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Toward Precision Antideuteron Spectra from Dark Matter: Percent-Level Uncertainty Control

Thursday, 25 September 2025 16:30 (40 minutes)

The detection of cosmic antideuterons ($\overline{\mathrm{D}}$) at kinetic energies below a few GeV/n could provide a smoking gun signature for dark matter (DM). However, the theoretical uncertainties of coalescence models have represented so far one of the main limiting factors for precise predictions of the $\overline{\mathrm{D}}$ flux. In this talk, I will present a novel calculation of the $\overline{\mathrm{D}}$ source spectra, based on the Wigner formalism, for which the Argonne v_{18} antideuteron wavefunction is implemented. The advantage of this approach is that this wave function does not have any free parameters related to the coalescence process. I show that the Argonne/Wigner model excellently reproduces the $\overline{\mathrm{D}}$ multiplicity measured by ALEPH at the Z-boson pole, which is usually adopted to tune the coalescence models based on different approaches. With this Monte Carlo approach, I show that the current theoretical uncertainty on the prediction of the $\overline{\mathrm{D}}$ source spectra to a few percent, for $\overline{\mathrm{D}}$ kinetic energies relevant to DM searches with GAPS and AMS, and for DM masses above a few tens of GeV. This result implies that the theoretical uncertainties due to the coalescence process are no longer the main limiting factor in the predictions.

Talk is based on:
https://arxiv.org/abs/2411.04815 (accepted for publication in PRL)
https://arxiv.org/abs/2312.01153
Discussion about QCD modeling is based on:
https://arxiv.org/abs/2303.11363
https://arxiv.org/abs/2202.11546
Dataset and code repo:
https://github.com/ajueid/CosmiXs.git

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