

Couplings of axion-like particles in linear and chiral EFT realisations

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Similarly to the difference between HEFT and SMEFT, a SM extension with an Axion-like Particle (ALP) can be parametrised in terms of a linear or chiral ALP-EFT, depending on whether the Higgs field is introduced as a doublet or a singlet, respectively.

In the linear case we particularly focus on the coupling of a light ALP to top quarks.

We use high-energy LHC probes and examine both the direct probe to this coupling in associated production of a top-pair with an ALP, and the indirect probe through loop-induced gluon fusion to an ALP leading to top pairs.

Using the latest LHC Run II data, we provide the best limit on this coupling and furthermore compare these limits with those obtained from loop-induced couplings in diboson final states.

In the chiral case, the EFT also contains tree-level couplings of an ALP to three bosons which give rise to the ALP-induced production of two Higgs bosons in association with a Z boson.

We examine the existing constraints from di-Higgs searches at Run 2 of the LHC and find that, despite the presence of extra objects in the final state, these searches are sensitive to ALP couplings.

Furthermore, we propose a dedicated search for HHZ states.

Finally, we compare the chiral EFT predictions with the contributions from top quark loops in the linear case.

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