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Revisiting $K \rightarrow \pi a$ decay

The theoretical calculation for pseudo-scalars hadronic decays $P \rightarrow Ma$, with the Axion-Like-Particle escaping the detection, is reviewed. While one-loop penguin contributions are usually considered, tree-level processes have most often been overlooked in literature. Following the Brodsky/Lepage approach the tree-level contribution to the ALP pseudo-scalar decay is estimated. Assuming generic ALP couplings to SM fermions, the latest NA62 results for the $K^+ \rightarrow \pi^+ a$ decay and the present and future KOTO results for the $K^0 \rightarrow \pi^0 a$ decay are used to study the tree-level vs one-loop interplay and provide updated bounds on the ALP-fermion Lagrangian sector.

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