Contribution ID: **288** Type: **Theory poster**

Collider probes of real triplet scalar dark matter

Thursday, 28 May 2020 18:45 (1 hour)

We study discovery prospects for a real triplet extension of the Standard Model scalar sector at the Large Hadron Collider (LHC) and a possible future 100TeV pp collider. We focus on the scenario in which the neutral triplet scalar is stable and contributes to the dark matter relic density. When produced in pp collisions, the charged triplet scalar decays to the neutral component plus a soft pion or soft lepton pair, yielding a disappearing charged track in the detector. We recast current 13TeV LHC searches for disappearing tracks, and find that the LHC presently excludes a real triplet scalar lighter than 287GeV with $\mathcal{L} = 36\text{fb}^{-1}$. The reach will extend to 608GeV and 761GeV with the collection of $\mathcal{L} = 300\text{fb}^{-1}$ and 3000fb^{-1} respectively. We extrapolate the 13TeV analysis to a prospective 100TeV pp collider, and find that a $\sim$ 3TeV triplet scalar could be discoverable with $\mathcal{L} = 30\ \text{ab}^{-1}$, depending on the degree to which pile up effects are under control. We also investigate the dark matter candidate in our model and corresponding present and prospective constraints from dark matter direct detection. We find that currently XENON1T can exclude a real triplet dark matter lighter than $\sim$ 3TeV for a Higgs portal coupling of order one or larger, and the future XENON20T will cover almost the entire dark matter viable parameter space except for vanishingly small portal coupling.

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Session Classification: Poster Session (I)

Track Classification: Dark Sector BSM