Solar WIMP Search with the IceCube Neutrino Observatory

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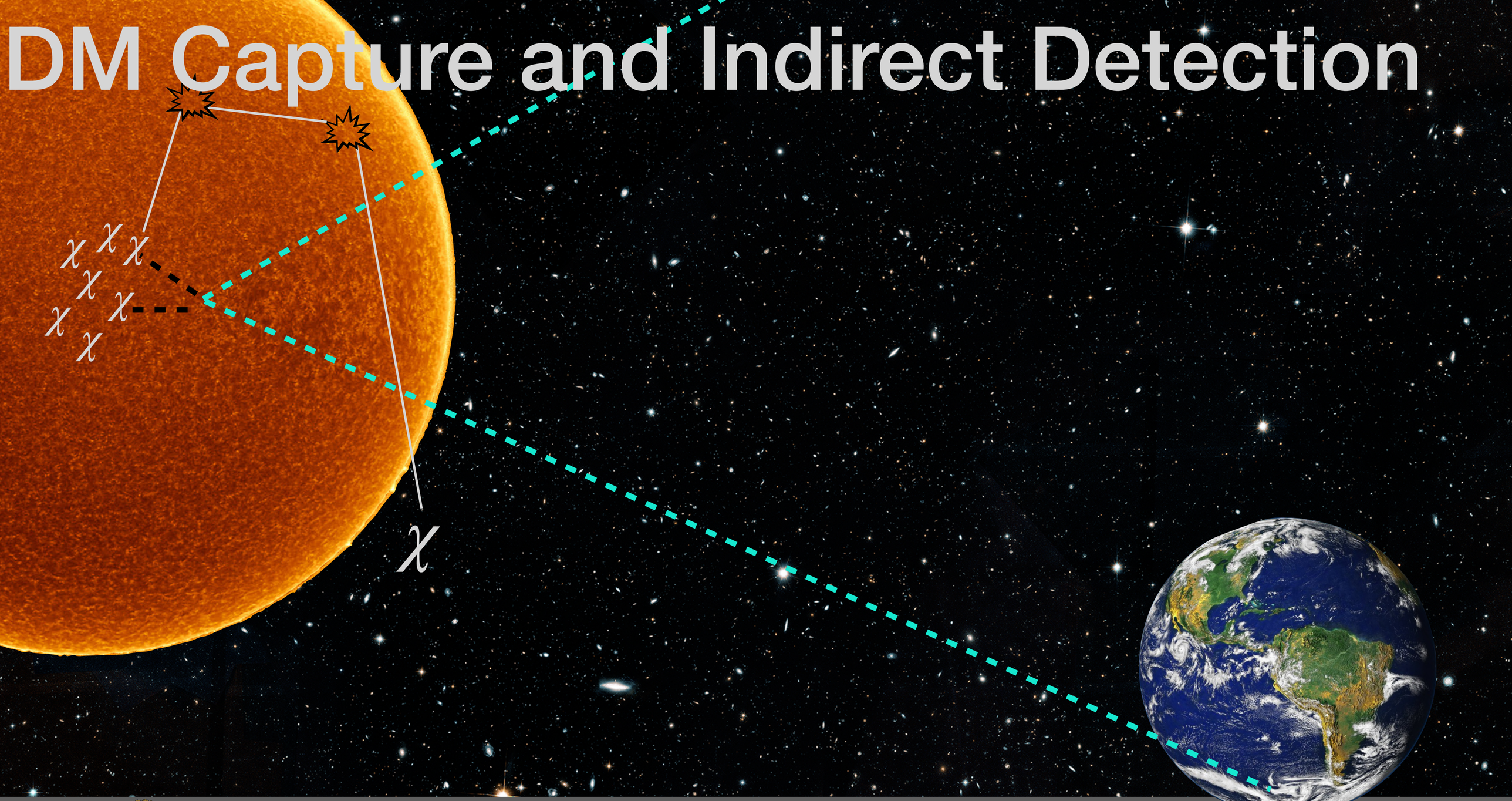
Beyond Standard Model: From Theory to Experiment

Zewail City of Science and Technology

Outline

- Background
- χaroν software
- Current analysis

DM Capture and Indirect Detection



Two Ways to Measure $\sigma_{N\chi}$

Annihilation rate

$$\dot{N} = C_C - C_A N^2 - C_E N$$

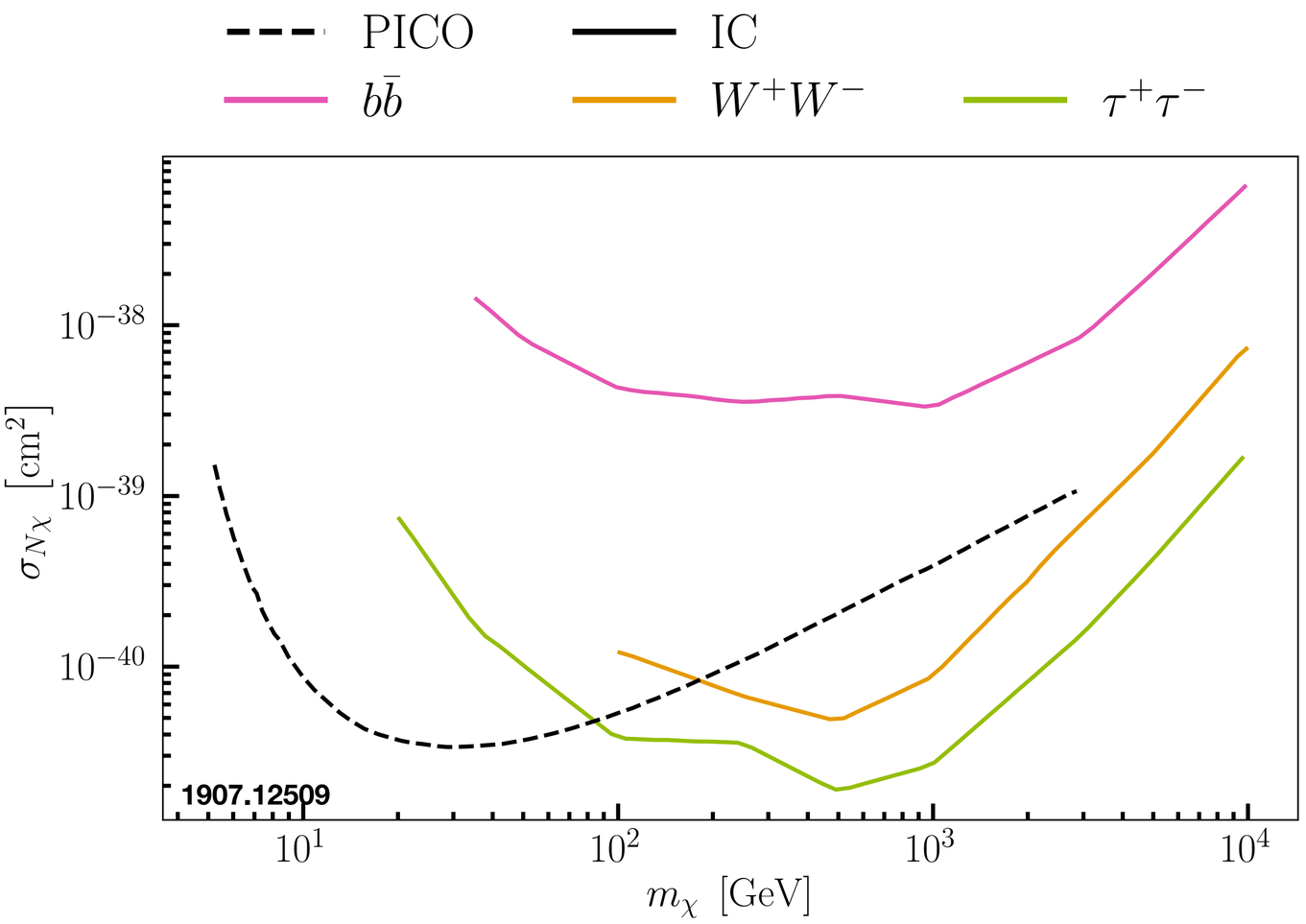
($\dot{N} = 0$; $C_E N = 0$)

Capture rate: Proportional to $\sigma_{\chi N}$

Annihilation rate: Sets rate of WIMP conversion to neutrinos

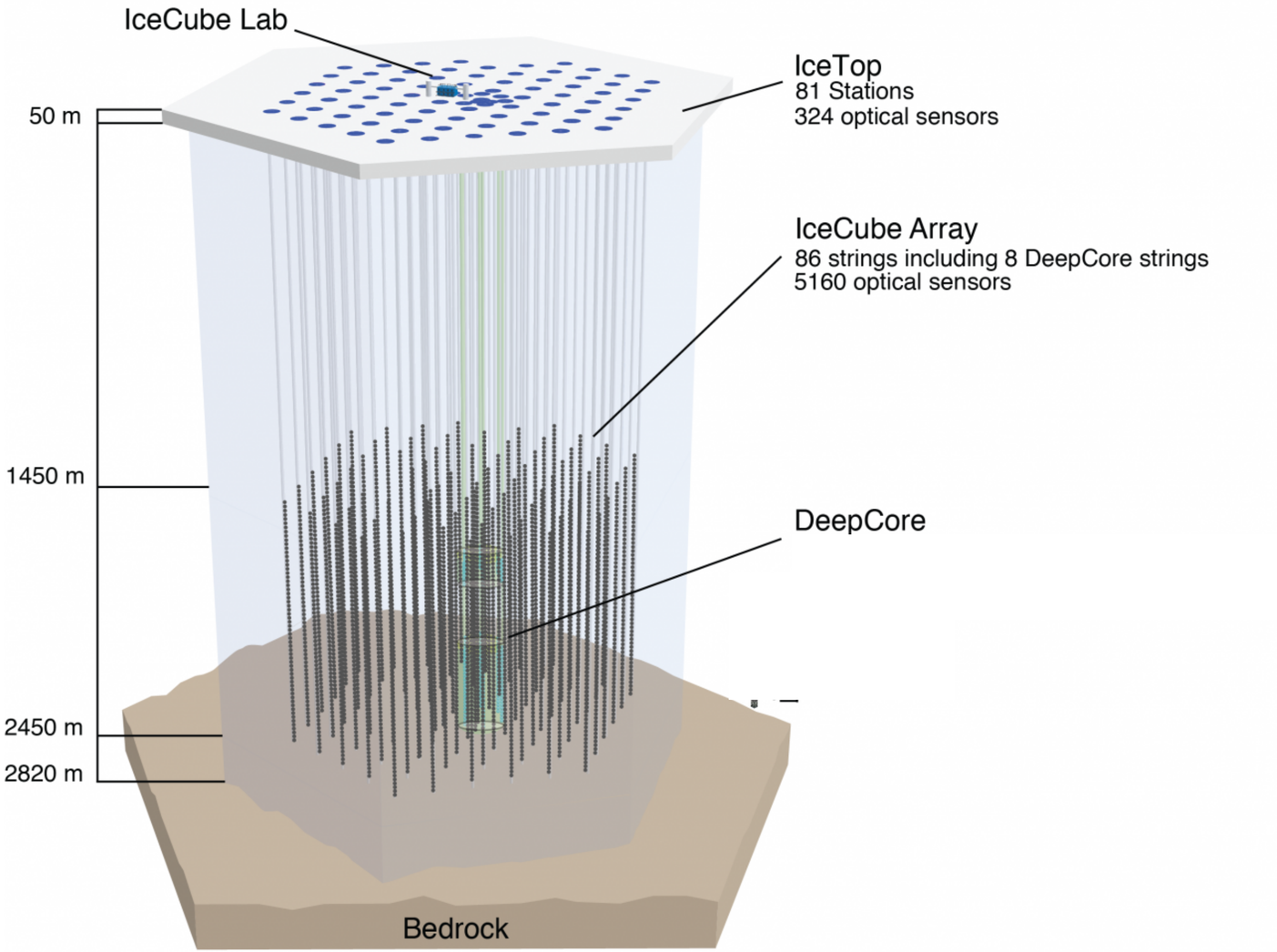
Evaporation rate: Negligible for WIMP masses above a few GeV

$$\Longrightarrow \frac{\Gamma_A}{2} = C_C \propto \sigma_{\chi N}$$



Current limits on WIMP-nucleon cross section from IceCube and PICO

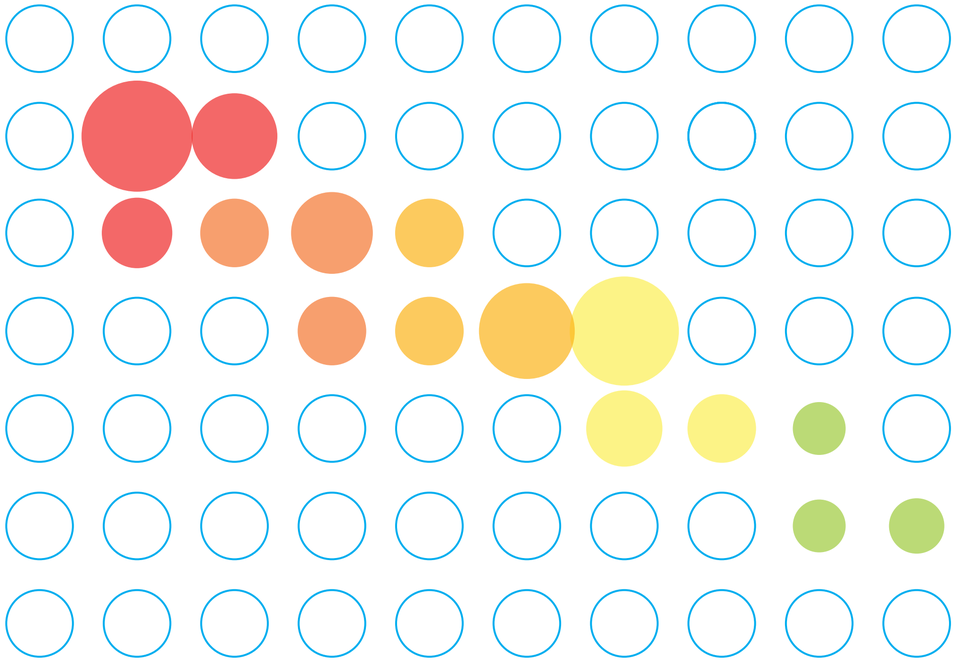
The IceCube Neutrino Observatory



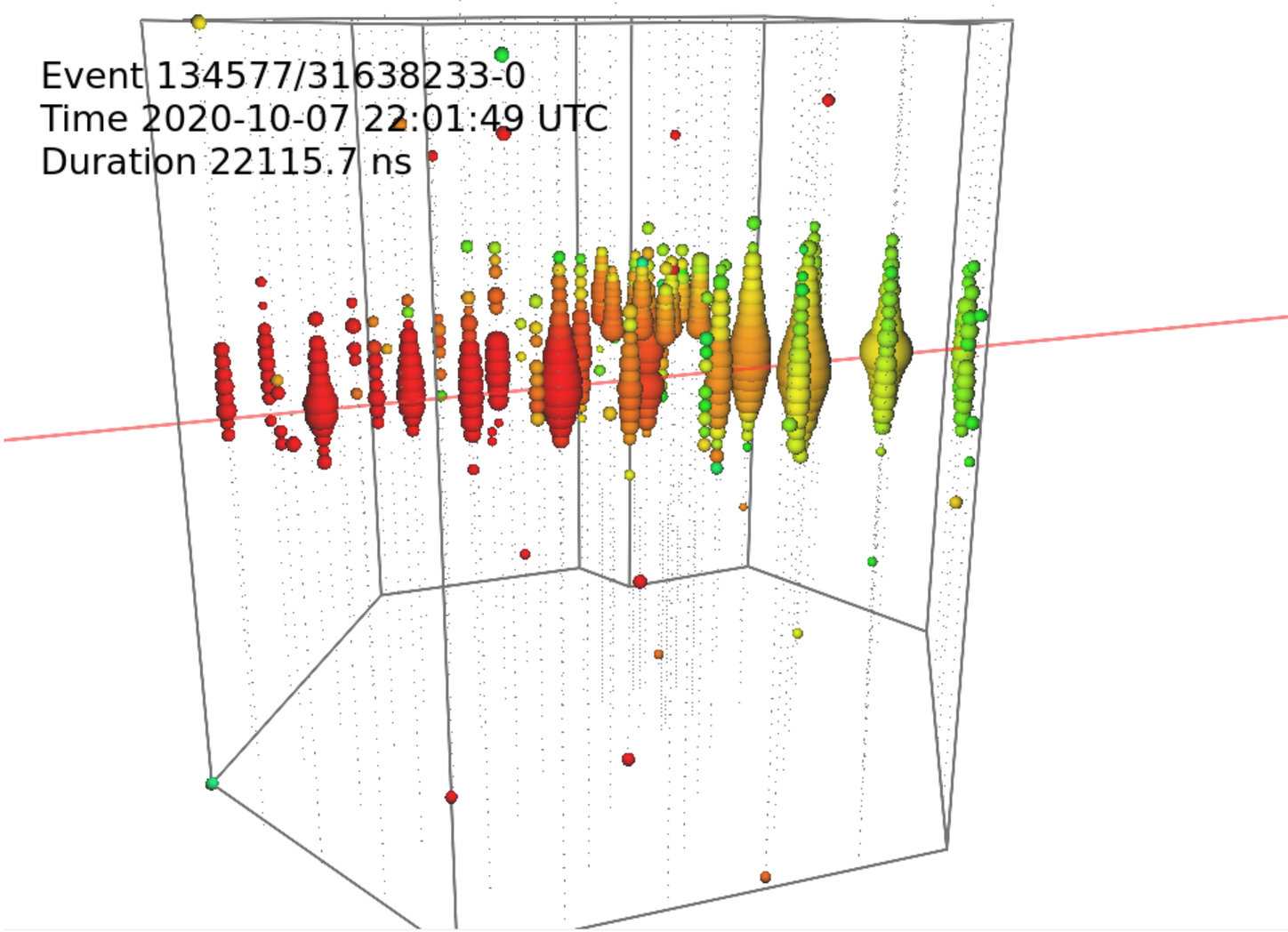
- 1 km^3 instrumented ice at the geographic south pole
- Digital optical module (DOM) detects light created by charged byproducts of neutrino interaction

Event Morphologies

Track



ν_μ CC



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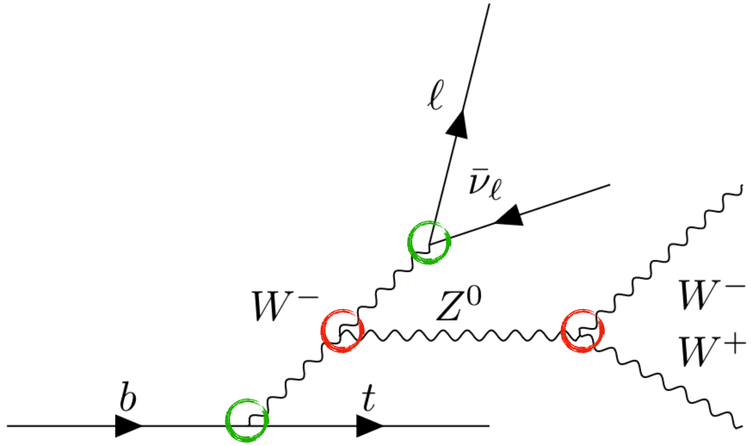
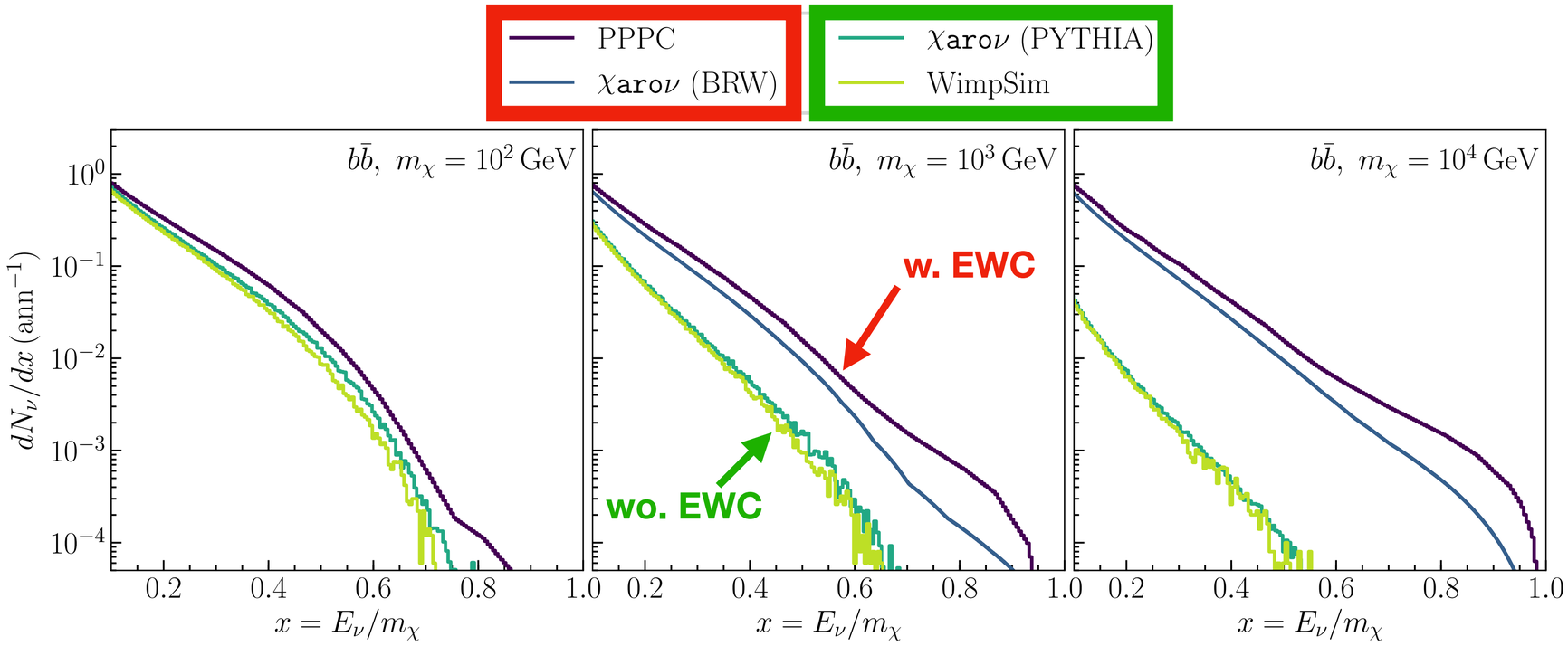
χaroν

Source code

- Software package for calculating neutrino yields from DM annihilation/decay. arXiv:2007:15010
- Couples PYTHIA8 to an updated calculation of EW correction (BRW calculation). arXiv:2007:15001





Flux Generator Comparison

	Generation	EW corrections	Secluded DM	Long-lived particle stopped decay	Locations	Flux production	Propagation
WimpSim	**PYTHIA 6.4**	✗	✓	✗	**Earth, Sun**	Read files or run Fortran scripts	Read files or run Fortran scripts with oscillation parameters
PPPC	**PYTHIA 8.1 (+ GEANT4)**	✓	✗	✓	**Galactic Halo, Sun**	Read table in Mathematica	Read table in Mathematica
Charon wo/ BRW	**PYTHIA 8.2**	✗	✓	✓	**Galactic Halo, Sun, Earth or custom environment**	Read table or run C++ script	Flexible propagation with nuSQuIDs by allowing
Charon w/ BRW	**DGLAP + PYTHIA 8.2**	✓	✗	✗	**Galactic Halo, Sun, Earth**	Read table	options of input fluxes, oscillation parameters, xsec…

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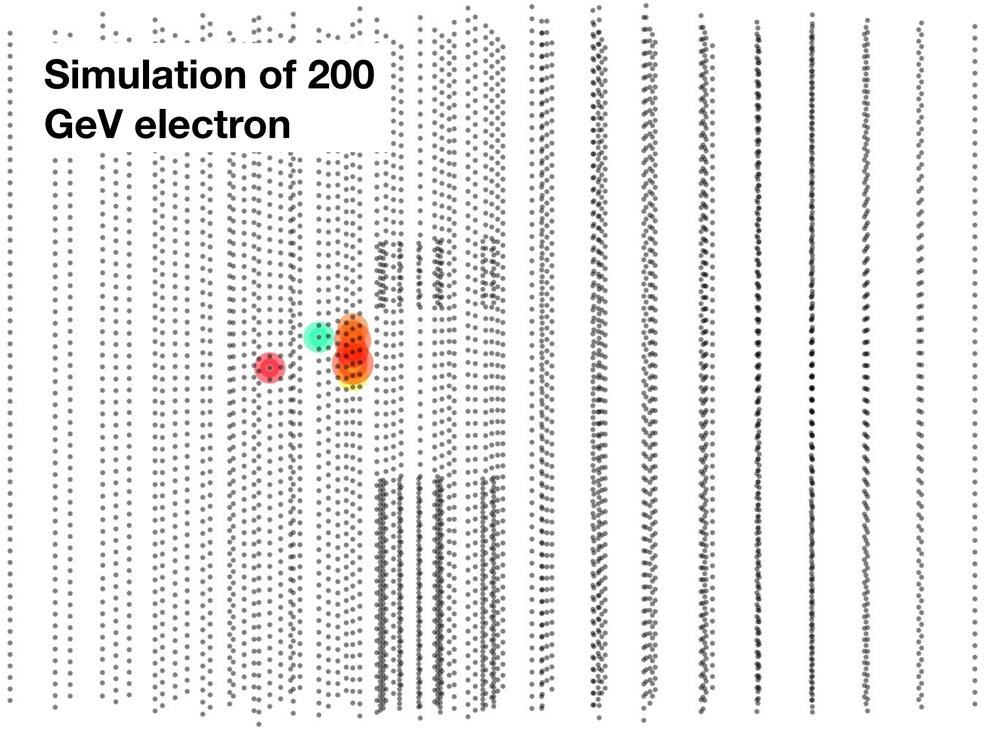
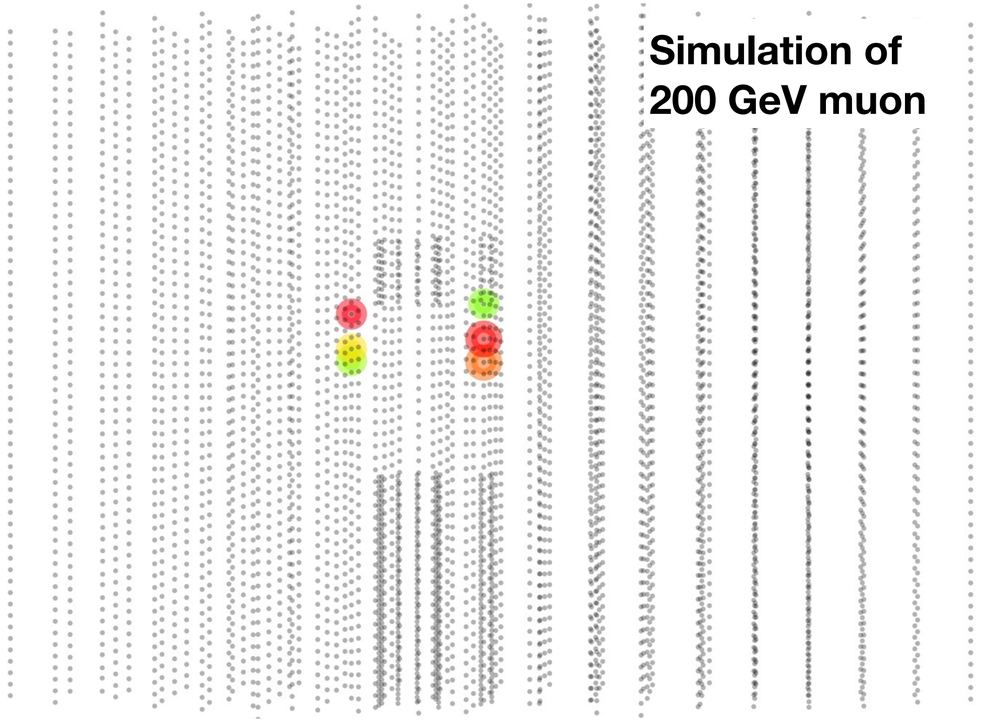
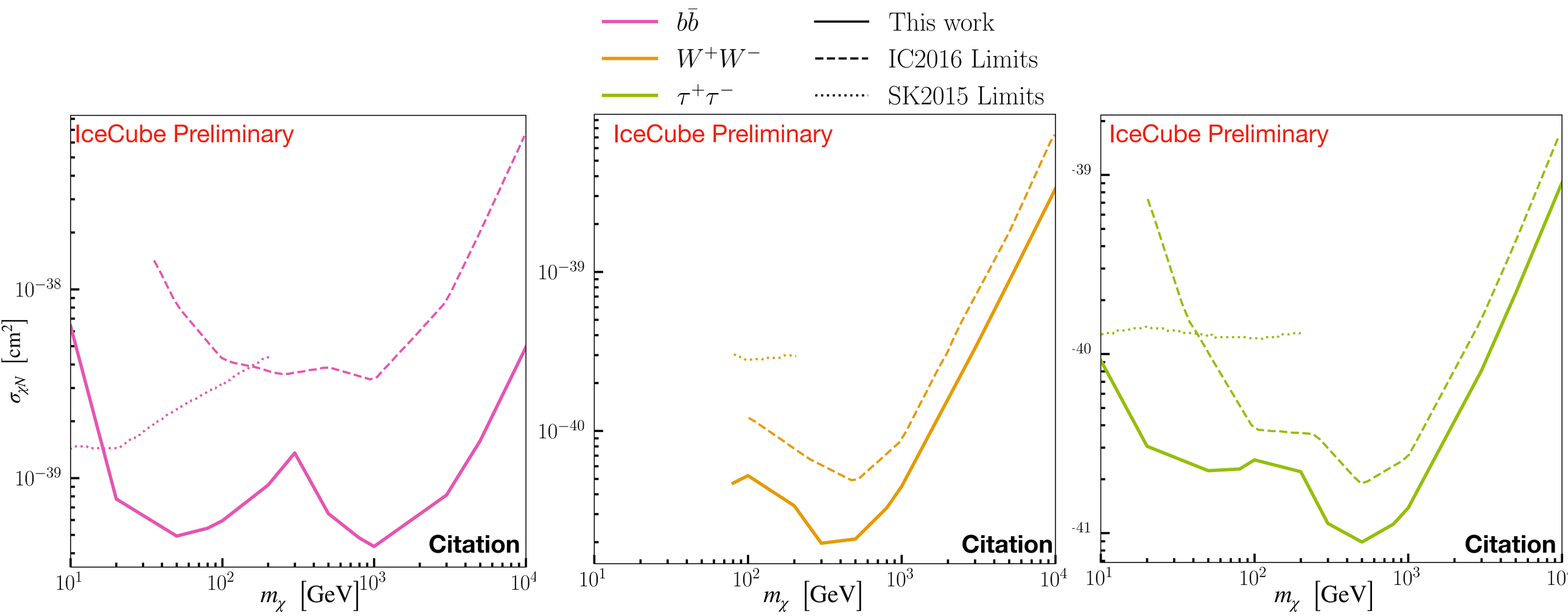
Improved All-Energy Analysis

- IceCube + DeepCore to cover WIMP mass range from 10 GeV to 10 TeV
- Directional reconstruction challenging at lower-energies
- Cascade backgrounds 10x lower—> Include all flavors in analysis
- Developing new event selection to target SUSY WIMP region of interest

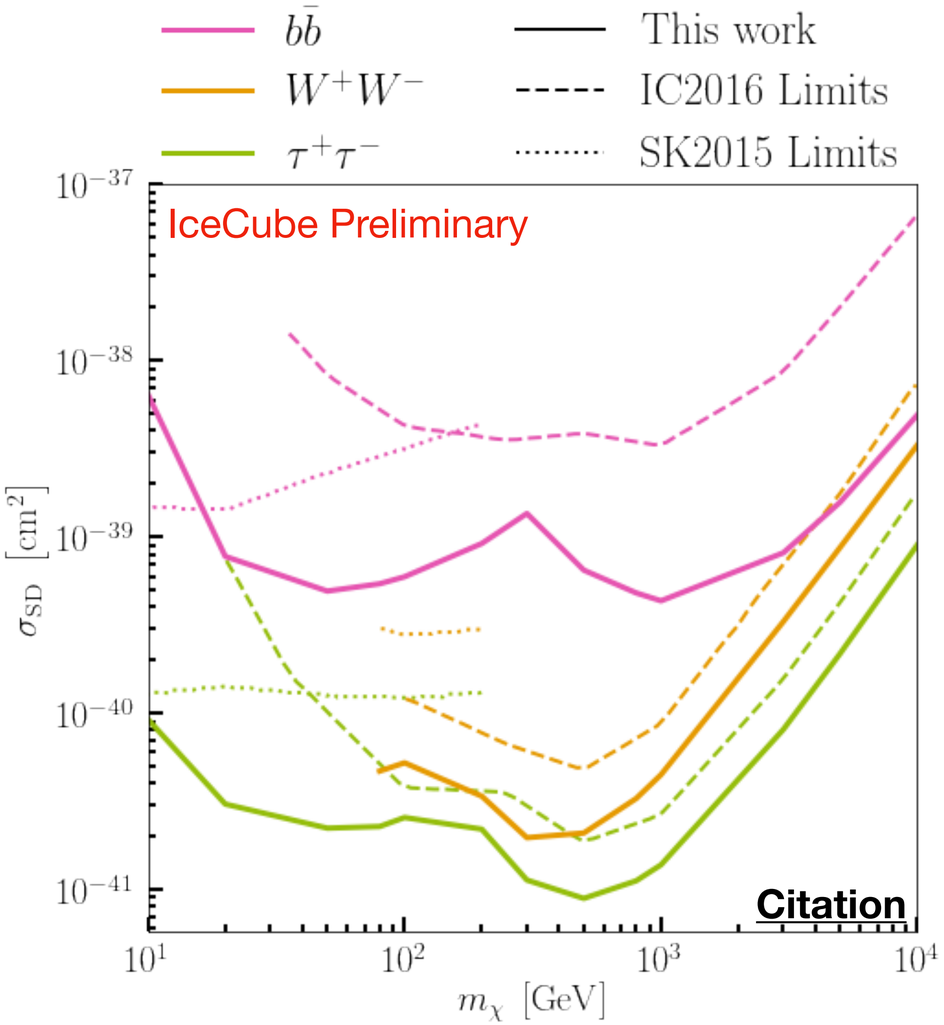




Ten Years IC+DeepCore Sensitivity



Status and Outlook



- World-leading sensitivities for almost entire range
- Currently working to further improve ~100 GeV range
- Stay tuned: results coming soon

Thank you to the Organizers

and thank you for listening

Question ??

Back Ups

Rough Comparison to DD