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Baryogenesis via QCD preheating with nonadiabatic baryon chemical potential

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The chiral phase transition in QCD can be supercooled in the thermal history of the universe to be instantaneously out-of equilibrium, if QCD is coupled to a dark QCD sector exhibiting the dark chiral phase transition of the first order. In that case the QCD sigma meson field (as the chiral order parameter, or the light quark condensate) starts to roll in a nonadiabatic way down to the true QCD vacuum. Meanwhile a dynamic baryonic chemical potential can be generated solely within QCD, which is governed by the dynamic motion of the QCD sigma meson field, analogously to the spontaneous baryogenesis or the leptogenesis via the Higgs or axionlike relaxation scenario. When QCD is further allowed to communicate with a dark fermion with mass of order of 1 GeV and the baryon number violating coupling to neutron, the nonadiabatic QCD sigma motion along with the nonadiabatic baryon chemical potential can trigger the preheating and produce the baryon number asymmetry. We discuss this scenario in details to find that the QCD-induced dynamic baryon chemical potential plays a significant role for the QCD preheating and the baryogenesis, which yields the desired amount of the asymmetry today consistently with current astrophysical, cosmological, and terrestrial experimental constraints. Cosmological and phenomenological consequences characteristic to the present scenario are also addressed.

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