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Hybrid Cosmological Collider of Axion

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If a light axion is present during inflation and becomes part of dark matter afterwards, its quantum fluctuations contribute to dark matter isocurvature. In this article, we introduce a whole new suite of cosmological observables for axion isocurvature, which could help test the presence of axions, as well as its coupling to the inflaton and other heavy spectator fields during inflation such as the radial mode of the Peccei-Quinn field. They include correlated clock signals in the curvature and isocurvature spectra, and mixed cosmological-collider non-Gaussianities involving both curvature and isocurvature fluctuations with shapes and running unconstrained by the current data. Taking into account of the existing strong constraints on axion isocurvature fluctuations from the CMB, these novel signals could still be sizable and potentially observable. In some models, the signals, if observed, could even help us significantly narrow down the range of the inflationary Hubble scale, a crucial parameter difficult to be determined in general, independent of the tensor mode.

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