observed strength of the galactic magnetic fields. Moreover, the coupling of the electromagnetic field with a generic function of the scalar curvature, i.e. $R^m F_{\alpha\beta}F^{\alpha\beta}$, is discussed. In this case, we find that a growing of the primordial magnetic field during the reheating epoch may occur for an appropriate choice of the powers m and n.

Keywords: magnetic fields, physics of the early universe

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