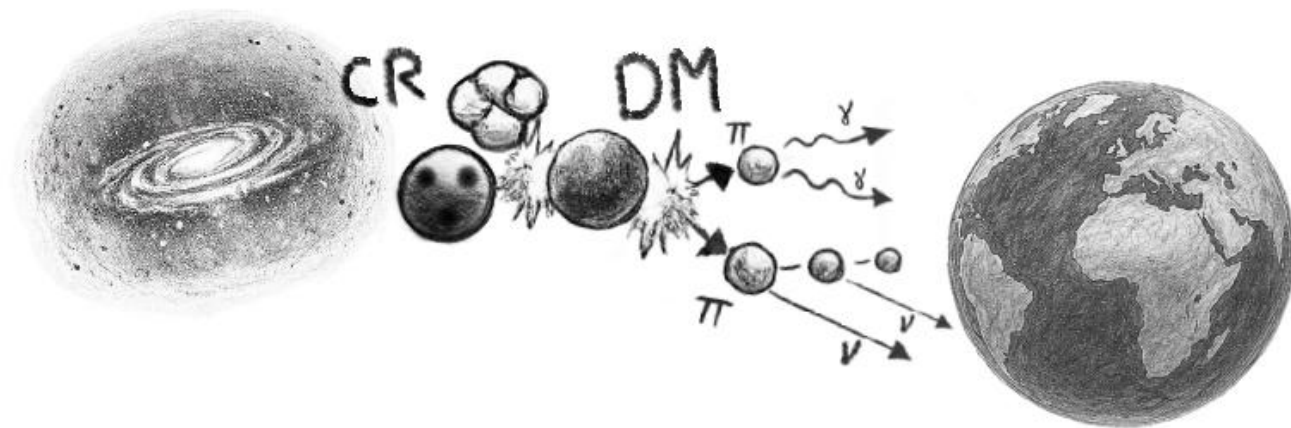

Galactic neutrinos from CR-DM interactions

Jorge Terol Calvo
INFN Torino

2606.XXXXX (Results shown are Preliminary)

JTC, P. de la Torre Luque, C. Cappiello, G. Herrera, M. Mukhopadhyay

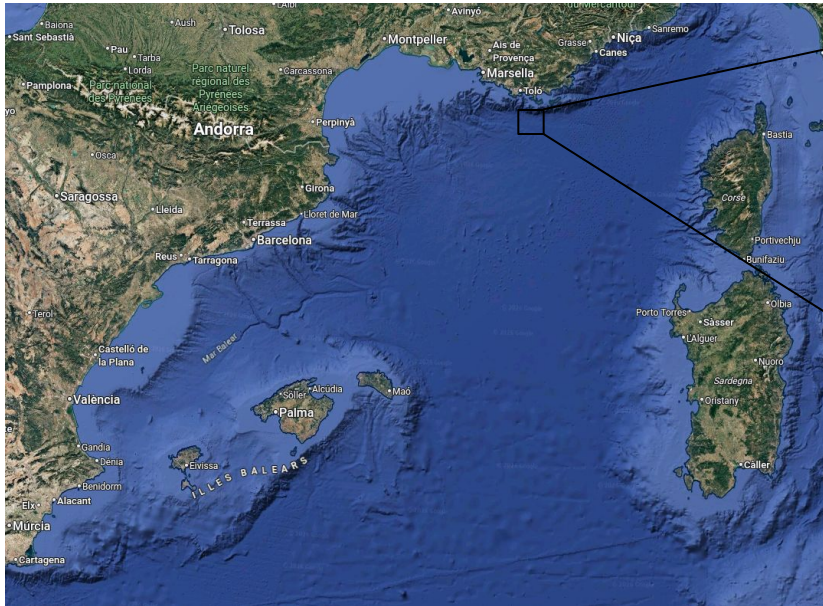
Galactic Neutrinos from CR-DM interactions



D. Hooper, S. D. McDermott, arXiv:1802.03025
G. Guo, Y.-L. S. Tsai, M.-R. Wu, and Q. Yuan, arXiv:2008.12137
I. Reis, E. Moulin, A. Viana, and V. P. Gonçalves, arXiv:2403.09343
A. G. De Marchi, A. Granelli, J. Nava, and F. Sala, arXiv:2412.07861

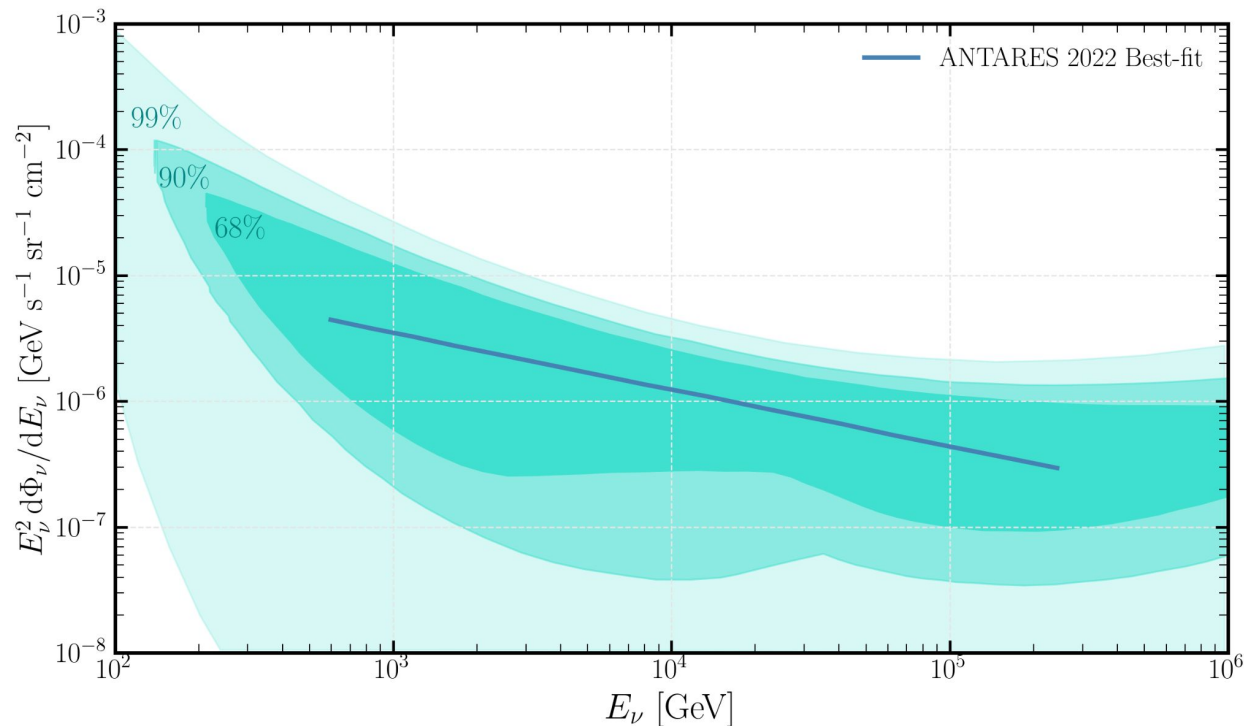
Observations of Galactic Neutrinos

ANTARES



Observations of Galactic Neutrinos

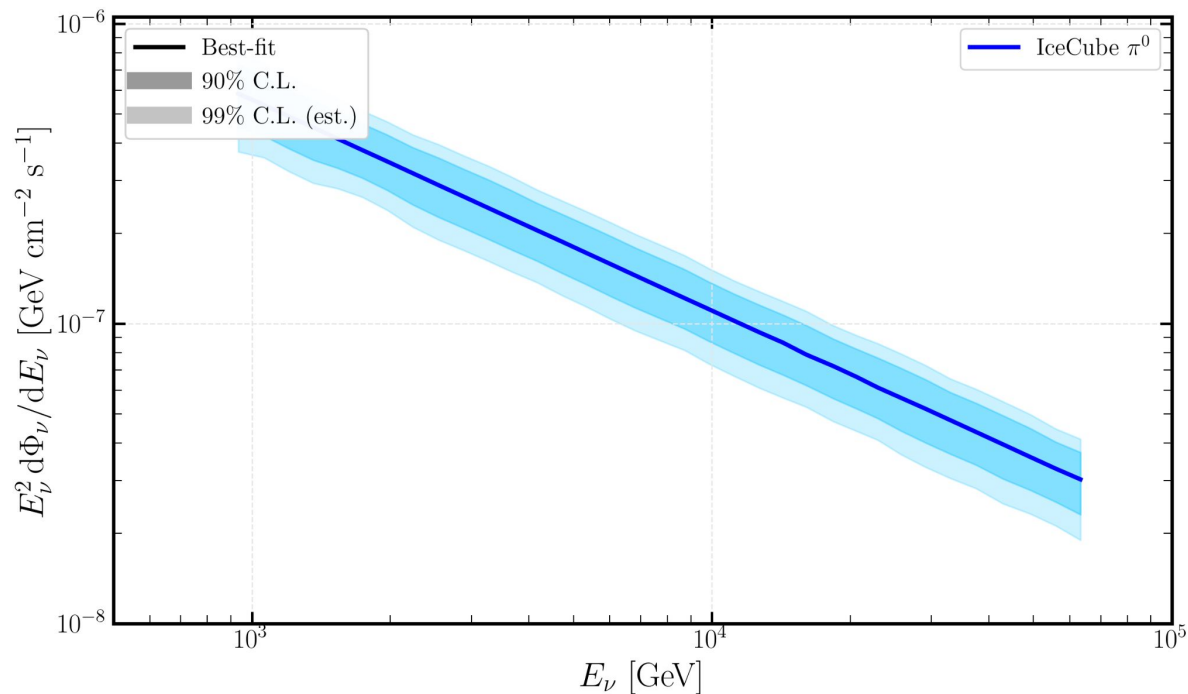
ANTARES (Galactic Ridge: $|l| < 30^\circ$, $|b| < 2^\circ$)



ANTARES Collaboration, arXiv:2212.11876

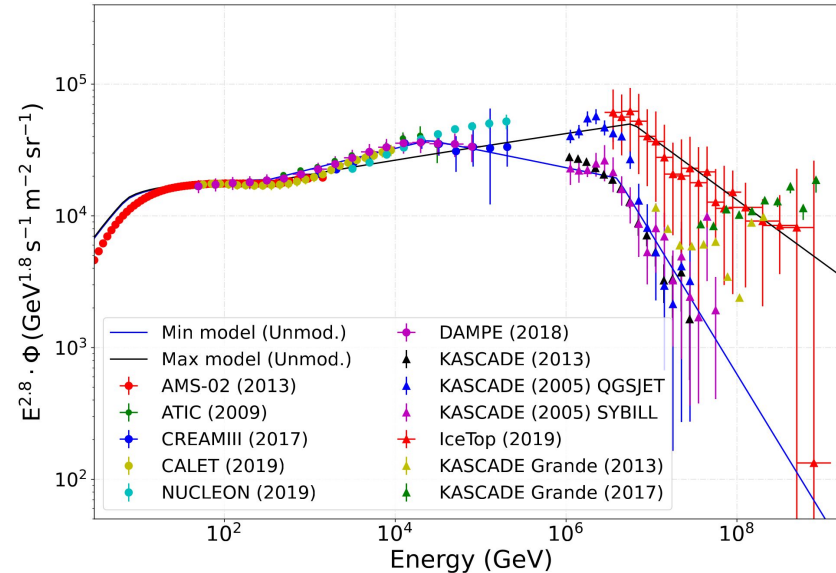
Observations of Galactic Neutrinos

IceCube (Galactic Plane: $0 < l < 360^\circ$, $|b| < 5^\circ$)



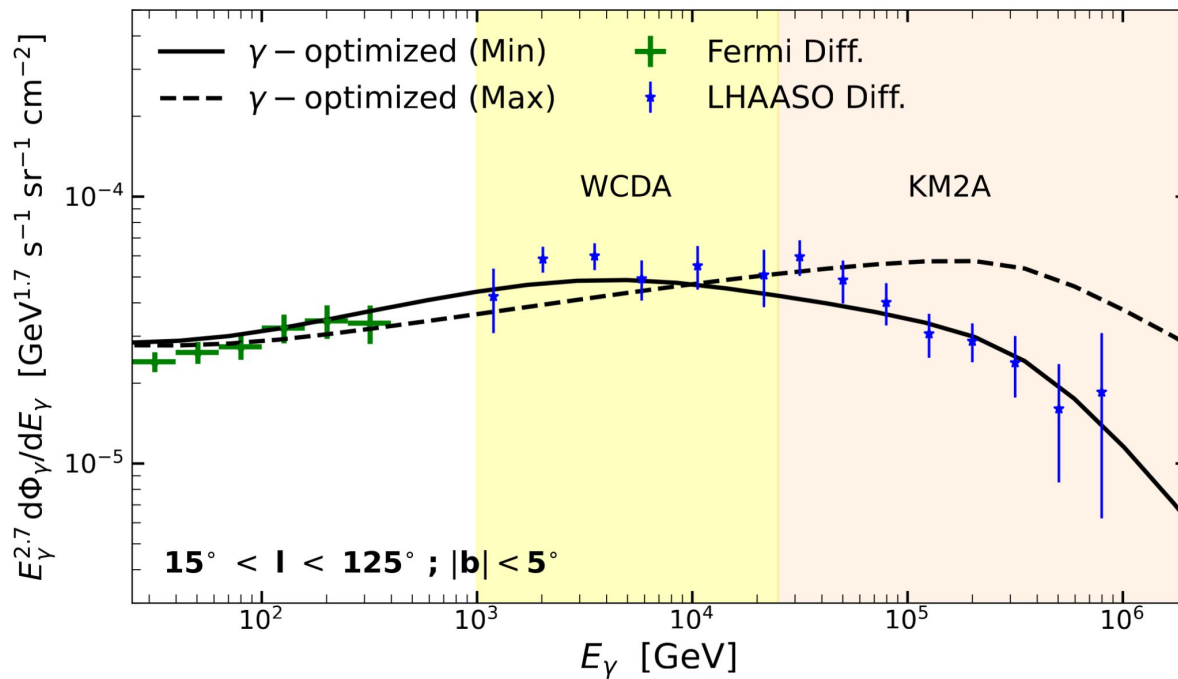
CR from the galaxy

- We make use of γ -optimized model
- Model fitted to CR, Gamma and neutrino observations



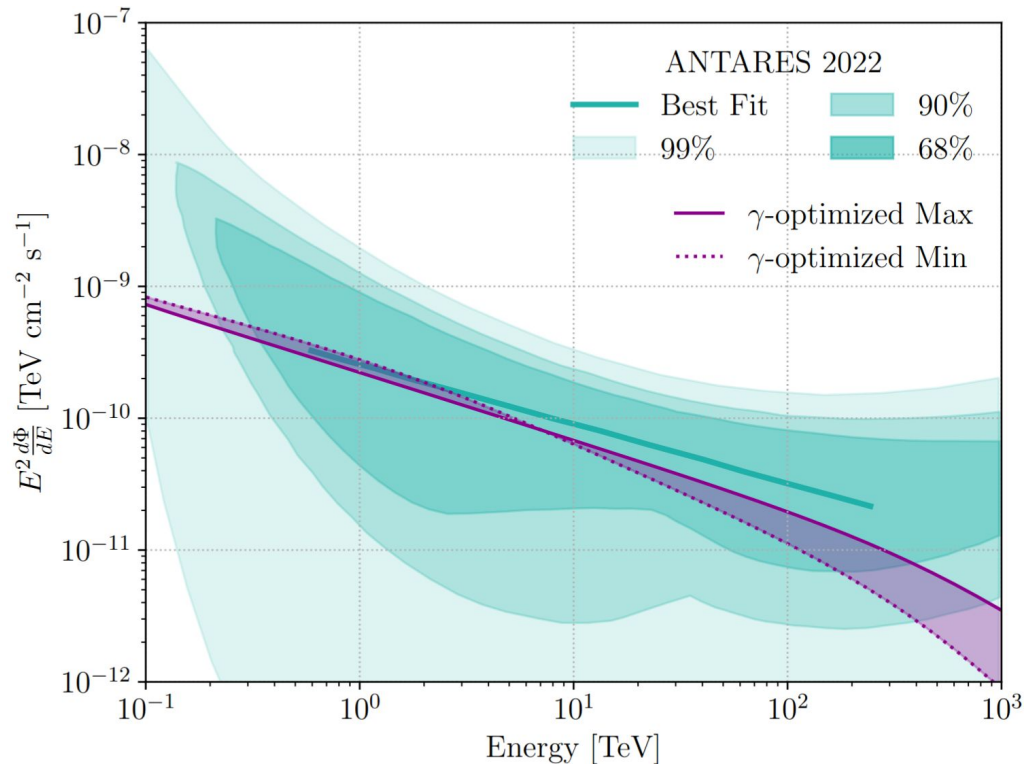
P. de la Torre Luque, et al., arXiv:2203.15759

CR from the galaxy



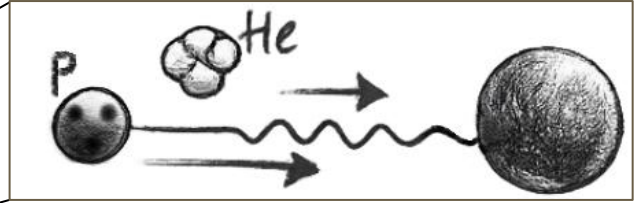
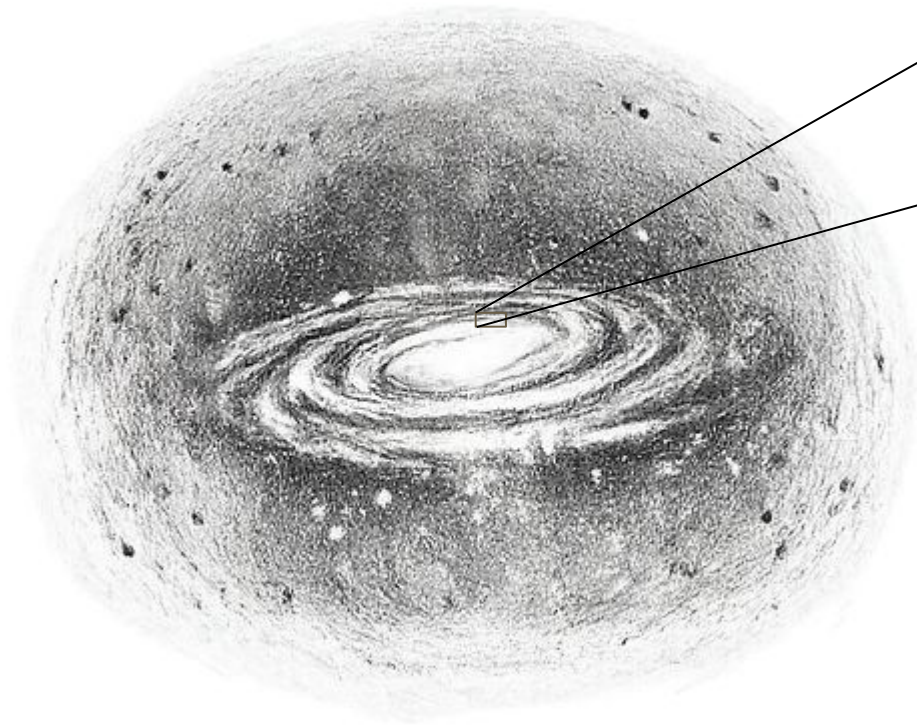
P. de la Torre Luque, et al., arXiv:2502.18268

CR from the galaxy

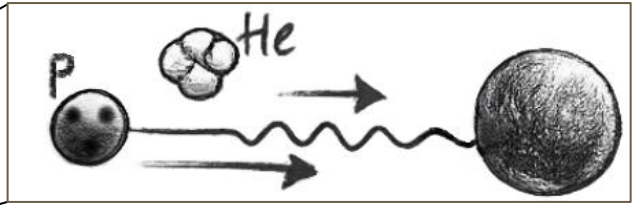
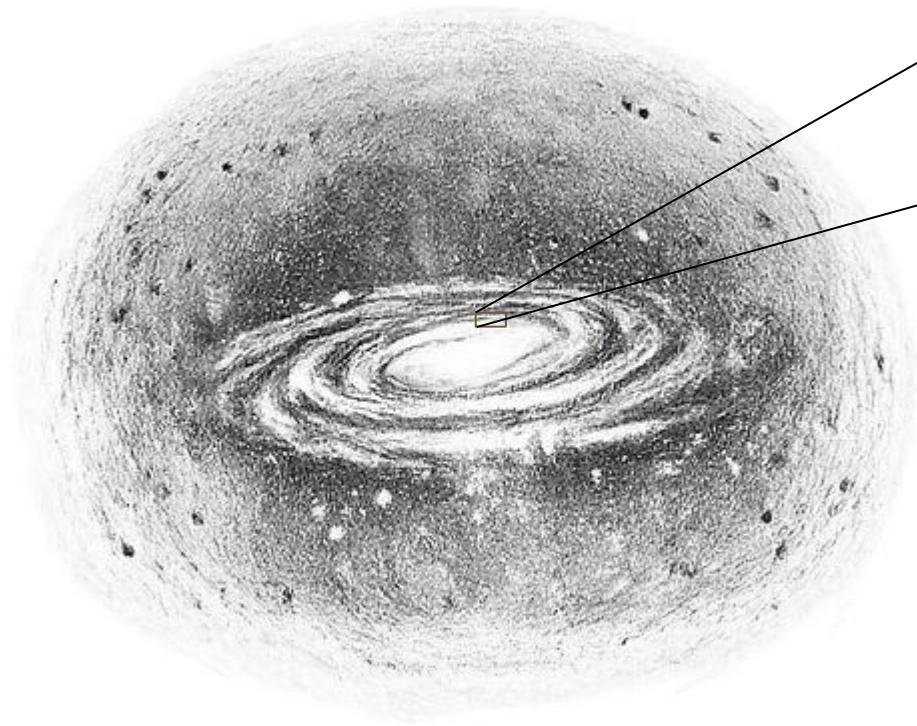


J. Zuriaga-Puiga, P. de la Torre Luque, V. Gammaldi, arXiv:2605.20117

Galactic Neutrinos from CR-DM interactions



Galactic Neutrinos from CR-DM interactions

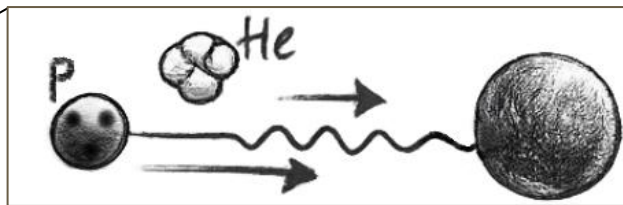
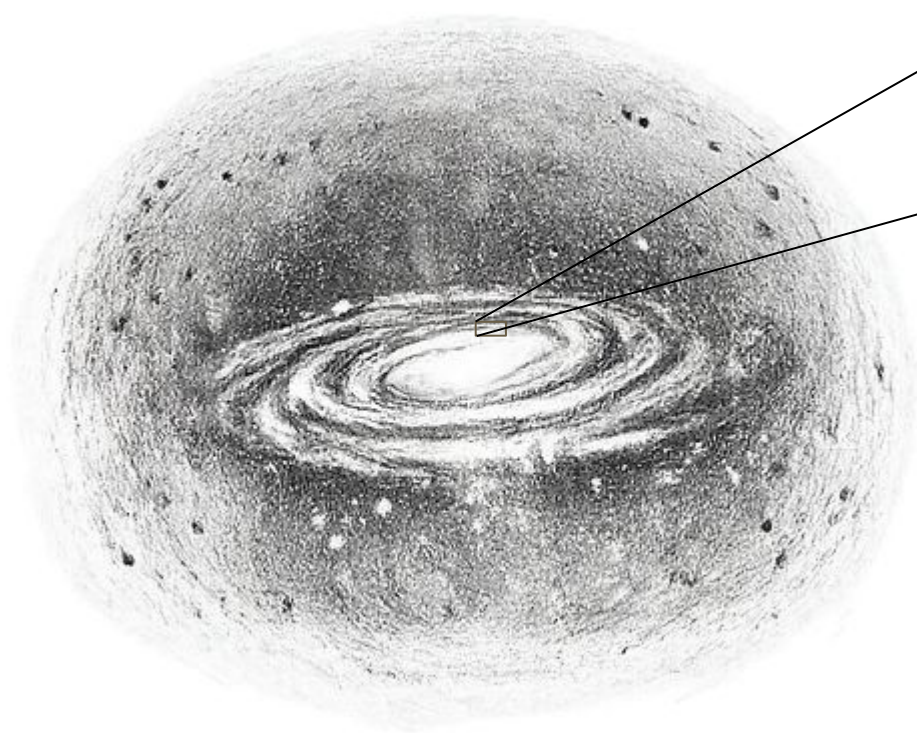


$$\mathcal{L} \supset g_\chi \bar{\chi} \gamma^\mu \chi V_\mu + g_q \sum_q \bar{q} \gamma^\mu q V_\mu$$

Dirac Dark Matter

Vector Mediator

Galactic Neutrinos from CR-DM interactions



$$\mathcal{L} \supset g_\chi \bar{\chi} \gamma^\mu \chi V_\mu + g_q \sum_q \bar{q} \gamma^\mu q V_\mu$$

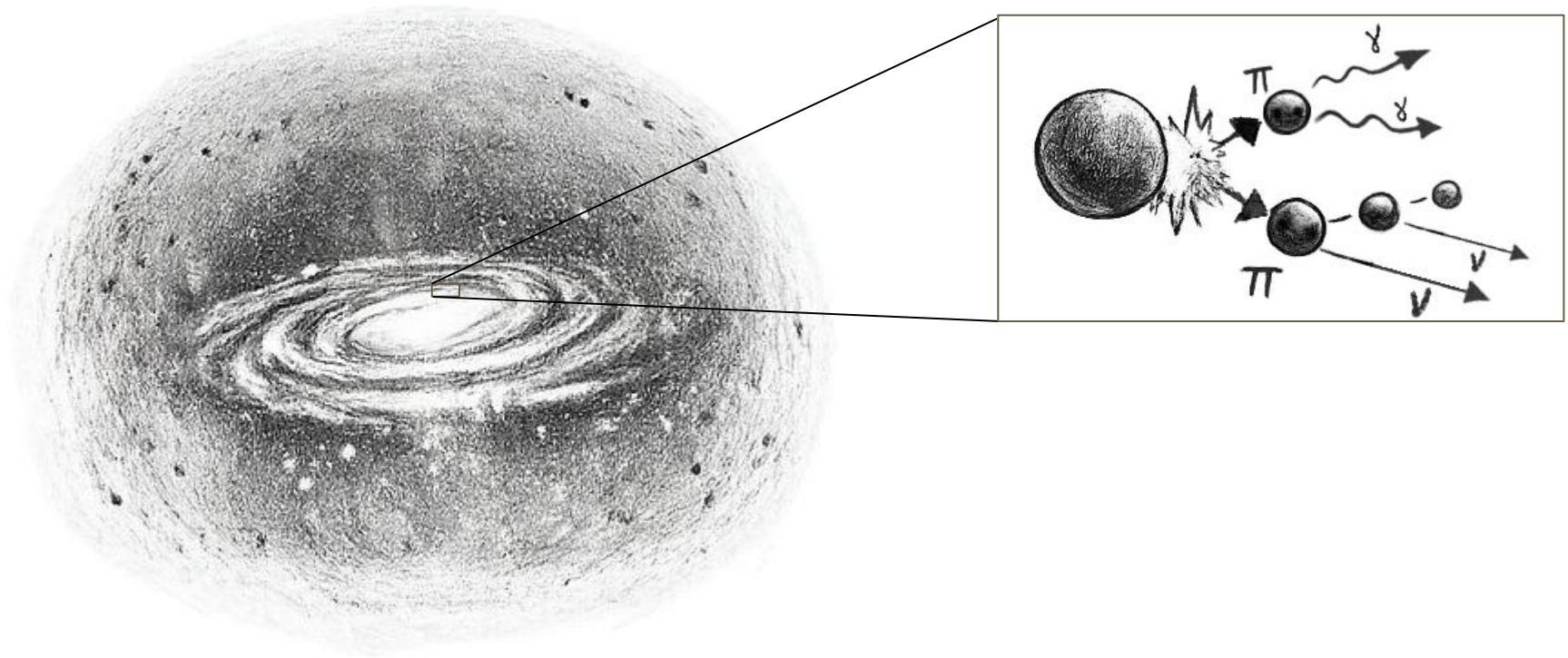
Dirac Dark Matter

Vector Mediator

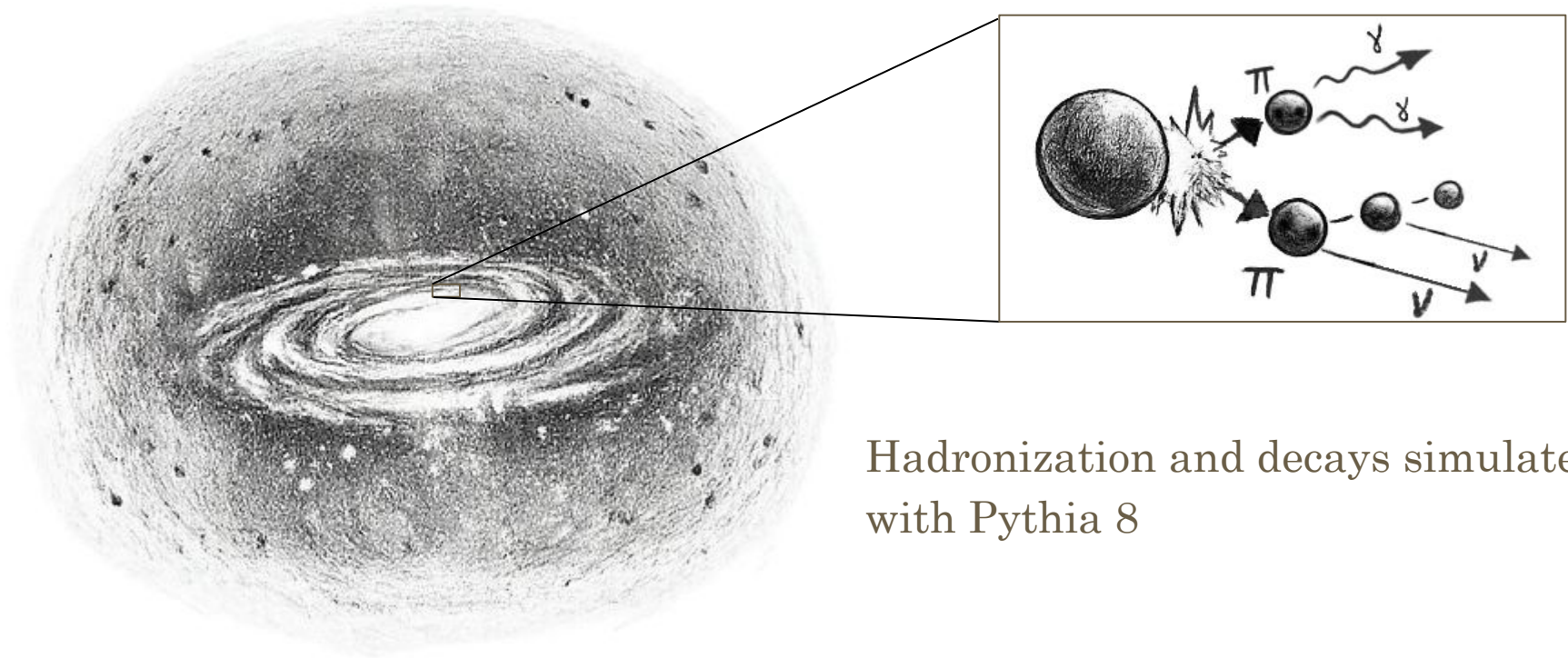
Simulated with MadGraph5 aMC@NLO

DM-simp: <https://feynrules.irmp.ucl.ac.be/wiki/DMsimp>

Galactic Neutrinos from CR-DM interactions



Galactic Neutrinos from CR-DM interactions



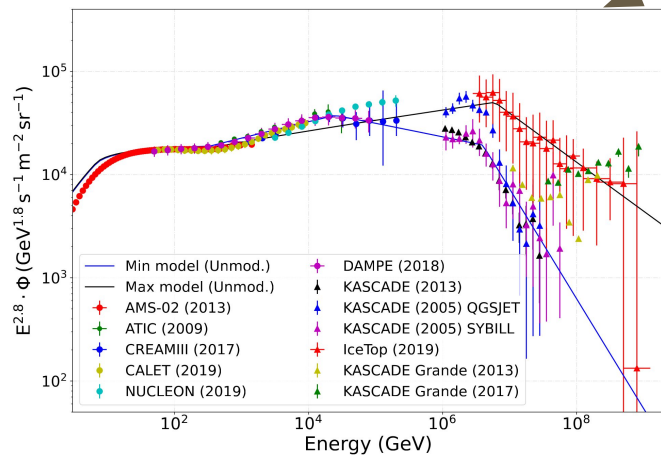
Hadronization and decays simulated
with Pythia 8

Galactic Neutrinos from CR-DM interactions

$$\frac{d\phi_\nu}{d\Omega dE_\nu}(l, b, E) = \int ds \frac{\rho_{\text{DM}}}{m_\chi} \int dE_{\text{CR}} \frac{d\phi_{\text{CR}}(E_{\text{CR}})}{d\Omega dE_{\text{CR}}} \sigma_{\text{CR}\chi}(E_{\text{CR}}) \frac{dN_\nu}{dE_\nu}(E_{\text{CR}})$$

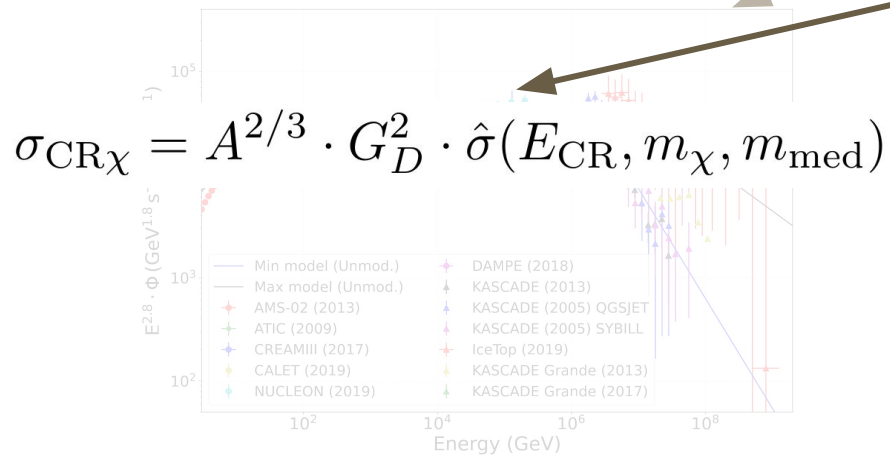
Galactic Neutrinos from CR-DM interactions

$$\frac{d\phi_\nu}{d\Omega dE_\nu}(l, b, E) = \int ds \frac{\rho_{\text{DM}}}{m_\chi} \int dE_{\text{CR}} \frac{d\phi_{\text{CR}}(E_{\text{CR}})}{d\Omega dE_{\text{CR}}} \sigma_{\text{CR}\chi}(E_{\text{CR}}) \frac{dN_\nu}{dE_\nu}(E_{\text{CR}})$$



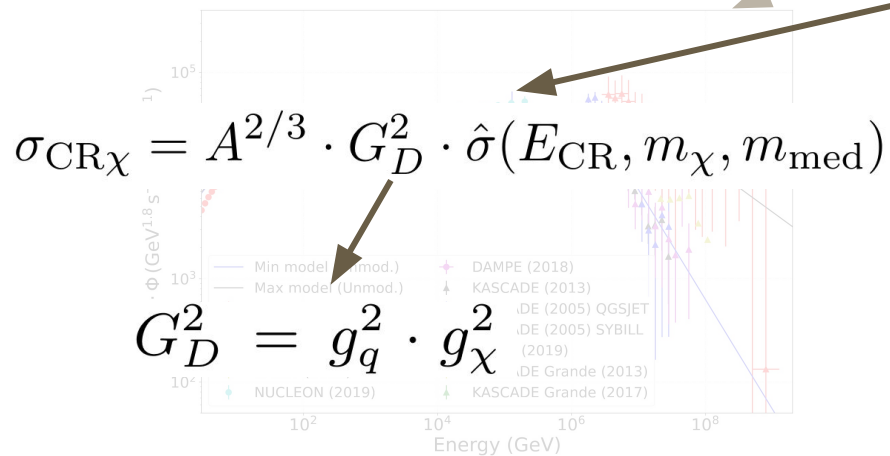
Galactic Neutrinos from CR-DM interactions

$$\frac{d\phi_\nu}{d\Omega dE_\nu}(l, b, E) = \int ds \frac{\rho_{\text{DM}}}{m_\chi} \int dE_{\text{CR}} \frac{d\phi_{\text{CR}}(E_{\text{CR}})}{d\Omega dE_{\text{CR}}} \sigma_{\text{CR}\chi}(E_{\text{CR}}) \frac{dN_\nu}{dE_\nu}(E_{\text{CR}})$$



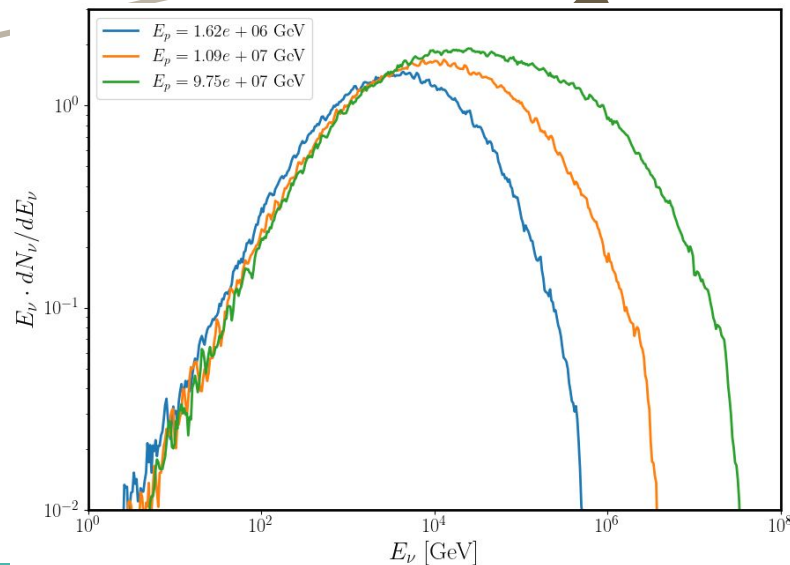
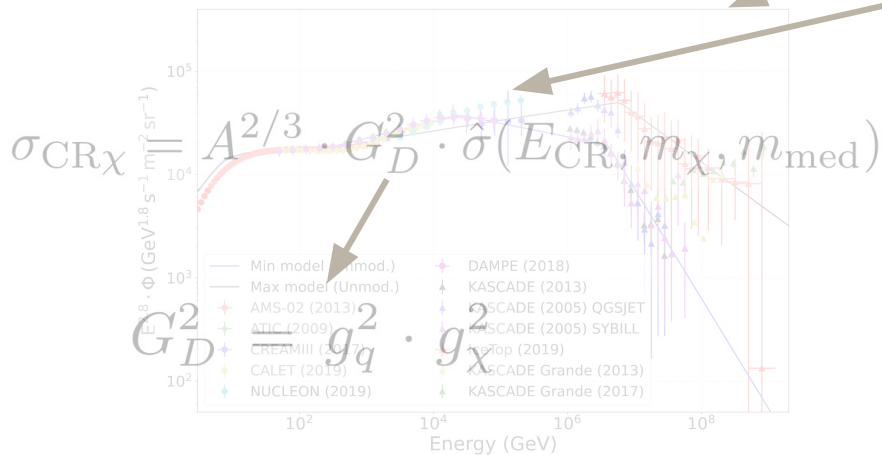
Galactic Neutrinos from CR-DM interactions

$$\frac{d\phi_\nu}{d\Omega dE_\nu}(l, b, E) = \int ds \frac{\rho_{\text{DM}}}{m_\chi} \int dE_{\text{CR}} \frac{d\phi_{\text{CR}}(E_{\text{CR}})}{d\Omega dE_{\text{CR}}} \sigma_{\text{CR}\chi}(E_{\text{CR}}) \frac{dN_\nu}{dE_\nu}(E_{\text{CR}})$$

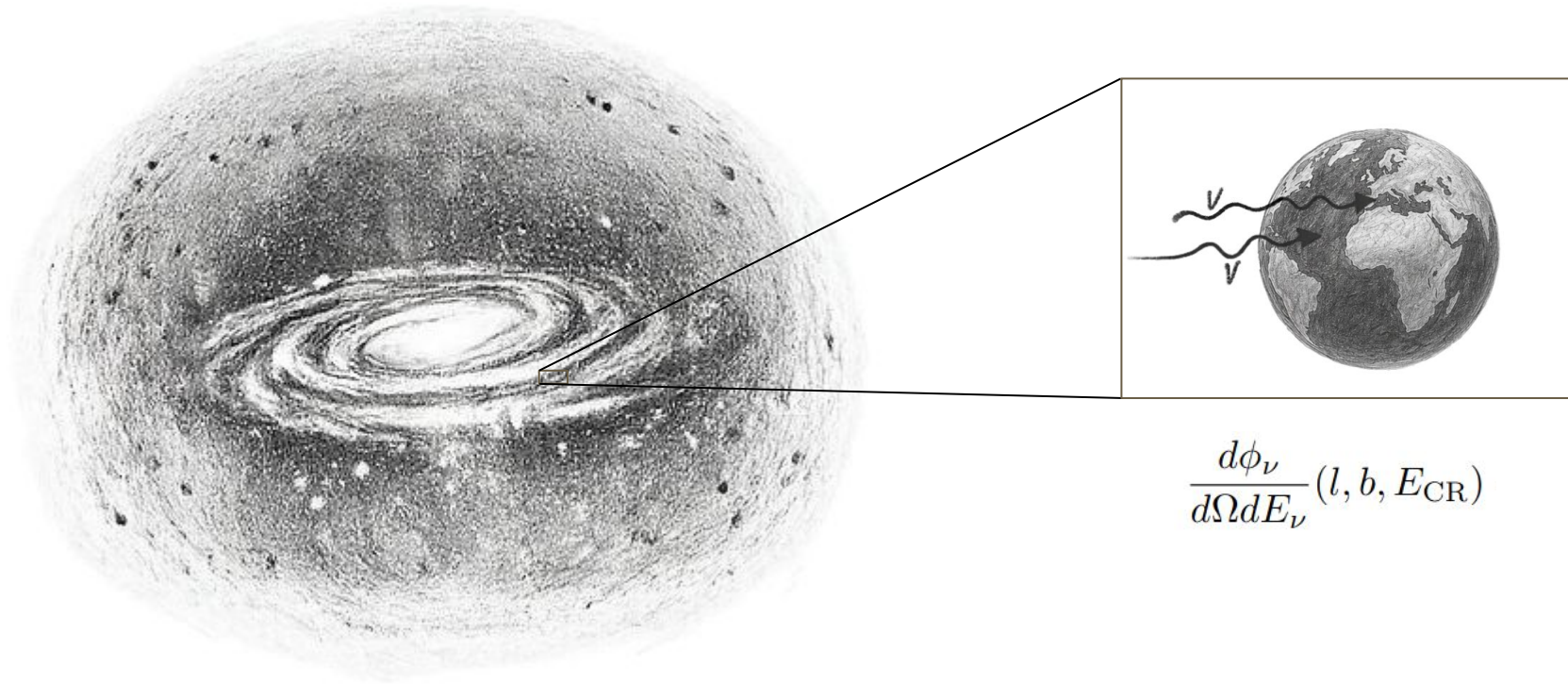


Galactic Neutrinos from CR-DM interactions

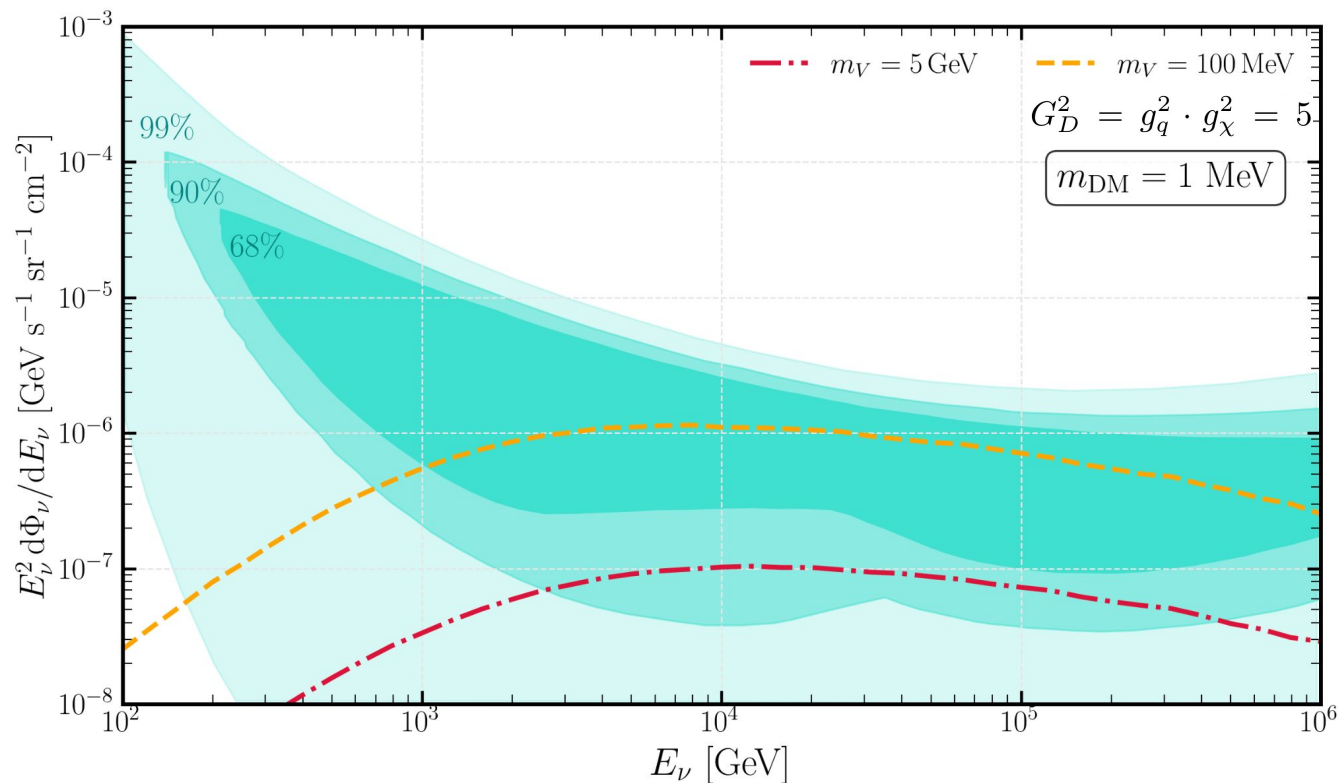
$$\frac{d\phi_\nu}{d\Omega dE_\nu}(l, b, E) = \int ds \frac{\rho_{\text{DM}}}{m_\chi} \int dE_{\text{CR}} \frac{d\phi_{\text{CR}}(E_{\text{CR}})}{d\Omega dE_{\text{CR}}} \sigma_{\text{CR}\chi}(E_{\text{CR}}) \frac{dN_\nu}{dE_\nu}(E_{\text{CR}})$$



Galactic Neutrinos from CR-DM interactions



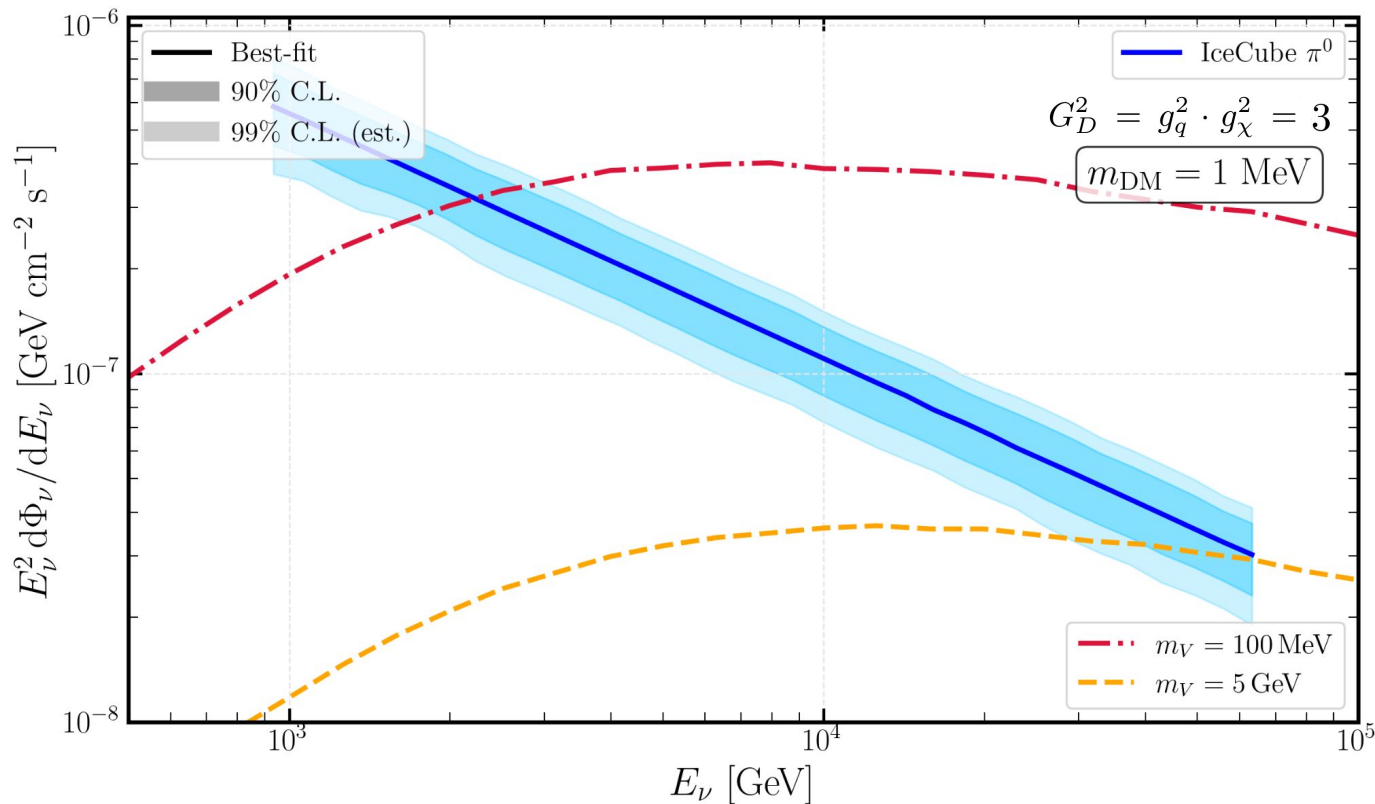
Galactic Neutrinos from CR-DM interactions



IceCube

- IceCube fit a template $\rightarrow$ Uncertainties from spectral shape disappear
- Need to rescale the flux calculated for the ridge
 - Use the same scaling as π^0 from Ridge to All-Sky

IceCube prospects



Constraints

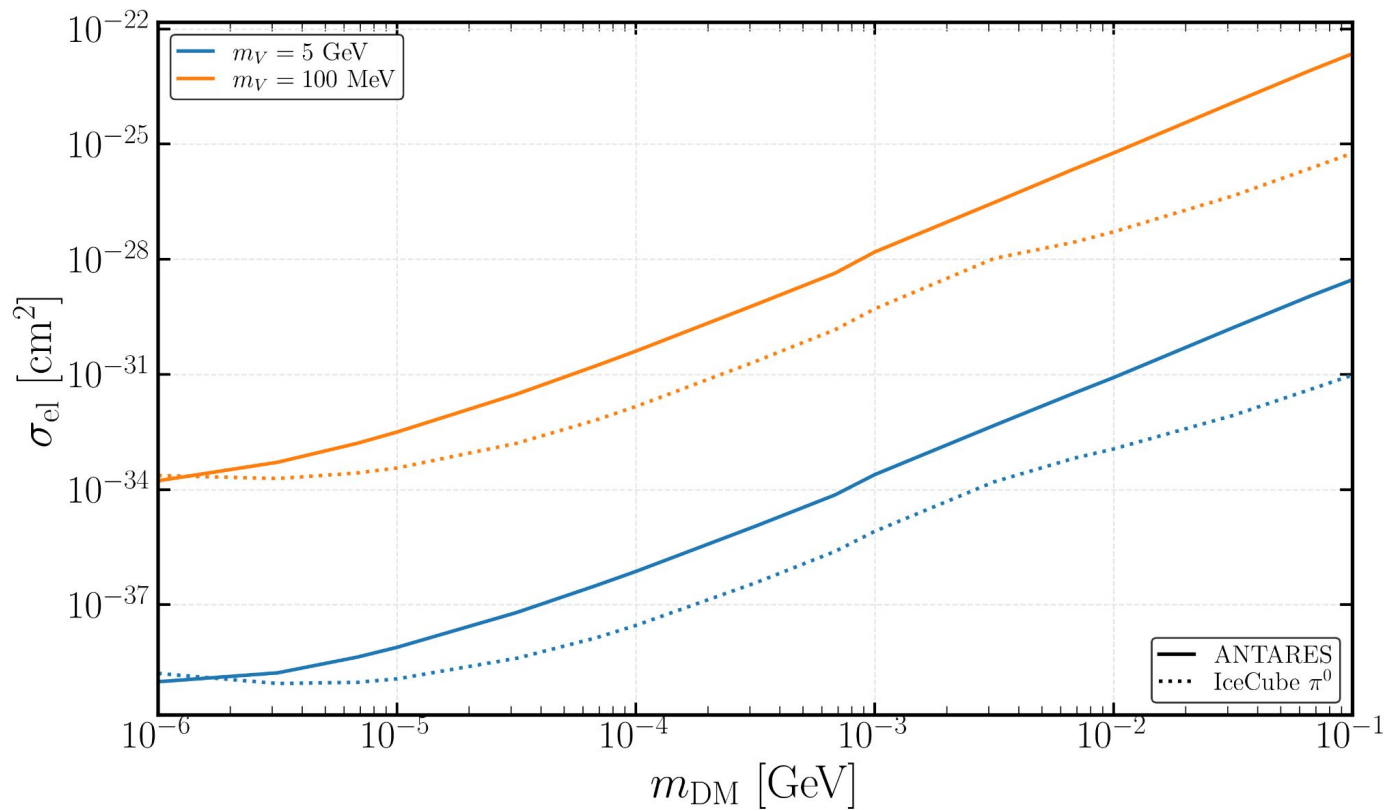
- Set constraints in product of couplings

$$\sigma_{\text{CR}\chi} = A^{2/3} \cdot G_D^2 \cdot \hat{\sigma}(E_{\text{CR}}, m_\chi, m_{\text{med}})$$

- Translate to elastic cross-section

$$\sigma_{\chi p}^{\text{el}} \equiv \frac{g_p^2 g_\chi^2 \mu_{\chi p}^2}{\pi m_V^4} = G_D^2 \frac{9 \mu_{\chi p}^2}{\pi m_V^4}$$

Constraints



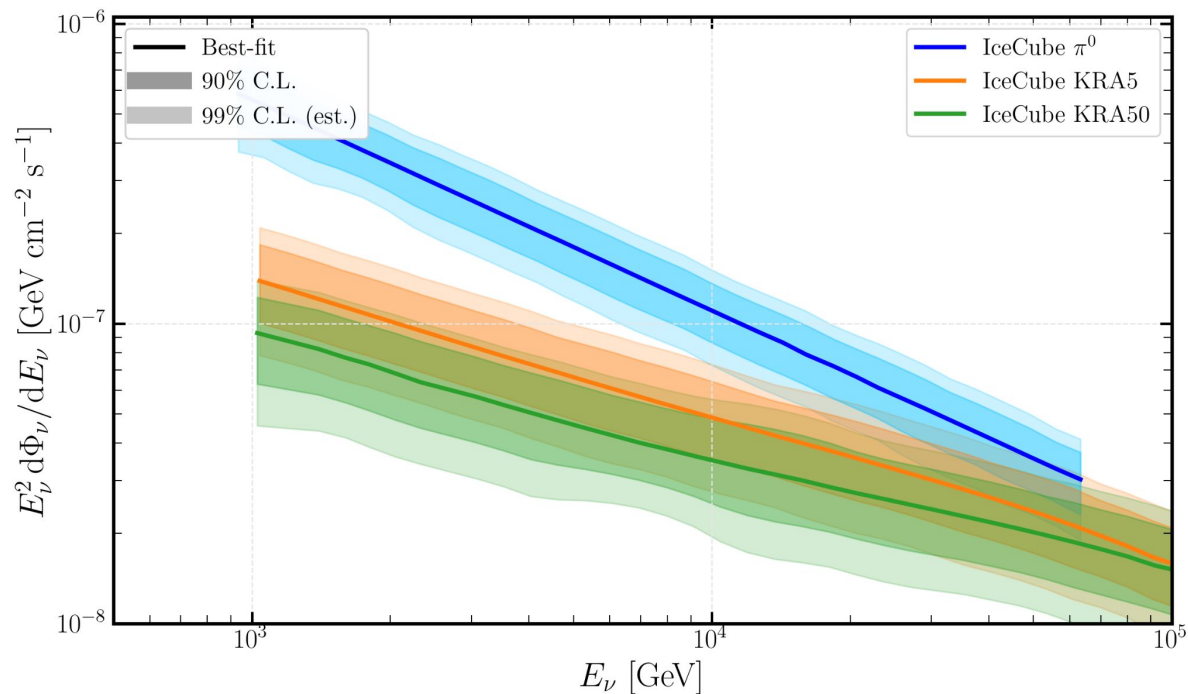
Fundamental ideas

- Galactic Neutrinos provide a new window to probe sub-GeV Dark Matter
- First observations: A lot of room for improvement!
- Conservative approach, we can fit SM + DM contribution, expecting larger constraints.

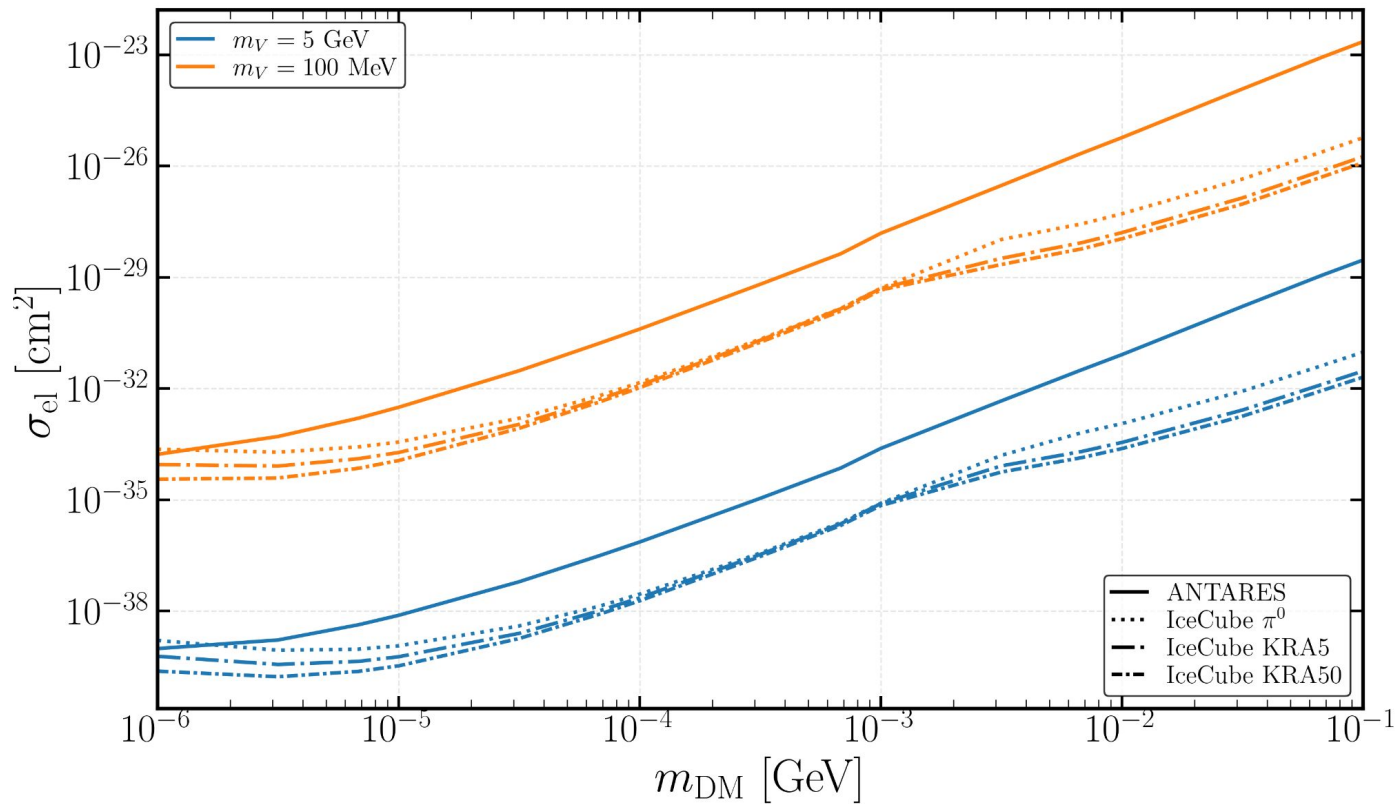
Thank you

Observations of Galactic Neutrinos

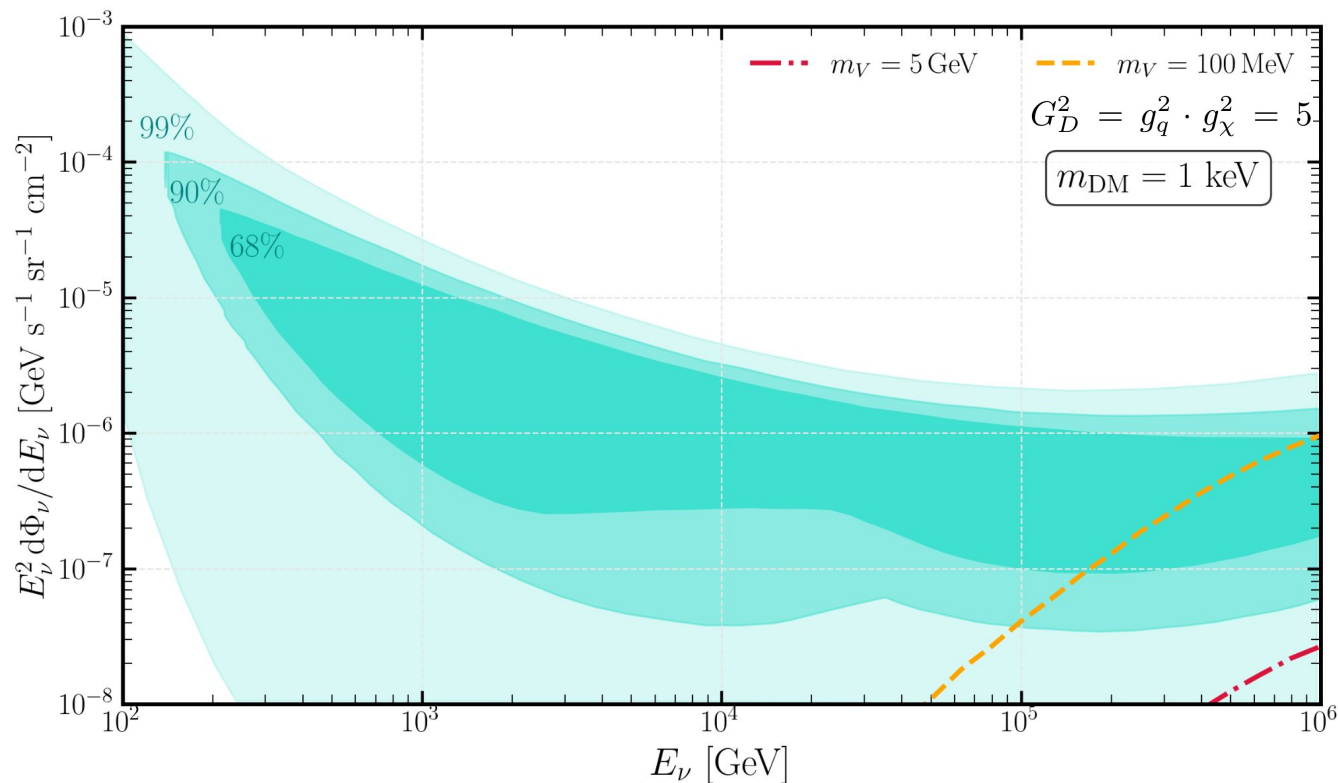
IceCube (Galactic Plane: $0 < l < 360^\circ$, $|b| < 5^\circ$)



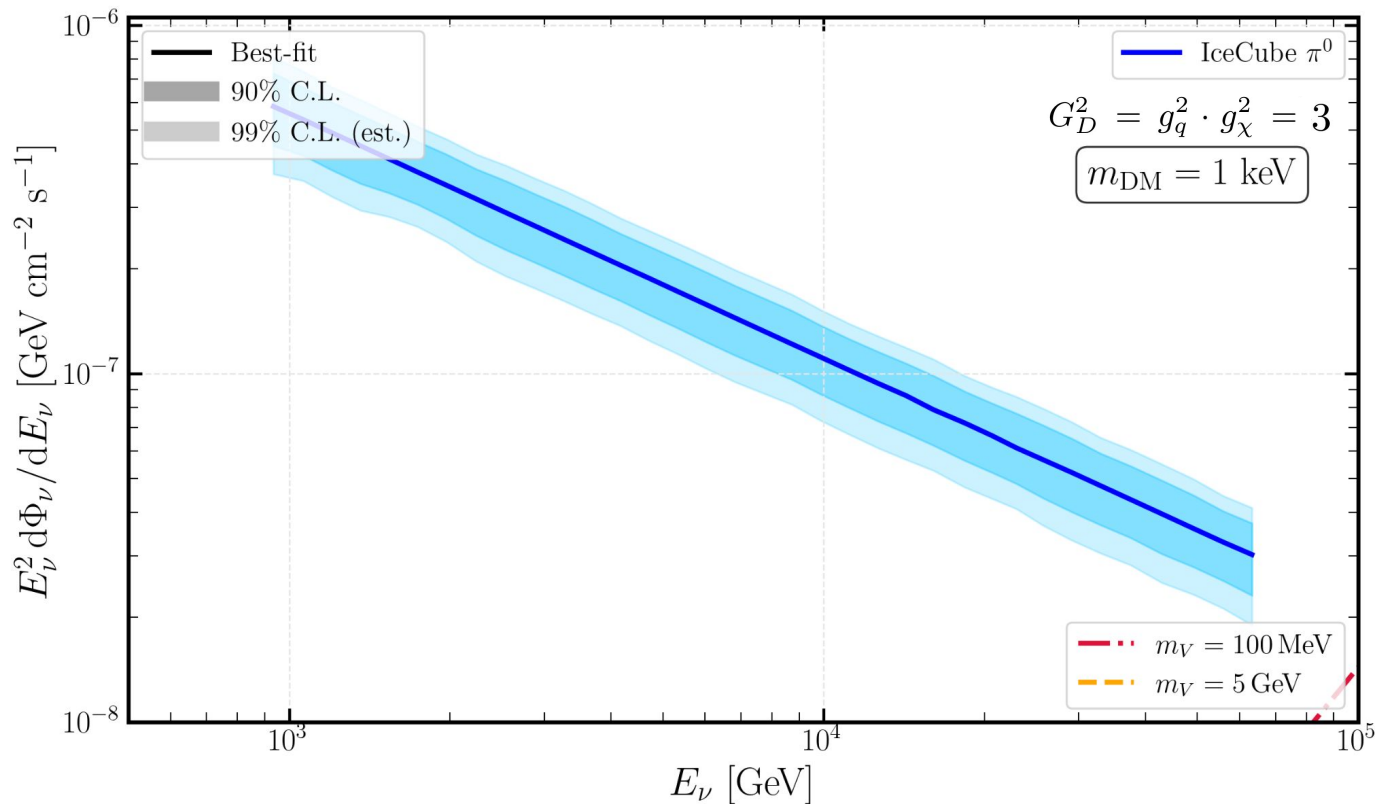
Constraints



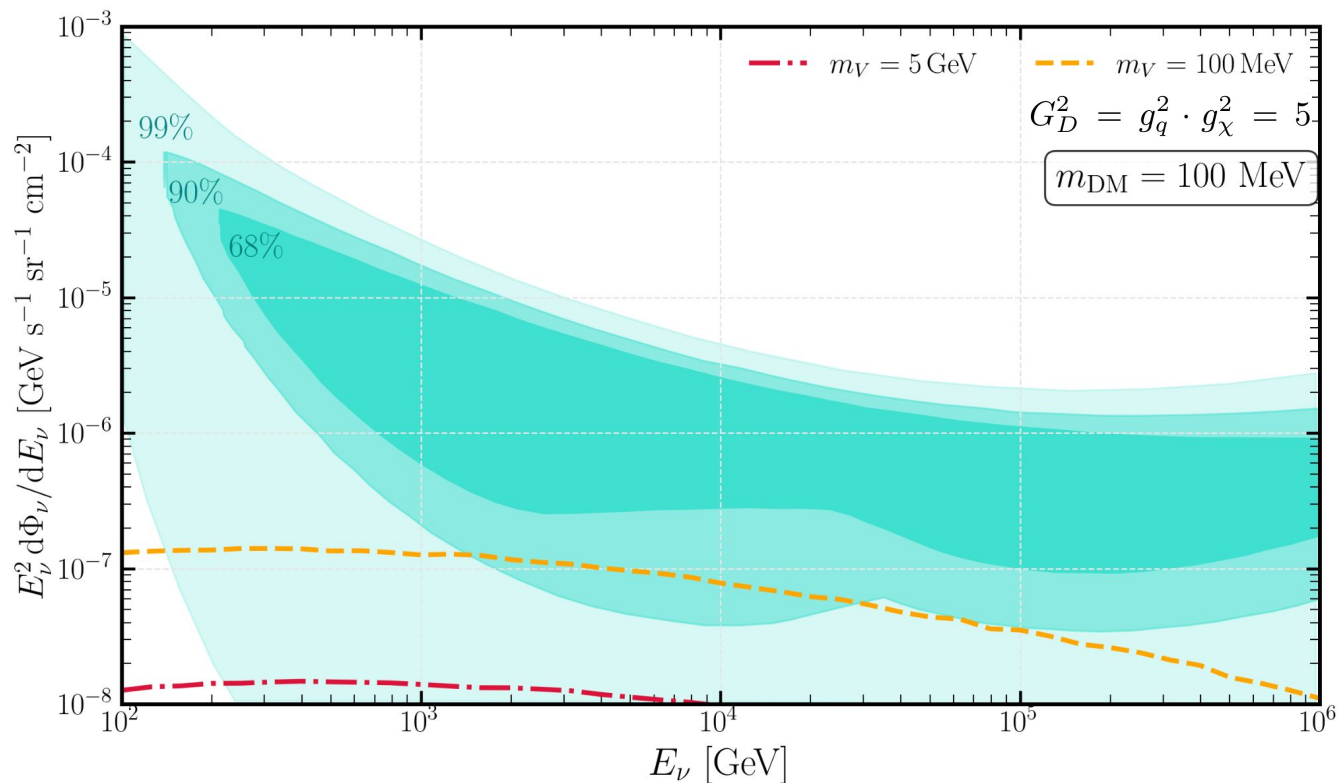
Galactic Neutrinos from CR-DM interactions



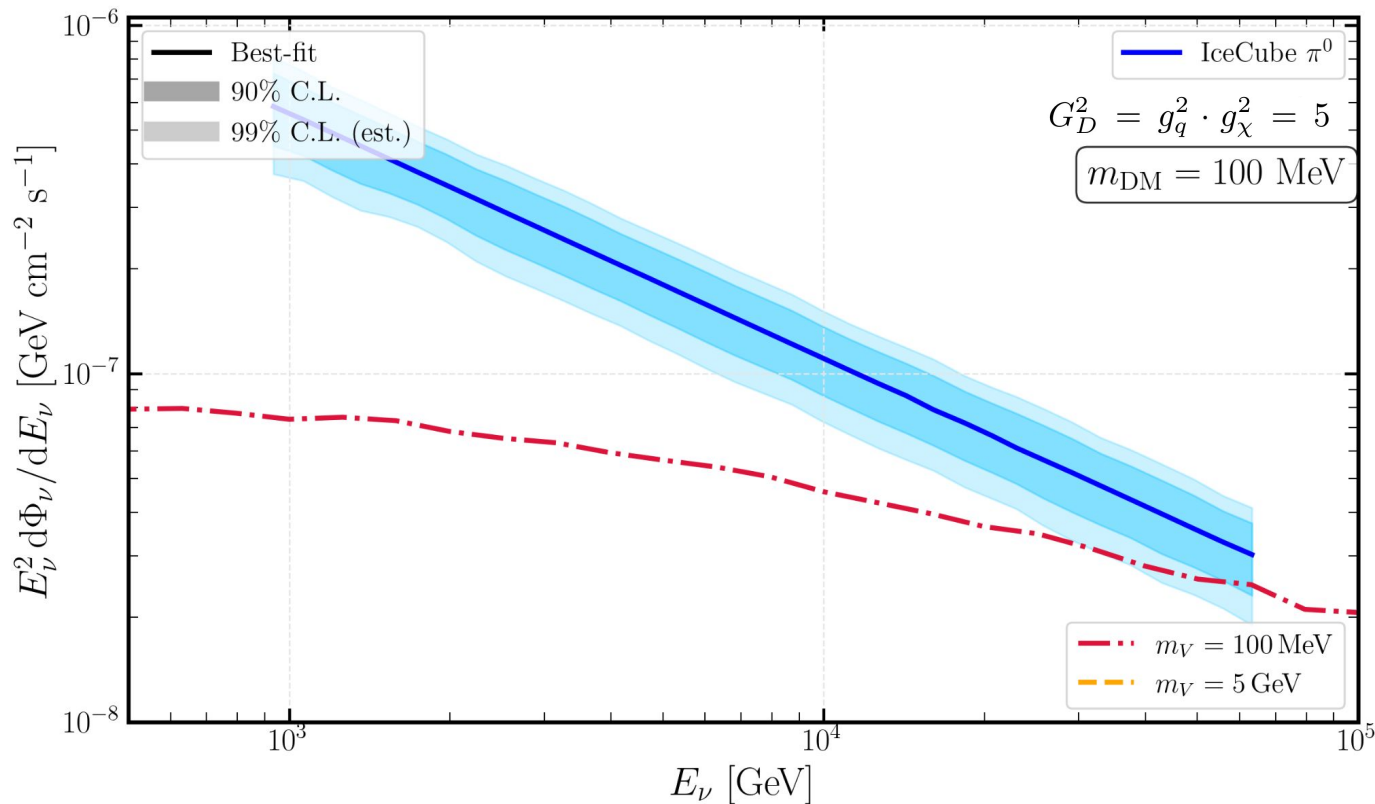
IceCube prospects



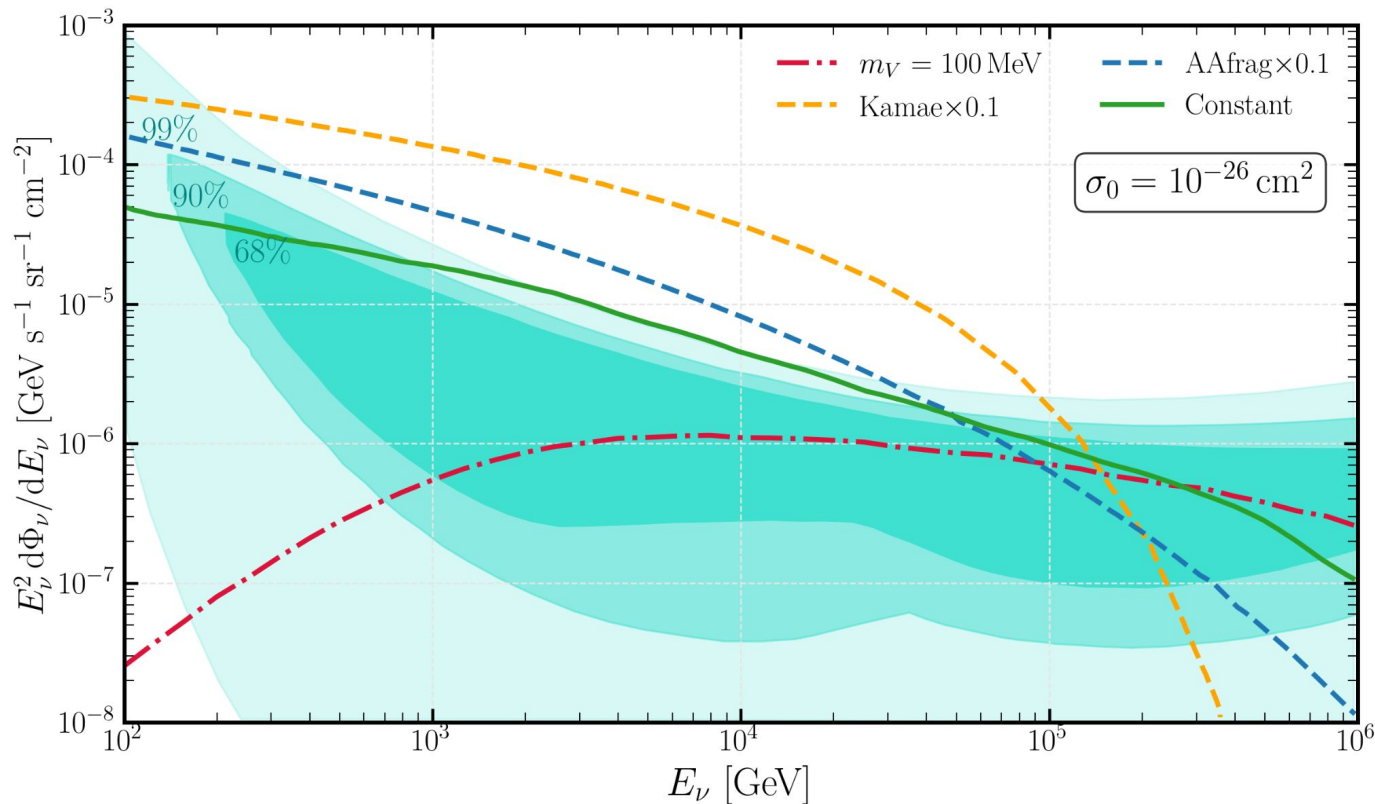
Galactic Neutrinos from CR-DM interactions



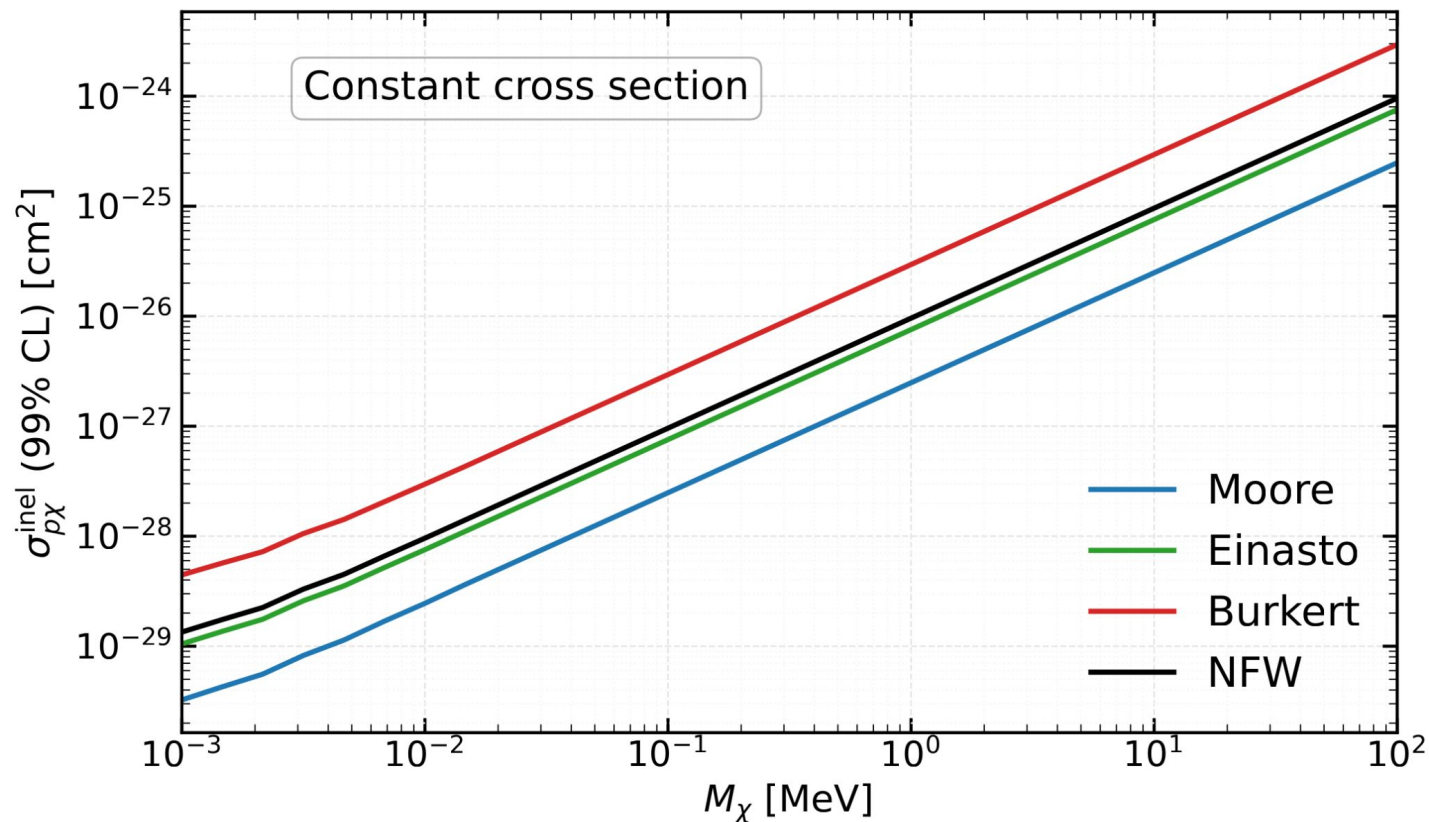
IceCube prospects



Cross-section



DM Profile choice



PDF choice

