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Heavy QCD Axion at Belle II

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The QCD axion is a well-motivated addition to the standard model to solve the strong CP problem. If the axion acquires mass dominantly from a hidden sector, it can be as heavy as O(1) GeV, and the decay constant can be as low as O(100) GeV without running into the axion quality problem. We propose new search strategies for such heavy QCD axions at the Belle II experiment, where the axions are expected to be produced via $B \rightarrow Ka$. We find that a subsequent decay $a \rightarrow 3\pi$ with a displaced vertex leads to a unique signal with essentially no background, and that a dedicated search can explore the range O(1-10) TeV of decay-constant values. We also show that $a \rightarrow \gamma\gamma$ can cover a significant portion of currently unexplored region of $150 < m_a < 500$ MeV.

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