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Phenomenological aspects of dark QCD at QCD scale inspired by strong CP problem

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We discuss a QCD-scale composite axion model arising from dark QCD coupled to QCD. The presently proposed scenario not only solves the strong CP problem, but also is compatible with the preheating setup for the QCD baryogenesis. The composite axion is phenomenologically required to mimic the QCD pion, but can generically be flavorful, which could be testable via the induced flavor changing processes at experiments. Another axionlike particle (ALP) is predicted to achieve the axion relaxation mechanism, which can phenomenologically act as the conventional QCD axion. This ALP can be ultralight, having the mass less than 1 eV, to be a dark matter candidate. The QCD \times dark QCD symmetry structure constrains dark QCD meson spectra, so that the dark \eta'-like meson would only be accessible at the collider experiments. Still, the Belle II experiment can have a high enough sensitivity to probe the dark \eta-like meson decaying to diphoton, which dominantly arises from the mixing with the QCD \eta' and the pionic composite axion. We also briefly address nontrivial cosmological aspects, such as those related to the dark-chiral phase transition, the dark matter production, and an ultraviolet completion related to the ultralight ALP.

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