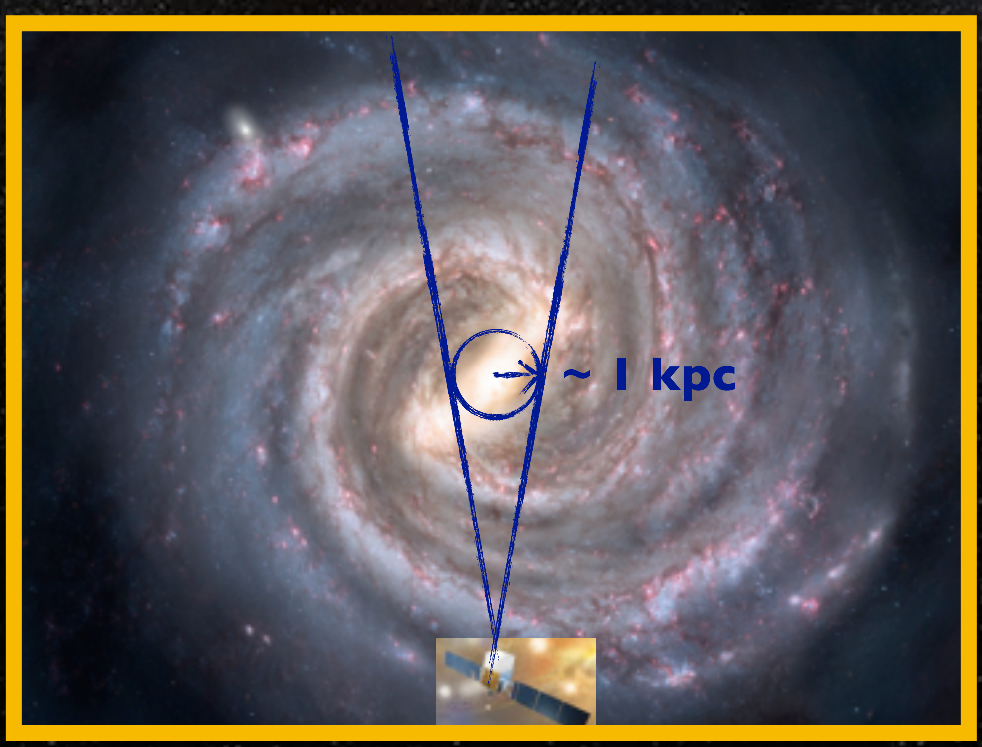
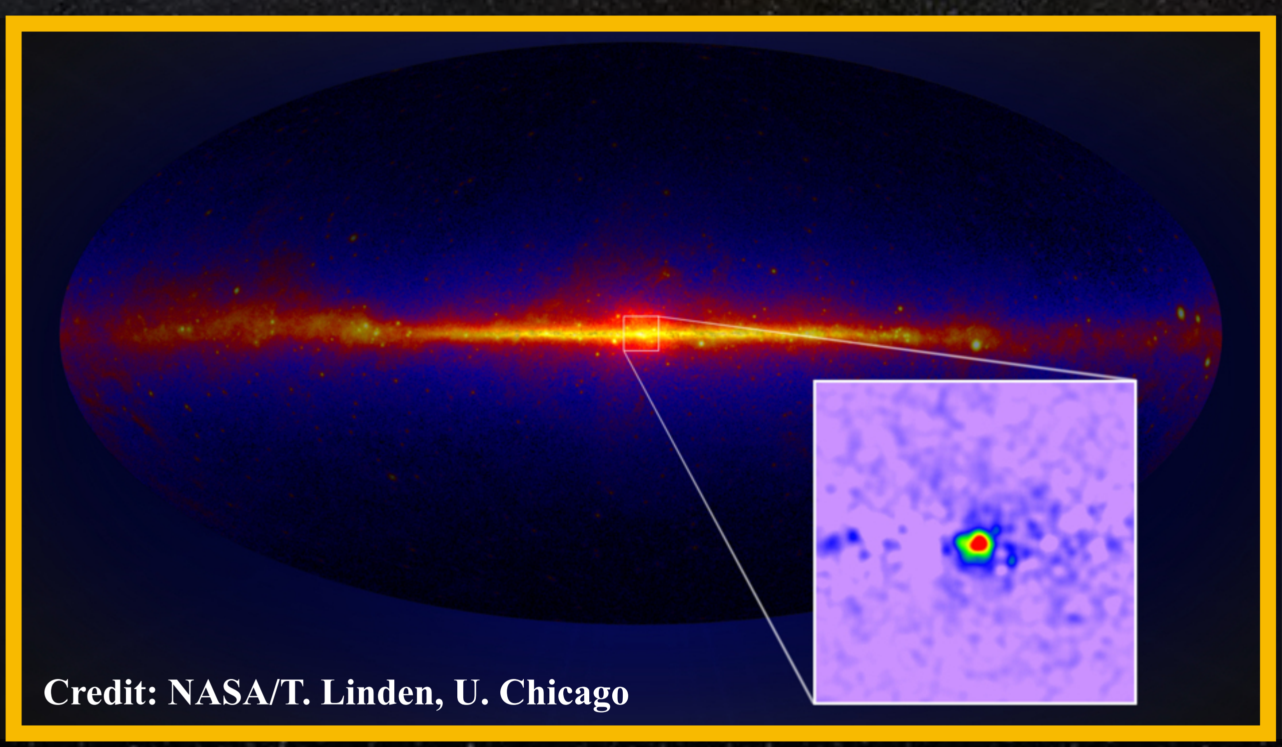
Credit: ESO/S. Brunier

The Galactic Center Excess

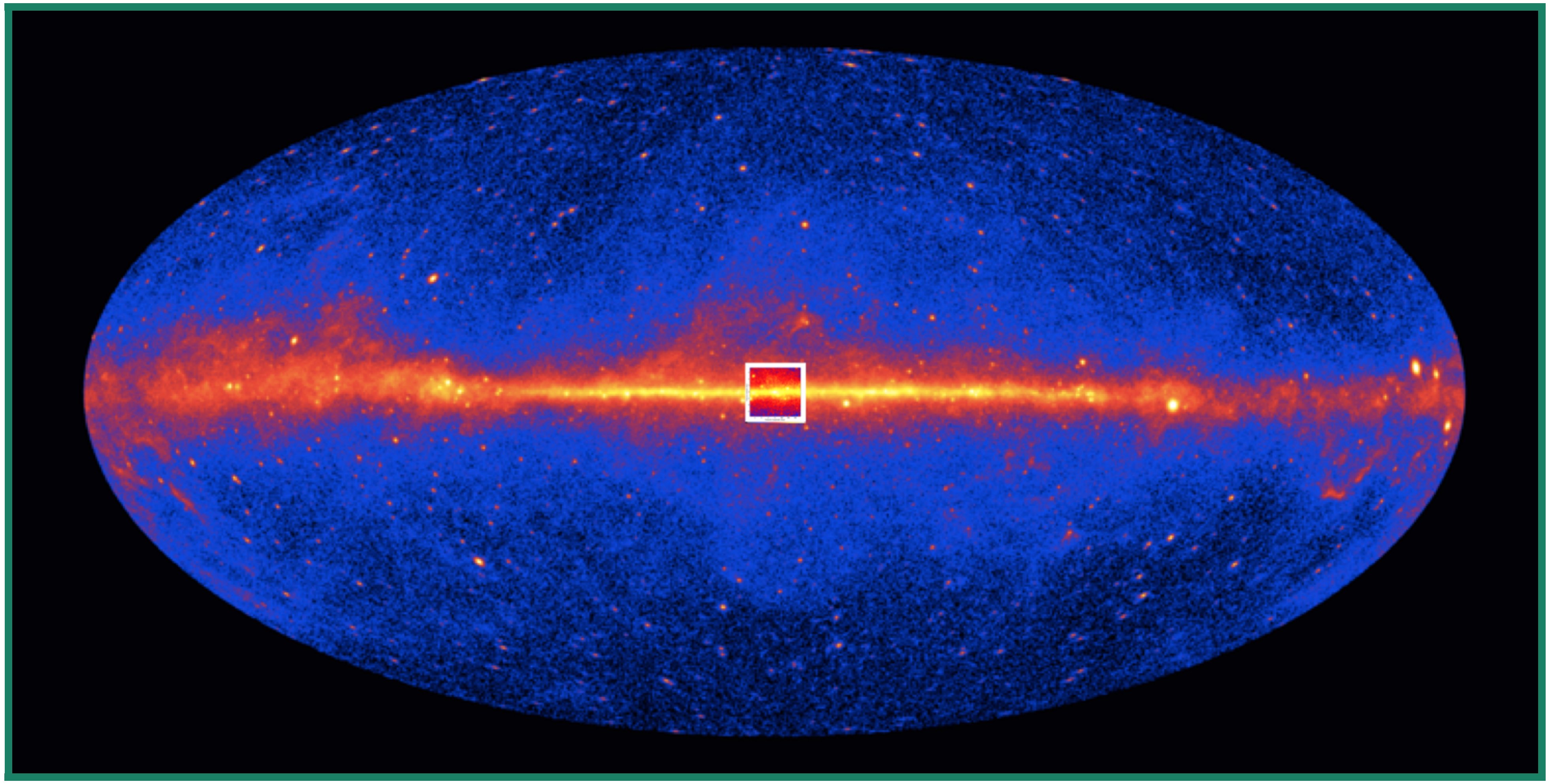




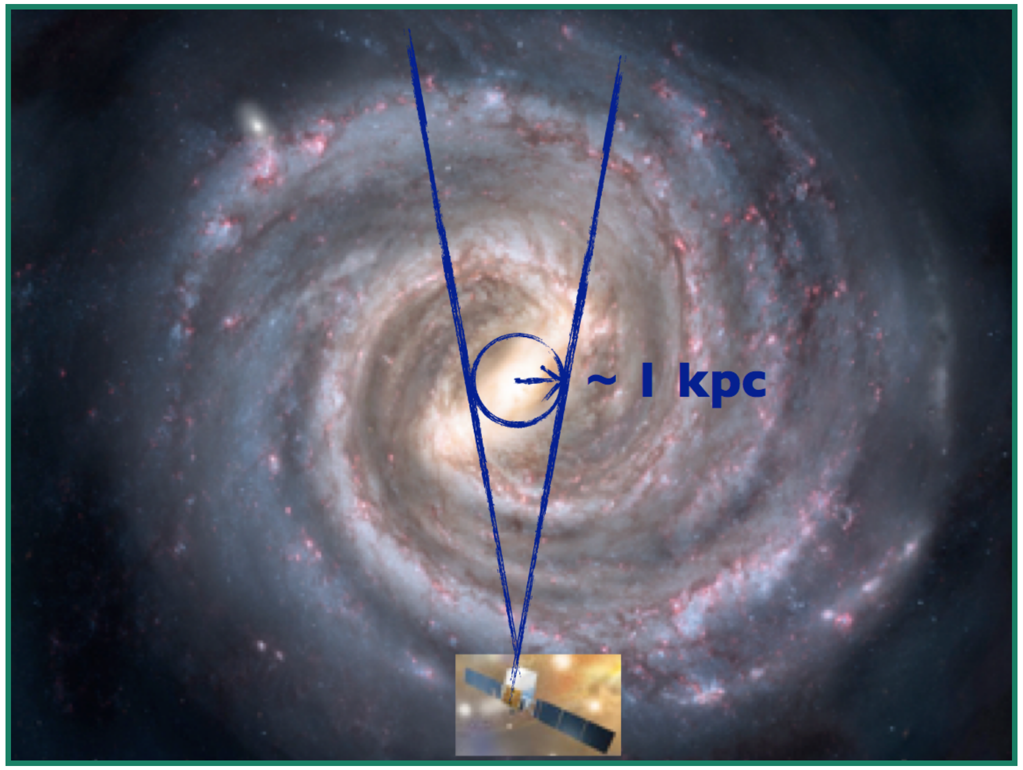
Credit: NASA/T. Linden, U. Chicago

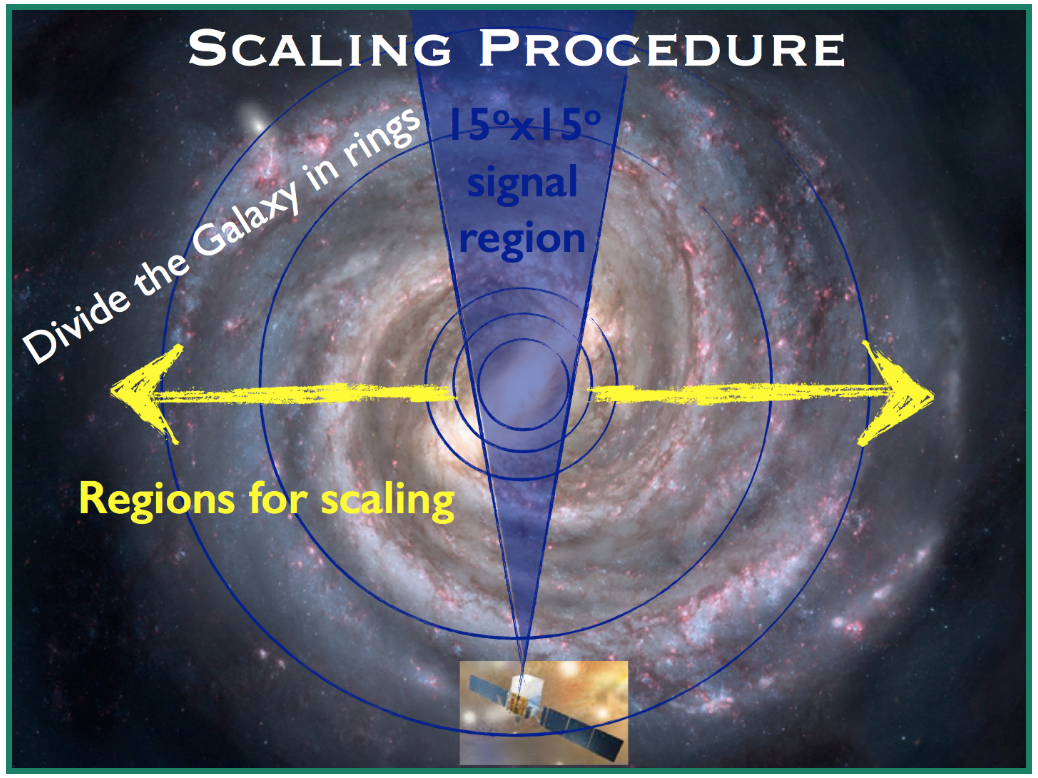
The Galactic Center Excess

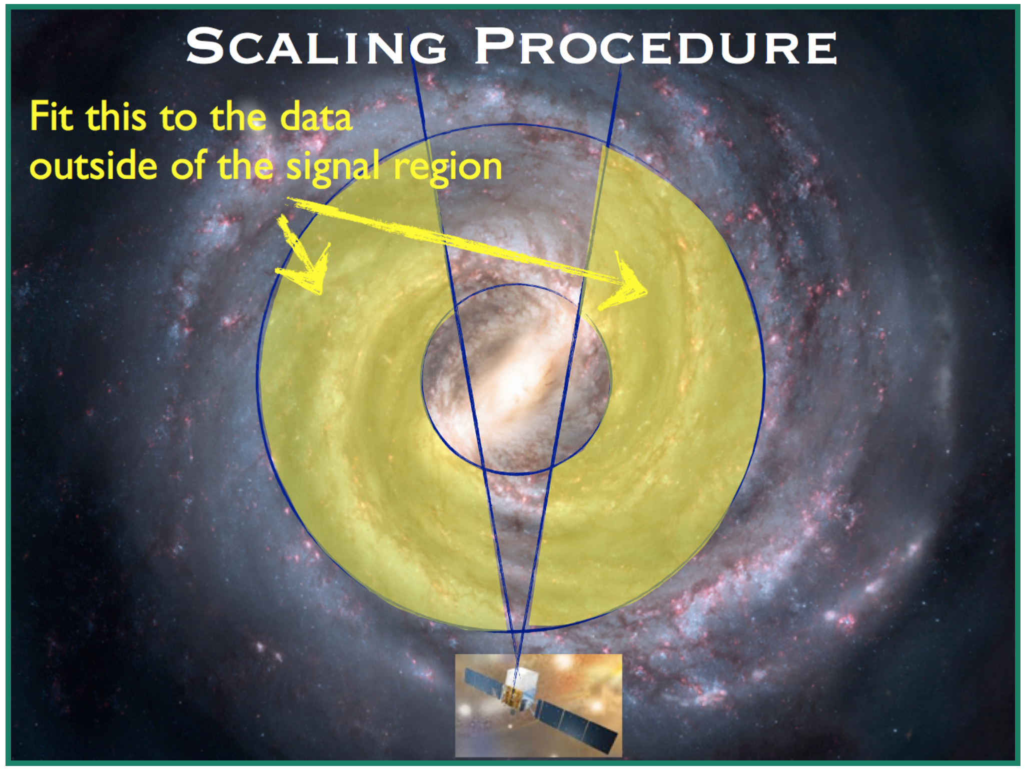
We analyze a 15x15 degree region centered about the Galactic center, corresponding to the white box in the image.

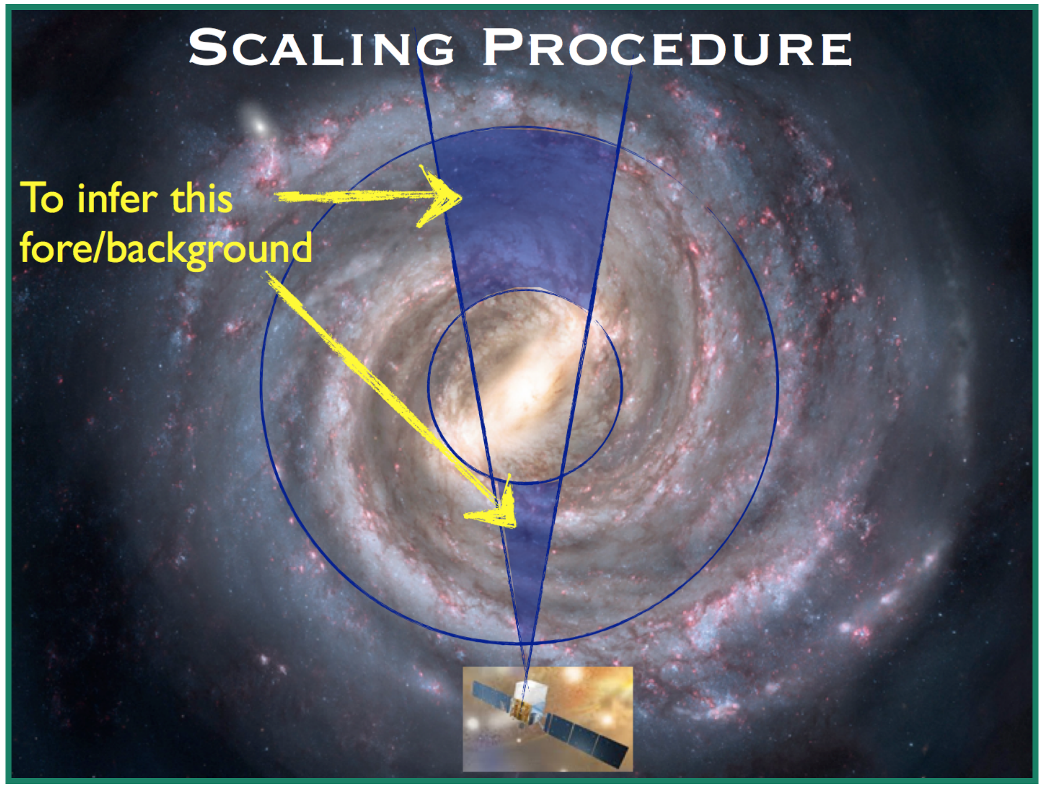


The Galactic Center Excess

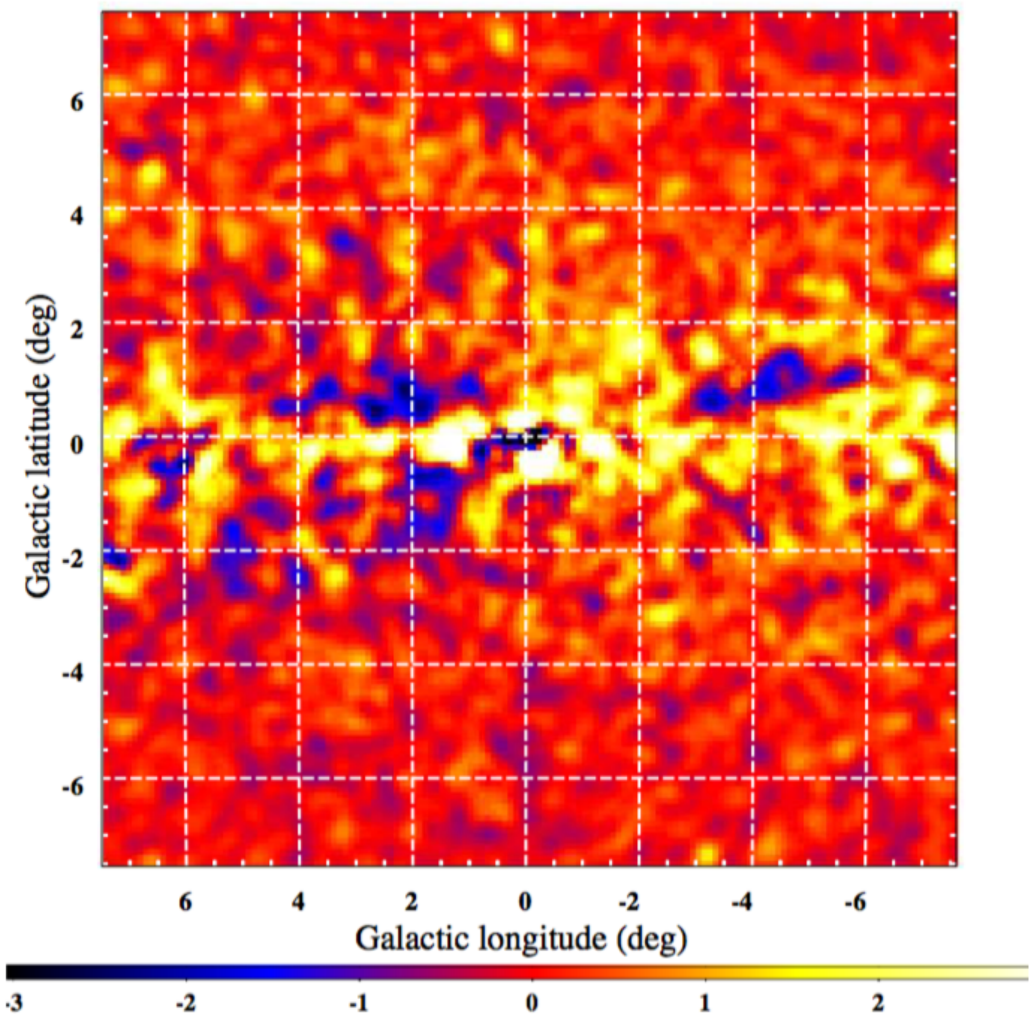


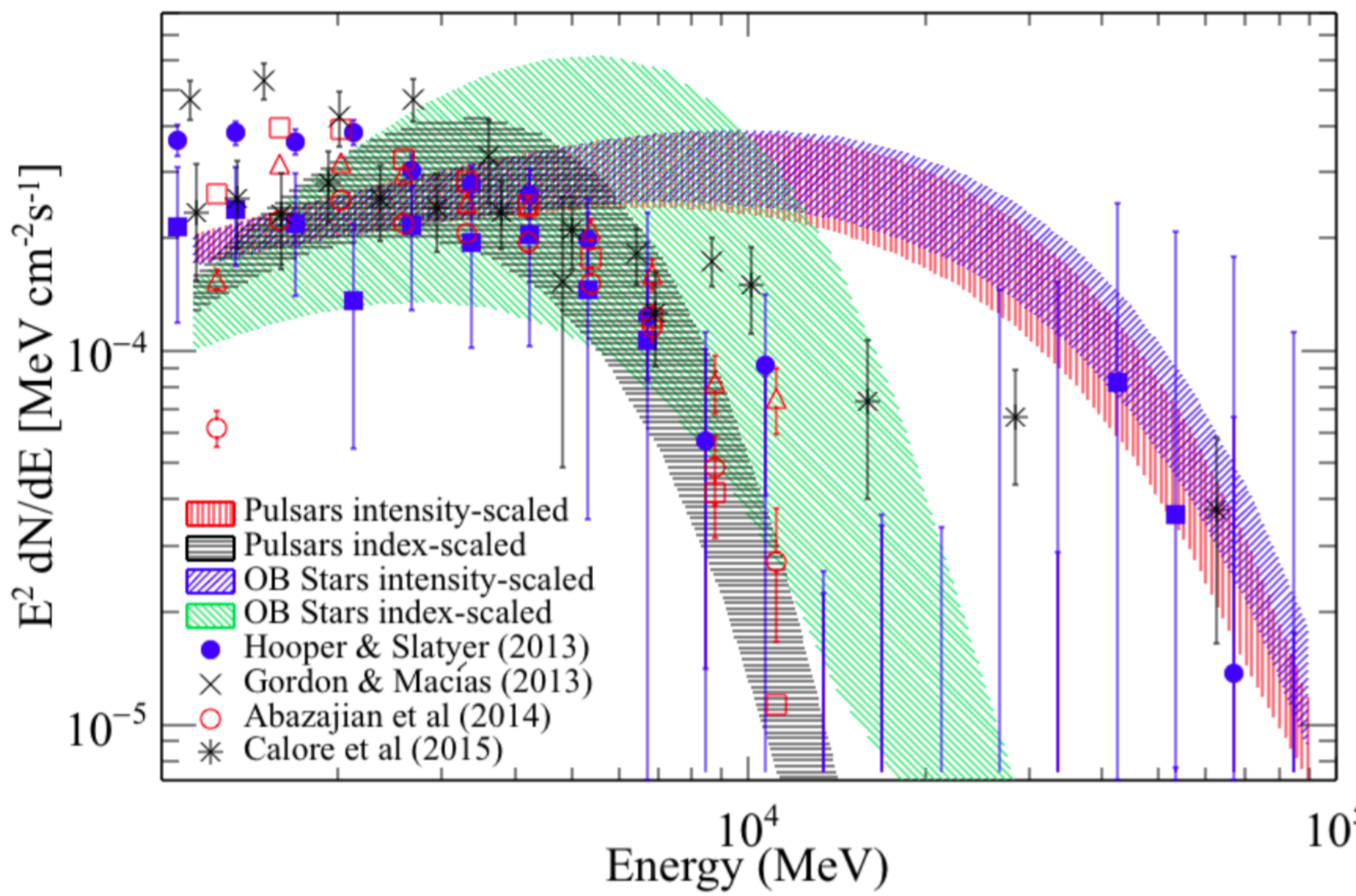






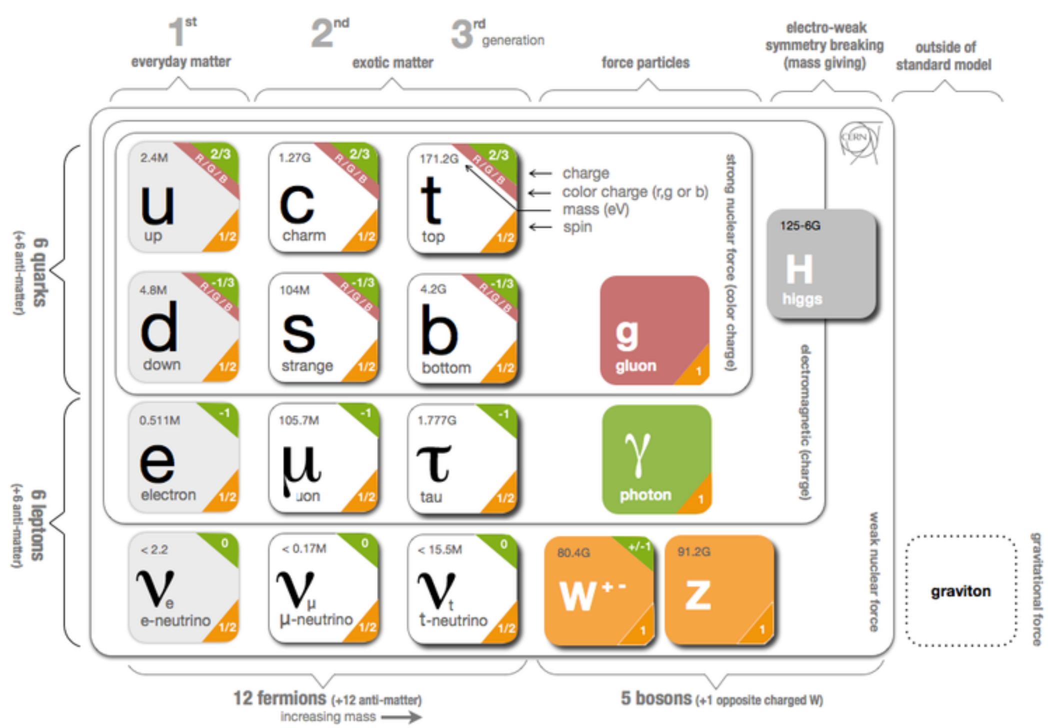
The Galactic Center Excess

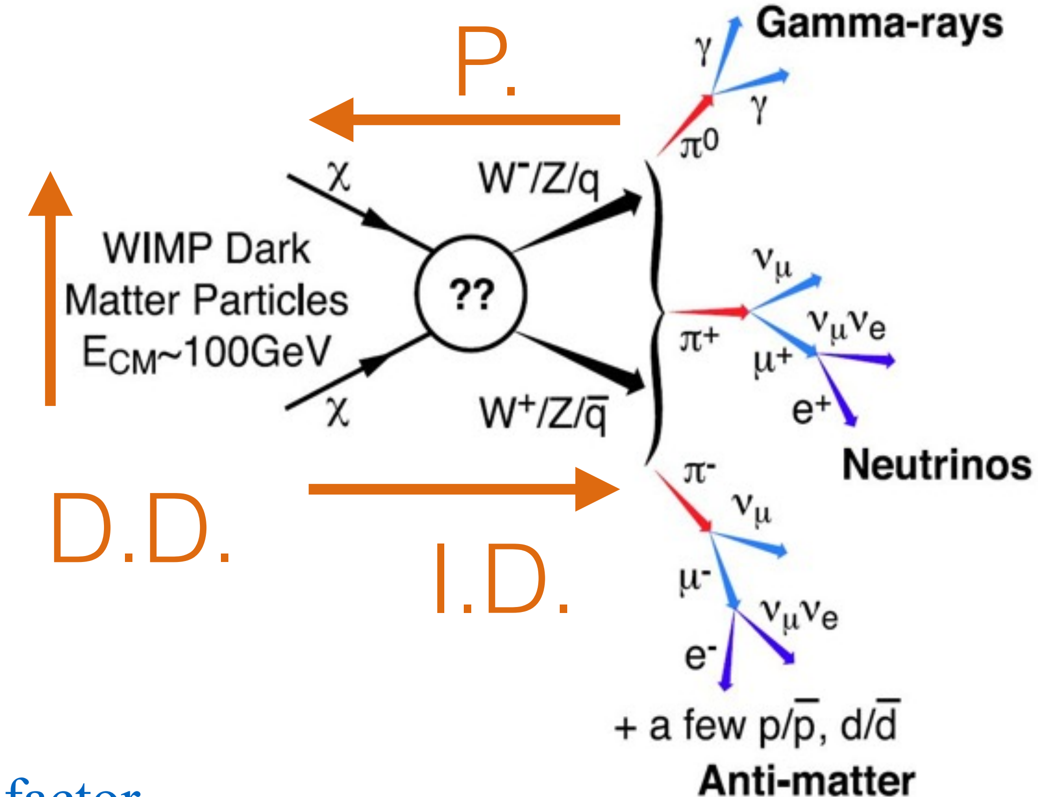




- From Ajello et al. 2016.
- Excess emission observed toward the Galactic center.
- The GC excess was first reported by Goodenough and Hooper in 2009, and has since been the subject of numerous studies.
- **Possible interpretations include mis-modeling of the foreground/background emission, population of unresolved sources (millisecond pulsars), and/or dark matter annihilation**.
- Galactic center is a complicated region! Significant systematic uncertainties.

Dark Matter Interpretation



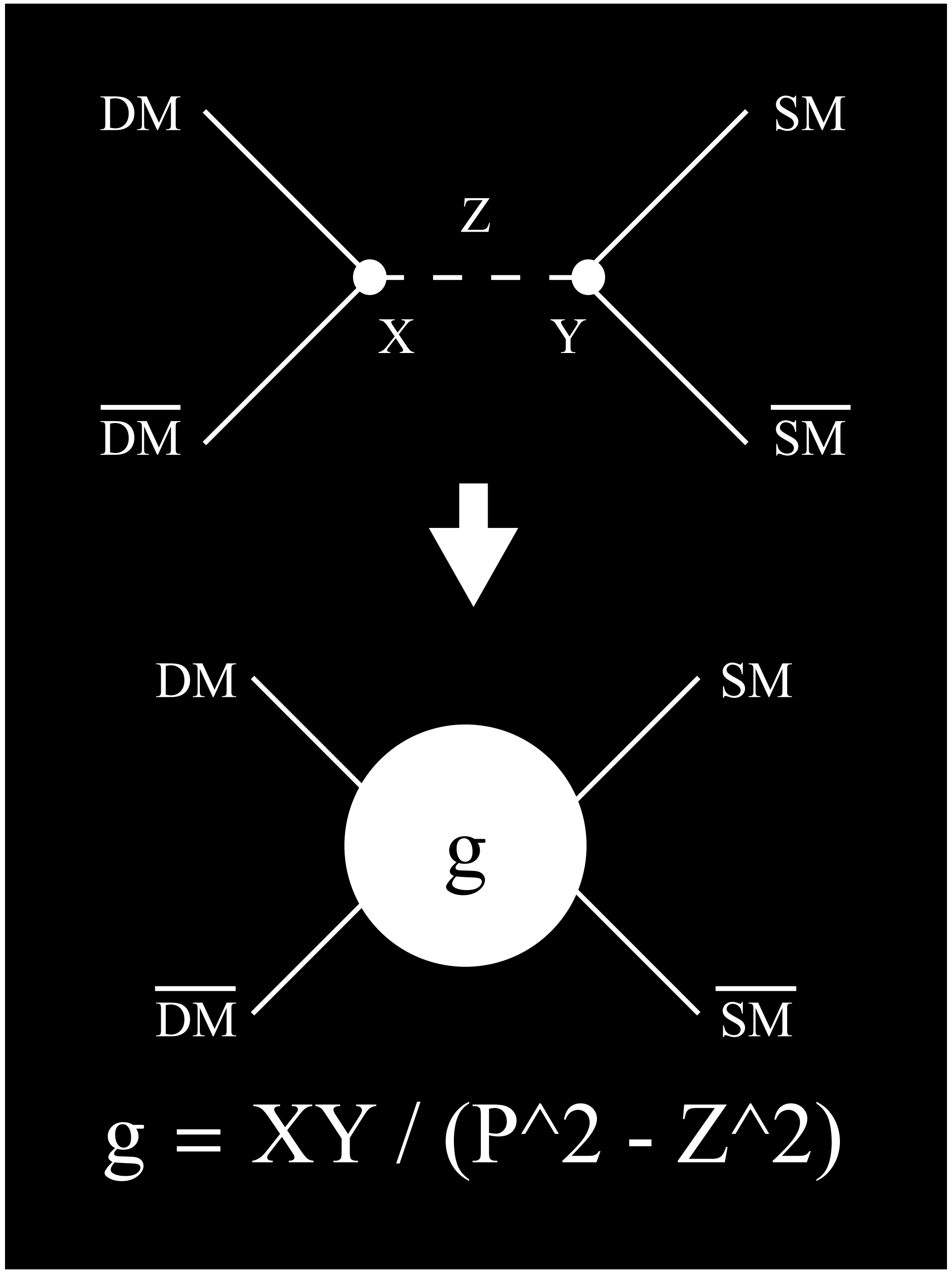


Particle — J-factor

$$\frac{dN_\gamma}{dE} = \sum_f \frac{\langle \sigma_f v \rangle}{4\pi\eta m_\chi^2} \frac{dN_\gamma^f}{dE} \times \int_{\Delta\Omega} d\Omega' \int_{\text{los}} ds \rho^2(r(s,\psi))$$

$$\rho(r) = \rho_0 \left(\frac{r}{R_s}\right)^{-\gamma} \left(1 + \frac{r}{R_s}\right)^{\gamma-3}$$

Dark Matter Interpretation



$$\mathcal{L}_{\rm ps} = \bar{\chi}\gamma_5\chi \times \sum_i \left\{ \frac{m_{u_i}}{\Lambda_u^3}\bar{u}_i\gamma_5 u_i + \frac{m_{d_i}}{\Lambda_d^3}\bar{d}_i\gamma_5 d_i + \frac{m_{\ell_i}}{\Lambda_\ell^3}\bar{\ell}_i\gamma_5\ell_i \right\}, \quad (2)$$

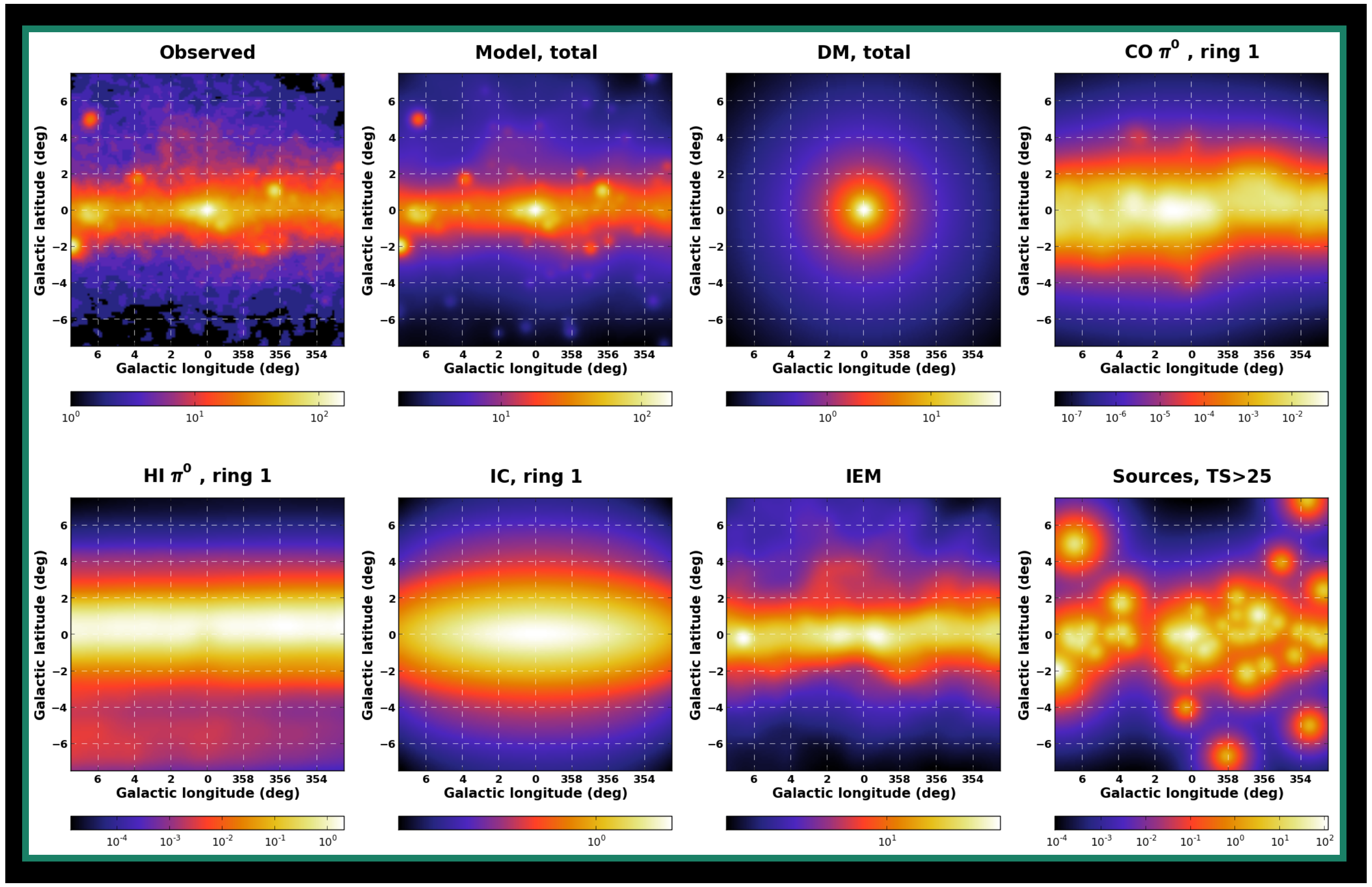
$$\mathcal{L}_{\rm vec} = \bar{\chi}\gamma^\mu\chi \times \sum_i \left\{ \frac{1}{\Lambda_u^2}\bar{u}_i\gamma_\mu u_i + \frac{1}{\Lambda_d^2}\bar{d}_i\gamma_\mu d_i + \frac{1}{\Lambda_\ell^2}\bar{\ell}_i\gamma_\mu\ell_i \right\}, \quad (3)$$

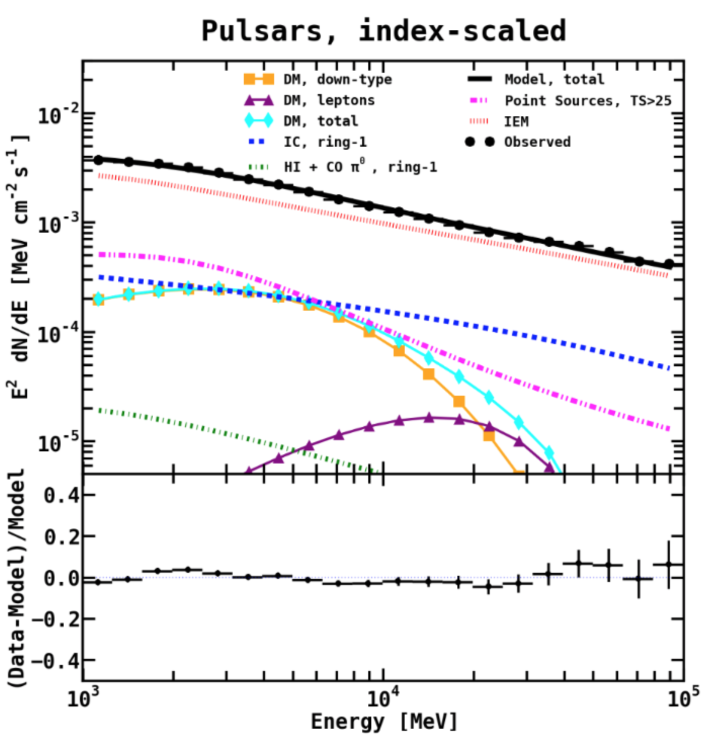
$$\langle\sigma_f v\rangle_{\rm ps} = \frac{N_f m_f^2 m_\chi^2}{\Lambda_f^6 \pi}\sqrt{1 - \frac{m_f^2}{m_\chi^2}} + \mathcal{O}(v^2), \quad (4)$$

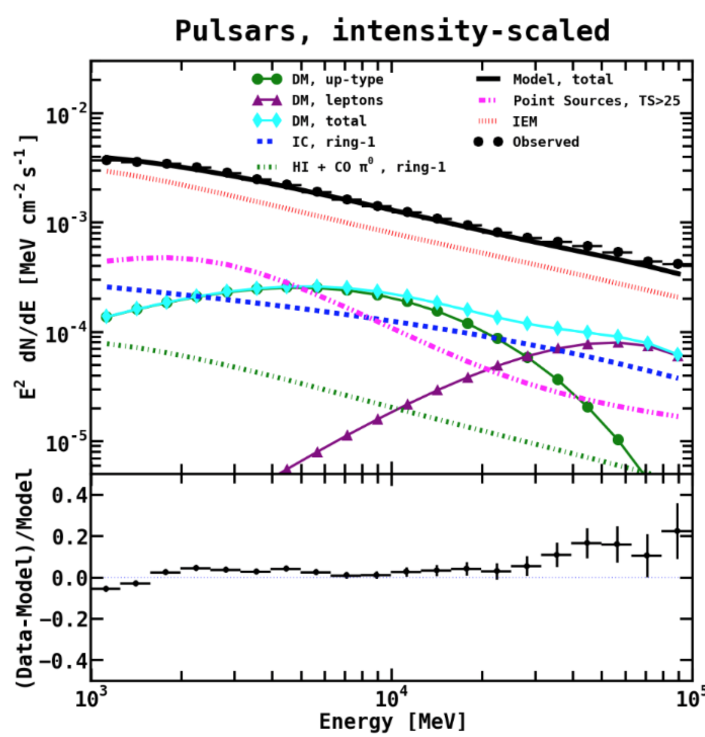
$$\langle\sigma_f v\rangle_{\rm vec} = \frac{N_f(2m_\chi^2 + m_f^2)}{\Lambda_f^4 \pi}\sqrt{1 - \frac{m_f^2}{m_\chi^2}} + \mathcal{O}(v^2), \quad (5)$$

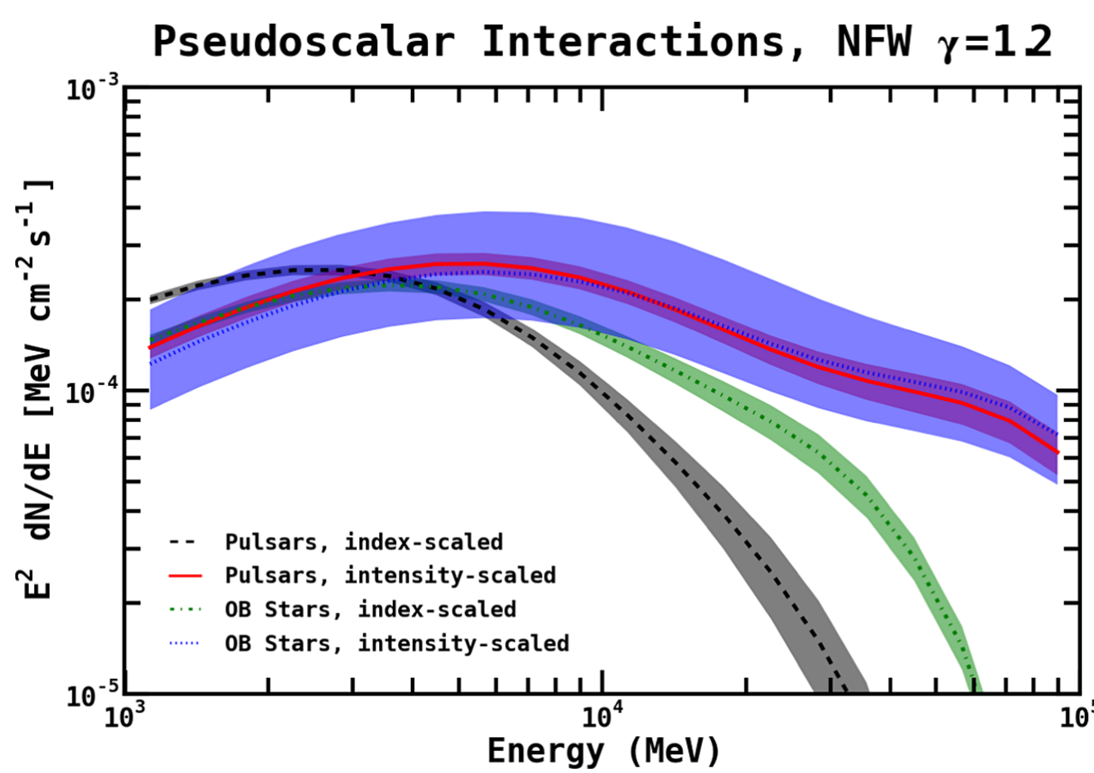
- We interpret the GC excess in the framework of an effective field theory.
- We map the corresponding indirect detection cross sections to direct detection cross sections.

Model Components (GC)

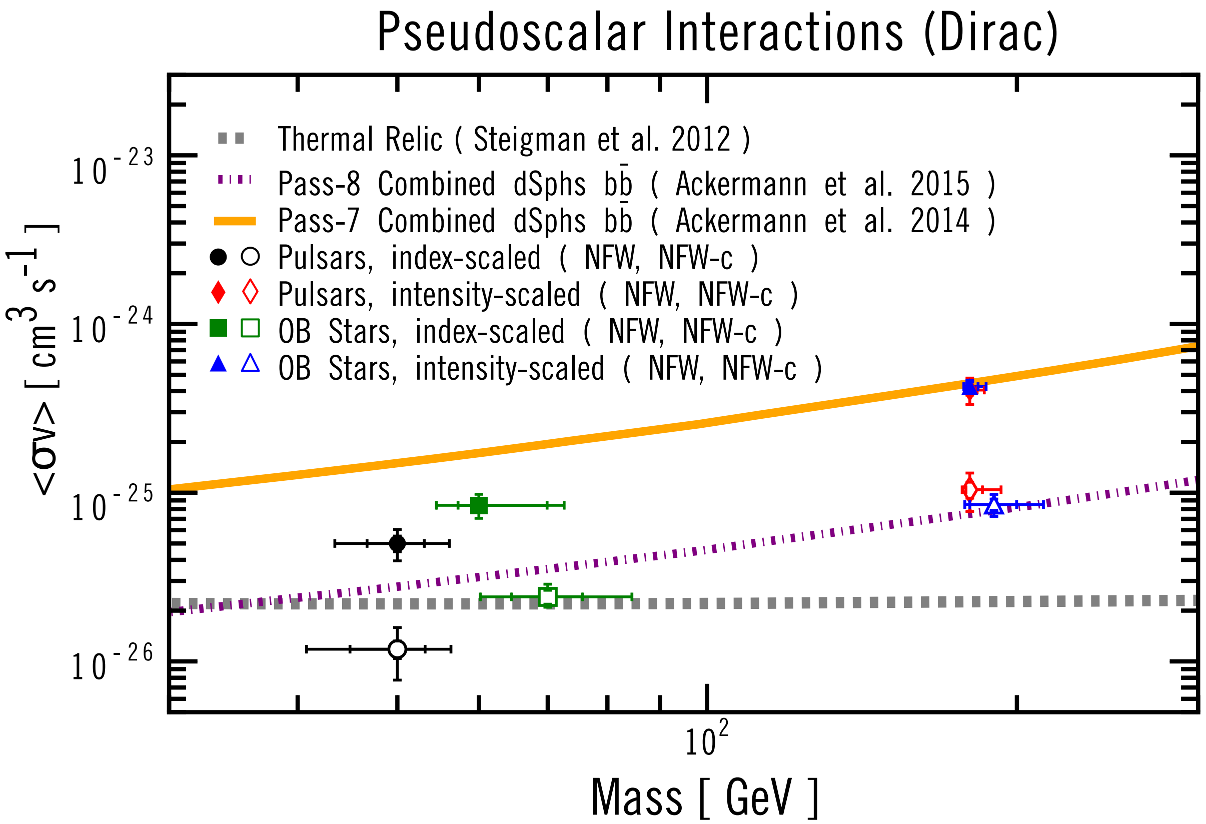


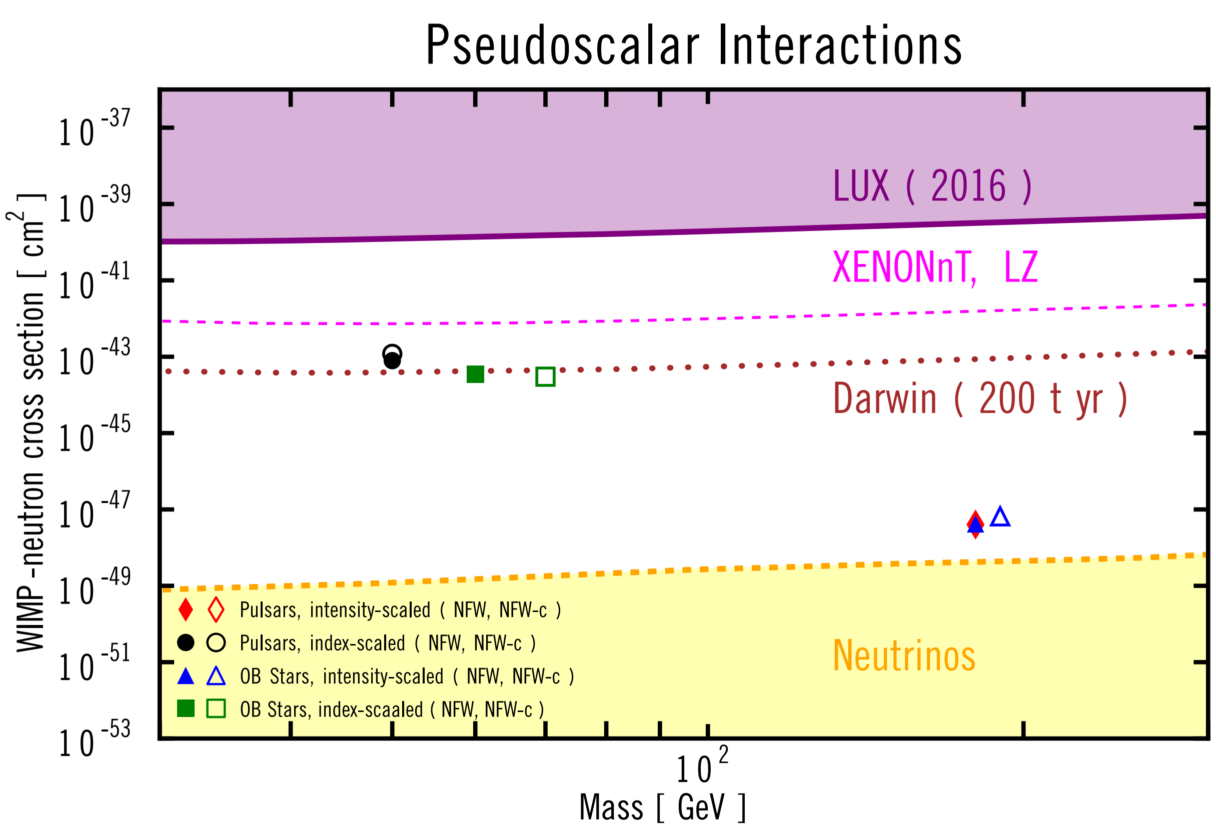






Derived DM Properties





- From Karwin et al. 2017
- The spectral characteristics of the GC excess favor a DM particle with a mass in the range approximately from 50 to 190 GeV and annihilation cross section approximately from 1E-26 to 4E-25 cm^3/s.
- The lower mass models go primarily to down-type quarks, with a small fraction going to leptonic final states.
- The higher mass models go primarily to up-type quarks, with a small fraction going to leptonic final states.
- There is tension between the DM interpretation of the GC excess and the non-detection of the dwarfs. But there are still significant uncertainties from extracting the signal, modeling the DM particle properties, and the J-factors for the dwarfs.
- We map these intervals into the corresponding WIMP-neutron scattering cross sections and find that the allowed range lies well below current and projected direct detection constraints.