

Halo Uncertainties in Dark Matter Direct Detection with SBI

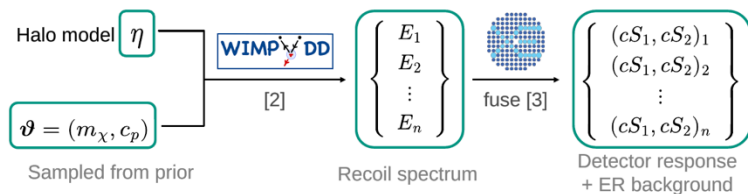
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SBI achieves exclusion limits close to the conventional PLR approach

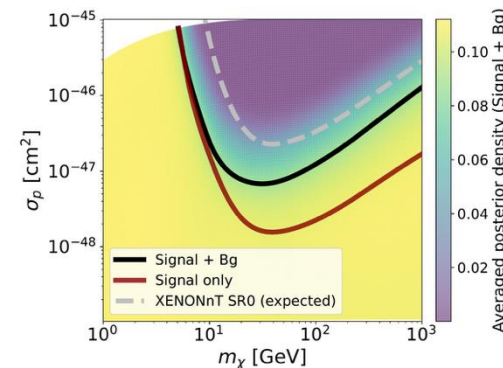
Nuisance parameters, e.g. halo uncertainties, are included at no extra inference cost

Problem & approach

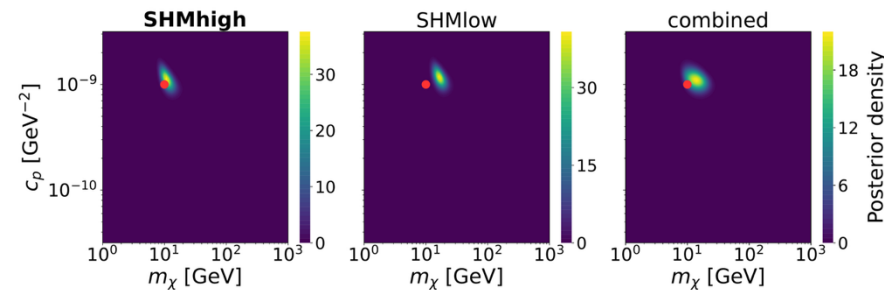
- **Problem:** the dark matter halo is uncertain, but standard analyses fix it to the Standard Halo Model
- **SBI:** simulate XENONnT SR0-like spectra (WimPyDD + fuse), then a classifier learns the likelihood ratio
- **Trick:** draw a new halo η in every simulation, so it is marginalized automatically



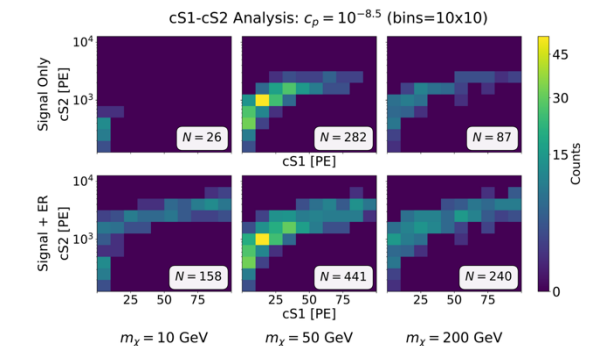
Results



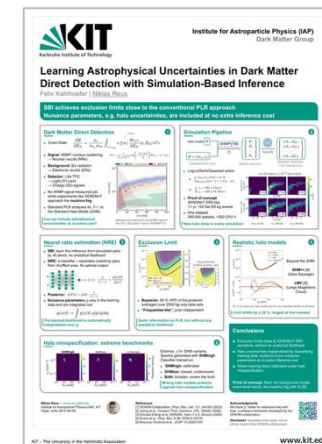
Exclusion limit
close to XENONnT
SR0 sensitivity —
no analytical
likelihood needed



Halo misspecification: wrong halo → biased;
mixed training → covers the truth



NRE input: (cS1, cS2) histograms



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arXiv:2610.06159