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Improved constraints for axion-like particles from 3-photon events at $e^+ e^-$ colliders

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Axions and axion-like particles (ALPs) are one of the most widely discussed extensions of the Standard Model when it comes to the strong CP problem and dark matter candidates. Current experiments are focused on the indirect searches of invisible pseudoscalars in a wide parameter range. In this paper we investigate limits on ALP mass, and its couplings to photons and leptons from 3-photon annihilation at $e^+ e^-$ colliders. We provide detailed calculations and apply them to the particular kinematics of the Belle II experiment, covering the ALP mass range from few hundred MeV to around 10 GeV. Our results, which improve upon previous analyses by also including the ALP coupling to electrons, show that such future analyses will allow to significantly extend the ALP search range and impose much more stringent restrictions on their couplings.

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