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Distinguishing Light Scalars via CP: Dilaton and Axion at Belle II

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We present a detailed phenomenological study of a light dilaton φ, arising from the spontaneous breaking of approximate scale invariance in a nearly conformal theory. Particular care is taken to account for the dilaton's enhanced coupling to photons, originating from loops of the conformal sector, which significantly shortens its lifetime and relaxes constraints from $K \to \pi + \text{inv.}$ searches at NA62 and cosmological constraints from the Big Bang Nucleosynthesis. New model-independent inclusive bounds from $b \to s\varphi$ transitions are obtained. Proceeding further, we consider the dilaton discovery prospect in a collider such as Belle II and outline how to distinguish it from an axion a having a similar final state signature without relying on how φ/a decays. The CP property can be used as it modifies the variation of the differential cross-section of $e^+e^- \to e^+e^-\varphi/a$ with the azimuthal angle between the outgoing leptons.

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