Alvaro E. Chavarria University of Washington



Dark Matter Summary

Dark matter conveners:

- Shawn Westerdale (UC Riverside)
- Alvine Kamaha (UC Los Angeles)
- Yonatan Kahn (University of Toronto)
- Alvaro E. Chavarria (University of Washington)



Dark Matter today



CIPANP2025

Hugh Lippincott, UCSB

Topics:

- Direct detection (18).
- Indirect detection (2).
- Astronomy (1).
- Grand theory (1).

- Several tons LXe targets.
- Now at background rates of 15 events/ kev/ton/year (XENONnT).
- ► A million (10⁶) improvement in sensitivity in 25 years.



Liquid Noble TPCs



H. Lippincott







Liquid Argon



► Undergoing unita m.









► First data in 2028.







Low threshold.



Scintillating Bubble Chamber (SBC)





- Introduce Xerin April p to 4%.
- Xe scintillation and electroluminescence properties.
- Higher S2 gain observed.
- Insensitive to β/γ .
 - Scintillation vetoes high-E NR.

Neutrinos with Noble Liquid DM detectors

XENONnT detects ⁸B v via CEvNS!



ersität ster D. Wenz

Neutron ER	PRL 133, 191002 (202	24)	
Component	Expectation	Best-fit	
Total background	$26.4^{+1.4}_{-1.3}$	26.3 ± 1.4	
⁸ B	$11.9^{+4.5}_{-4.2}$	$10.7^{+3.7}_{-4.2}$	
Observed		37).6 0.8
004[11]		Zumme or c	JDT score
Measured ⁸ B flux: <u>4</u> 7/ <u>h</u> ³ versit 0 ⁶ cm ⁻² s ⁻¹ Münster		2 Discovery significance of 2.73 σ in blind analysis!	
		1 (3.22 σ without S2 shadow inference dimensi	

- First observation of solar neutrinos via CEvNS!
- First observation of CEvNS in xenon!



$0\nu\beta\beta$ prospects with XLZD

- Future >50 ton *natural* LXe TPC for DM and other physics.
- Joint between XENON and LZ Collaborations.
- ► Will have >5 ton of ¹³⁶Xe.
- Search for energy peak at $Q_{\beta\beta}$.

C. Amarasinghe





DAMIC-M P. Privitera









- 2025.

Two prototype DAMIC-M CCD modules at Modane Underground Lab.

1.3 kg-day exposure, significant improvement in single e rate.

Results exclude benchmark hidden-sector models for sub-GeV DM. Freeze-in models strongly constrained.

Deployment of 26 modules in large detector scheduled by the end of





Other CCD efforts

NR ionization efficiency



- Previous measurement by Chavarria et al. confirmed.
- Relevant for WIMP searches and CEvNS.

NR/ER discrimination in CCDs

By spatial correlation with defects.

B. Cervantes Dark BeaTS

- 100-gram skipper-CCD multi-layer detector to search for millicharged particles from NuMI beam at Fermilab.
- Coincidences between hits in multiple layers.
- Commissioning started in February.
- Similar detectors deployed at other sites (e.g., Moskita at LHC).

Vijay Azad





Directionality



Single-photon Fluorescence from Trans-Stilbene crystals read out by skipper CCDs



- Directionality and particle ID for keV-scale NR. Anisotropic response of the crystal results in daily modulation (10s of %) of sub-GeV Allows to separate DM from v signals into the v fog. DM signal.
- ML to identify molecules with the best response.

Low-pressure gas TPCs D. Loomba



- Proposal for 1000 m³ He detector to look for 10 GeV WIMPs.







- Migdal effect provides ionization detectors with sensitivity to very low energy nuclear recoils (and low-mass DM).
- The process has not been observed at these low energies.

Measurement of the Migdal effect in CF₄ with an optical TPC D. Loomba



- Optical TPC with 3D reconstruction performing well.
- Two science runs acquired (problems with DD gun).
- Third science run to start.



Lower mass particle DM



T. Trickle

Axions



v > 300 MHz

Proposal: Sikivie (1983)



Indirect detection with IceCube



M. Nisa

 IceCube has searched for neutrinos from different possible DM sources: Sun, Earth, Dwarf Galaxies, Galactic Center. No signal yet.

Sensitivity to neutrino signals from GeV to PeV.
Uniquely sensitive to neutrino annihilation channel.
Deployment of seven additional strings for upgrade will improve sensitivity.

Sensitivity to spin-dependent scattering looks very



More interesting ideas!

- Sensitivity of nuclear clocks to hidden-sector dark matter through time variation of α_{EM} .
- quadrupole moment of the Sun (helioseismology vs. inner solar system probes)?



Is there evidence for a dark disk around the sun from different measurements of the gravitational

