All the Light we cannot see: the search for Dark Photons

A long-standing puzzle in our universe is the existence of dark matter (DM), a kind of matter that does not interact significantly with ordinary matter but that is confirmed by a series of astrophysical and cosmological observations, including in the stunning recent pictures from James Webb Space Telescope. The dominance of this DM over ordinary matter remains one of the main questions for high energy physics and astrophysics [1]. Particle physicists are working on models that can ameliorate our understanding of fundamental interactions, and to reconcile DM with the Standard Model. Dark Photons (DPs) could be the key in developing Beyond Standard Model theories. DPs are hypothesised hidden sector gauge bosons, akin to the photon. Neutral under Standard Model interactions, DPs can be detected due to kinematic mixing with the ordinary photon. A few theoretical models postulate the existence of a DP [2], [3], further classifying them as either massive or light.

Reconstruction in the detector faces some challenges. Energy deposits in the calorimeter are collected as objects termed jets. If a light DP is Lorentz boosted and using the model that the DP decays into electrons, the separation between the electrons would be too small for the detector to resolve and they would be reconstructed as a single electron. In the jet reconstruction, this would be seen as a single jet. We use the jet as a proxy for the dilepton system, and call it the lepton jet to distinguish from the usual hadronic calorimeter jets. Usual searches look at multiplicity of objects based on the signal characteristics, but here looking for two leptons (electrons) will make us miss the event. Lepton jets have been studied before [4], but in our analysis we will perform a feasibility study of a novel final state for a DP decaying into lepton jets.

Bibliography

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