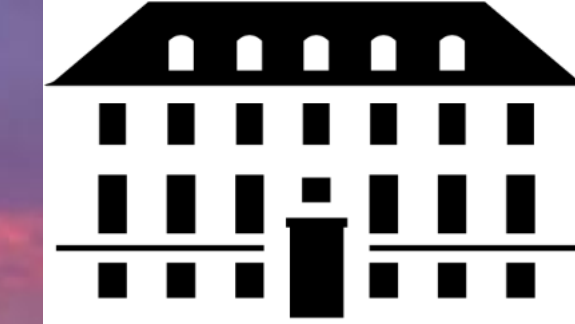


Talk @ NBIA Summer Schools on Neutrino: Here, There, Anywhere



The Niels Bohr
International Academy

Super-Kamiokande Strongly Constrains Leptophilic Dark Matter Capture in the Sun

Thong T.Q. Nguyen



Based on: 2501.14864 (submitted to PRL)

Super-Kamiokande Strongly Constrains Leptophilic Dark Matter Capture in the Sun

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The Sun can efficiently capture leptophilic dark matter that scatters with free electrons. If this dark matter subsequently annihilates into leptonic states, it can produce a detectable neutrino flux. Using 10 years of Super-Kamiokande observations, we set constraints on the dark-matter/electron scattering cross-section that exceed terrestrial direct detection searches by more than an order of magnitude for dark matter masses below 100 GeV, and reach cross-sections as low as $\sim 4 \times 10^{-41} \text{ cm}^{-2}$.



Tim Linden

Stockholm University



Pierluca Carenza

Stockholm U.



Axel Widmark

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(Marie Curie Fellow)

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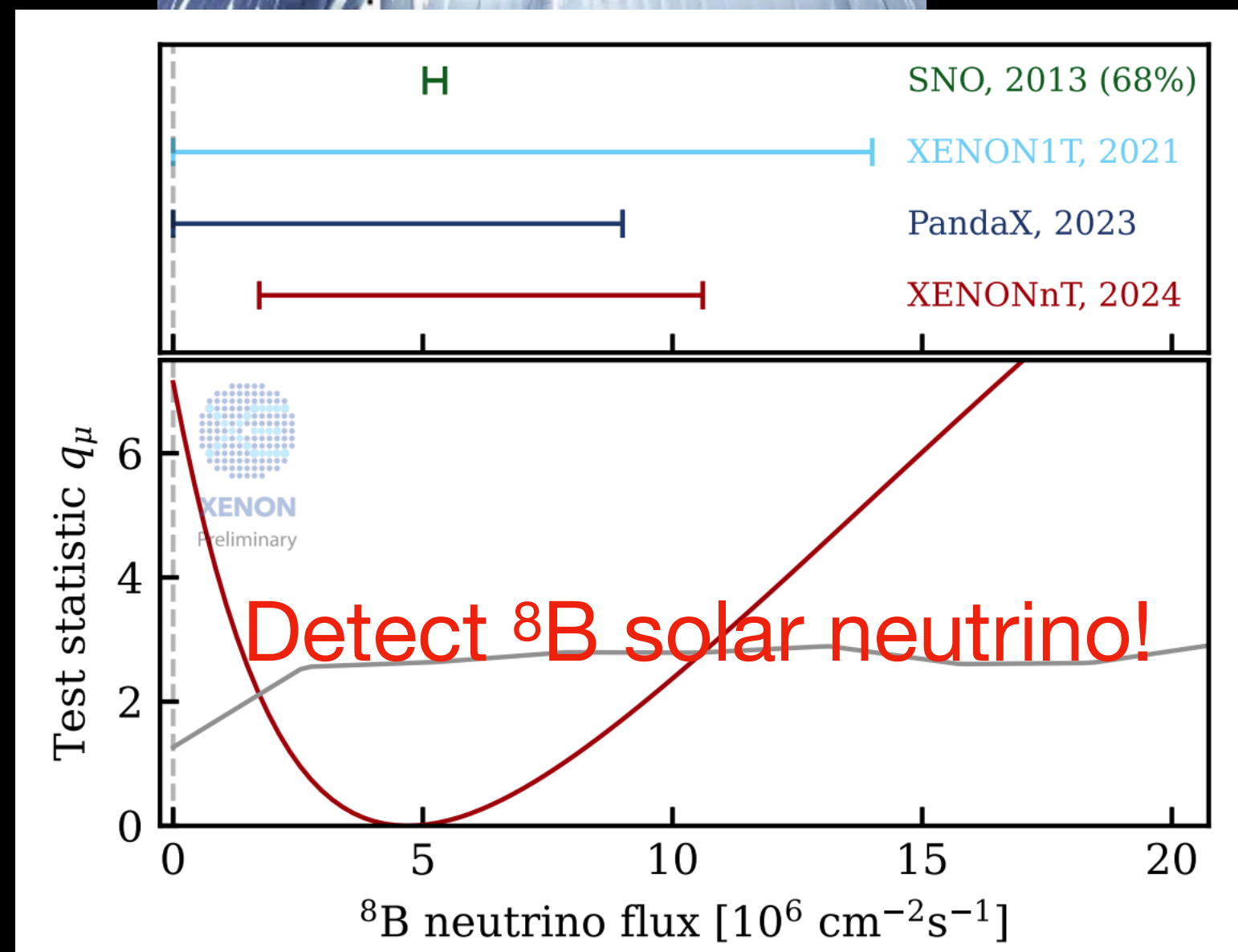
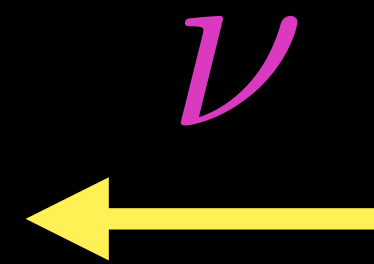
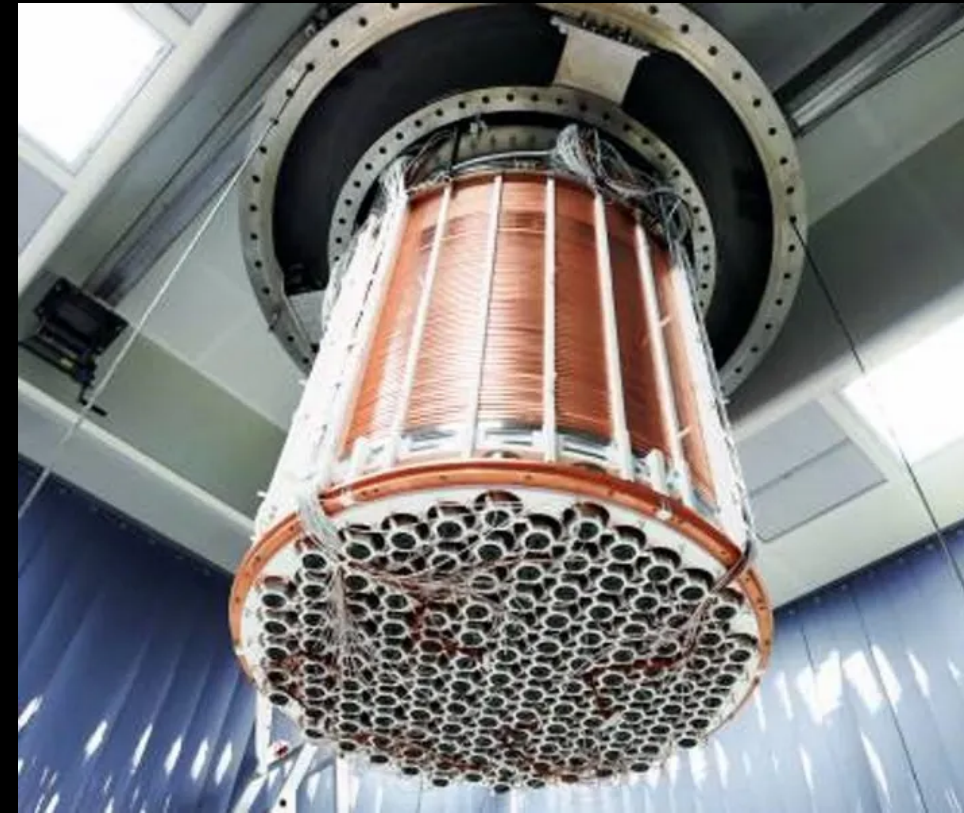
Dark Matter Detector = Neutrino Detector

Xenon1T vs Super-Kamiokande



Dark Matter Detector = Neutrino Detector

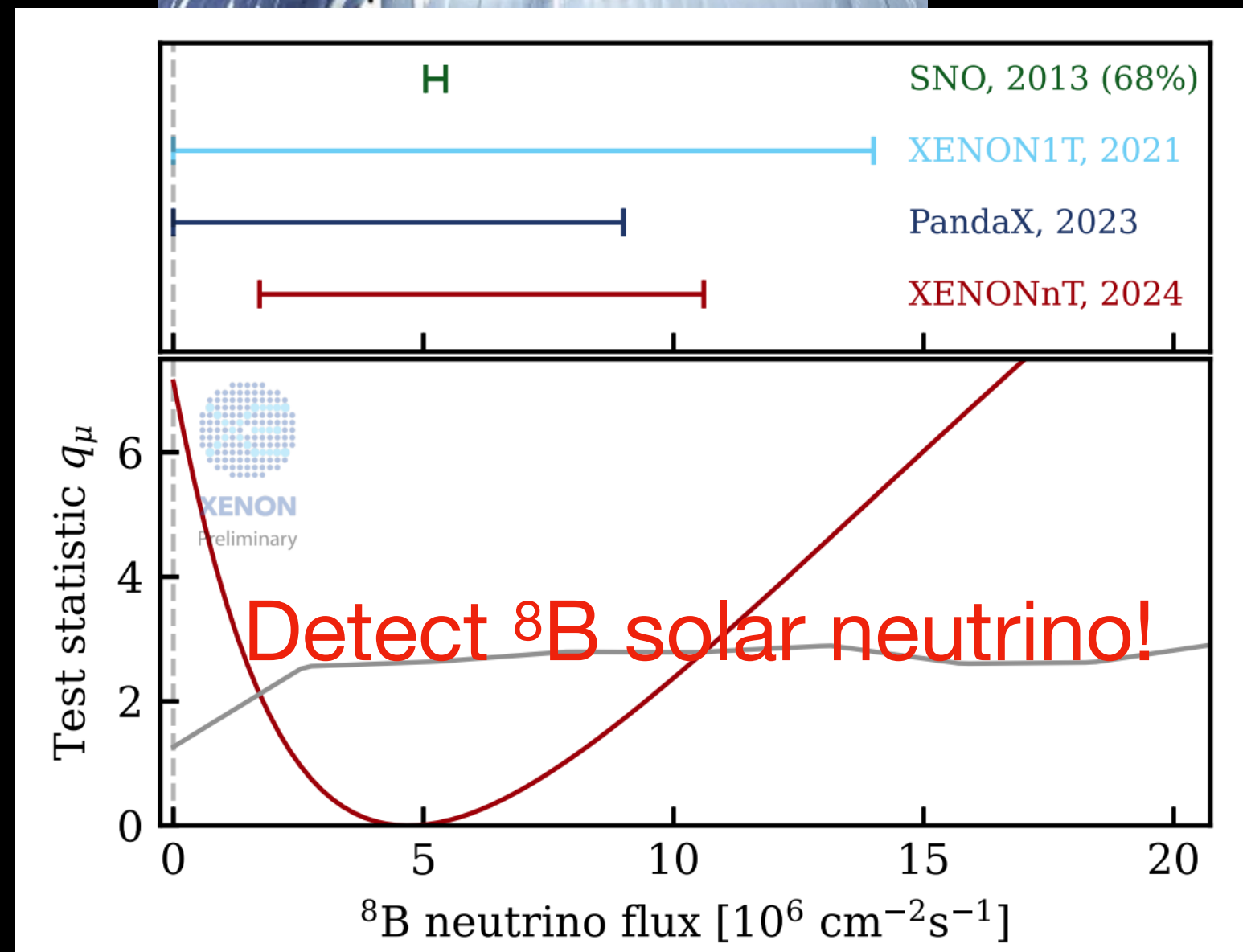
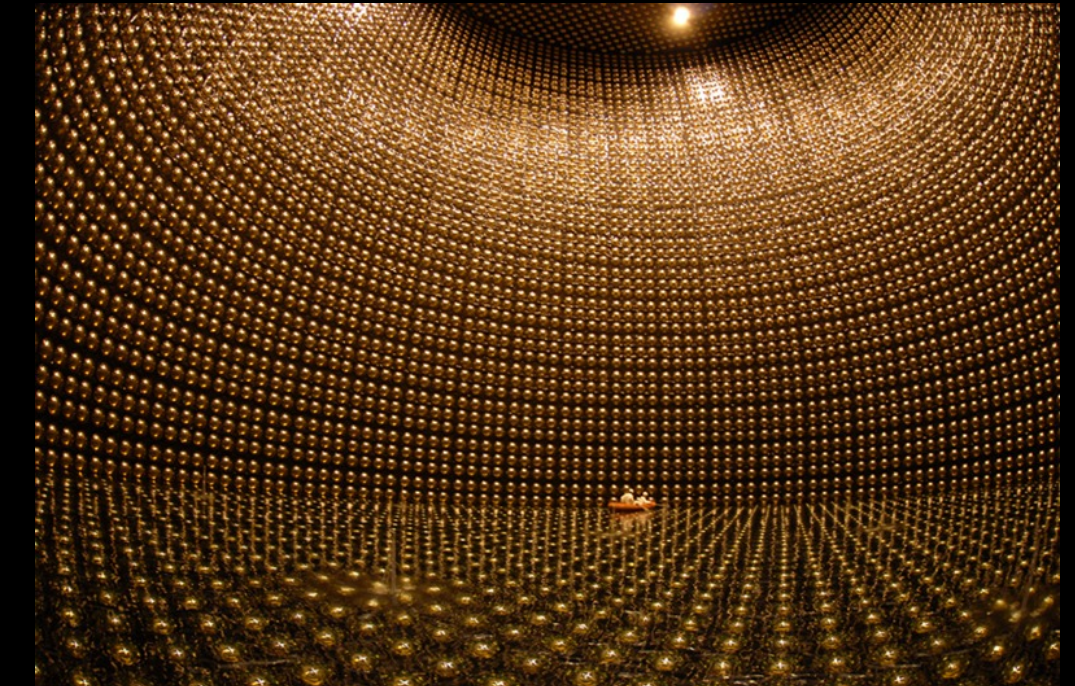
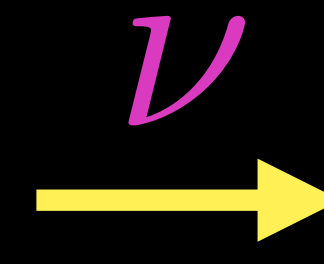
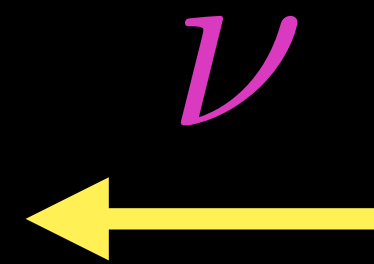
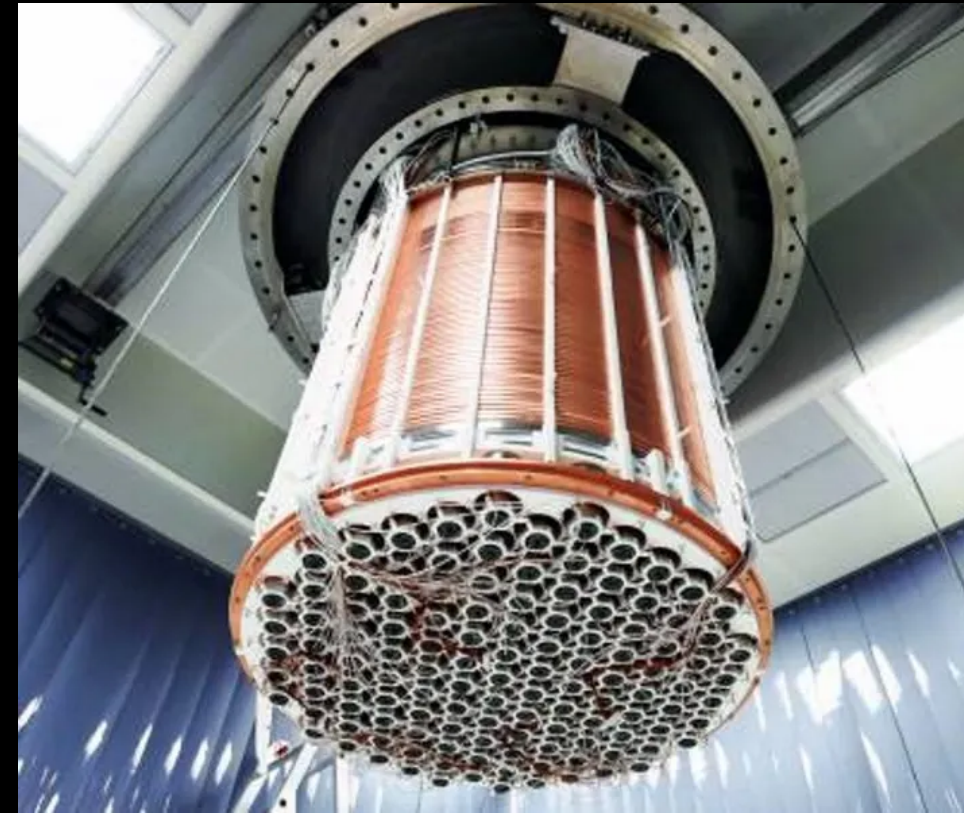
Xenon1T vs Super-Kamiokande



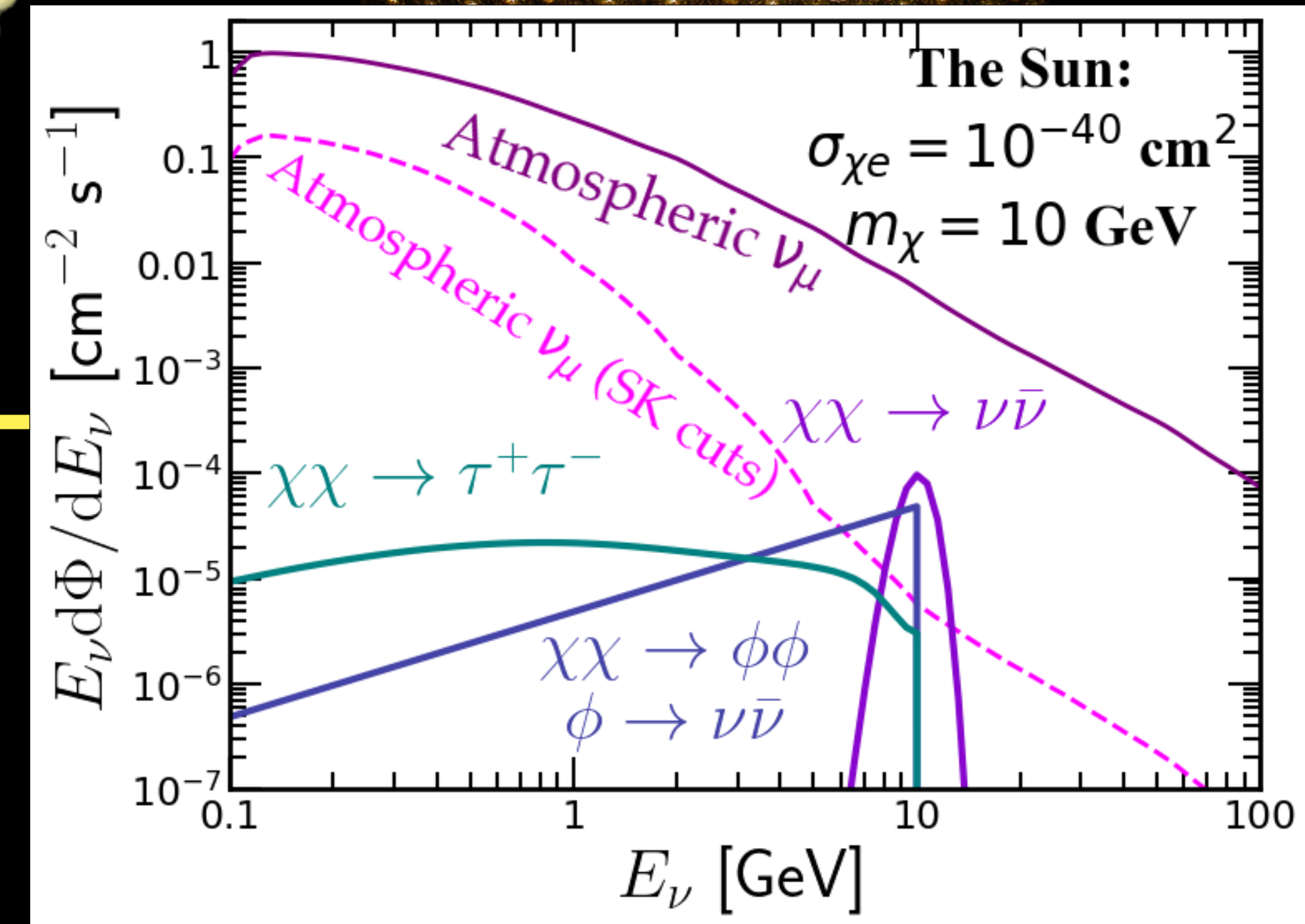
XENON collaboration, *PRL* 2024

Dark Matter Detector = Neutrino Detector

Xenon1T vs Super-Kamiokande



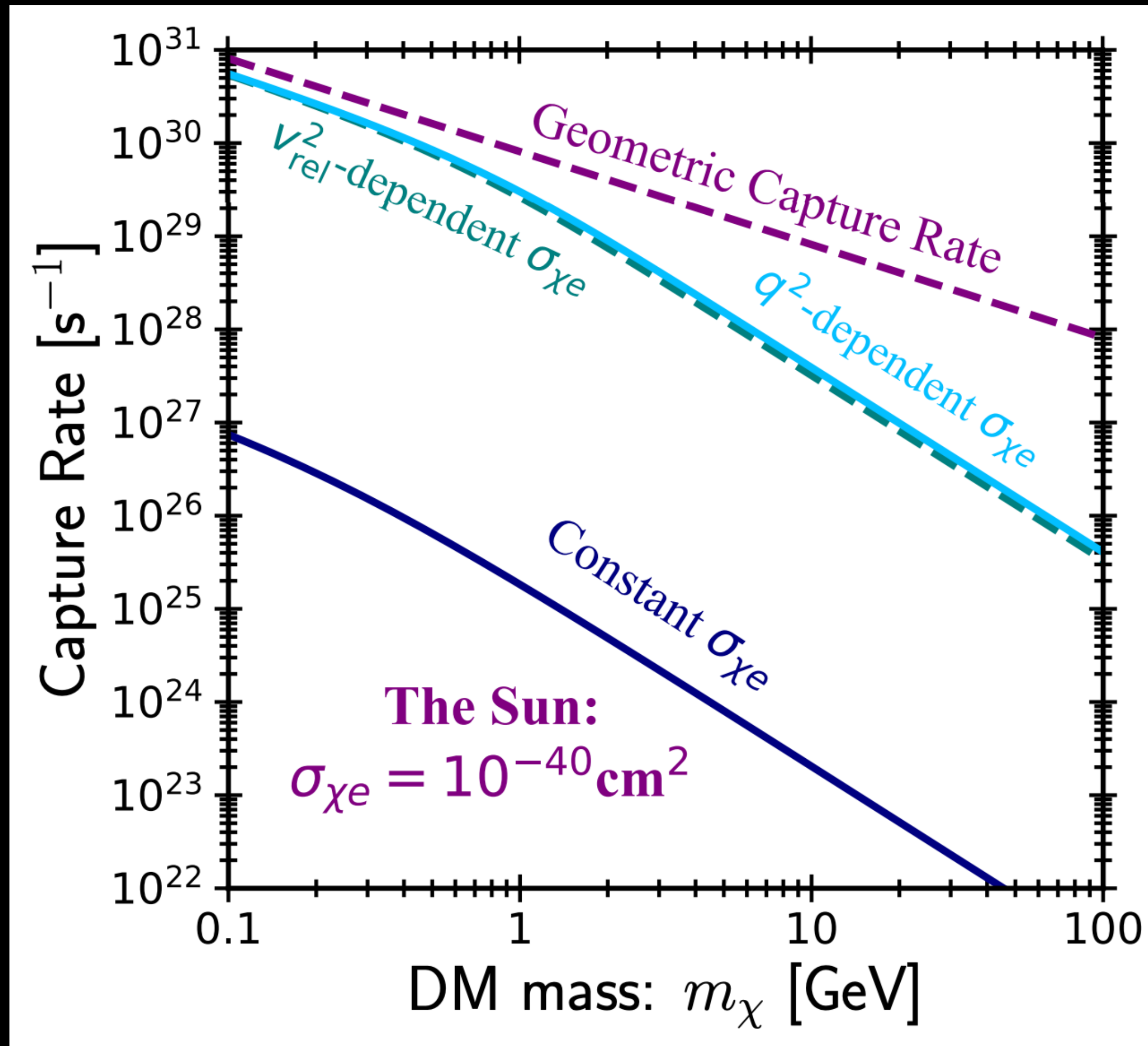
Super-K can
observe
neutrinos from
DM annihilation
inside the Sun!



XENON collaboration, *PRL* 2024

Leptophilic dark matter capture in the Sun

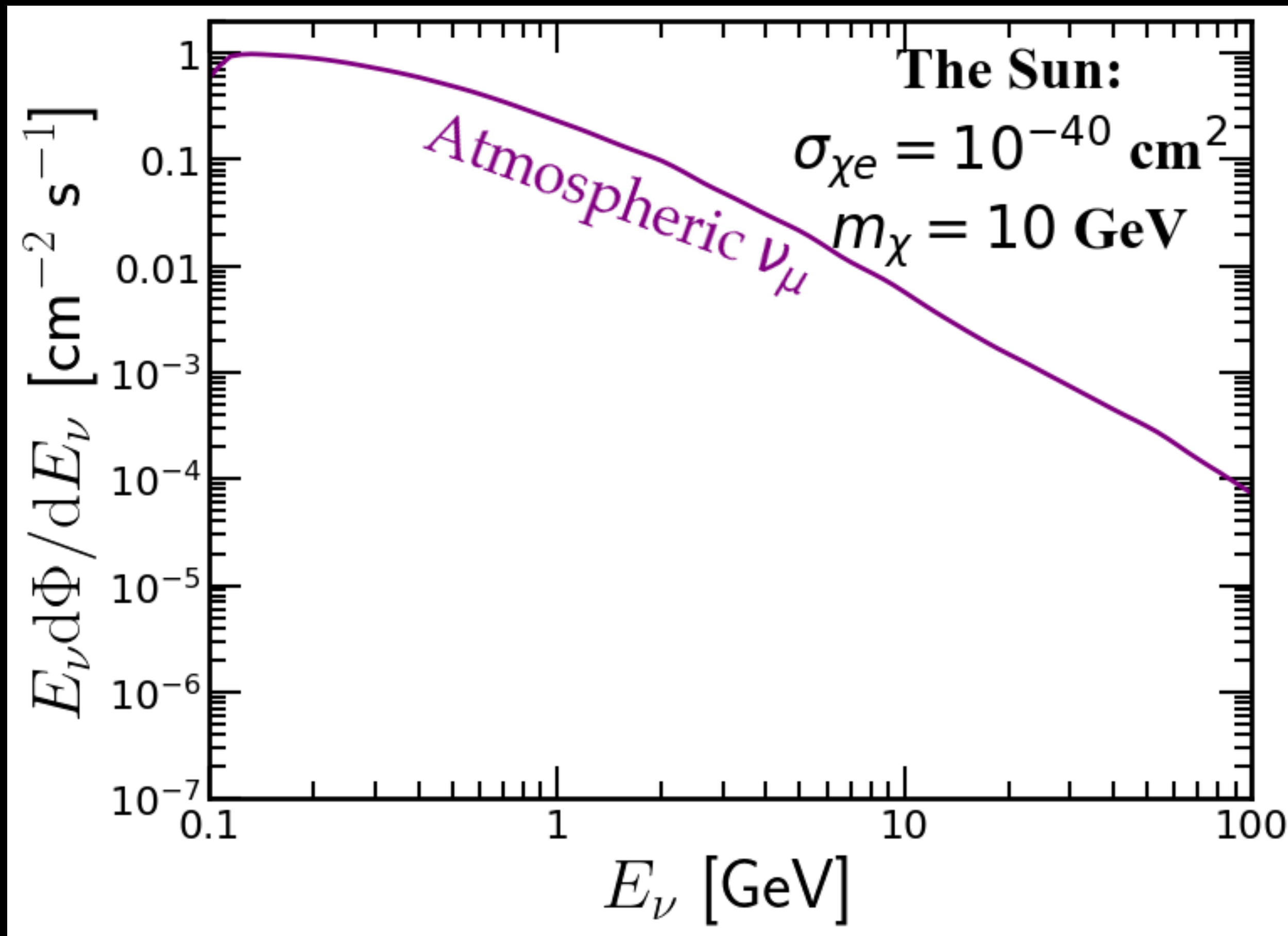
For constant, velocity, and momentum-dependent DM-electron cross sections



- Leptophilic DM scattering with electrons inside the Sun
- Loose Kinetic Energy.
- DM Velocity below Escaped Velocity!
- Being captured! Enhance the DM density inside the Sun

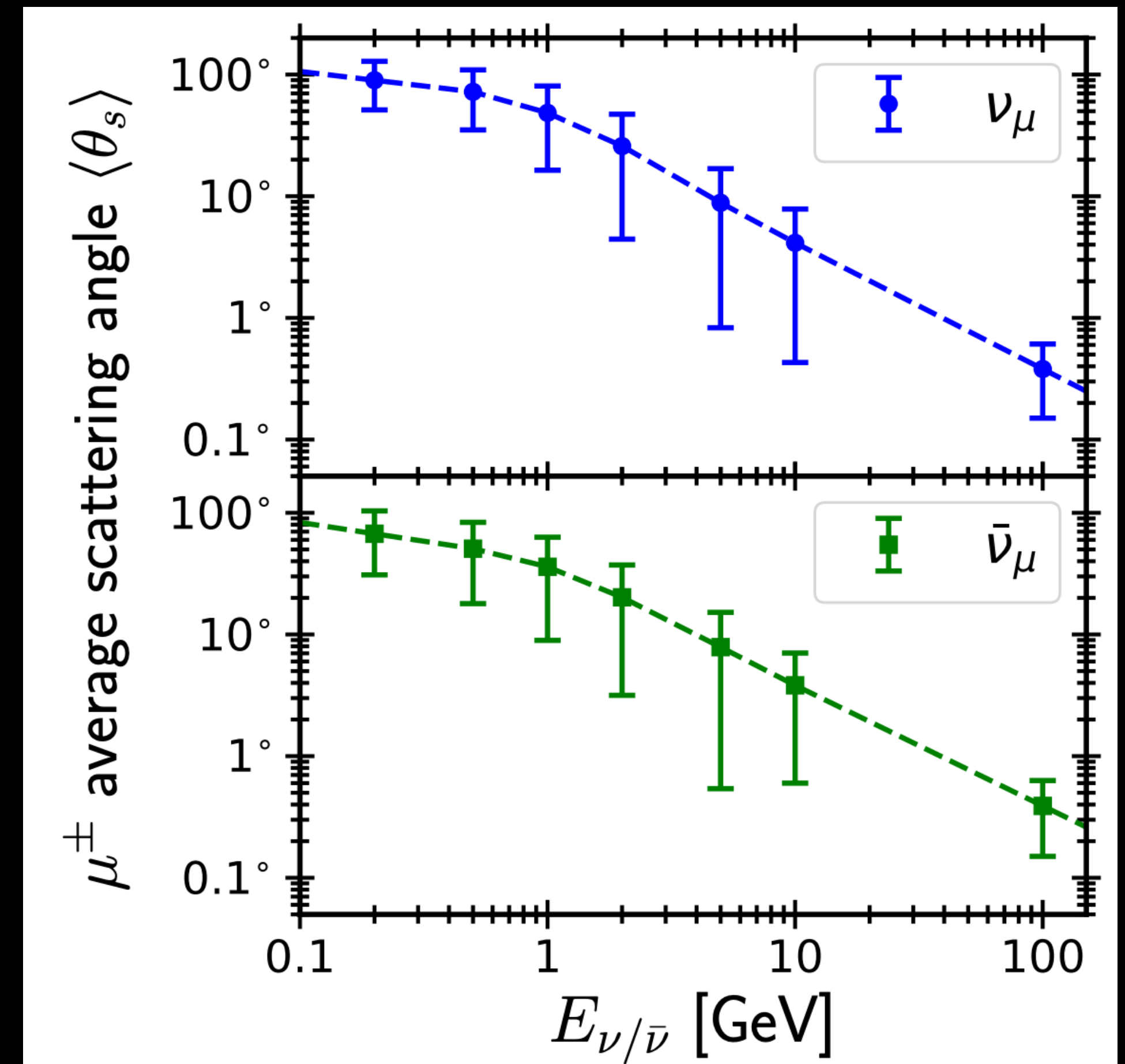
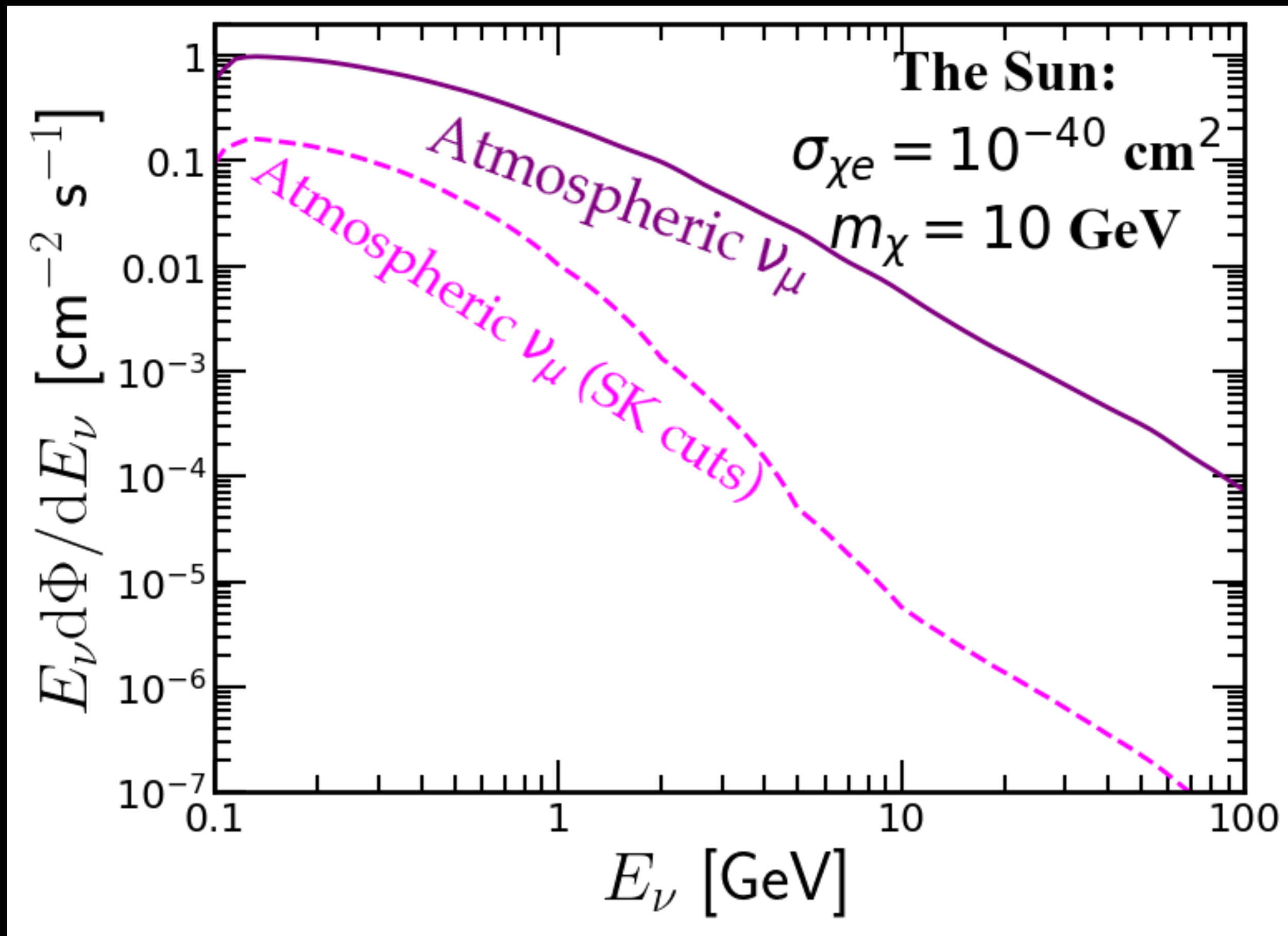
Reduce Atmospheric Neutrino Background

Using Super-K angular resolution



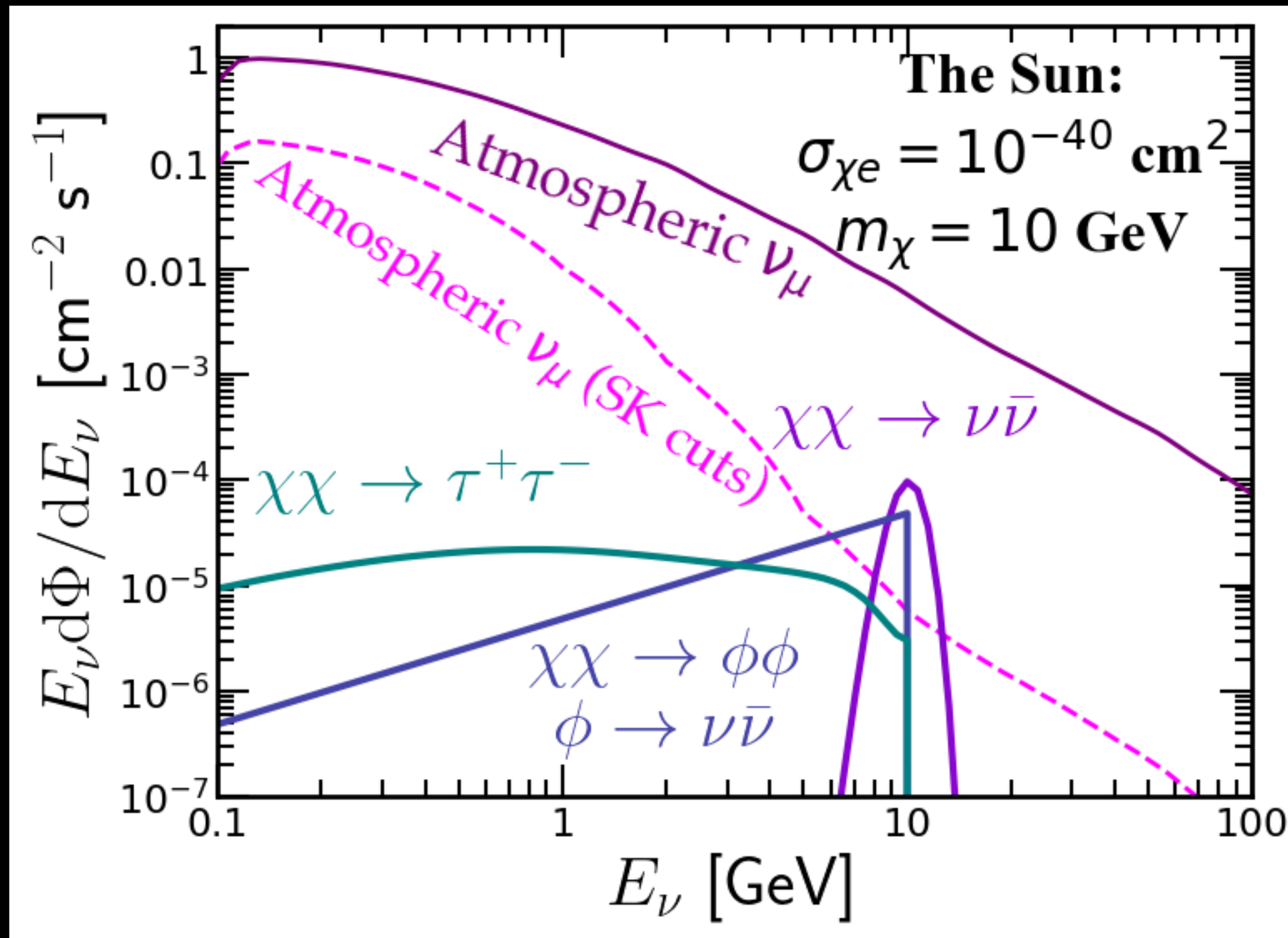
Reduce Atmospheric Neutrino Background

Using Super-K angular resolution



Neutrinos from leptophilic DM annihilation inside the Sun

Consider leptophilic annihilation channels

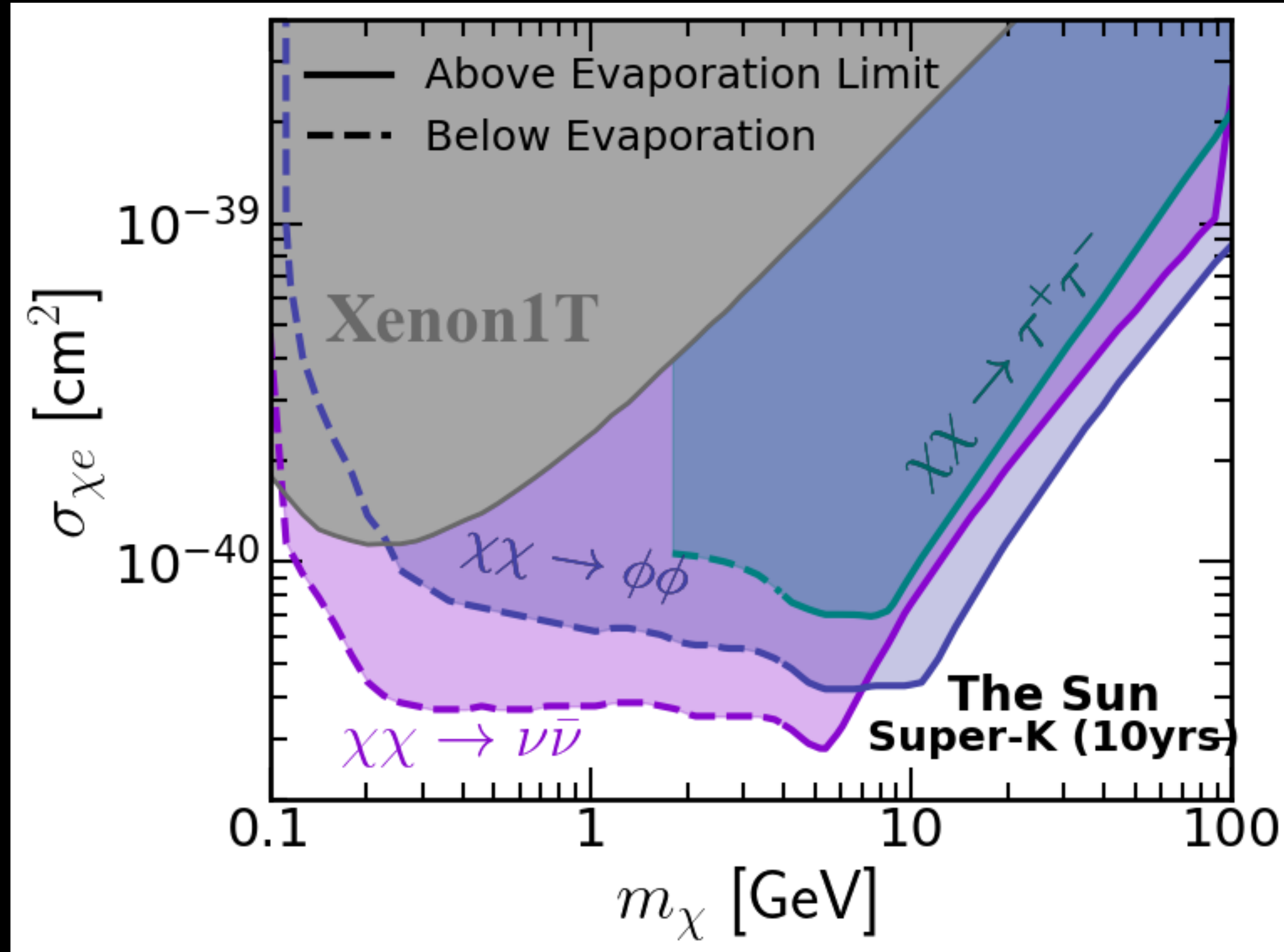


Tools to generate neutrino spectra inside the Sun:

- **PPPC4DMv**, Baratella et al. (1312.6408)
- **Xarov (Charon)**, Liu et al. (2007.15010)
- **DarkSUSY**, Bringmann et al. (1802.03399)

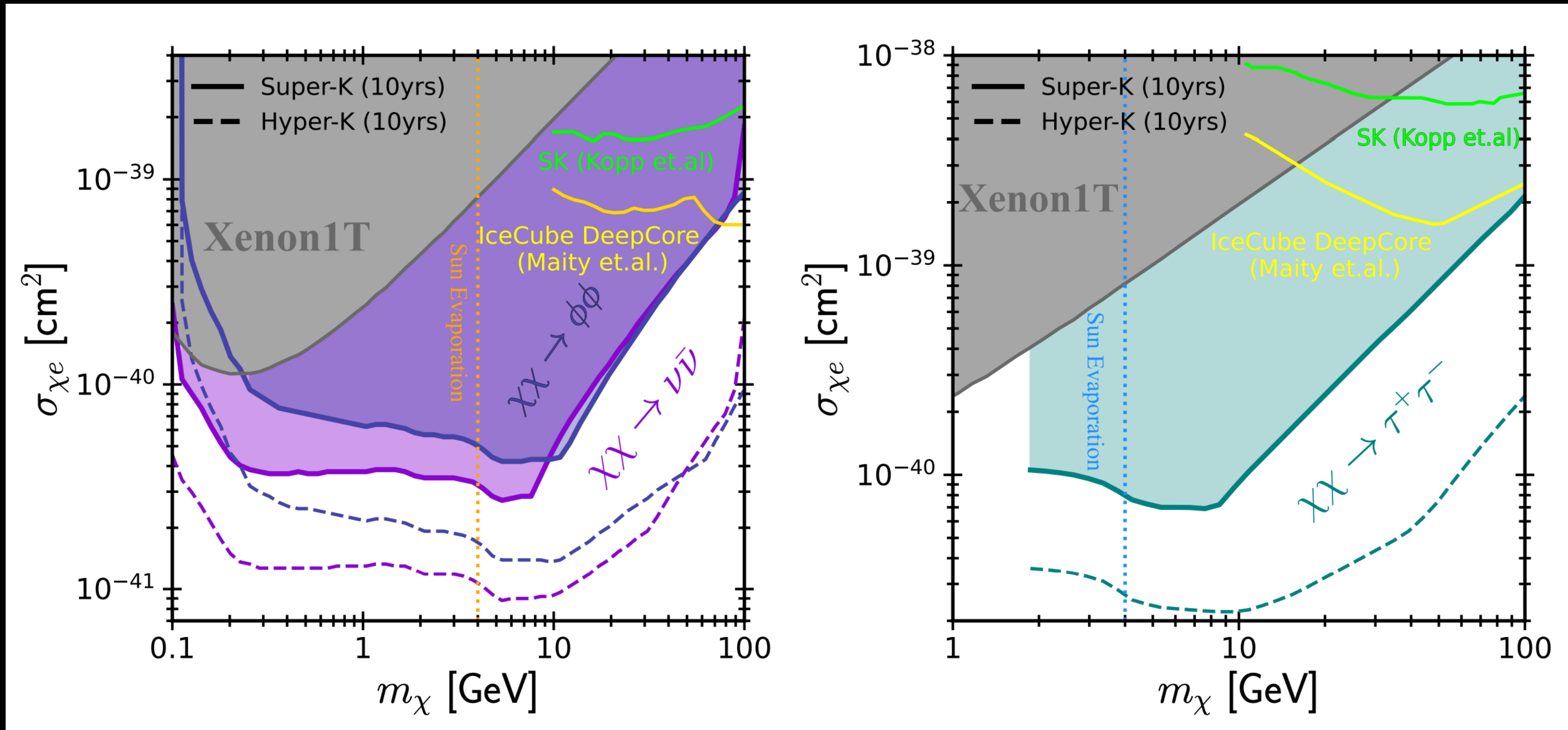
Constraints on Leptophilic Dark Matter

Using 10-year Super-K observation on atmospheric muon neutrino



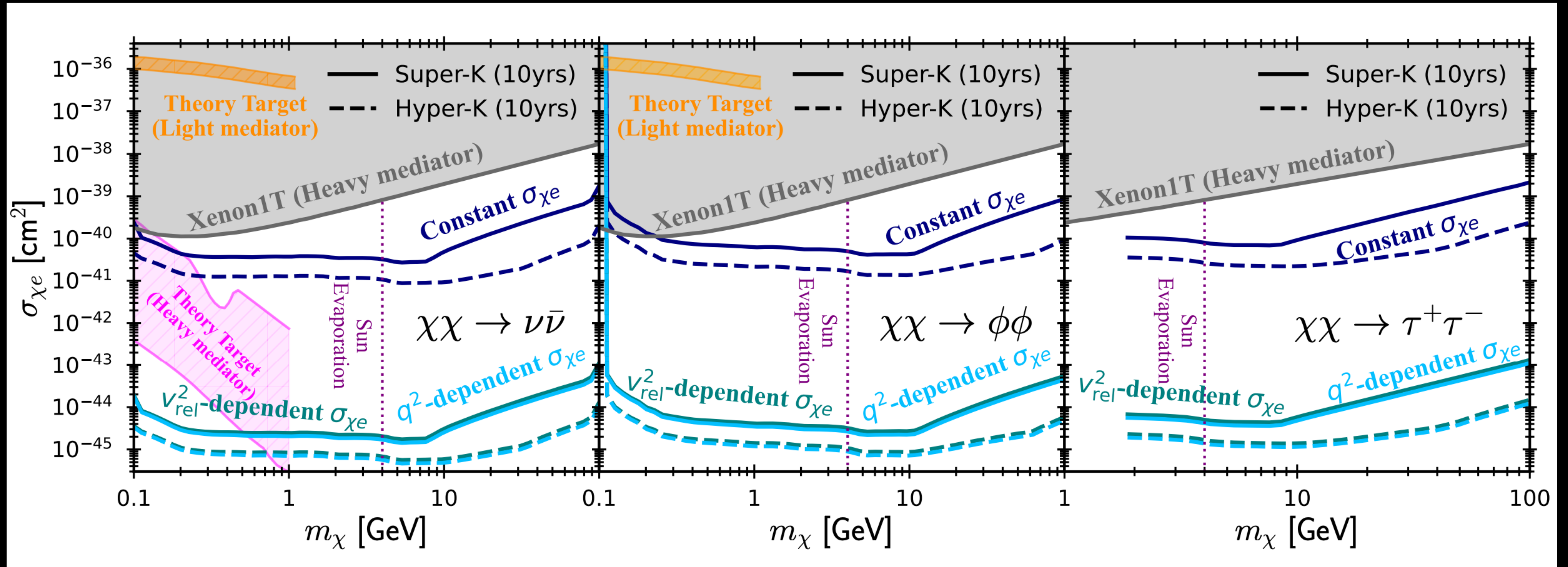
Constraints on Leptophilic Dark Matter

Projections for Hyper-K (10 years)



Constraints on Leptophilic Dark Matter

For constant, velocity and momentum-dependent cross section



Take home messages

- The Sun is an excellent target for detecting Dark Matter.
- Neutrino Detectors can be used as Dark Matter Detectors.
- Our results support the mission of neutrino detectors to look for DM and BSM physics!

Want to know more about searching for DM using Celestial Objects?

DD	GeV Scale	Sun		    Heating Signatures (Thermal Spectra)
	Asymmetric	Jupiter		  Thermal Transport (Seismology)
	Self-Interacting	S-Cluster		 Thermal Transport (Affect on Neutrino Flux)
	Light Mediator	G-Objects		   Thermal Transport (Cooling Curves)
				  Escaping Signals (DM Neutrinos)
no DD	<GeV Mass	GC Brown Dwarfs		    Escaping Signals (Cosmic Rays/ γ -Rays)
	>TeV Mass	GC White Dwarfs		    Structural Changes (Longer Lifespan of CBs)
	Spin-Dependent			    Structural Changes (Destruction of CBs)
	Inelastic			    Structural Changes (Spectral Changes)
	Velocity-Dependent	Dark Stars		    Structural Changes (Population Level)

Our team at SU is developing novel methods to search for DM using Celestial Objects!

Talk to me in this school, or reach out to me through this email:

thong.nguyen@fysik.su.se

Thank you for listening!

Chiao is searching
for Dog-matter
too!

