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Search for long-lived particles in the ATLAS hadronic calorimeter in association with leptons or jets using 13 TeV collision data

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A search for neutral long-lived particles (LLPs) decaying in the ATLAS hadronic calorimeter using 140fb^{-1} of proton-proton collisions at $s = \sqrt{13}\text{ TeV}$ delivered by the LHC is presented. The analysis is composed of three channels. The first targets pair-produced LLPs, where at least one LLP is produced with sufficiently low boost that its decay products can be resolved as separate jets. The second and third channels target LLPs respectively produced in association with a W or Z boson that decays leptonically. In each channel, different search regions target different kinematic regimes, to cover a broad range of LLP mass hypotheses and models. No excesses of events relative to the background predictions are observed. Higgs boson branching fractions to pairs of hadronically decaying neutral LLPs larger than 1% are excluded at 95% confidence level for proper decay lengths in the range of 30 cm to 4.5 m depending on the LLP mass, a factor of three improvement on previous searches in the hadronic calorimeter. The production of long-lived dark photons in association with a Z boson with cross-sections above 0.1 pb is excluded for dark photon mean proper decay lengths in the range of 20 cm to 50 m, improving previous ATLAS results by an order of magnitude. Finally, long-lived photophobic axion-like particle models are probed for the first time by ATLAS, with production cross-sections above 0.1 pb excluded in the 0.1 mm to 10 m range.

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