GeV excess electrons upscattering the CMB

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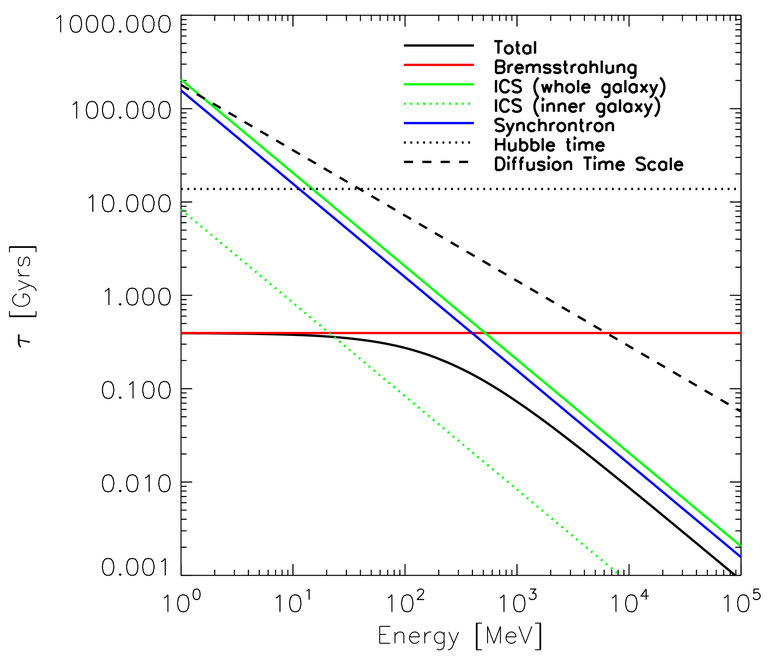
Electron injection into the IGM due to DM annihilations

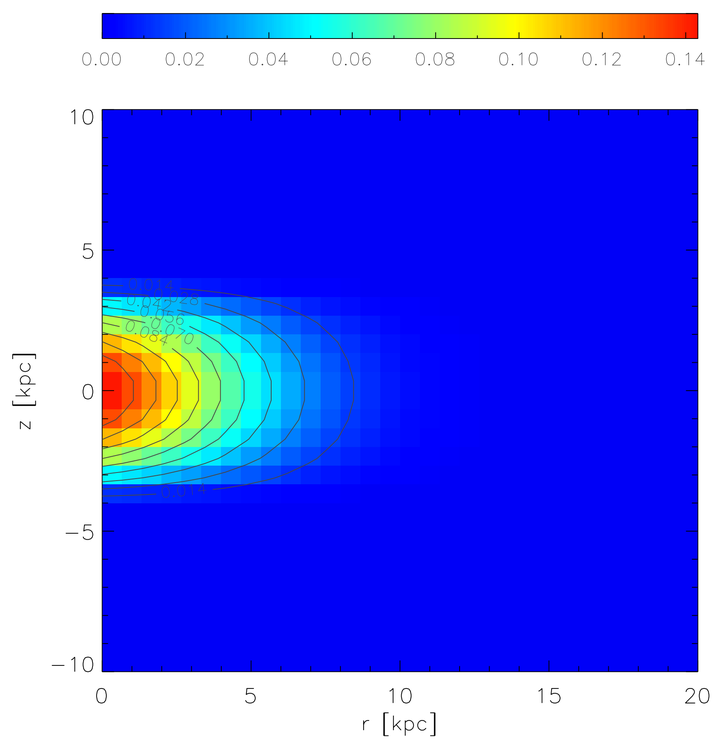
Recently a gamma-ray excess has been identified [1] in the inner Milky Way, which may be associated with the photon shower following DM annihilation to $b\bar{b}$ or $\tau\bar{\tau}$. We study an astrophysical implication of this scenario, i.e., electron injection into the IGM and up-scattering on the CMB.

If the GeV excess is due to DM annihilations, then $M_{DM} \sim 30$ GeV WIMPs should be dumping energy to $\sim$ GeV electrons with $\langle\sigma v\rangle \sim 3\times10^{-26}$ cm^3/s. Depending on the gas content of the halo of origin, they diffuse and cool.

$$\Psi_e^{gal}(E_e,\vec{x}) = \sum_{n=0}^{\infty}\frac{1}{b(E_e)}\int_{m_e}^{M_{DM}} dE_s q(E_s)\rho_0^2 \int_{DZ} d^3\vec{x}_s^n \frac{e^{-(\vec{x}-\vec{x}_s^n)^2/\lambda^2(E_e,E_s)}}{\pi^{1.5}\lambda^{1.5}(E_e,E_s)}\frac{\rho^2(\vec{x}_s^n)}{\rho_0^2}$$

Given their relatively long energy loss timescale, *some* of these electrons diffusively escape the halo into the IGM.

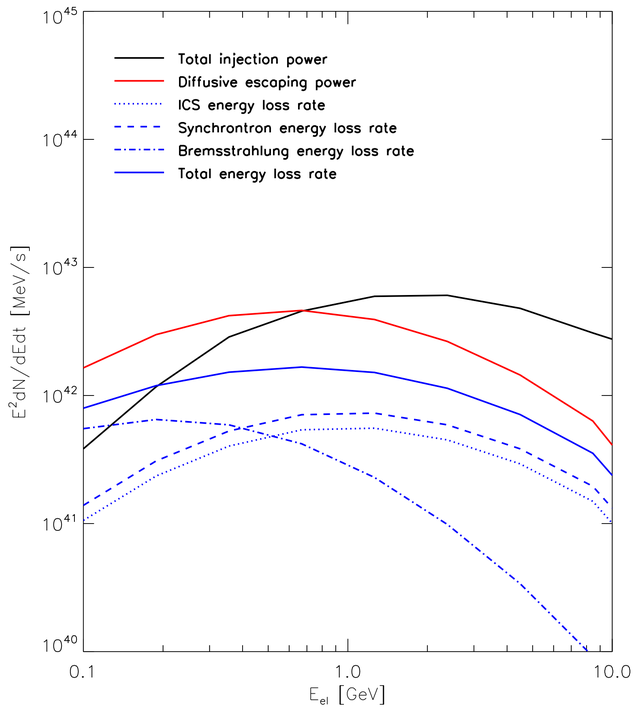


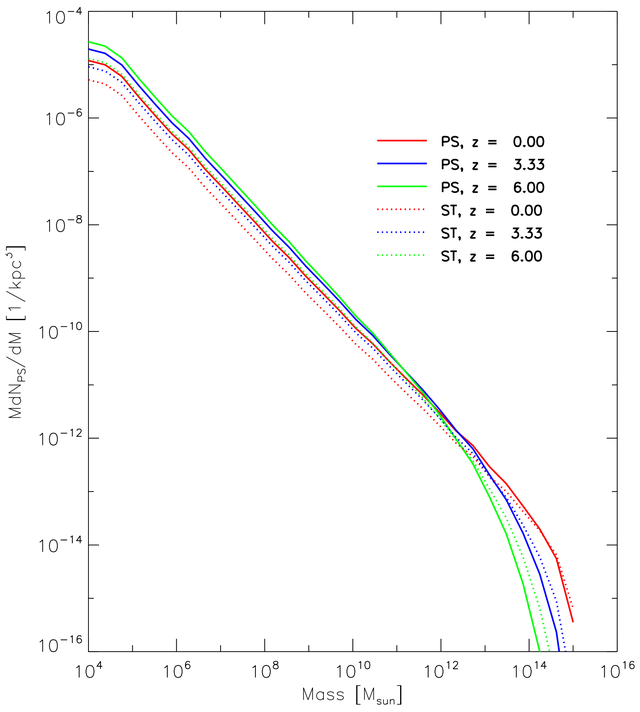


a) Relevant time scales b) Halo function showing lossy e^-/e^+ diffusion at scale λ

Treating the IGM as a giant calorimeter, one observable consequence is that they up-scatter the CMB to UV/X-ray energies.

$$j_\gamma(E_\gamma,z) = \int_{m_e}^{M_{DM}} dE_e \frac{dP}{dE_e}(E_\gamma,E_e,z)\Psi_e^{igm}(E_e,z)$$





a) Power budget of a DM halo b) Halo abundance function

Contributing to the CUB

The thermal state of the IGM is set by the photoheating due to the Cosmic UV Background (CUB) and adiabatic cooling. UV photons blueward of the Lyman limit can efficiently ionize the IGM, decreasing the mean opacity of the absorbers.

$$\Gamma(z) = 4\pi\int_{E_L}^{4E_L} dE_\gamma \frac{d\sigma}{dE_\gamma}\phi_\gamma(E_\gamma,z)$$

If generous assumptions on the mass-concentration relation is made up-scattered photons may contribute to the ionization of the IGM at late times.

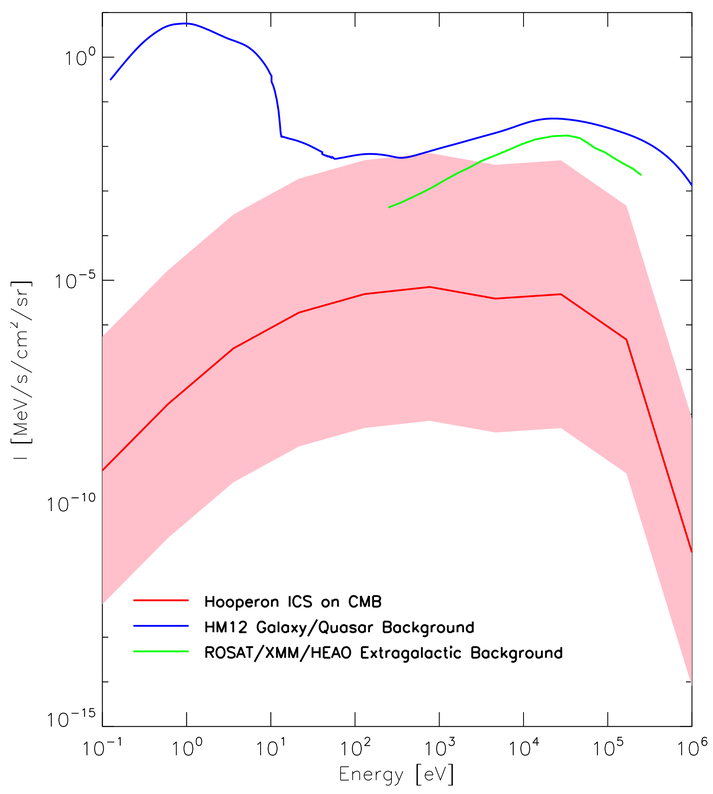


Fig: UV/X-ray flux

1. This may resolve the "Photon Underproduction Crisis" [2].

2. Current estimates of the UV/X-ray EGB flux is compatible with experimental bounds.

3. Regardless of the relevance to the crisis, ICS on the CMB can constrain DM annihilation parameters.

References

[1] D. Hooper and L. Goodenough, Phys.Lett. B697, 412 (2011), 1010.2752.

[2] Kollmeier J. A. et al., 2014, ApJ, 789, L32