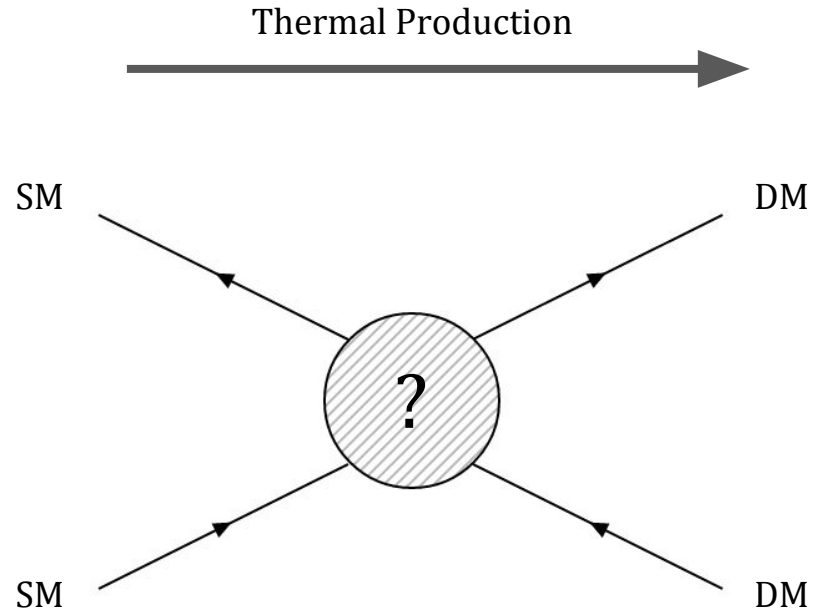


The Dark Matter Interpretation of the Gamma-ray Excess at the Galactic Centre

Hamish Clark
University of Sydney

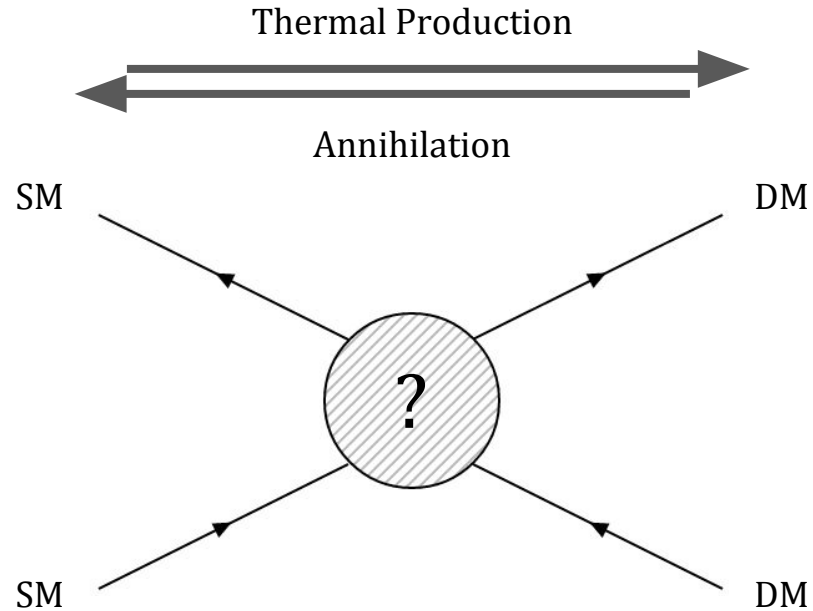


Particle Physics for Astronomers





Particle Physics for Astronomers





Astronomy for Particle Physicists

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



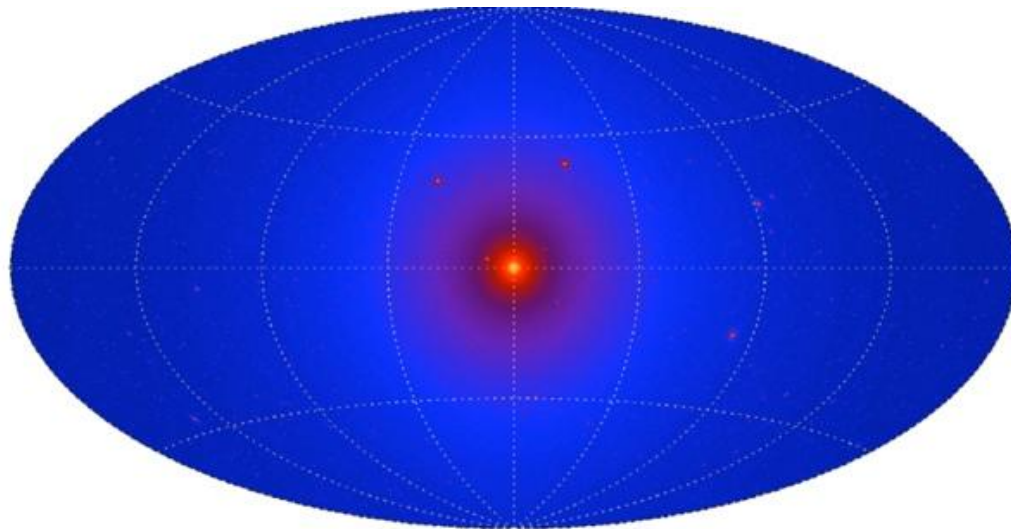
Galactic DM density is (approximately)
distributed as $1/r$



We should be looking at the Galactic Centre.



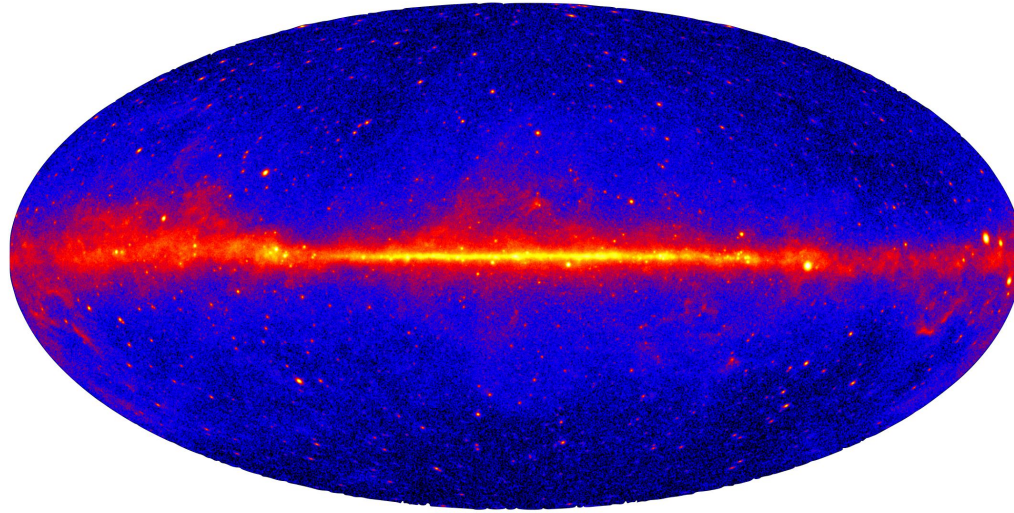
What would DM look like?



Fermi-LAT Collaboration (2016)



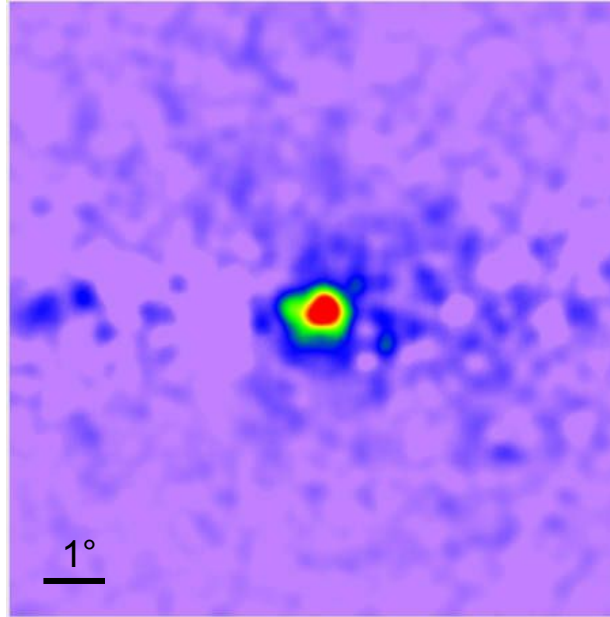
The Galactic Centre



Fermi-LAT Collaboration (2016)



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



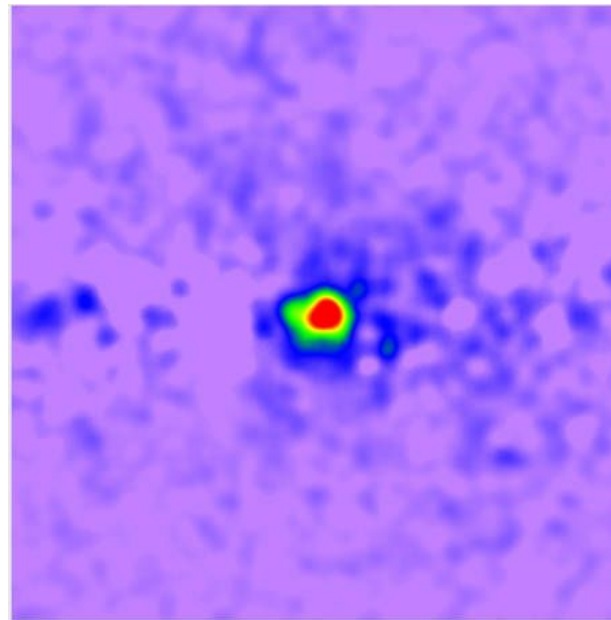
The Galactic Centre Excess

✓ Spherically symmetric population of *something*

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

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Spectral peak at around 2 GeV



Daylan et al. (2016)



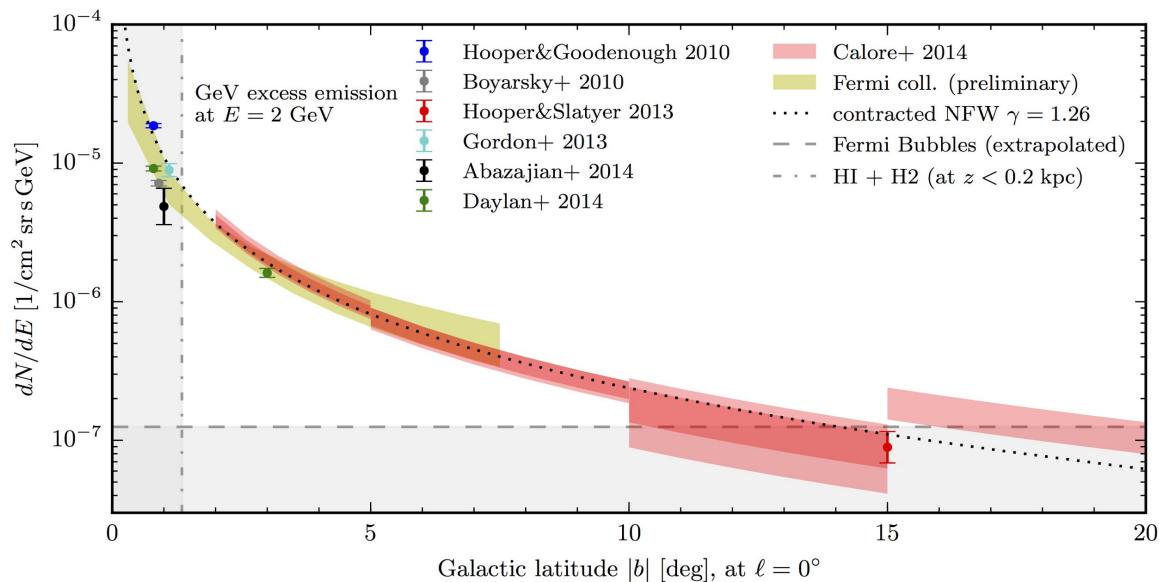
The Galactic Centre Excess

✓ 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

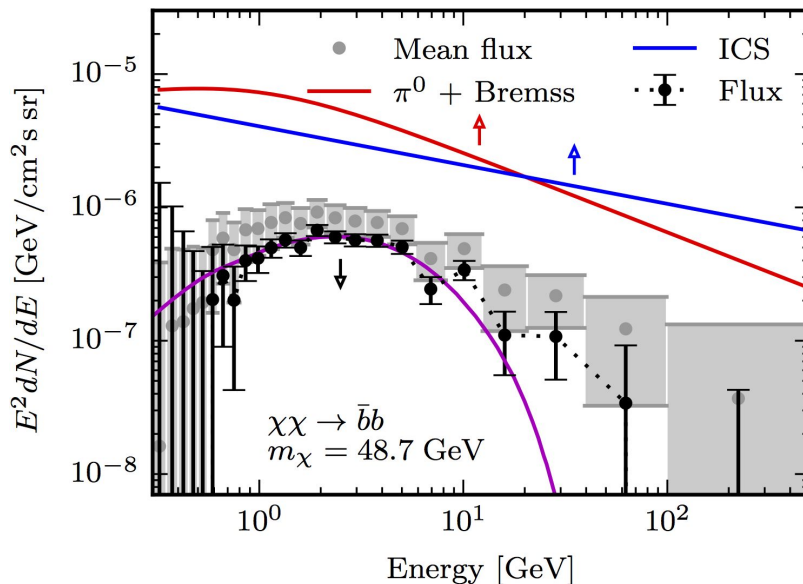


Calore et al. 2015



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



Calore et al. 2015



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

- A new population of millisecond pulsars?
- Cosmic ray injection?
- Dark matter?



The Galactic Centre Excess

Spherically symmetric population of *something*



- A new population of millisecond pulsars?

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

Spatially extended out to 10°

- Cosmic ray injection?

Spectral peak at around 2 GeV

- Dark matter?

How do we tell these apart?

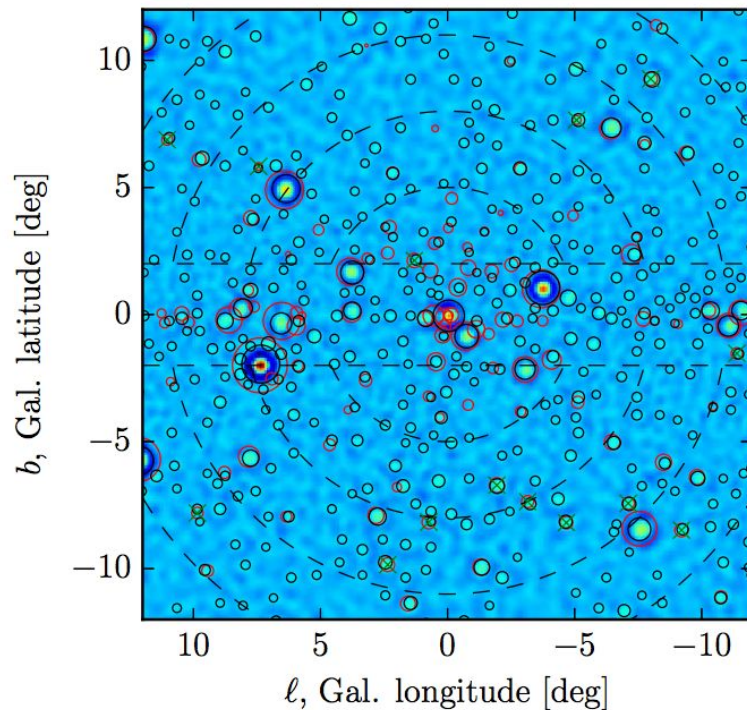


The Galactic Centre Excess

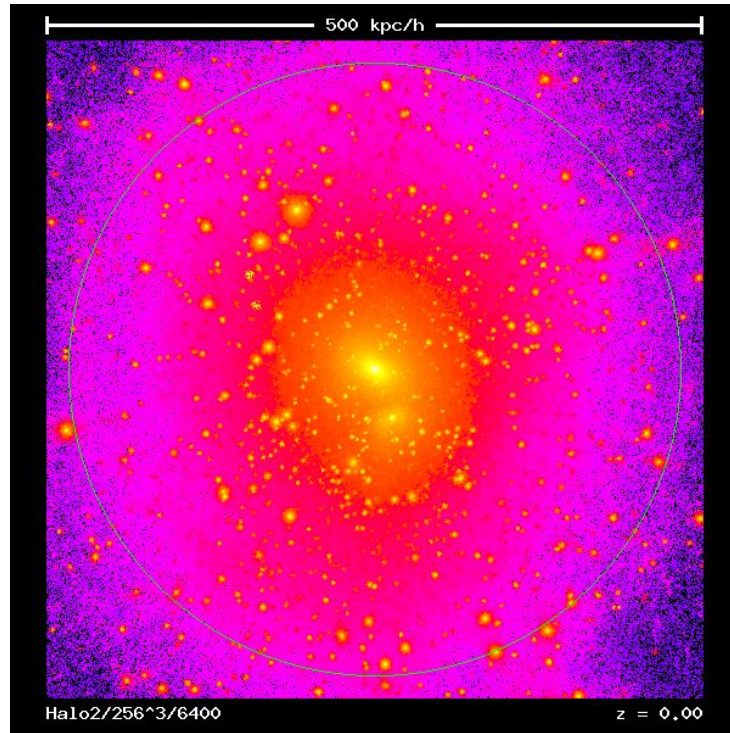
Bartels et al. 2016
(pictured)

&

Lee et al. 2016



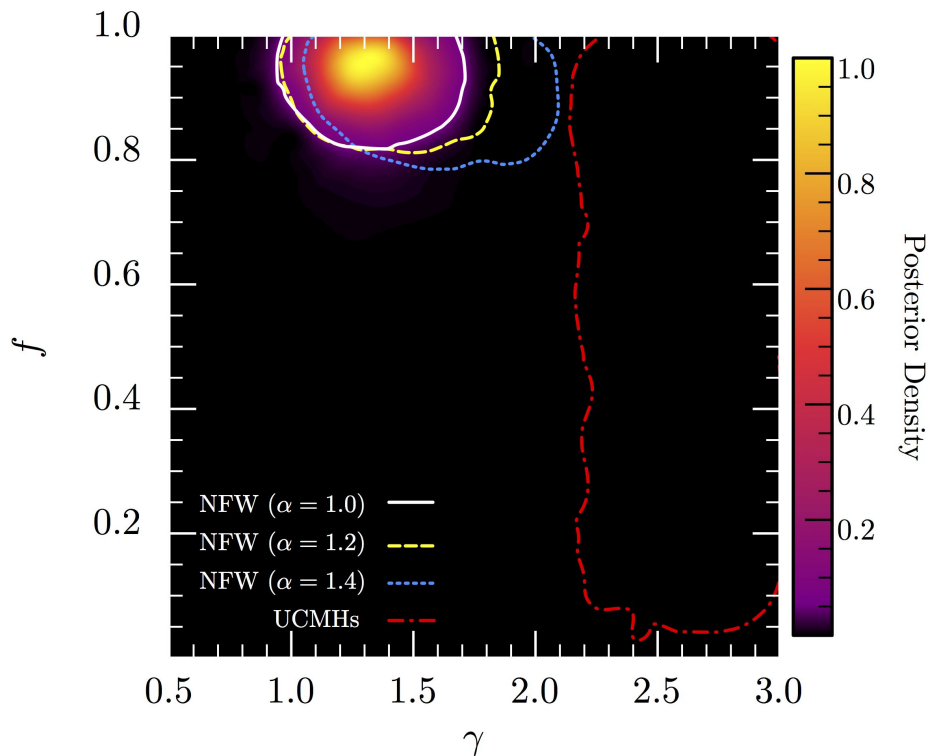
Unresolved DM halos?



- 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