Light Dark Matter Detection with SENSEI

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SENSEI

- Sub-Electron-Noise Skipper-CCD Experimental Instrument
- Fermilab, Stony Brook University, Tel Aviv University, University of Oregon
Nuclear Recoil Bounds

CRESST Collaboration (2019)
Nuclear Recoil Bounds

\[ E_N \lesssim 1 \text{eV} \times \left( \frac{m_\chi}{100 \text{MeV}} \right)^2 \left( \frac{20 \text{GeV}}{m_N} \right) \]
Electron Recoil

- Not in momentum eigenstate
- Speed $\sim \alpha c$
Semiconductor Use

- Detect with silicon
  - Bandgap 1.1 eV

\[ E_e \lesssim \frac{1}{2} \text{eV} \times \left( \frac{m_X}{1 \text{MeV}} \right) \]
SENSEI

- Sub-Electron-Noise Skipper-CCD Experimental Instrument
Yields

- Need to be sensitive to few electrons
- Skipper-CCD achieves low enough noise
Current status of SENSEI

- Readout technology successful in 2017
- Initial surface run 2017, paper 2018 \((\text{arXiv 1804.00088})\)
- Prototype run with 0.1 g silicon in 2018 \((\text{arXiv 1901.10478})\)
  - MINOS cavern at Fermilab
  - Publication in PRL accepted April 2019
ProtoSENSEI

- 2 readout strategies
- Periodic: 0.07 g-days
- 5x 120 ks

Exposure: 0.069 g day

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Limits

Limits

Future of SENSEI

- Prototype: 0.1g Silicon
- 2019: 10g
- 2020: 100g
  - SNOLAB
Thank You!
Backup: More Exclusion Curves

Backup: More Yields

Essig, Fernandez-Serra, Mardon, Soto, Volansky, Yu (2016)
Backup:
Sub-Electron Noise

\[ \sigma \propto \frac{1}{\sqrt{N}} \]

Backup: Absorption Expectations for SENSEI