New measurements with high-energy neutrinos in IceCube

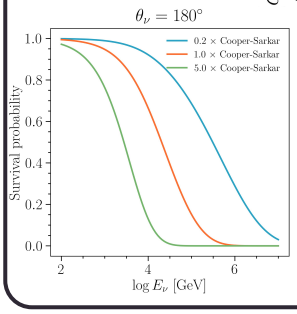
T. Yuan for the IceCube collaboration

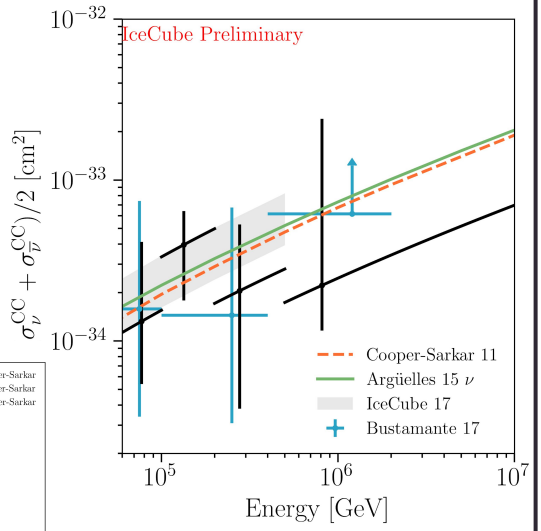
Significant contributions to this work have been made by the following people: C. Argüelles, H. Djumović, S. Mandalia, A. Schneider, J. Stachurska and N. Wandkowsky

High-energy cross section

Measured via in-Earth flux attenuation

- For charge-current interactions, neutrinos are either lost or regenerated via tau decay
- For neutral-current interactions, neutrinos are not destroyed but cascade down in energy
- 7.5 year High-energy Starting Events (HESE) sample
- Forward-folded fit in energy and zenith; different from IC-Cascade measurement with unfolding





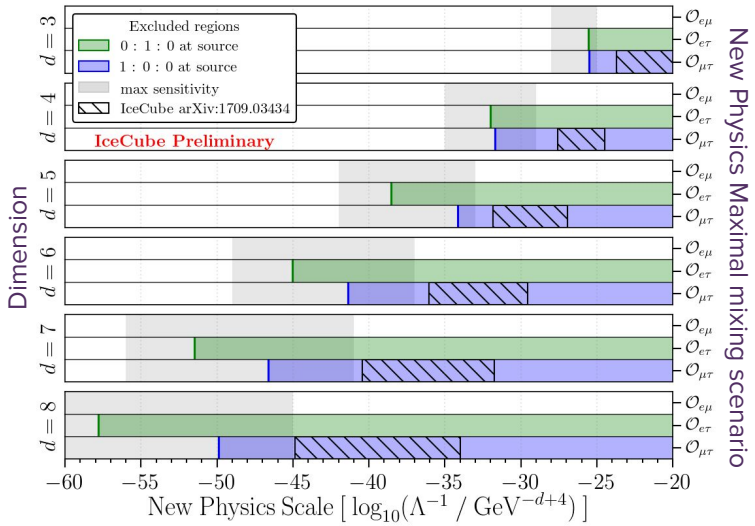
New Physics in the Astrophysical Flavour

Astrophysical neutrino flavor is one of the most powerful tools to look for new physics in neutrino sector.

$$H_d = \frac{1}{2E} U M^2 U^\dagger + \frac{E^{d-3}}{\Lambda_d} \tilde{U}_d O_d \tilde{U}_d^\dagger = V_d(E)\,\Delta V_d^\dagger(E)$$

Dimension · Standard Mixing · New Physics Terms · Mixing Matrix with New Physics

➔ Introducing new physics in the **mixing matrix elements**



We set limits on new physics scale through the measurement of astrophysical neutrino flavors.

Limits corresponding to different assumptions on the **source flavour** and also on the dominant New Physics **mixing scenario.**

Dark matter searches

All dark matter models assume an Einasto profile following [1]

Annihilation
Heavy galactic DM self-annihilating into νs

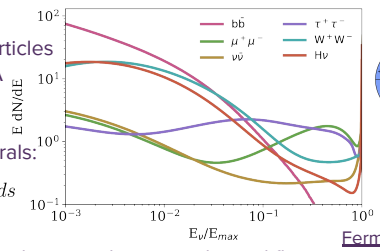
Decay
Heavy (extra)galactic DM decaying into νs

Scattering
Neutrinos scattering off light galactic DM

Annihilation and decay models

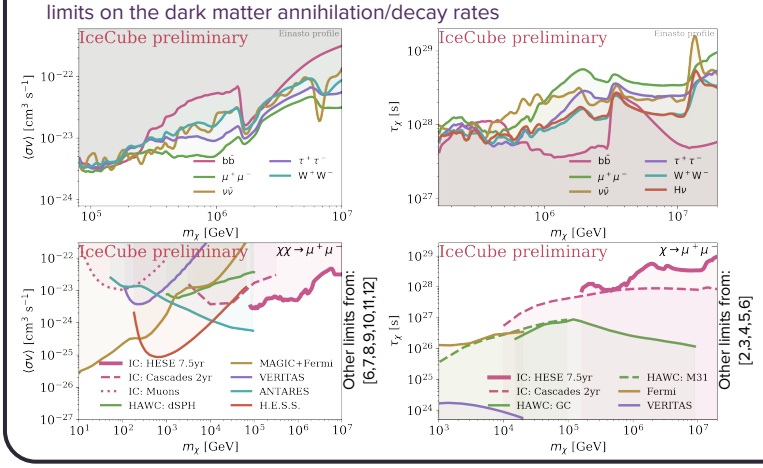
- Spin-0 particle annihilates/decays into SM particles
- The spectra at origin are simulated in PYTHIA
- ν propagated to Earth by taking into account oscillations and cosmological redshift
- ν flux is calculated from the line of sight integrals:

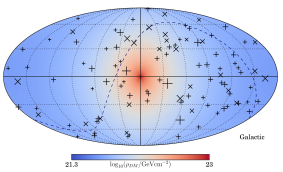
$$\Phi_{an} \sim \int_{l.o.s.} \rho_\chi(r(s))^2\, ds \qquad \Phi_{dc} \sim \int_{l.o.s.} \rho_\chi(r(s))\, ds$$



Annihilation and decay limits

- Background is standard diffuse model with single power-law astrophysical flux
- Non-observation of a significant dark matter signal is used to derive 90% C.L. limits on the dark matter annihilation/decay rates



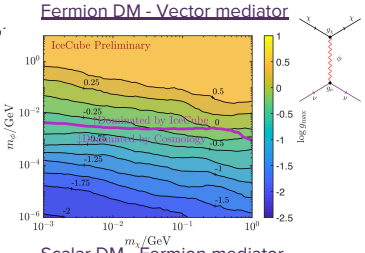


HESE neutrino events overlay with the DM column density.

Dark matter scattering

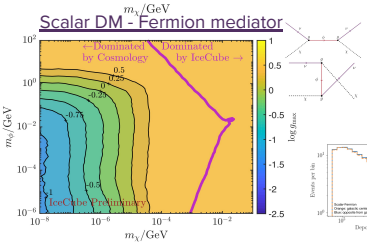
Assume an isotropic power-law neutrino spectrum incident on the galaxy. Dark matter-neutrino interactions introduces a deficit in the direction of DM over densities.

Fermion DM - Vector mediator

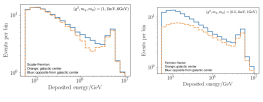


The color plots show the maximum allow coupling given for given dark matter and mediator masses. The bright pink line signals the region where IceCube bounds are stronger with respect to cosmological observations.

Scalar DM - Fermion mediator



Examples of the effects on the distributions



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