The Dark Matter Interpretation of the Gamma-ray Excess at the Galactic Centre

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Thermal Production

SM -> ? -> DM
SM -> ? -> DM

SM
DM
Particle Physics for Astronomers

Thermal Production

Annihilation

SM  DM  SM  DM
Annihilation rate $\propto (\text{DM density})^2$

Galactic DM density is (approximately) distributed as $1/r$

We should be looking at the Galactic Centre.
What would DM look like?

Fermi-LAT Collaboration (2016)
The Galactic Centre

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The Galactic Centre

Daylan et al. (2016)
The Galactic Centre Excess

Spherically symmetric population of *something*

Radial slope of $r^{-\Gamma} \rightarrow 2.2 \lesssim \Gamma \lesssim 2.4$

Spatially extended out to 10°

Spectral peak at around 2 GeV
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Calore et al. 2015

Galactic latitude $|b|$ [deg], at $\ell = 0°$
The Galactic Centre Excess

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- A new population of millisecond pulsars?
- Cosmic ray injection?
- Dark matter?
The Galactic Centre Excess

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- Dark matter?

How do we tell these apart?

- Spherically symmetric population of *something*
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The Galactic Centre Excess

Bartels et al. 2016 (pictured)
&
Lee et al. 2016
Unresolved DM halos?

- Standard CDM predicts small scale dark matter substructure (NFW minihalos)

- Ultracompact minihalos (formed in the early universe), could be extremely bright annihilation sources

- Low mass substructure would not be resolvable by Fermi
Unresolved DM halos?

Clark et al. (Will be appearing on the arXiv later this week)
What does this mean for DM?

Either:

- The photon statistics have been misinterpreted
- Dark matter *doesn’t* annihilate
- Dark matter *does* annihilate, but has a large mass/low cross-section
Summary

- Dark matter (clumpy or smooth) doesn’t appear to be the source of the excess.

- An astrophysical source is the more likely candidate

- Continuation of the Fermi mission will provide marginally higher resolution, potentially allowing the point source population to be observed