Contribution ID: **66** Type: **Oral**

Reviving Millicharged Dark Matter for 21-cm Cosmology

Tuesday 3 December 2019 14:50 (20 minutes)

The existence of millicharged dark matter (mDM) can leave a measurable imprint on 21-cm cosmology through mDM-baryon scattering. However, the minimal scenario is severely constrained by existing cosmological bounds on both the fraction of dark matter that can be millicharged and the mass of mDM particles. We point out that introducing a long-range force between a millicharged subcomponent of dark matter and the dominant cold dark matter (CDM) component leads to efficient cooling of baryons in the early universe, while also significantly extending the range of viable mDM masses. Such a scenario can explain the anomalous absorption signal in the sky-averaged 21-cm spectrum observed by EDGES, and leads to a number of testable predictions for the properties of the dark sector. The mDM mass can then lie between 10 MeV and a few hundreds of GeVs, and its scattering cross section with baryons lies within an unconstrained window of parameter space above direct detection limits and below current bounds from colliders. In this allowed region, mDM can make up as little as 10^{-8} of the total dark matter energy density. The CDM mass ranges from 10 MeV to a few GeVs, and has an interaction cross section with the Standard Model that is induced by a loop of mDM particles. This cross section is generically within reach of near-future low-threshold direct detection experiments.

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Session Classification: Parallel

Track Classification: Cosmology