The GC gamma-ray excess
Diffusion of electrons and positrons from DM
Fitting the Fermi-LAT GeV excess with the leptonic channels

Fitting the Fermi-LAT GeV excess: on the importance of the propagation of electrons from dark matter
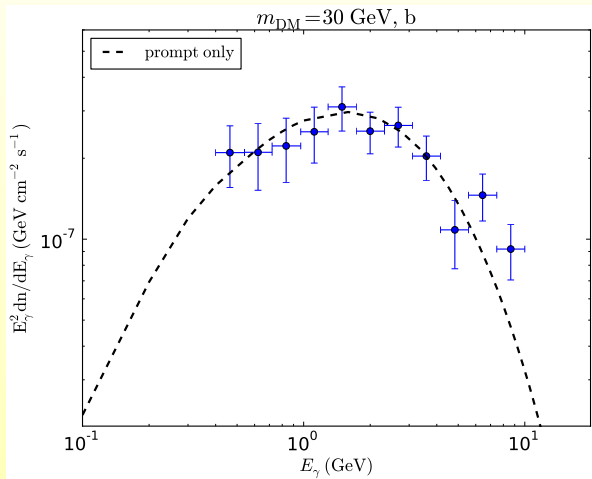
Thomas Lacroix (IAP)

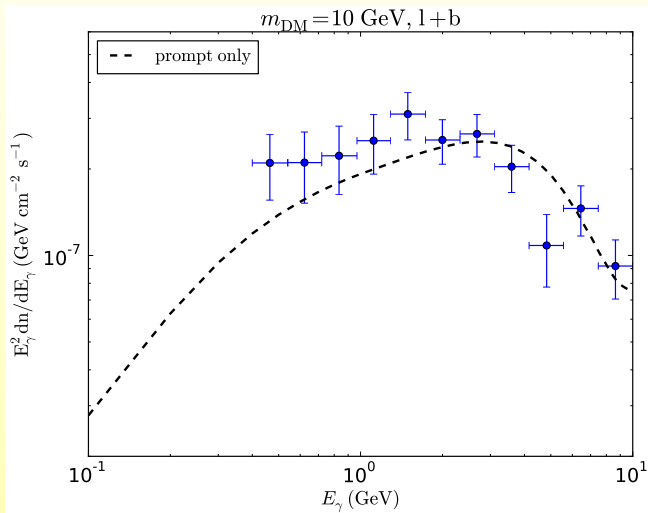Supervisors: Joseph Silk (IAP) & Céline Bœhm (IPPP)

TeVPA/IDM 2014

26 June 2014

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Fits with prompt emission only
Diffusion must be taken into account

Best fit a priori for prompt emission only for $b\bar{b}$

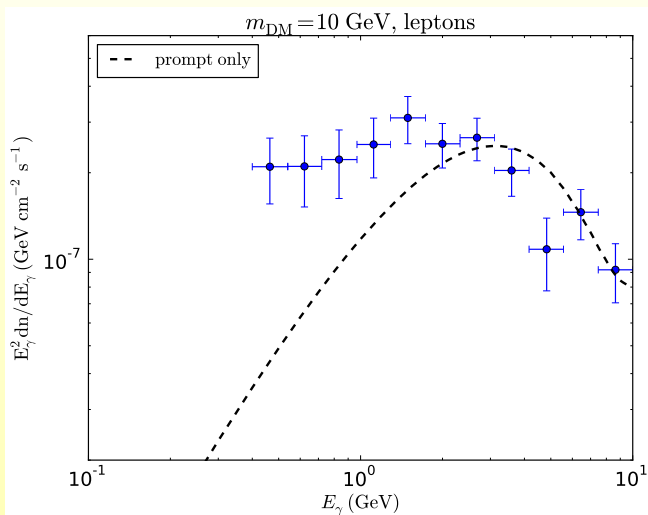$\rho \propto r^{-1.2}$, $\langle \sigma v \rangle \sim 2 \times 10^{-26}$ cm^3 s^{-1}

Data points from Gordon & Macias 2013

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Relatively good fit with mixture of leptons and b quarks

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Diffusion must be taken into account

But we're nowhere near a priori with leptons only...

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Fits with prompt emission only
Diffusion must be taken into account

- But this is for prompt emission only

- Electrons also by-products of DM annihilations

- Inverse Compton and Bremsstrahlung emissions from e^+ and e^- produced in DM annihilations shouldn't be neglected (Ackermann *et al.* 2013, Cirelli *et al.* 2013) $\longrightarrow$ corrections

- Diffusion must be included to model these emissions $\implies$ totally changes the interpretation of the data!

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- Resolution of the diffusion-loss equation of cosmic rays (semi-analytic method)

- Dedicated treatment of diffusion to take into account the very steep profile at the center

- Resolution using modified Green's function method (TL, C. Bœhm, J. Silk, arXiv:1311.0139)

- Electron spectrum after propagation $\longrightarrow$ IC and Bremsstrahlung fluxes

The GC gamma-ray excess — Contributions from diffusion
Diffusion of electrons and positrons from DM — Total spectrum
Fitting the Fermi-LAT GeV excess with the leptonic channels — Morphology

All contributions of the same order of magnitude

$m_{DM} = 10$ GeV, $B = 3$ μG, $n_{gas} = 3$ cm^{-3}, leptons

TL, C. Bœhm, J. Silk, arXiv:1403.1987

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Contributions from diffusion
Total spectrum
Morphology
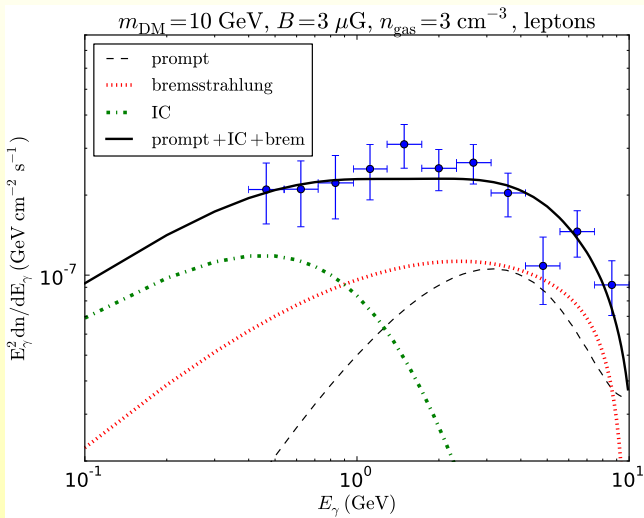
Best fit for democratic annihilation into leptons!
$\langle \sigma v \rangle = 0.86 \times 10^{-26}$ cm^3 s^{-1}

TL, C. Bœhm, J. Silk, arXiv:1403.1987

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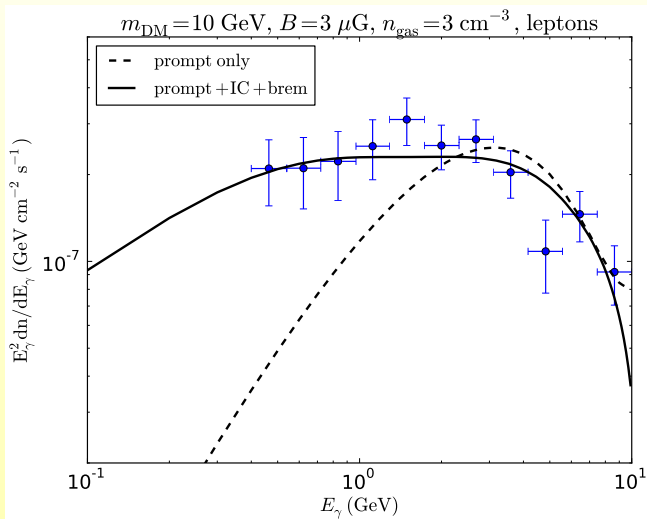
Fit for $b\bar{b}$ only slightly affected

TL, C. Bœhm, J. Silk, arXiv:1403.1987

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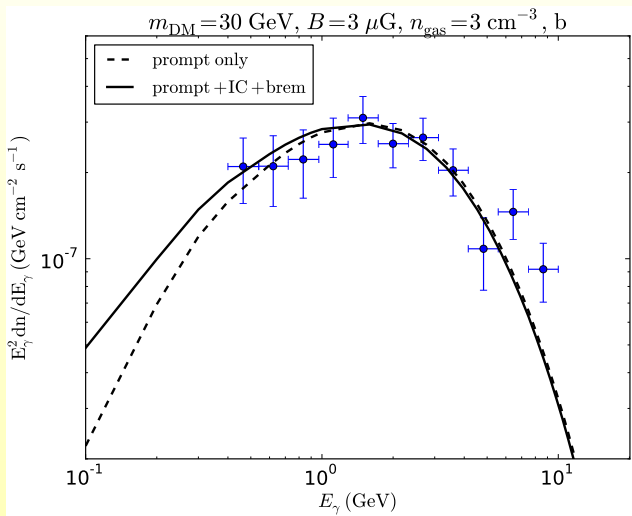
Very good fit with only muons and taus (cf. AMS limits on e^+e^-, Bergström *et al.* 2013, Ibarra *et al.* 2014)

The GC gamma-ray excess
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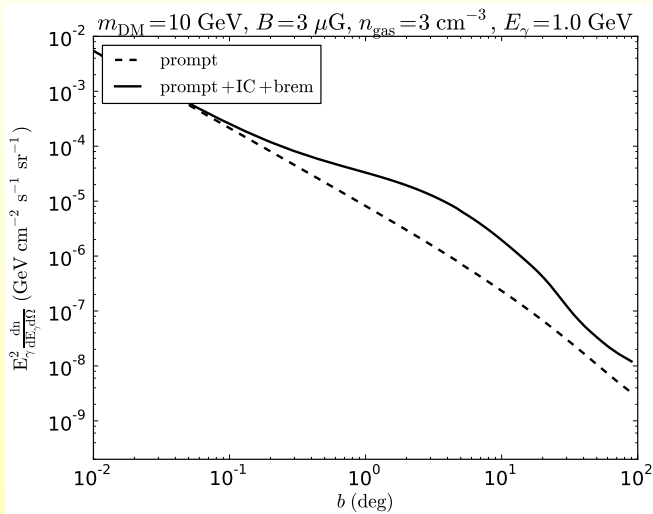Contributions from diffusion
Total spectrum
Morphology
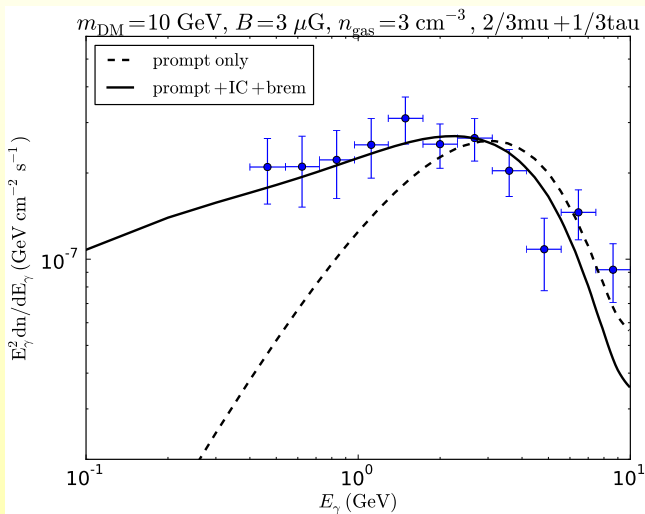
At low energy possible tension between signal from diffusion and morphology in the literature between $0.1°$ and $1°$

TL, C. Bœhm, J. Silk, arXiv:1403.1987

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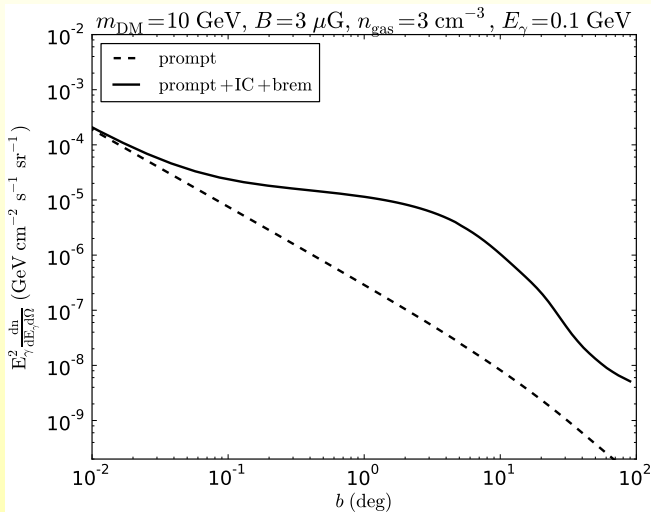
Morphology closer to the literature at 1 GeV

TL, C. Bœhm, J. Silk, arXiv:1403.1987

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Conclusion

- Strong case for DM
- $b\bar{b}$ and prompt emission simplest set-up a priori
- But very important to include all relevant emission processes and diffusion
- $b\bar{b}$ and 30 GeV is not the only possibility: DM can be 10 GeV and annihilate into leptons
- Including emissions of diffused electrons changes interpretation of the excess in terms of DM
- Morphology below $\sim 1°$ can help to discriminate
- Advertisement: possible link between GeV excess and 511 keV line at the GC (arXiv:1406.4683)

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Thank you for your attention!