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Probing Axion-Like Particles in Association with Top Quarks at Colliders

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Axion-Like Particles (ALPs), arising from spontaneous global symmetry breaking in many Standard Model extensions, provide a compelling avenue for probing new physics. We study ALP production in association with top quarks through several channels at the LHC and future colliders. We focus in particular on light ALPs that escape detection and appear as missing transverse energy. Using full Run 2 data at 13 TeV, we analyze ttbar+ALP events in the semileptonic and dileptonic decay modes to set limits on ALP couplings to top quarks and gluons. We also investigate single top production with a W boson and an ALP, using spin correlation measurements to further constrain couplings to W bosons. Projections for the HL-LHC and FCC-hh show that ttbar+ALP channel offer excellent sensitivity to ALP–gluon and ALP–EW couplings. Our results include two-dimensional exclusion limits and comparisons with indirect bounds from B-meson decays and top (chromo)magnetic dipole moments.

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