



Contribution ID: 225

Type: **Contributed Oral**

Detecting dark matter with atomic systems

Thursday 4 December 2025 16:40 (15 minutes)

The mystery of dark matter (DM) is a long-standing issue in physics, with numerous dedicated experiments returning no confirmed detection. As many direct detection experiments rely on catching a signal of nuclear recoil, these types of experiments are not applicable to many DM models.

Instead, we can utilise the precision that atomic physics allows to search for potential interactions between atomic systems and DM, with possibilities spanning a large mass range.

For DM particles with masses just above electrons, we can search for signals of atomic ionisation from DM scattering off atomic electrons. If we instead move to DM with masses just below electrons, then we look to absorption of DM on atomic electrons.

For both cases, accurate treatment of the atomic physics plays an important role when calculating the possible scattering rates. To assess the accuracy of DM-electron scattering rates, we can find some comparison to electron-electron scattering experiments, providing an ability to test the theoretical calculations.

In this work, I will discuss the prospect for DM detection with atomic systems, the tools needed to accurately assess the possibility, and potential extensions of the calculations to include other types of scattering.

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Session Classification: Atomic and Molecular Physics

Track Classification: Topical Groups: Atomic and Molecular Physics