

Cosmic Ray-Boosted Dark Matter at IceCube

Christopher Cappiello

Based on arXiv:2405.00086 (CC, Qinrui Liu, Gopolang
Mohlabeng, Aaron Vincent)

Pheno 2024, May 13, 2024

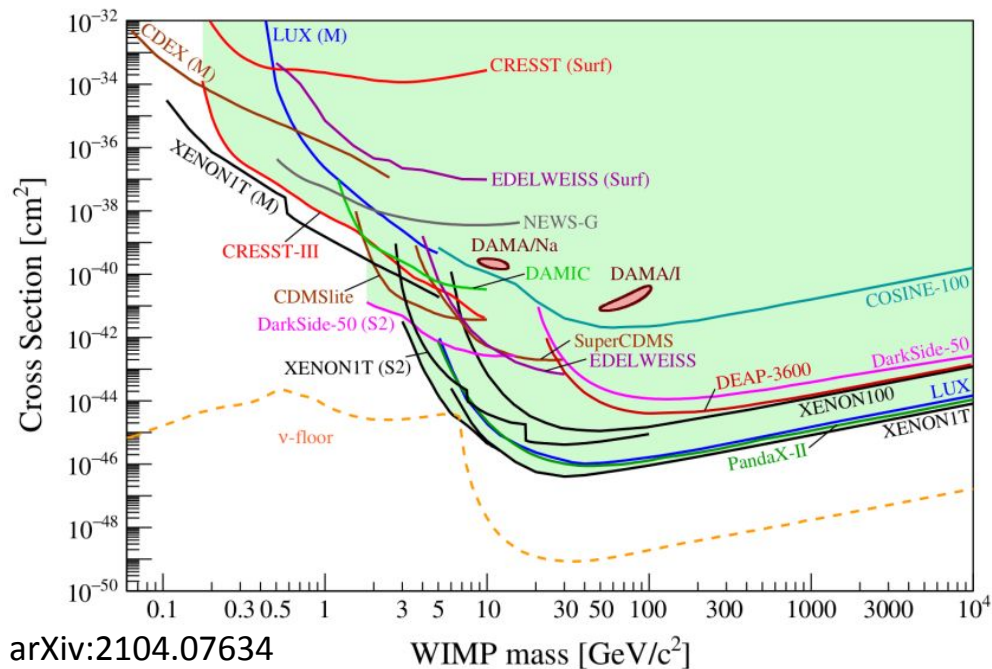
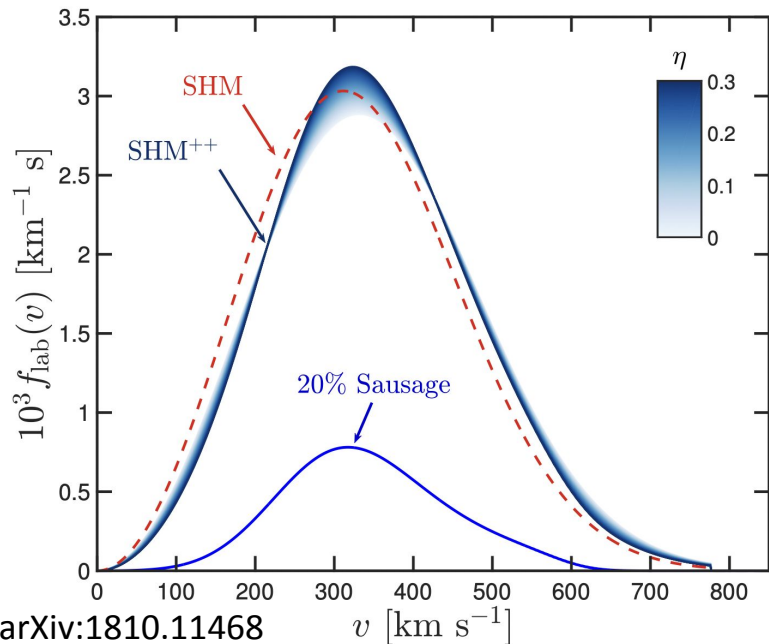


Arthur B. McDonald
Canadian Astroparticle Physics Research Institute

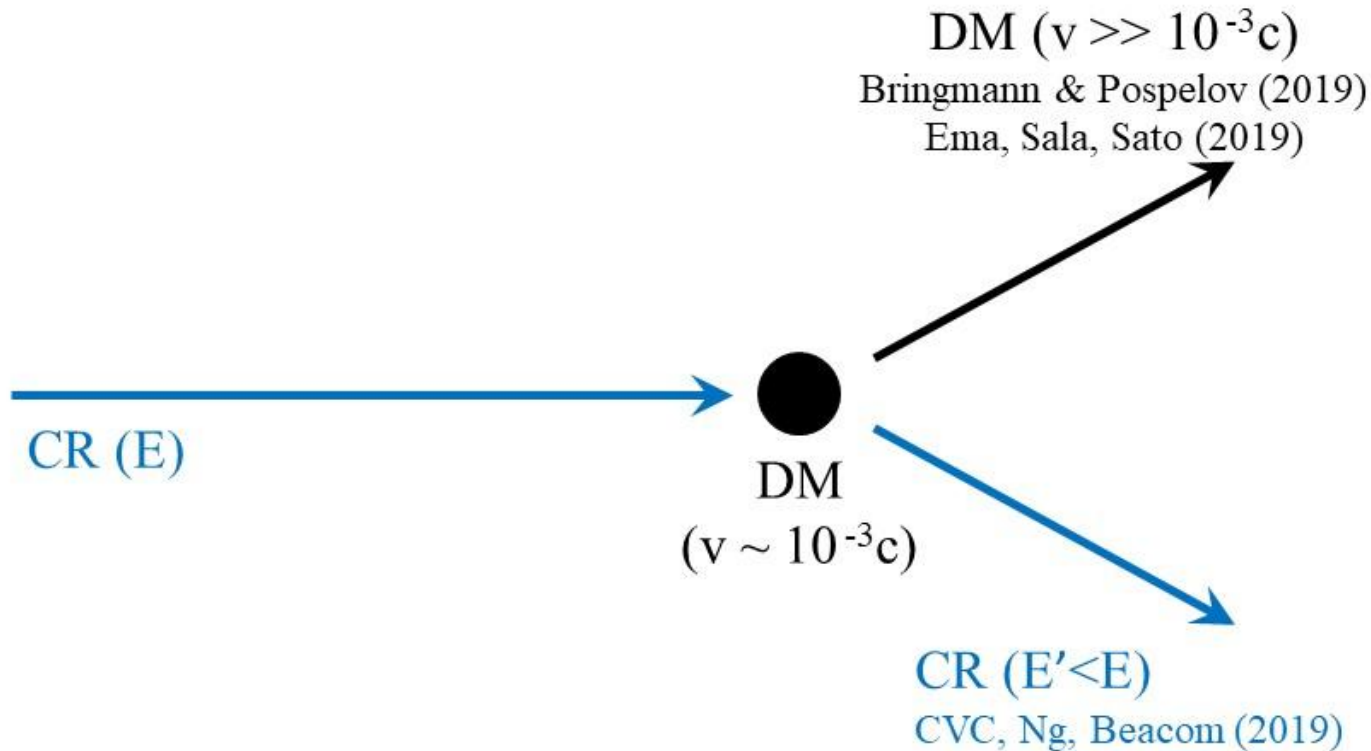


Queen's
UNIVERSITY

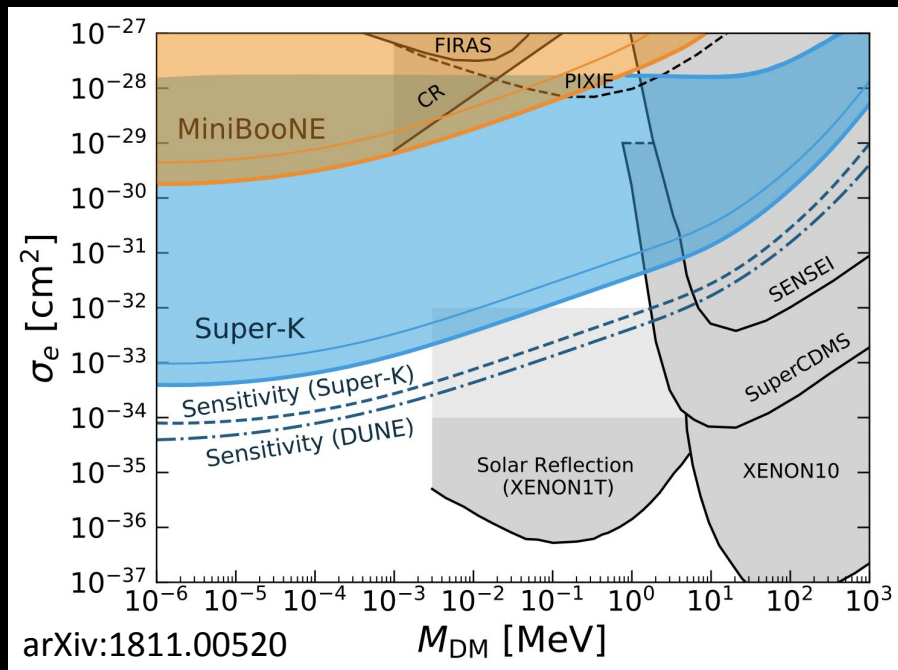
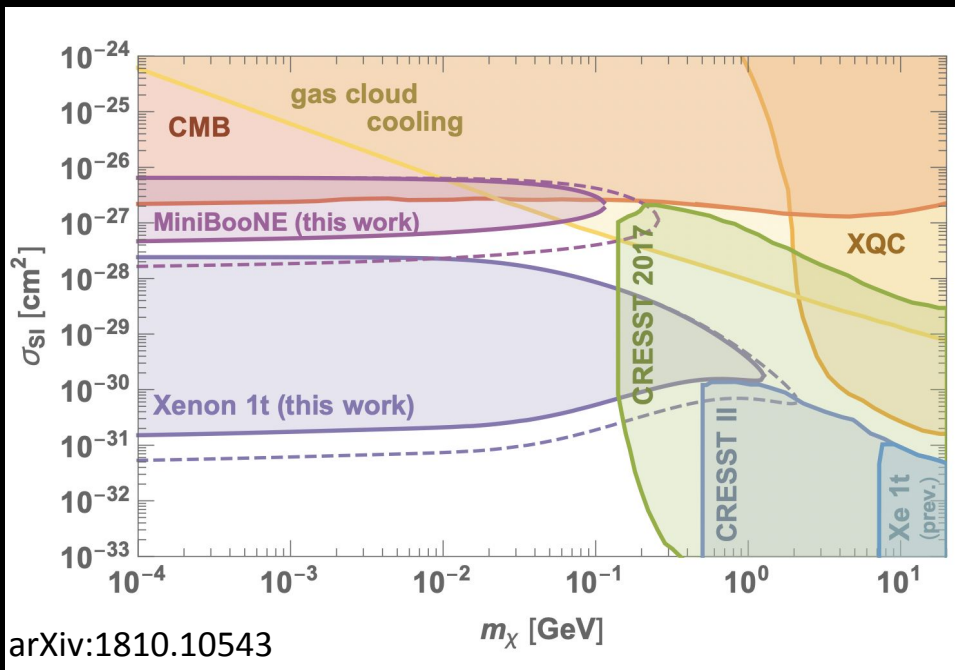
What is Dark Matter's Velocity?



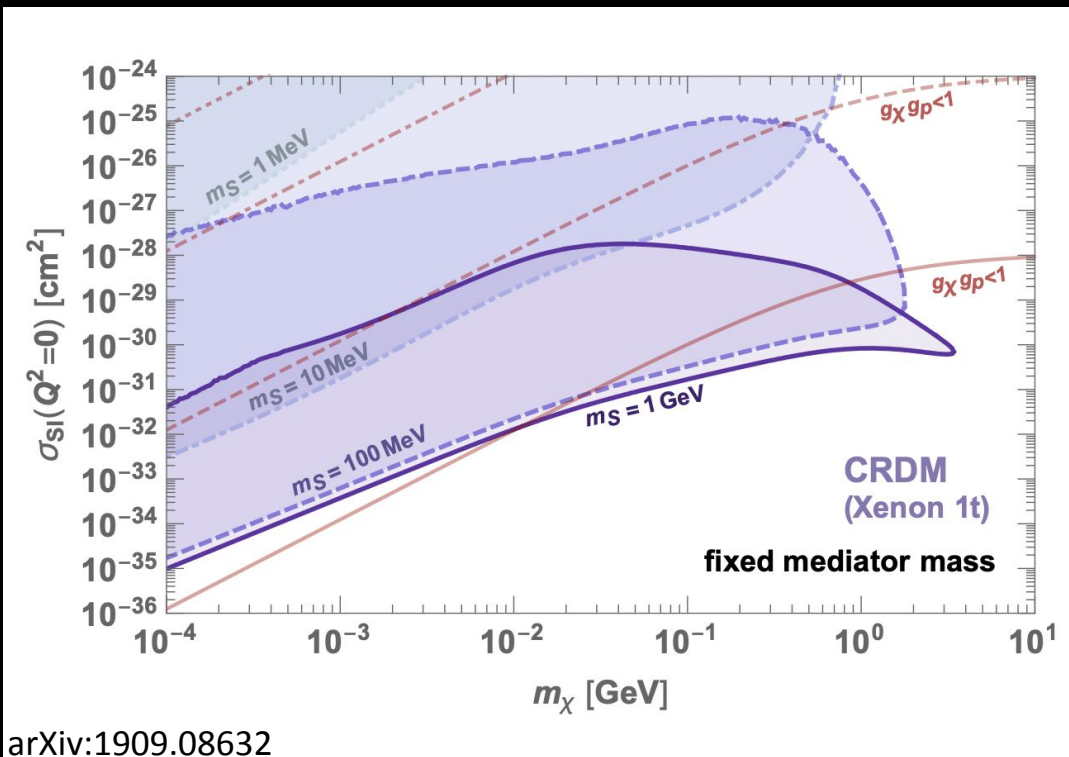
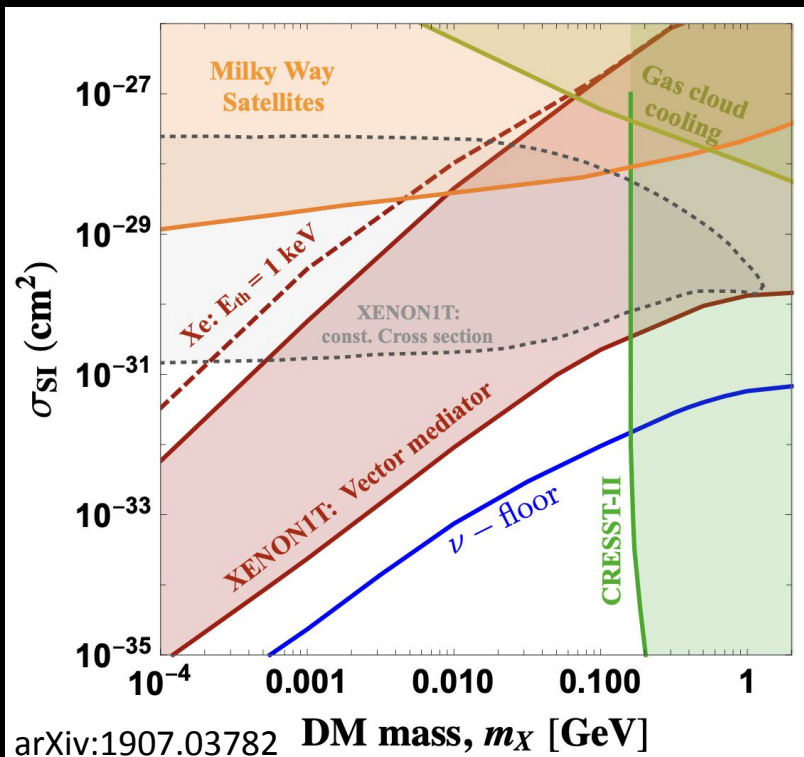
Cosmic Ray Upscattered Dark Matter



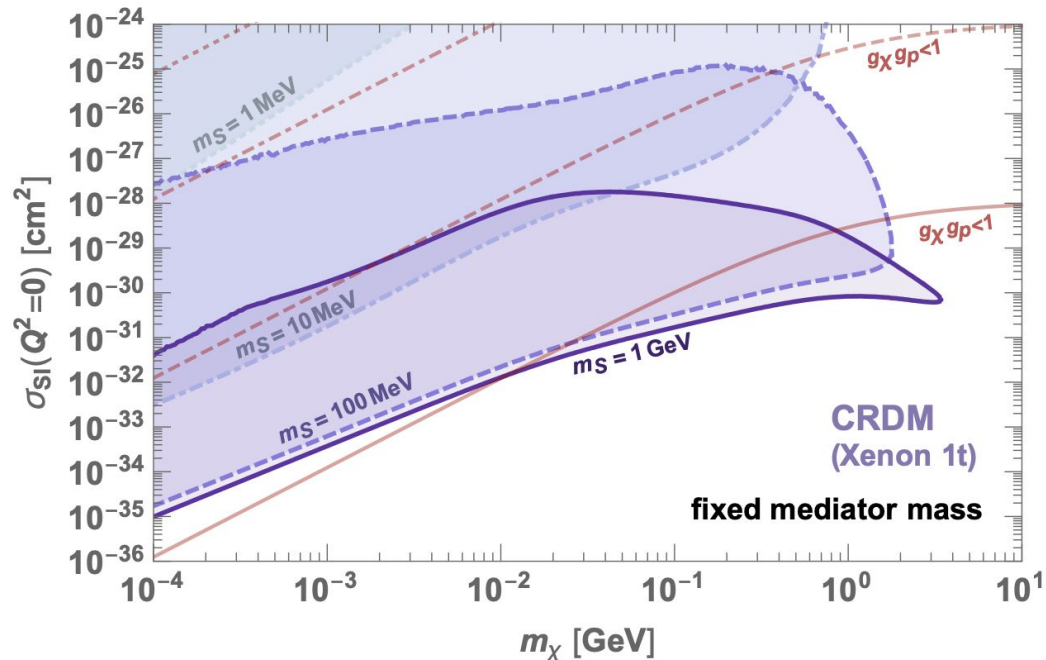
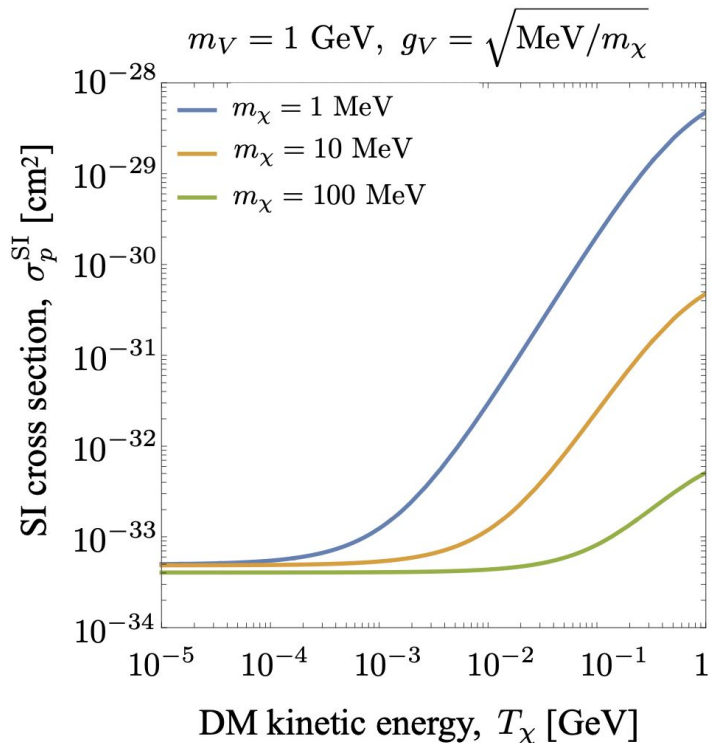
Cosmic Ray Upscattered Dark Matter



Simplified Models For Cosmic Ray DM

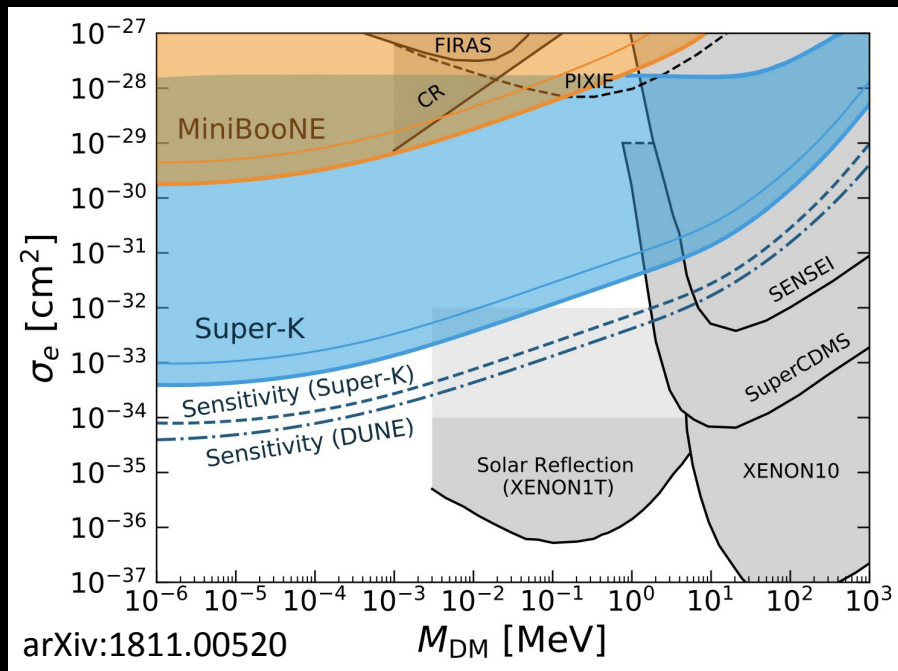
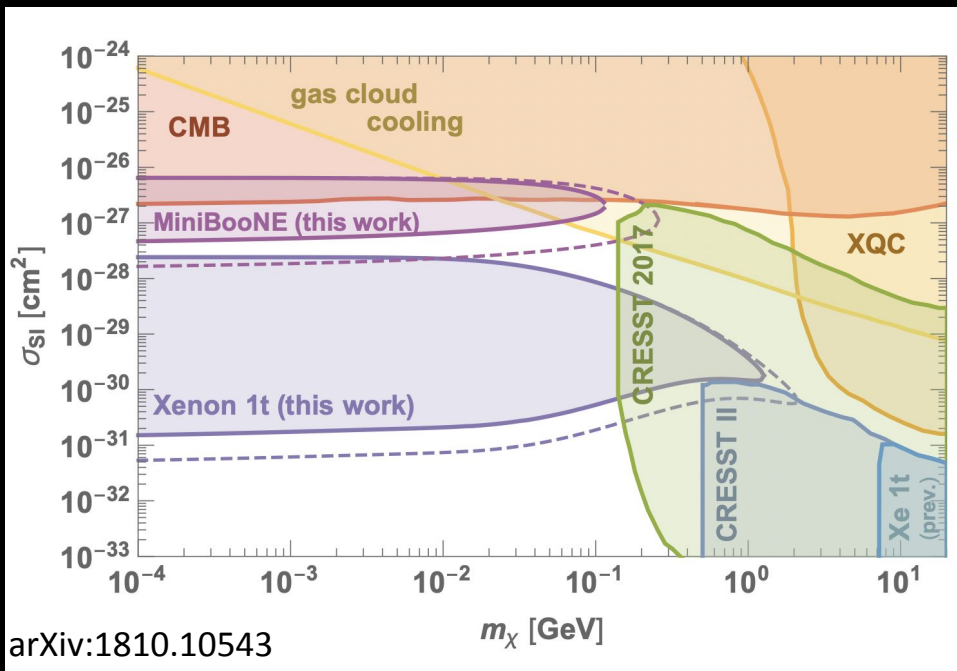


Simplified Models: Energy Scaling

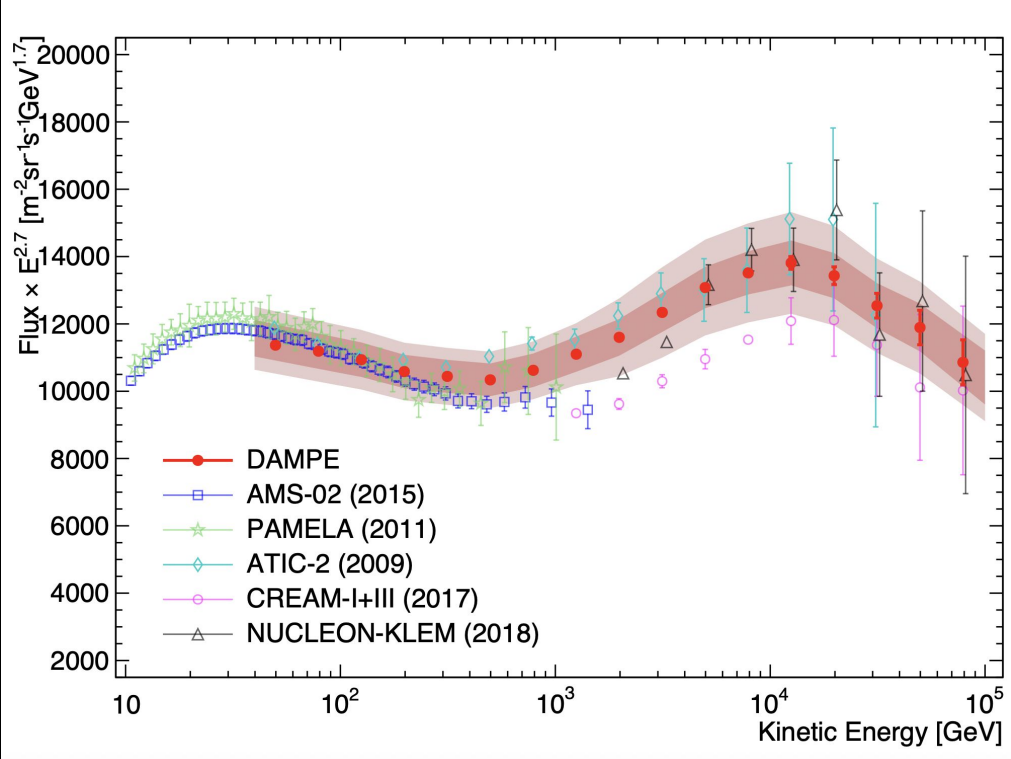
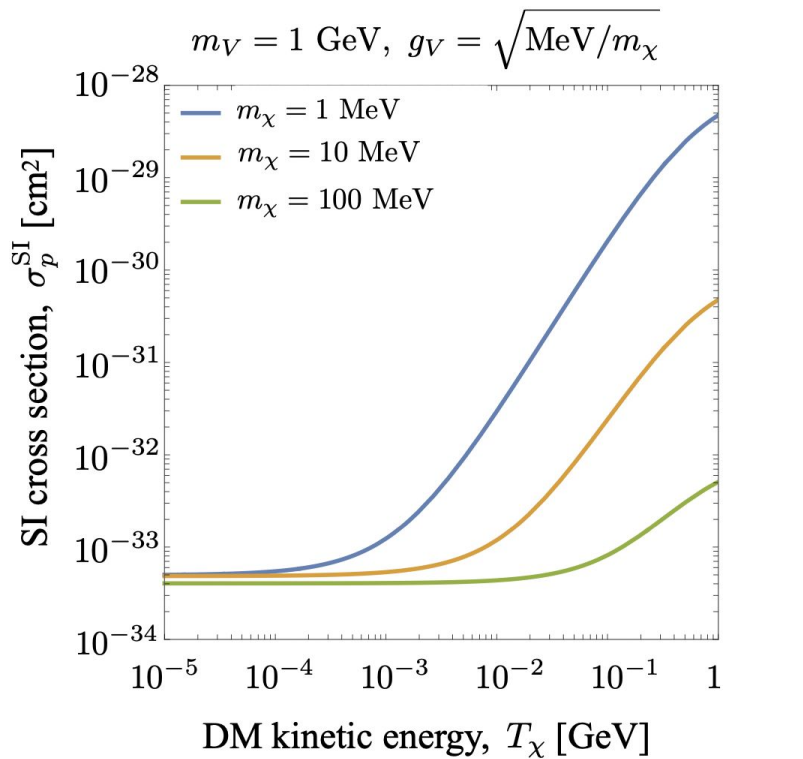


arXiv:1909.08632

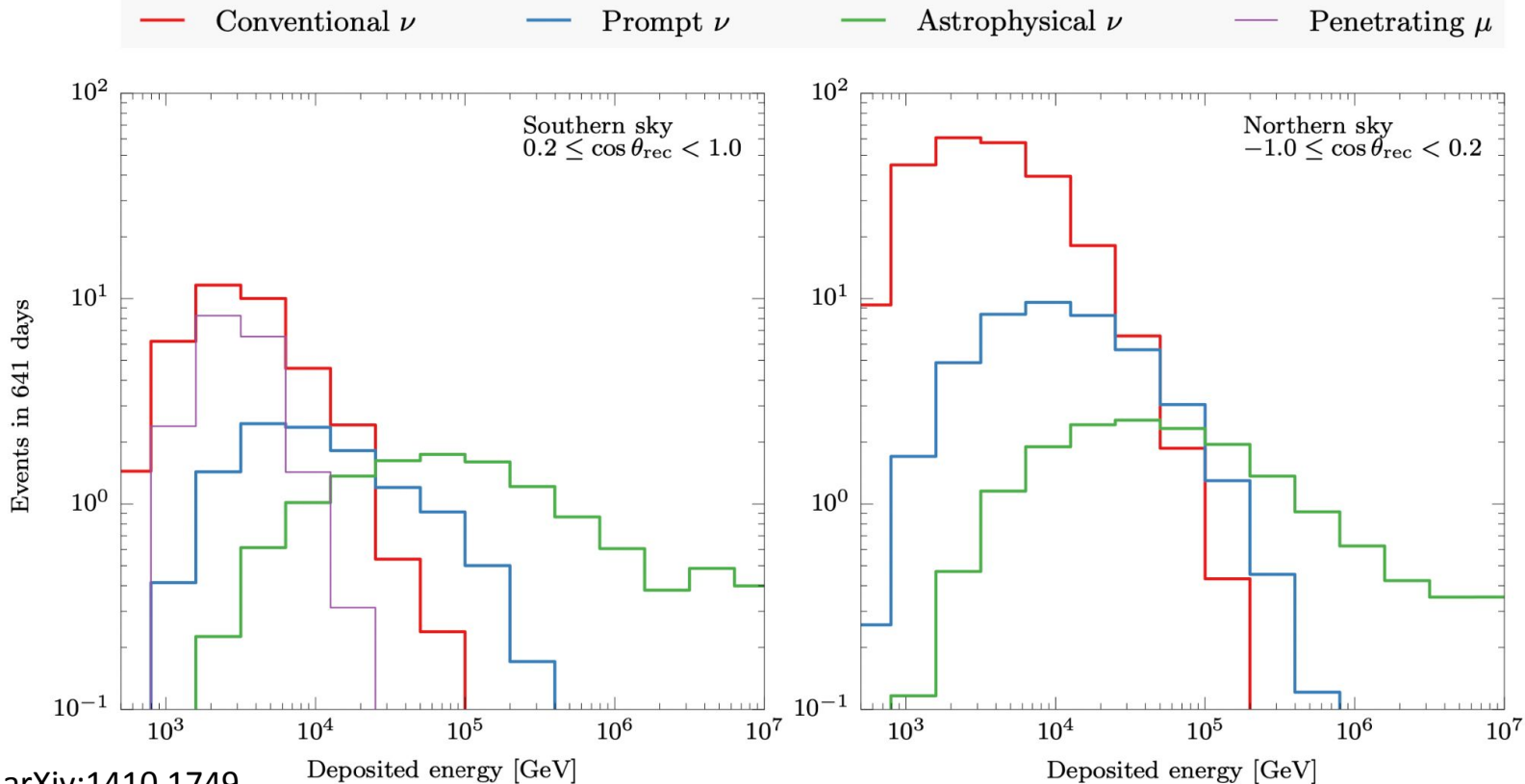
Cosmic Ray Upscattered Dark Matter



Simplified Models: Energy Scaling

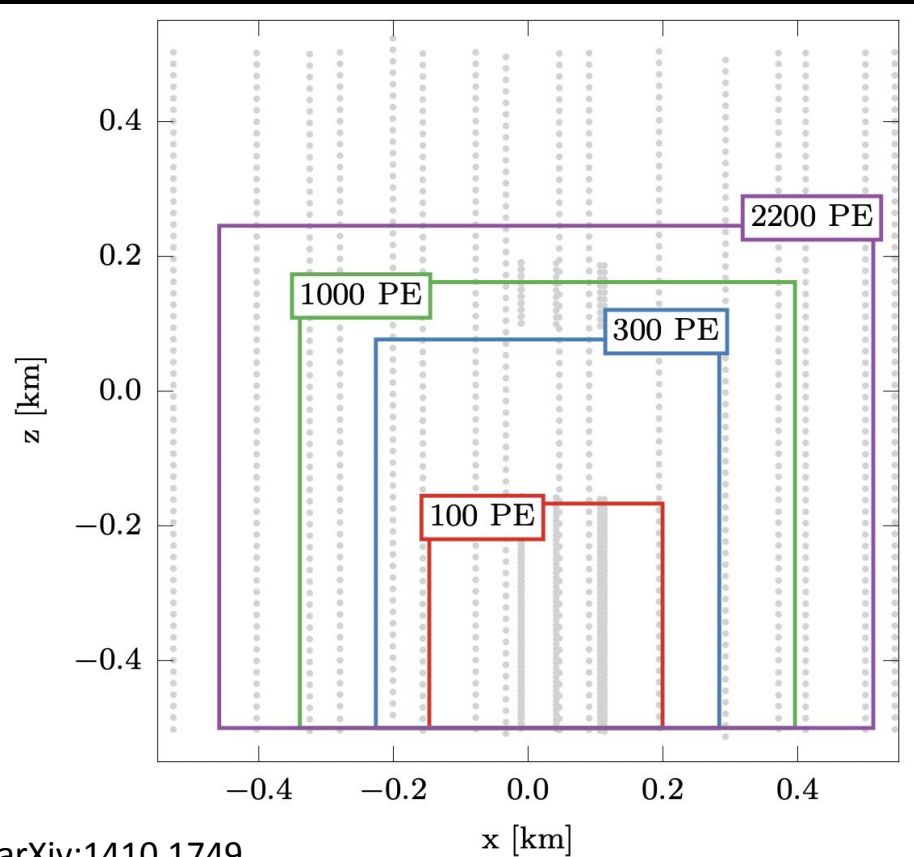


TeV-Scale Events at IceCube

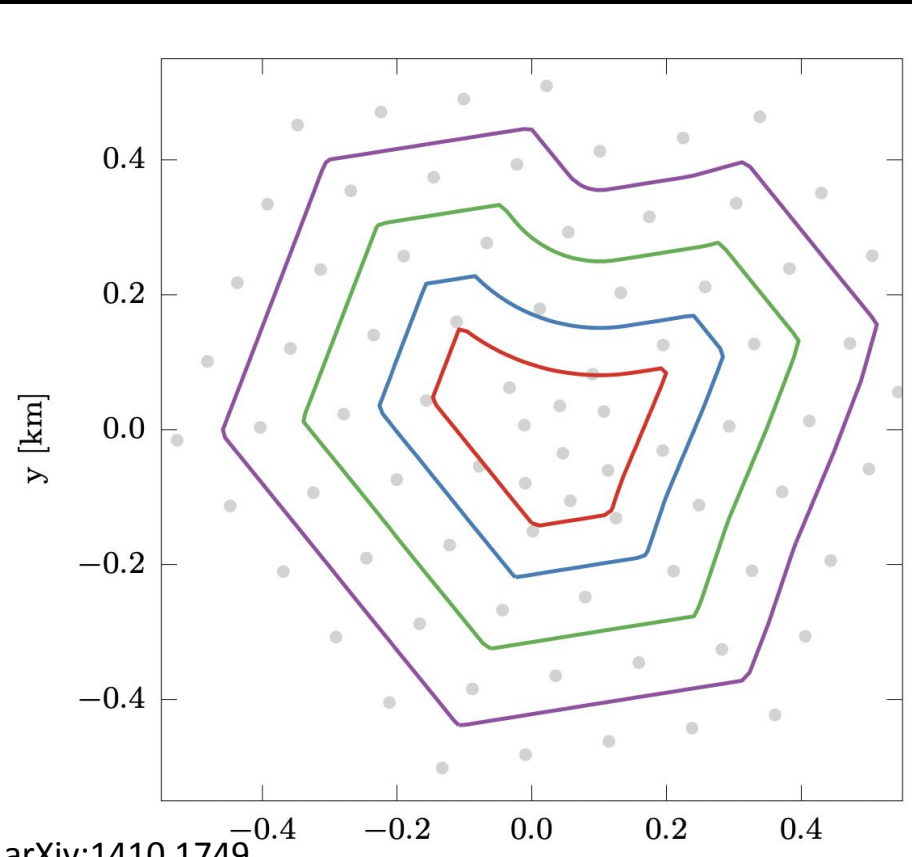


arXiv:1410.1749

IceCube Volume

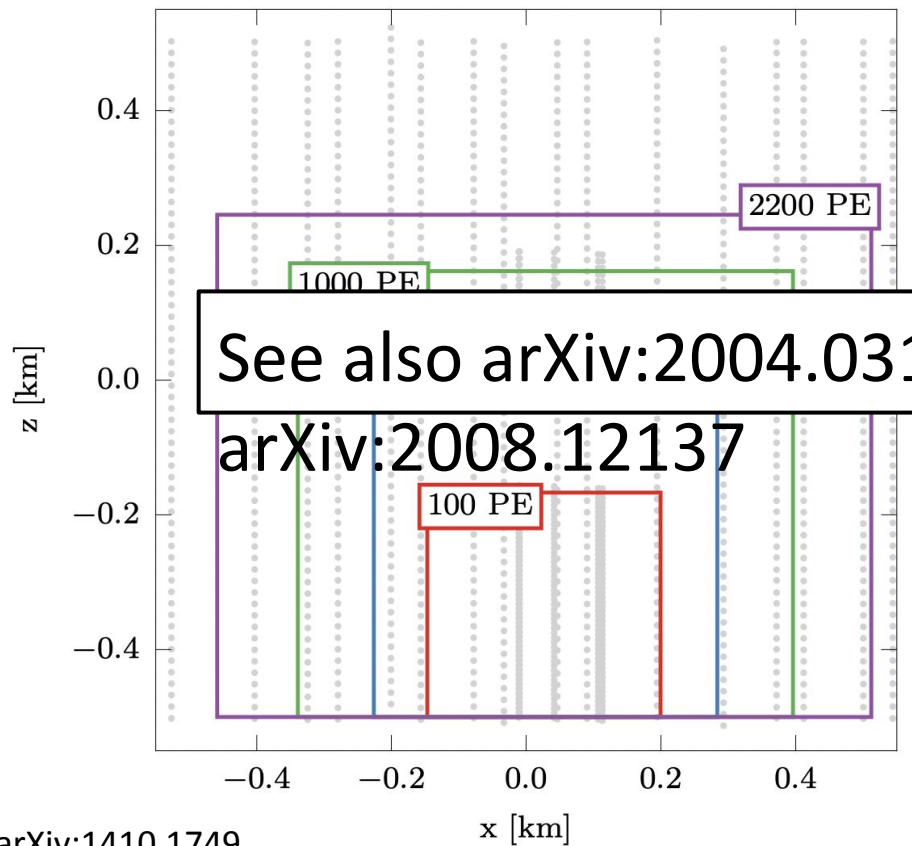


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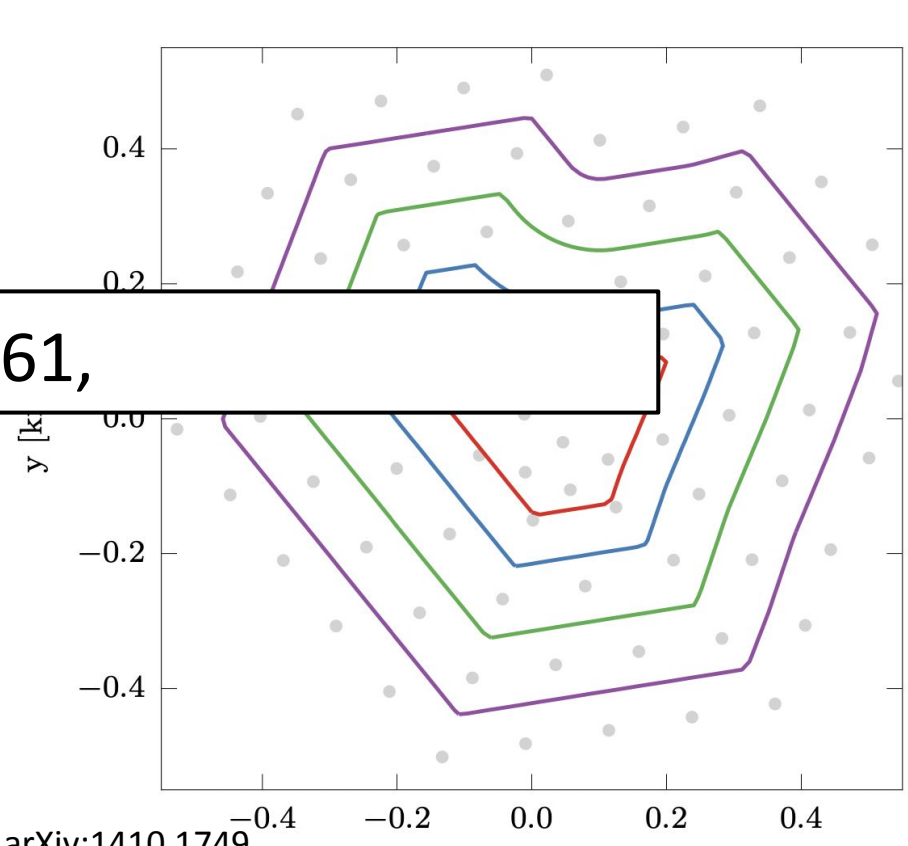


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IceCube Volume

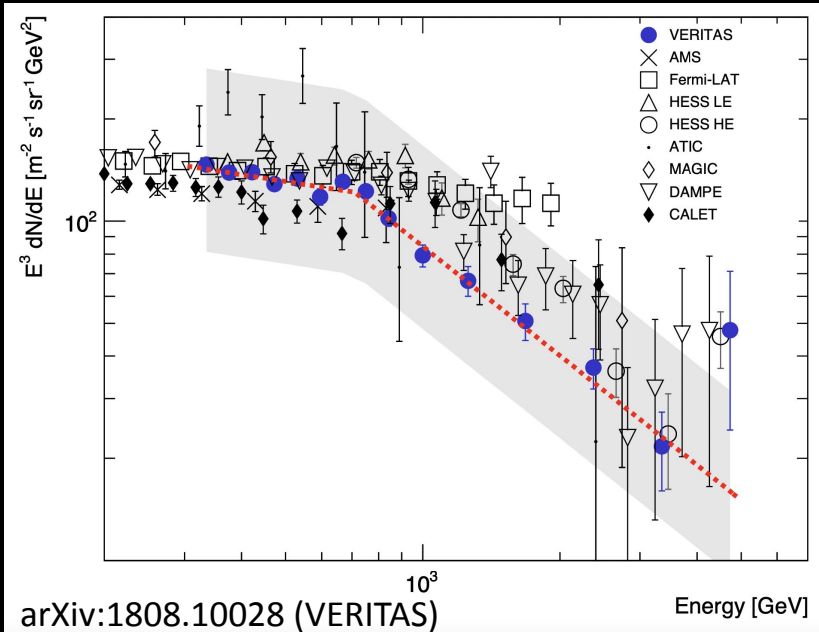


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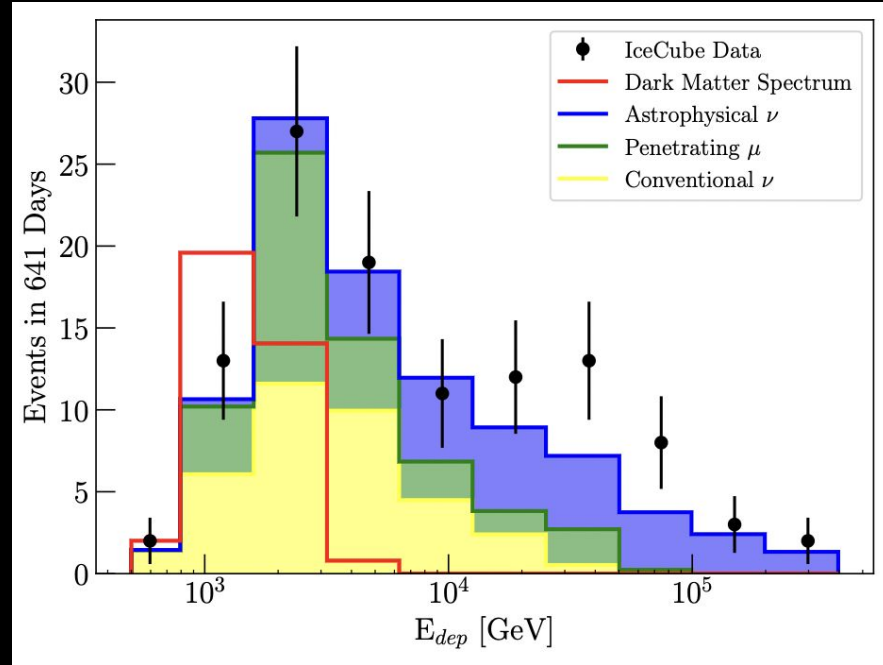
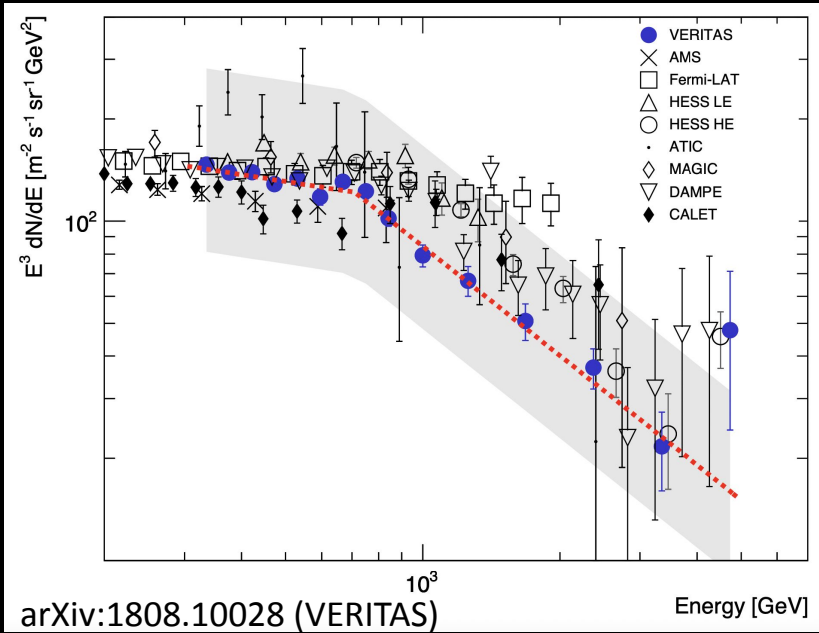
DM Upscattering by Cosmic Ray Electrons



$$\frac{d\Phi_\chi}{dT_\chi} = \int \frac{d\Omega}{4\pi} \int_{l.o.s.} dl \frac{\rho_\chi(r)}{m_\chi} \int dT_i \frac{d\sigma_{\chi i}}{dT_\chi} \frac{d\Phi_i}{dT_i}$$

$$\frac{dR}{dE_{dep}} = \left(\frac{5}{9}\right) N_A T_{exp} \int_{T_{\chi,min}}^{\infty} M_{eff}(E_{dep}) \frac{d\sigma_{\chi e}}{dE_{dep}} \frac{d\Phi_\chi}{dT_\chi}$$

DM Upscattering by Cosmic Ray Electrons

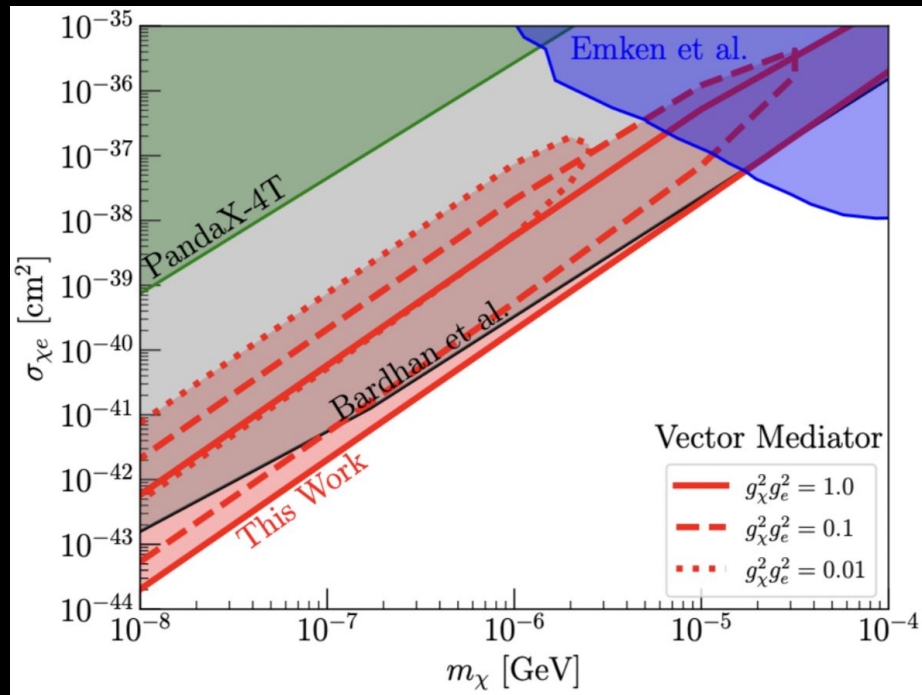
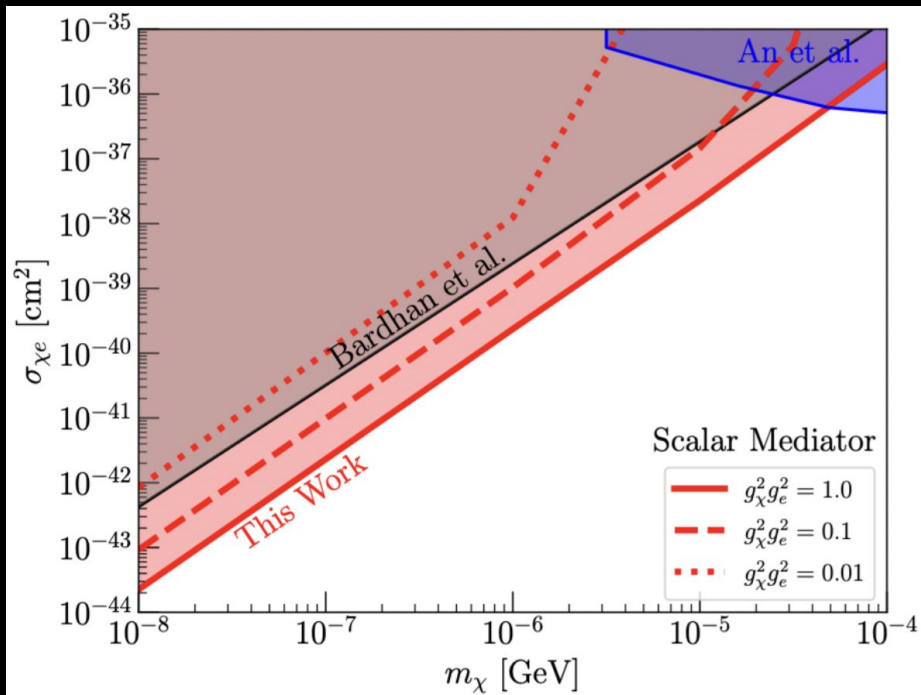


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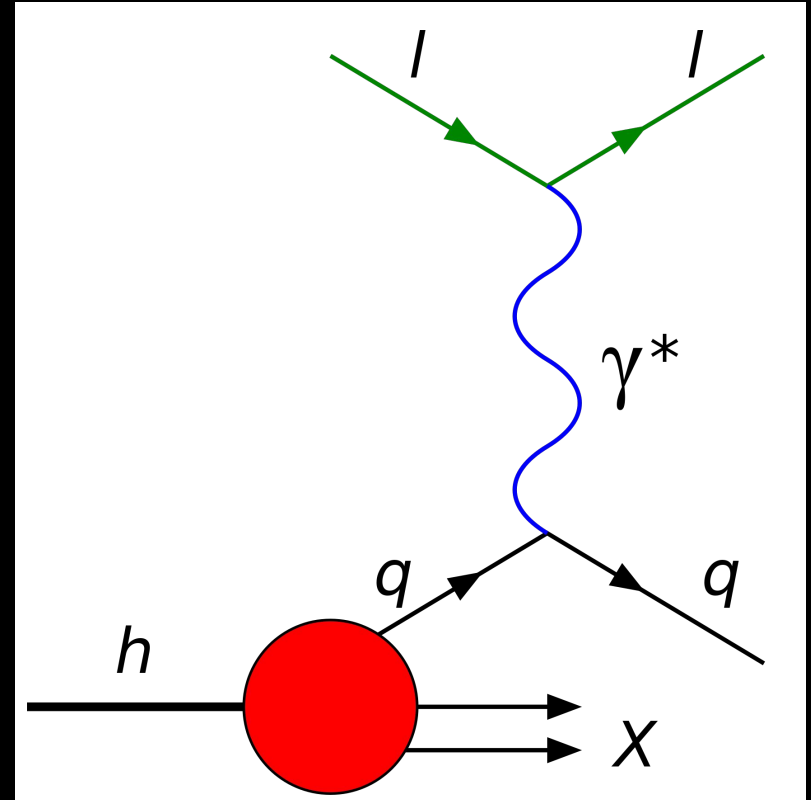
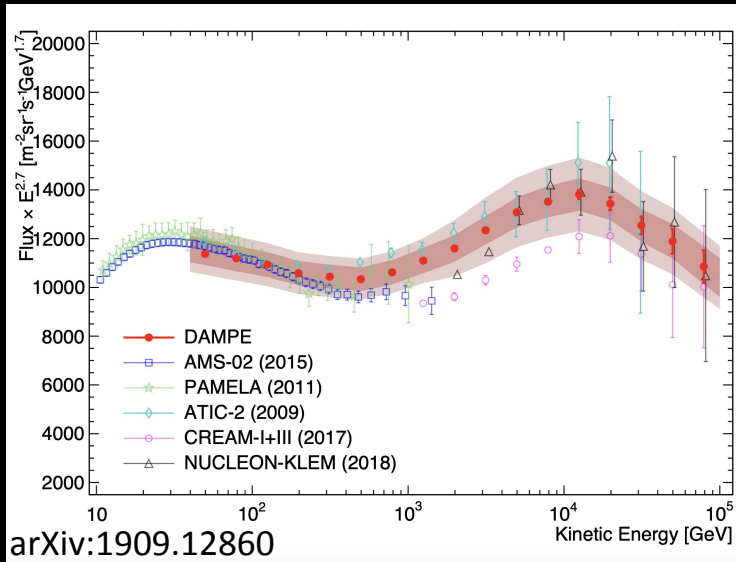
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- Data from arXiv:1410.1749 (IceCube)
- Perform binned likelihood analysis including neutrino/muon backgrounds modeled by IceCube

DM Upscattering by Cosmic Ray Electrons

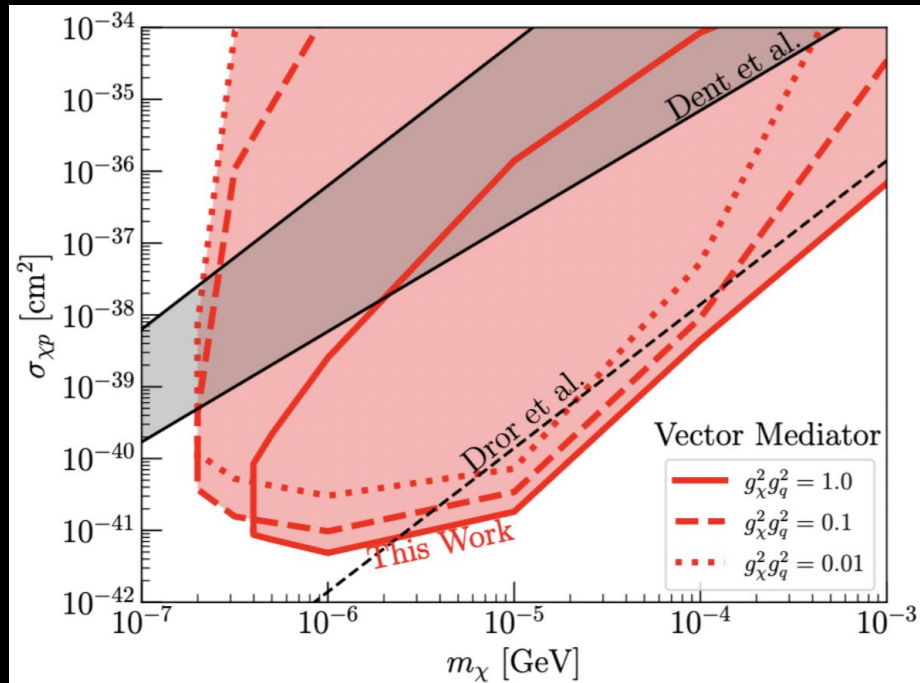
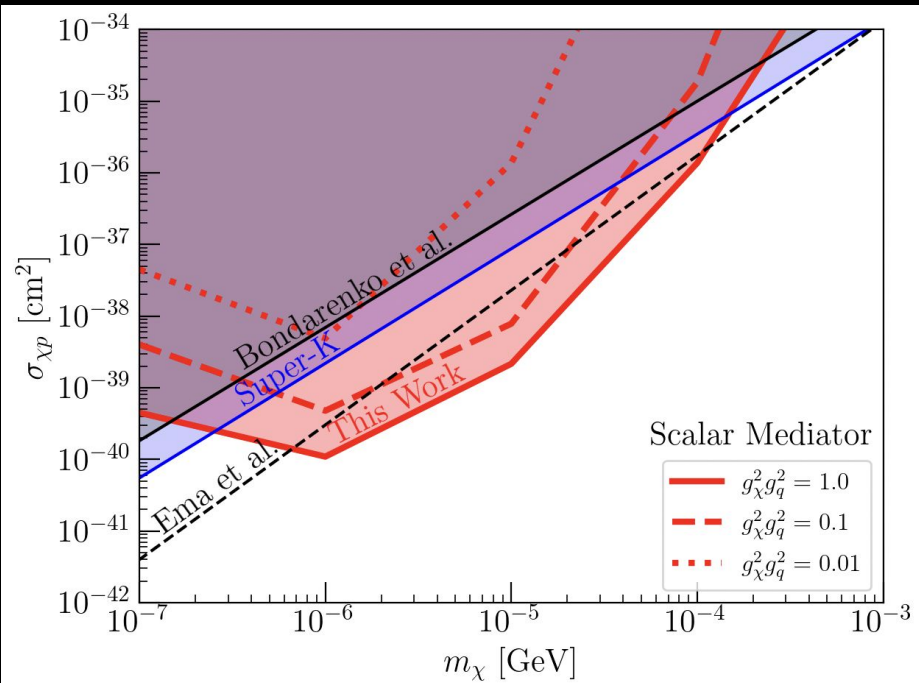


DM Upscattering by Cosmic Ray Protons



$$\frac{d\sigma}{d\nu dQ^2} = \frac{1}{2\nu} \frac{g_q^2 g_\chi^2}{4\pi(Q^2 + m_Z^2)^2} \times \left(1 - \frac{\nu}{E_\chi} + \frac{\nu^2}{2E_\chi^2} - \frac{Q^2}{4E_\chi^2}\right) F_2(x, Q^2)$$

DM Upscattering by Cosmic Ray Protons



Thank you!