

Double ALP production at the LHC

Thursday 5 June 2025 11:50 (15 minutes)

Axion-like particles (ALPs) are hypothetical pseudoscalar states that emerge as pseudo-Nambu-Goldstone bosons from the breaking of an approximate global $U(1)$ symmetry. They appear in several extensions of the Standard Model, offering potential solutions to the strong CP problem, the muon $(g-2)$ anomaly, neutrino mass generation, and dark matter. While most collider-based studies focus on the production of a single ALP, in this work I investigate scenarios involving the production of an ALP pair. These processes offer the opportunity to probe dimension-6 operators, which include either Higgs-portal interactions (if the ALPs are produced via exotic Higgs decays such as $h \rightarrow aa$) or shift-symmetry breaking couplings, like $a^2 G_{\mu\nu} G^{\mu\nu}$, which are typically excluded in conventional shift-symmetric constructions of the ALP Lagrangian. In particular, I focus on the process $gg \rightarrow aa \rightarrow 4\gamma$, considering both the standard shift-preserving coupling and the shift-breaking gluon interaction. Our analysis simultaneously considers the presence of couplings to both gluons and electroweak bosons, including the standard dimension-5 operators as well as the dimension-6 interactions.

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Session Classification: Extended Scalars