Contribution ID: **24** Type: **not specified**

Lepton Jets from Radiating Dark Matter

Wednesday, 30 September 2015 16:35 (15 minutes)

The idea that dark matter forms part of a larger dark sector is very intriguing, given the high degree of complexity of the visible sector. In this paper, we discuss lepton jets as a promising signature of an extended dark sector. As a simple toy model, we consider an
O(GeV) DM fermion coupled to a new U(1)' gauge boson (dark photon) with a mass of order GeV and kinetically mixed with the Standard Model photon. Dark matter production at the LHC in this model is typically accompanied by collinear radiation of dark photons whose decay products can form lepton jets. We analyze the dynamics of collinear dark photon
emission both analytically and numerically. In particular, we derive the dark photon energy spectrum using recursive analytic expressions, using Monte Carlo simulations in Pythia, and using an inverse Mellin transform to obtain the spectrum from its moments. In the second
part of the paper, we simulate the expected lepton jet signatures from radiating dark matter at the LHC, carefully taking into account the various dark photon decay modes and allowing for both prompt and displaced decays. Using these simulations, we recast two existing
ATLAS lepton jet searches to significantly restrict the parameter space of extended dark sector models, and we compute the expected sensitivity of future LHC searches.

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Session Classification: Particle Phenomenology