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Flipped rotating axion non-minimally coupled to gravity: Baryogenesis and Dark Matter

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We demonstrate that the co-genesis of baryon asymmetry and dark matter can be achieved through the rotation of an axion-like particle, driven by a flip in the vacuum manifold's direction at the end of inflation. This can occur if the axion has a periodic non-minimal coupling to gravity, while preserving the discrete shift symmetry. In non-oscillating inflation models, after inflation there is typically a period of kination (with $w = 1$). In this case, it is shown that the vacuum manifold of the axion is flipped and the axion begins rotating in field space, because it can slide across the decreasing potential barrier as in Ricci reheating. Such a rotating axion can generate the baryon asymmetry of the Universe through spontaneous baryogenesis, while at later epochs it can oscillate as dark matter. The period of kination makes the primordial gravitational waves (GW) generated during inflation sharply blue-tilted which constrains the parameter space due to GW overproduction, while being testable by next generation CMB experiments. As a concrete example, we show that such a cogenesis of baryon asymmetry and dark matter can be realized for the axion as the Majoron in the Type-I seesaw setup, predicting mass ranges for the Majoron below sub eVs, with right-handed neutrino mass above $\mathcal{O}(10^8)$ GeV.

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