Light from Dark (Matter) via Multi-Wavelength Synergies

Stefano Camera

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DARK MATTER PARTICLES

- Particle dark matter established ingredient of concordance cosmology

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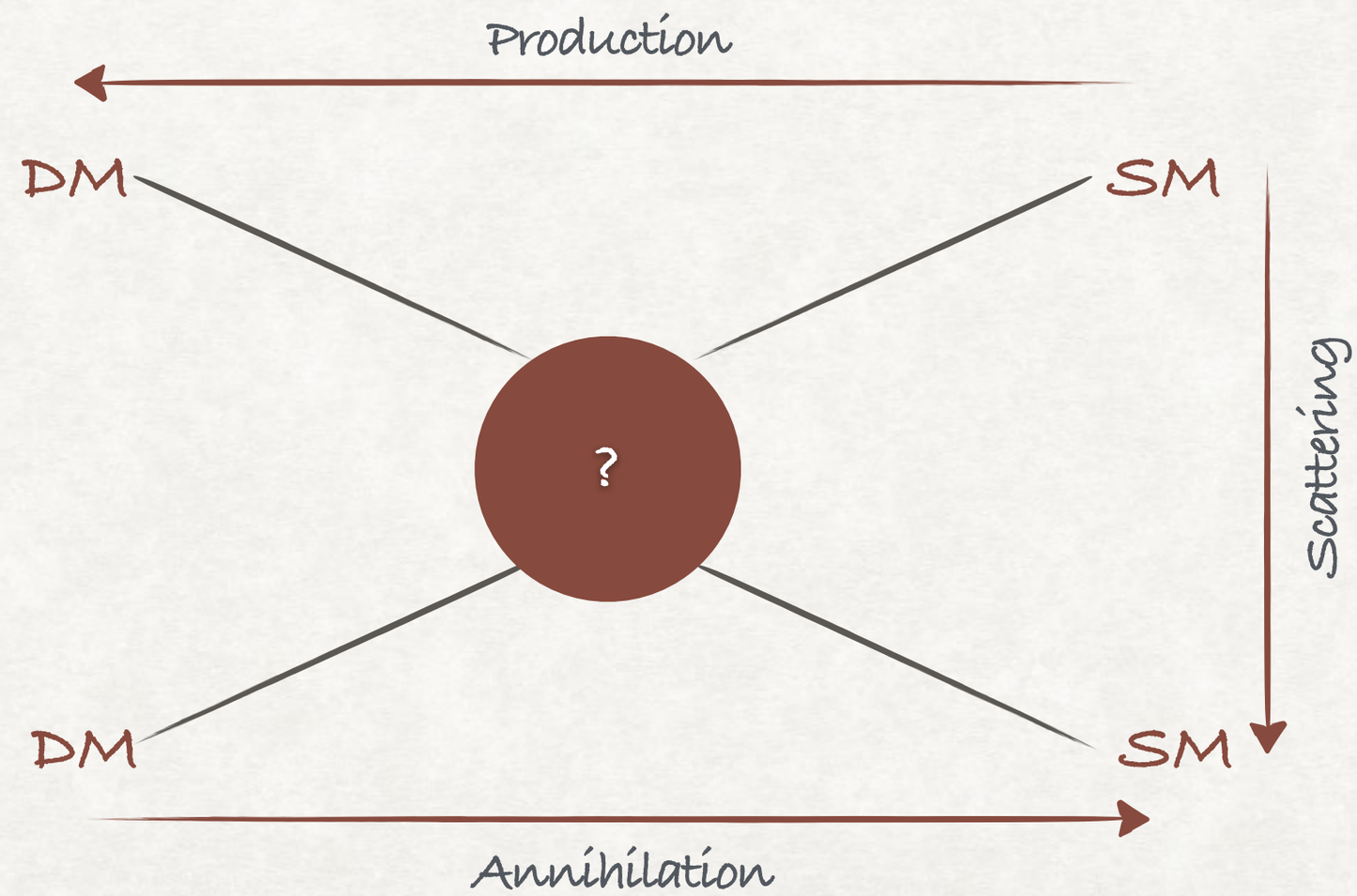

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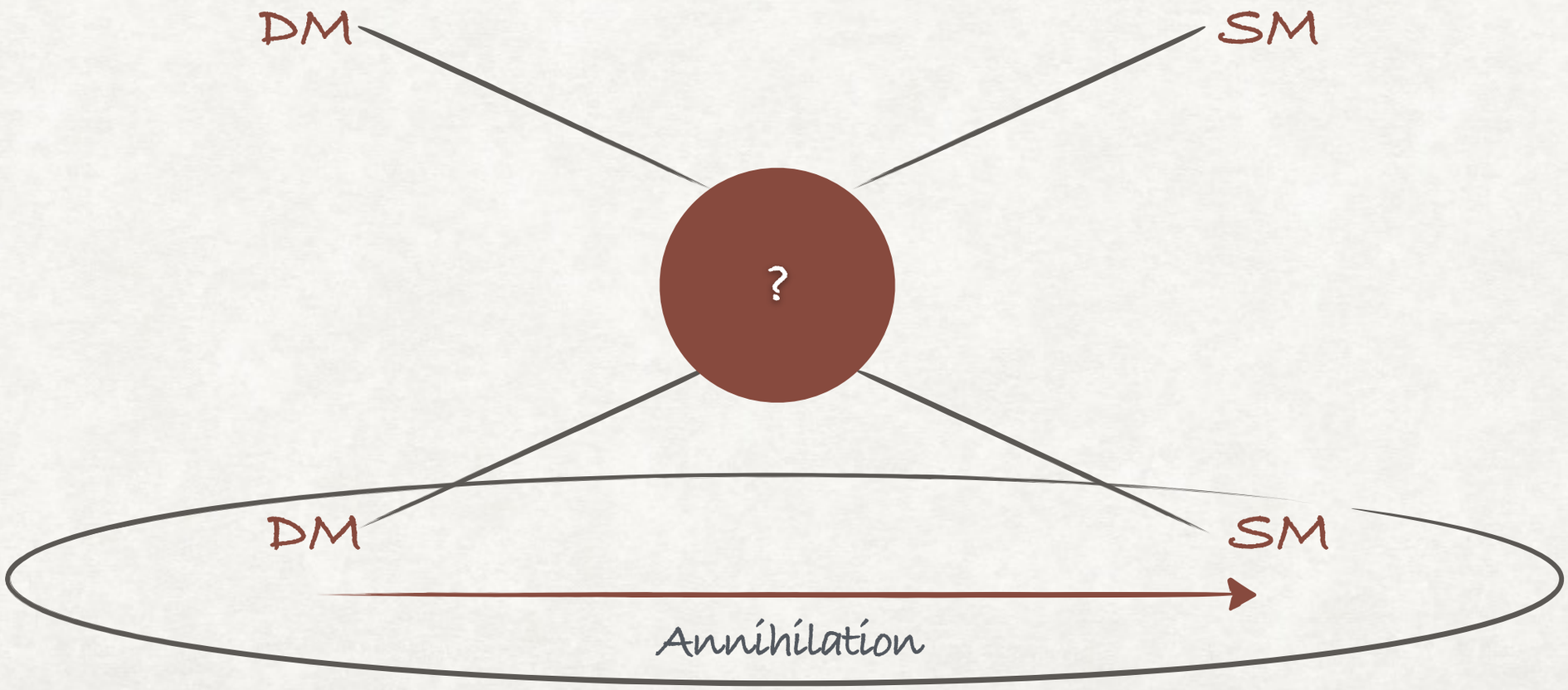

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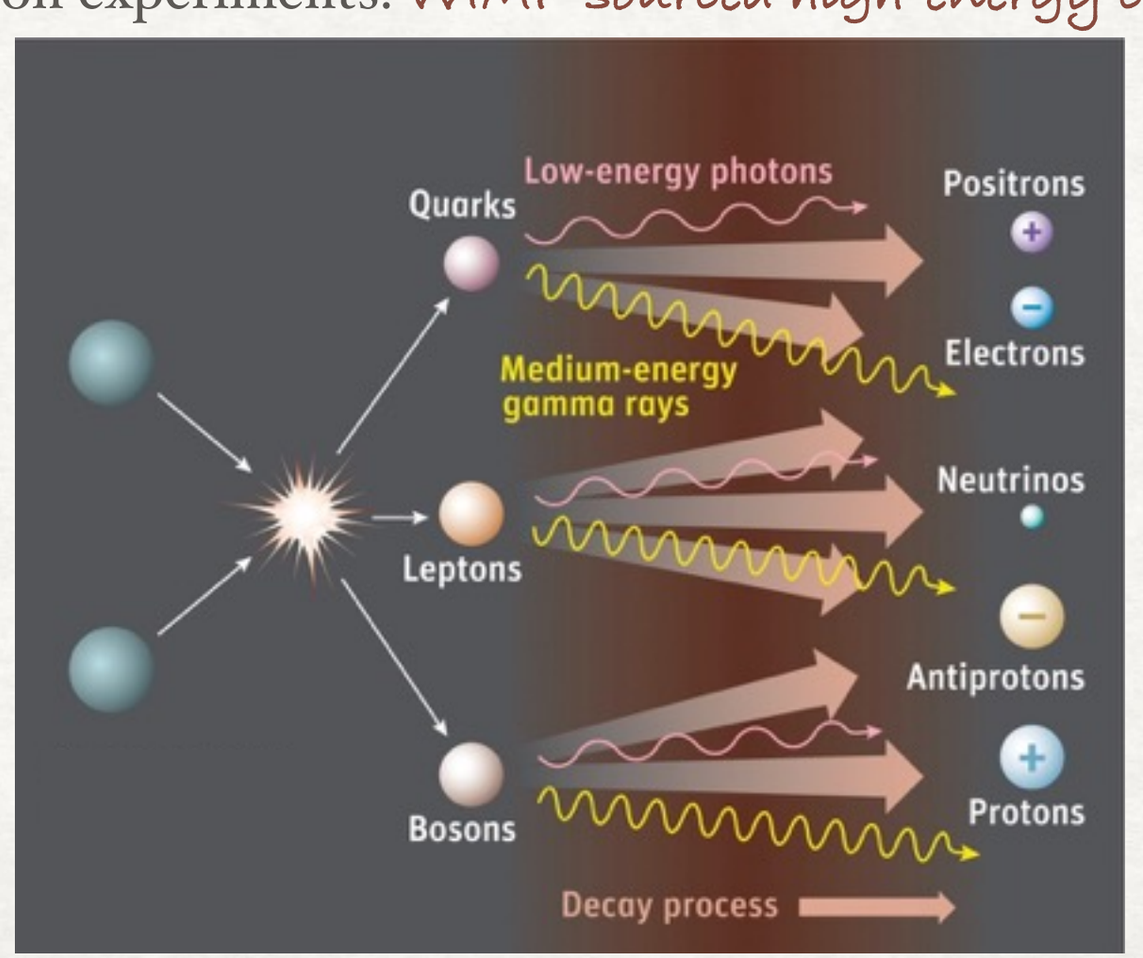

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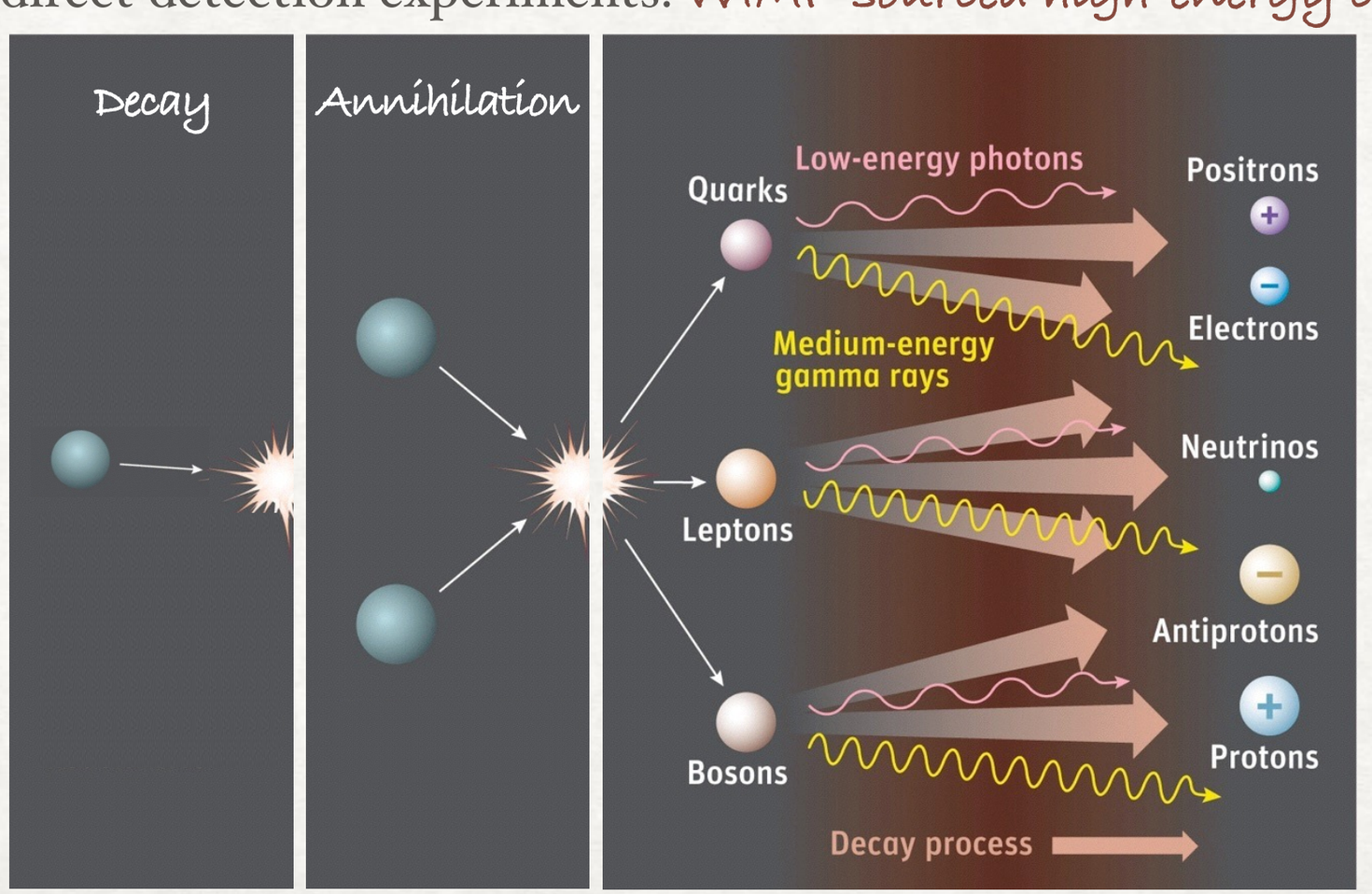
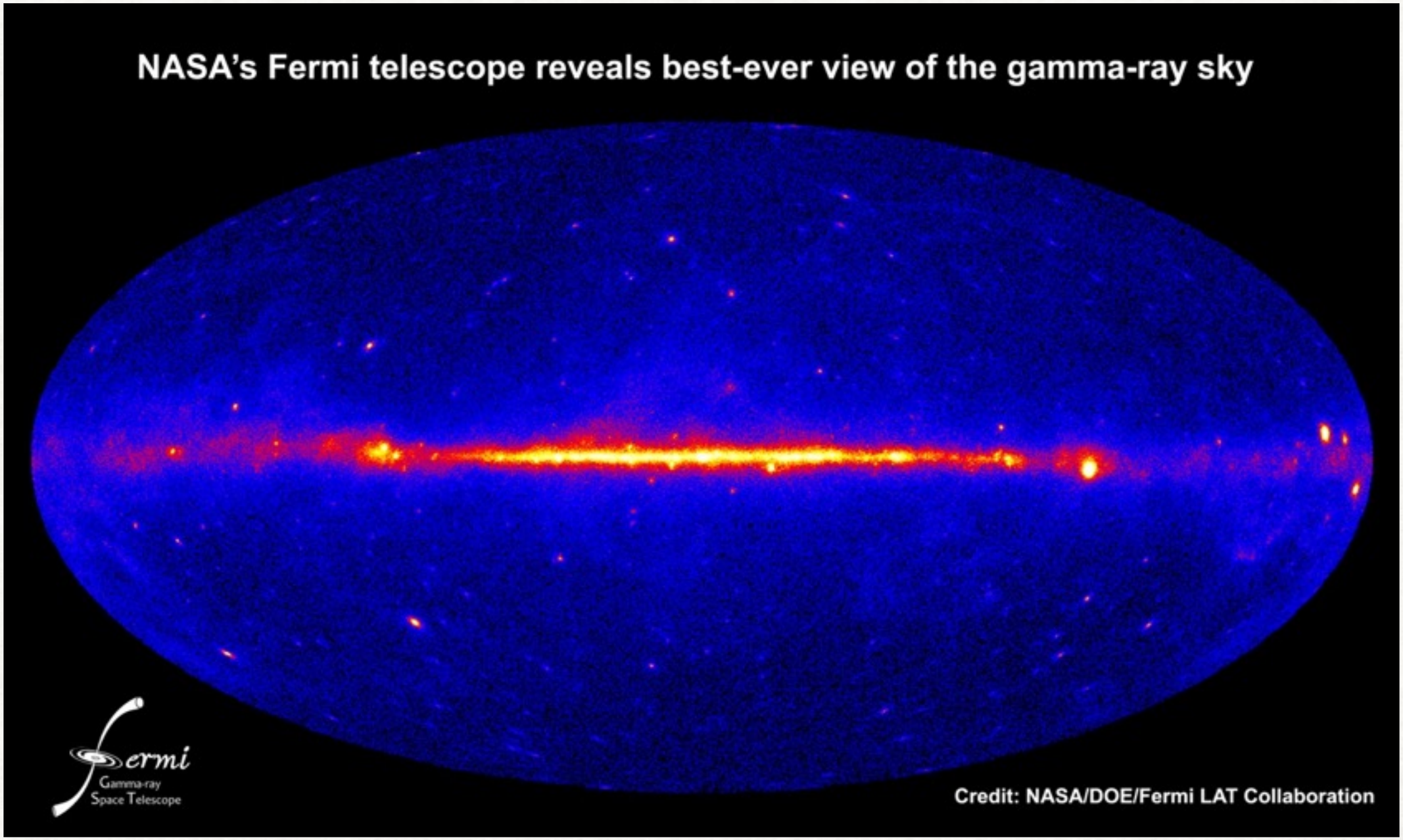


DM-SOURCED GAMMA RAYS



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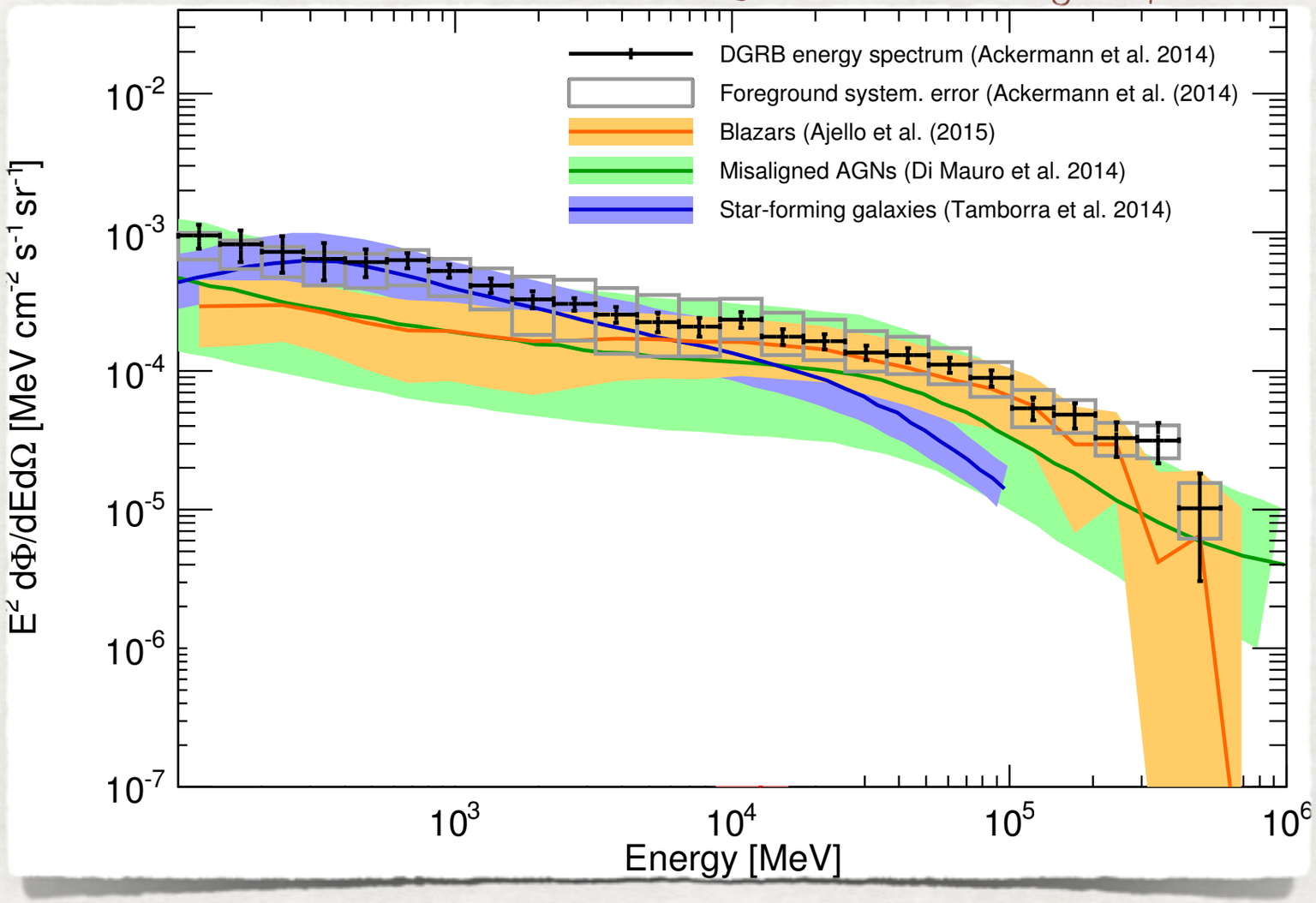

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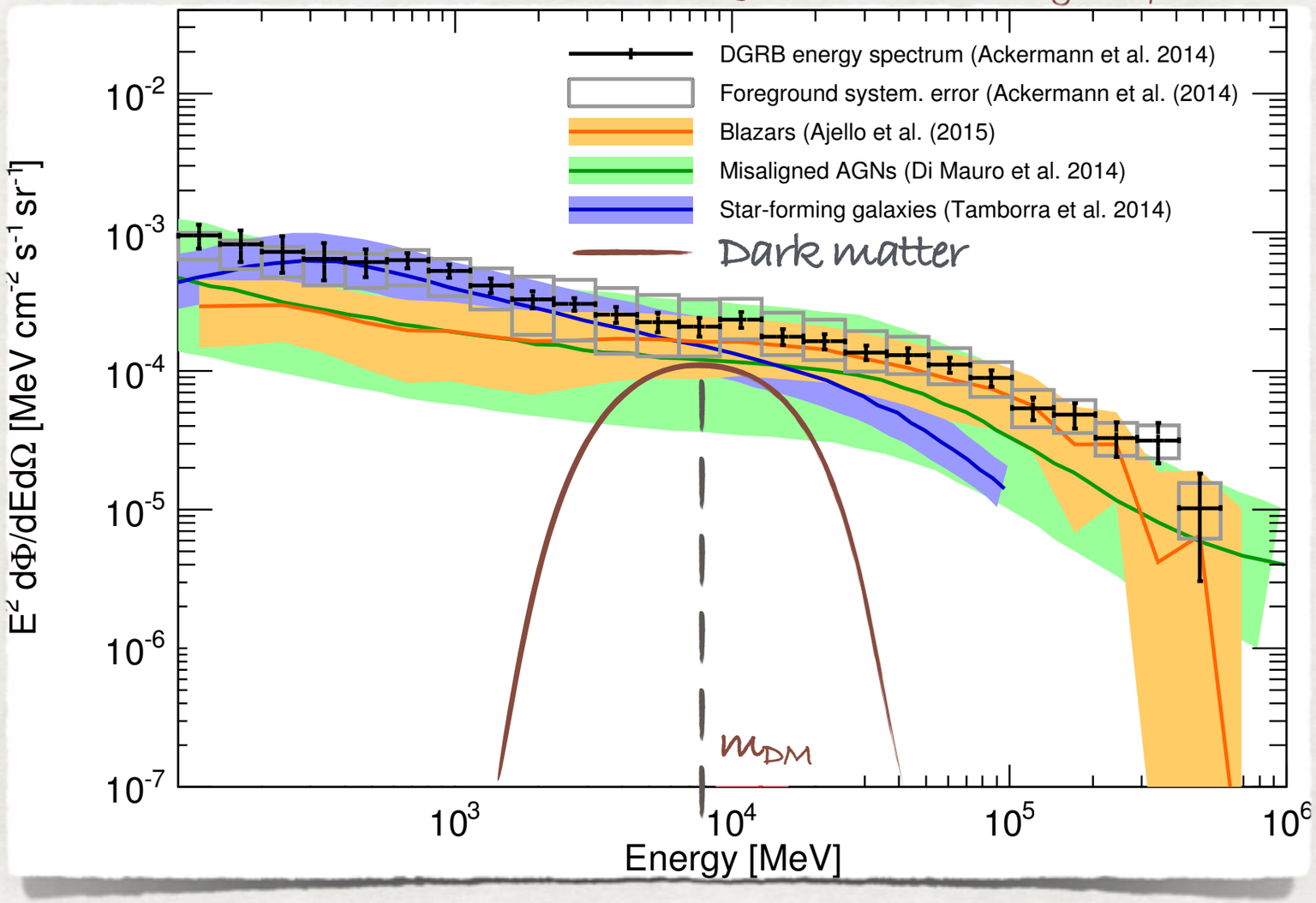
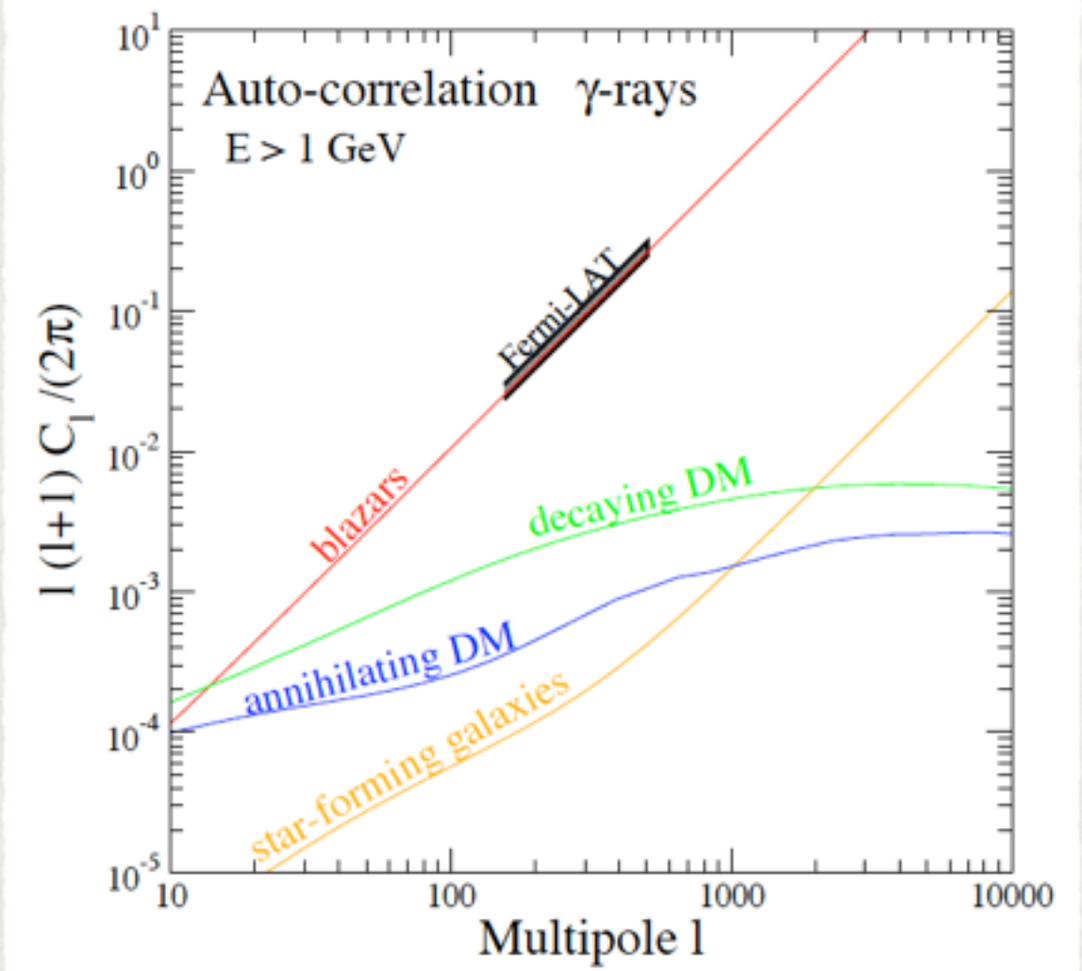


DM-SOURCED GAMMA RAYS

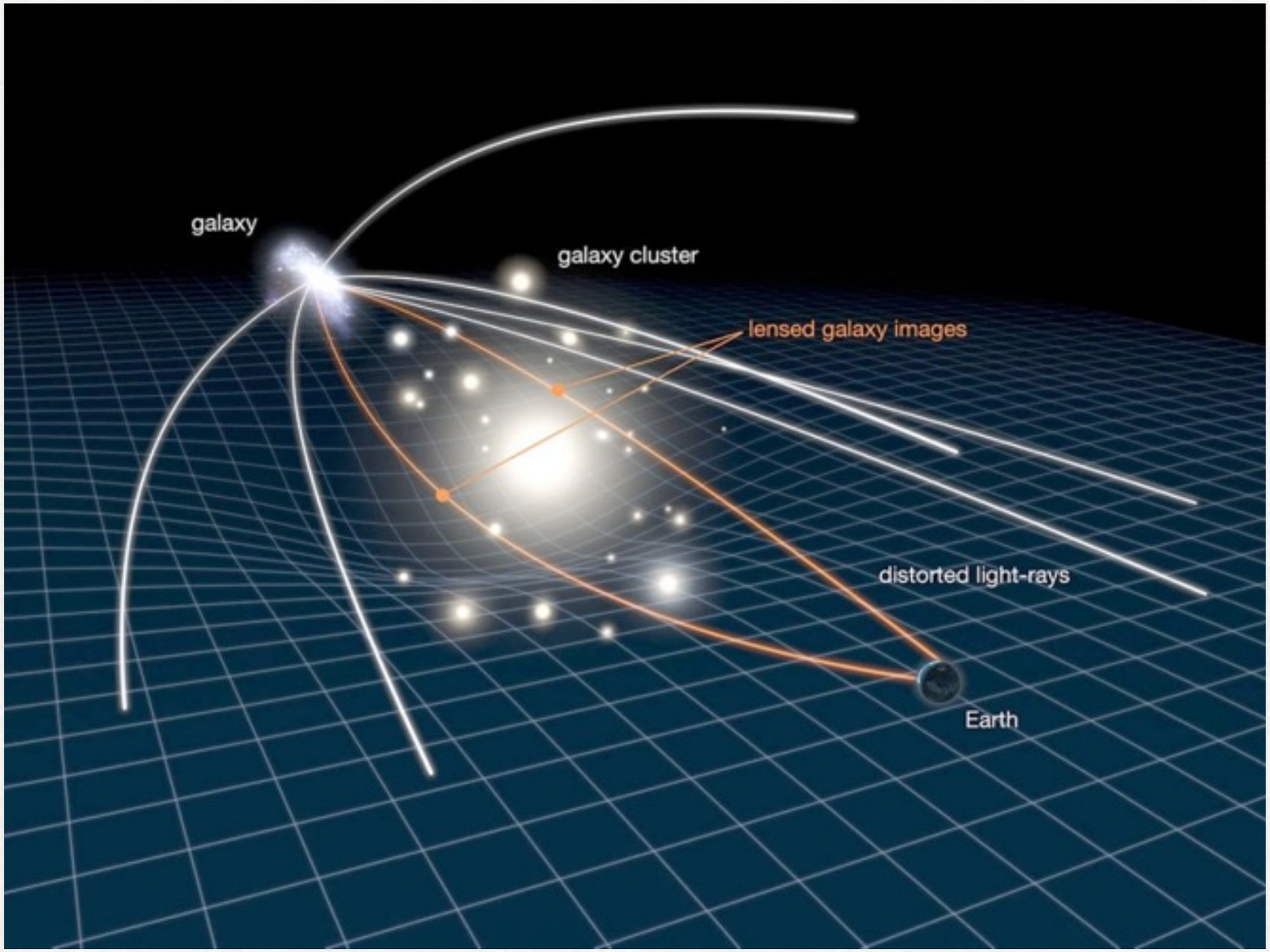
- Hunting down signals of annihilations/decays of dark matter particles
  - Gamma-ray anisotropy angular power spectrum

[SC, Fornasa, Fornengo & Regis, ApJL 2013]



MULTI-WAVELENGTH SYNERGIES

DIRECT GRAVITATIONAL PROBES OF DM



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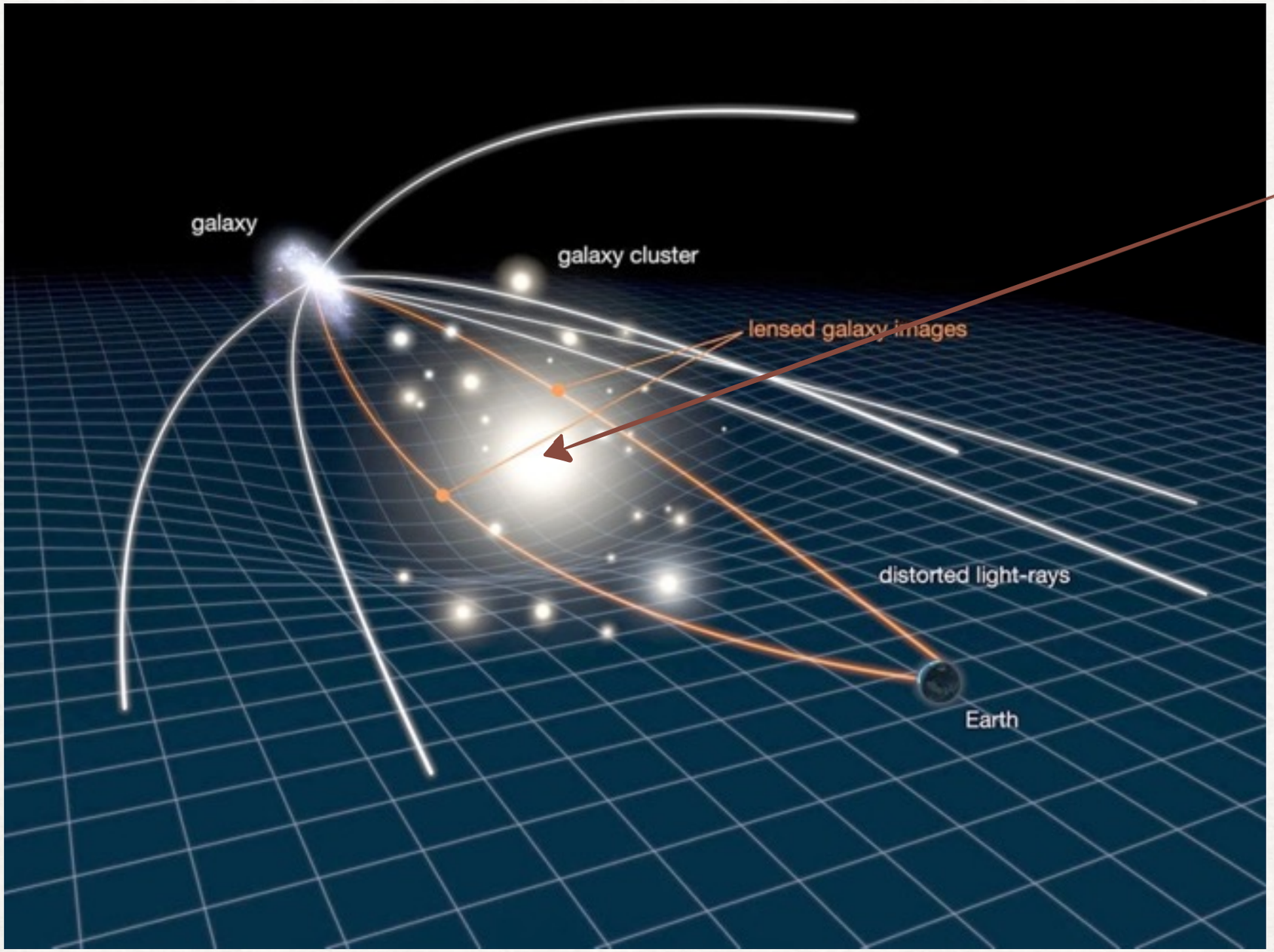

Cosmic large-scale structure

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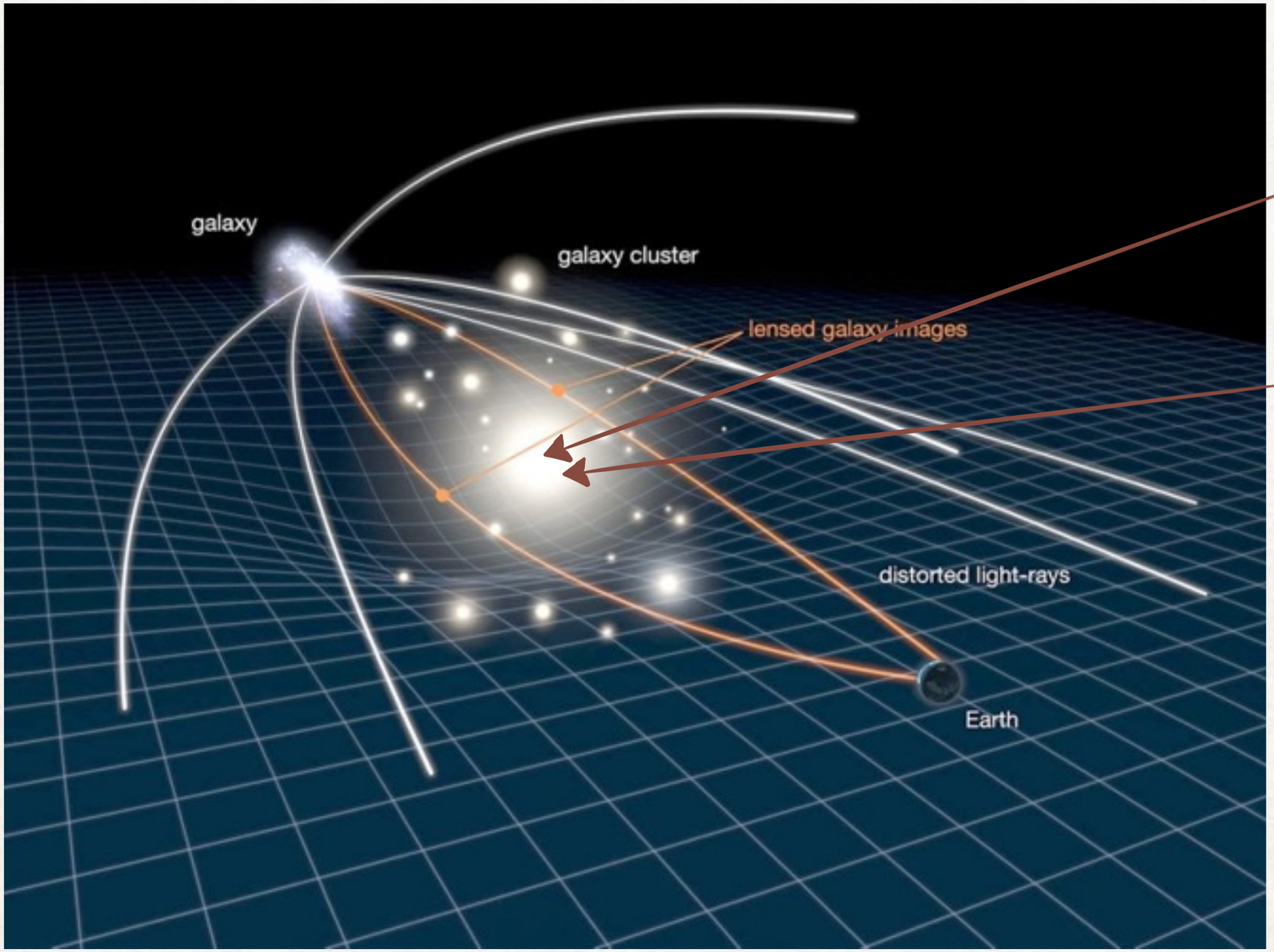

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Gamma rays from astrophysical sources hosted within the dark matter halo

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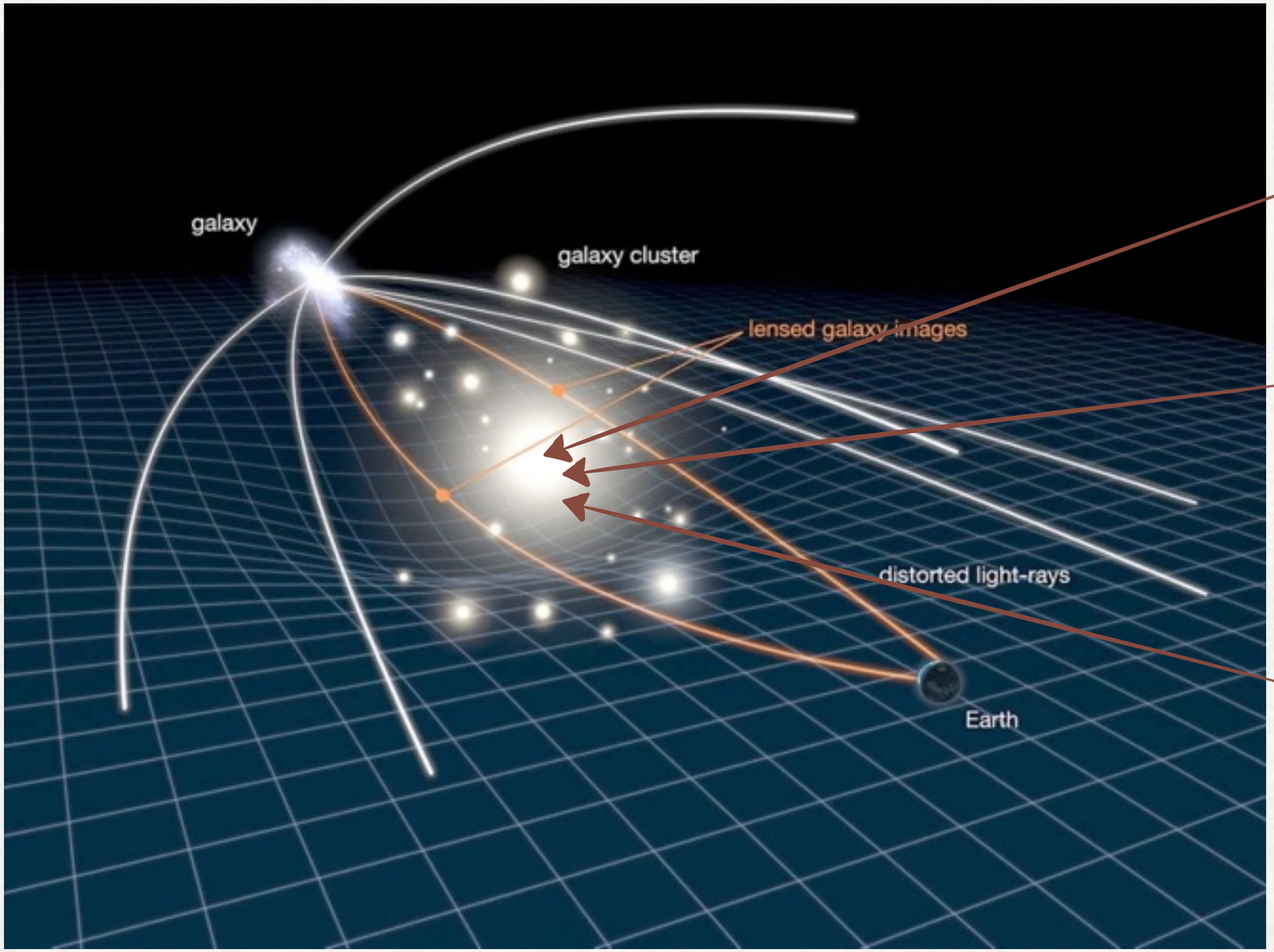


Cosmic large-scale structure

Gamma rays from astrophysical sources hosted within the dark matter halo

Gamma rays from annihilations/decays of dark matter particles in the dark matter halo

DIRECT GRAVITATIONAL PROBES OF DM

- Find an accurate tracer of the *cosmic dark matter distribution* on large scales *to filter out* astrophysical non-thermal emissions from the dark matter gamma-ray signal

- Main tracers of the cosmic large-scale structure:

  - weak gravitational lensing *(cosmic shear, CMB lensing…)*

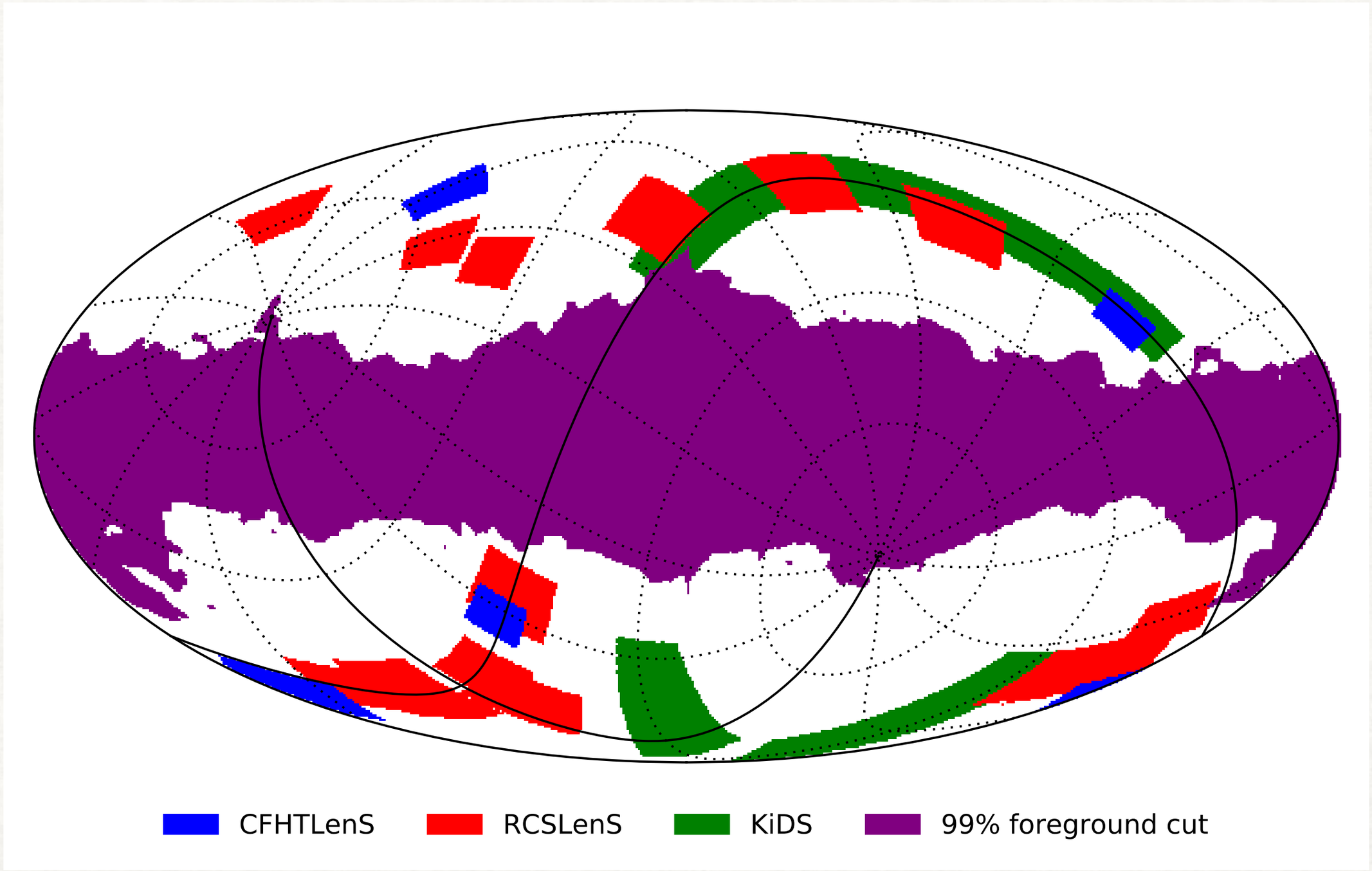
    [SC, Fornasa, Fornengo & Regis, ApJL 2013; 2015; Shirasaki et al., 2015; 2016]

  - clustering of structure *(galaxies, galaxy clusters…)*

    [Fornengo & Regis, 2014; Xia et al., ApJS 2015; Regis et al., PRL 2015; Shirasaki et al., 2015]

GAMMA RAYS & WEAK LENSING

Fermi X CFTHLenS/RCSLenS/KiDS



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GAMMA RAYS & WEAK LENSING

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- Cosmic shear [CFHTLens + RCSLenS + KiDS]
- Diffuse gamma-ray background [Fermi 84 months (Pass8)]

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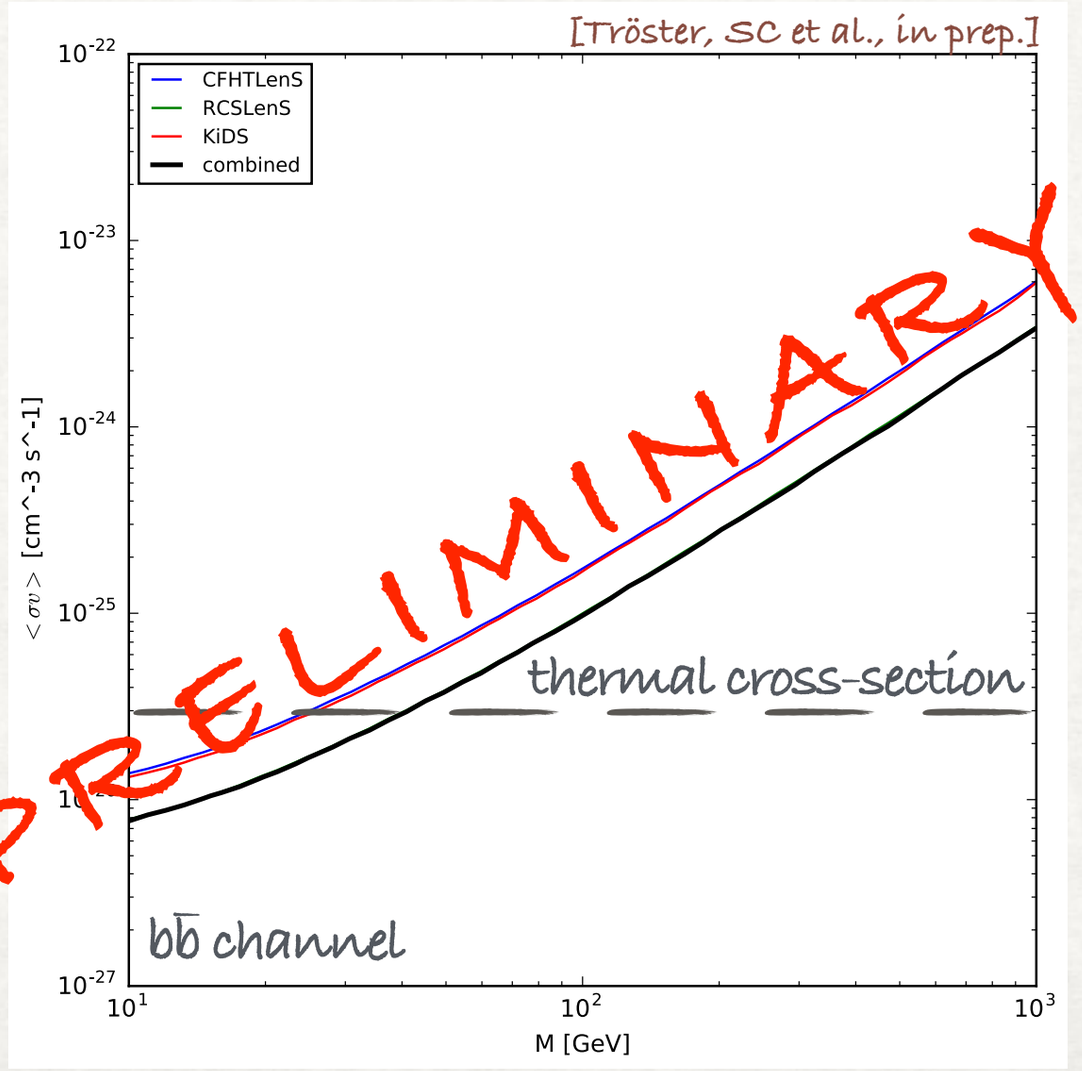

GAMMA RAYS & WEAK LENSING

Fermi x Euclid

- Cosmic shear [Euclid]
- Diffuse gamma-ray background [Fermi 10 years & 'Fermissimo']

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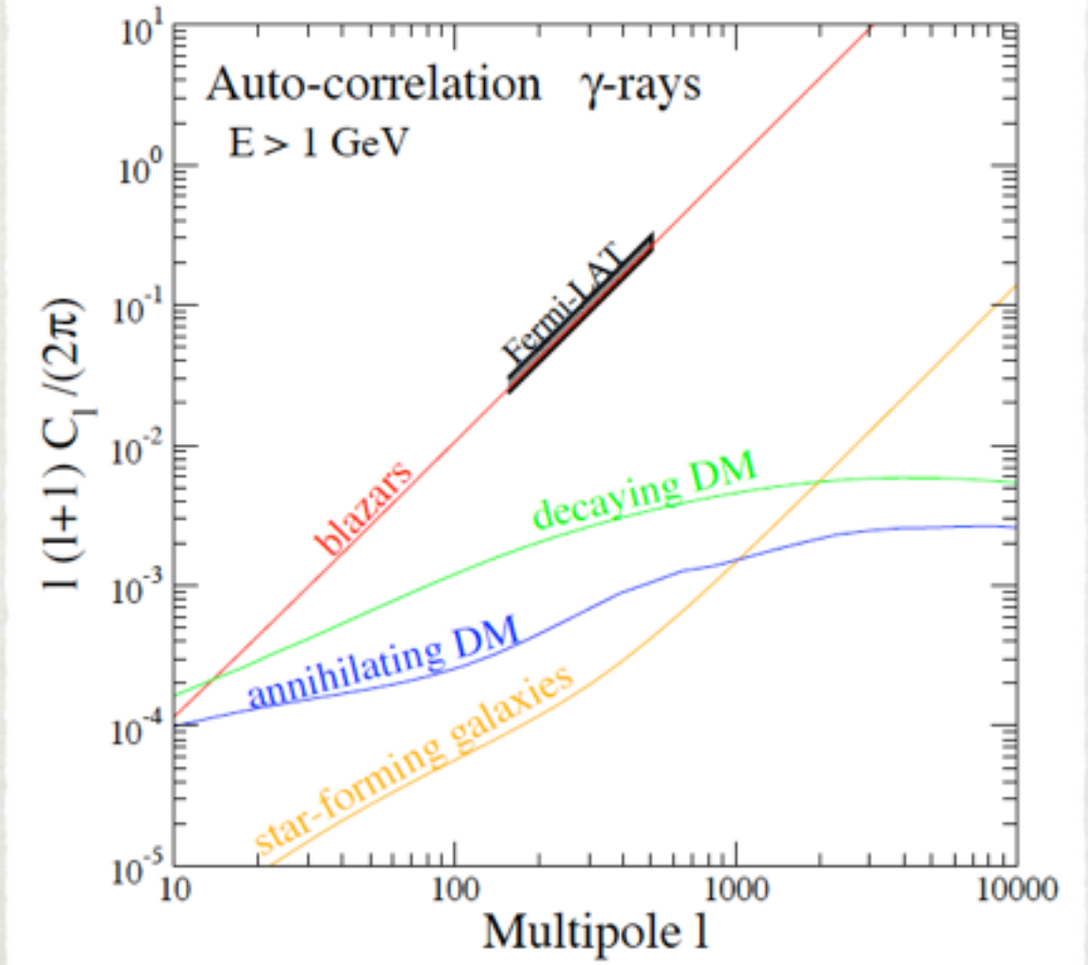

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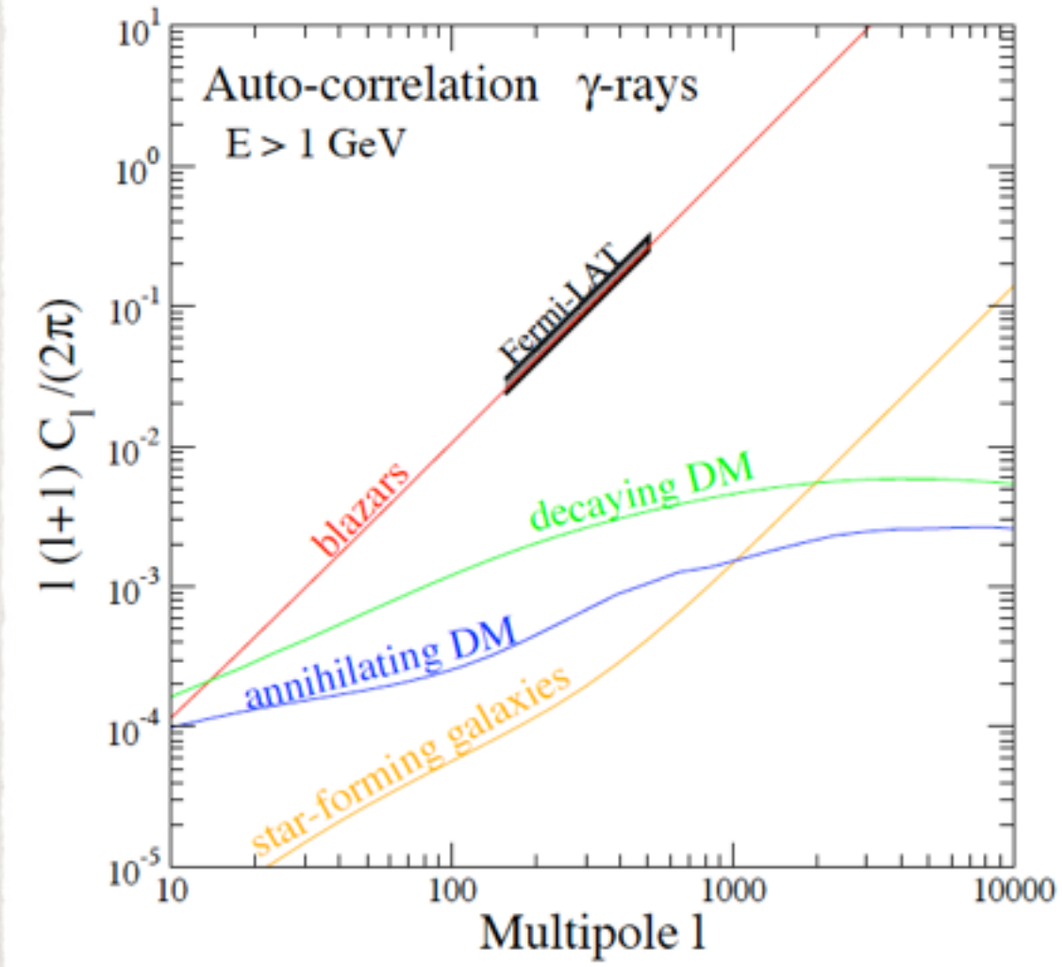

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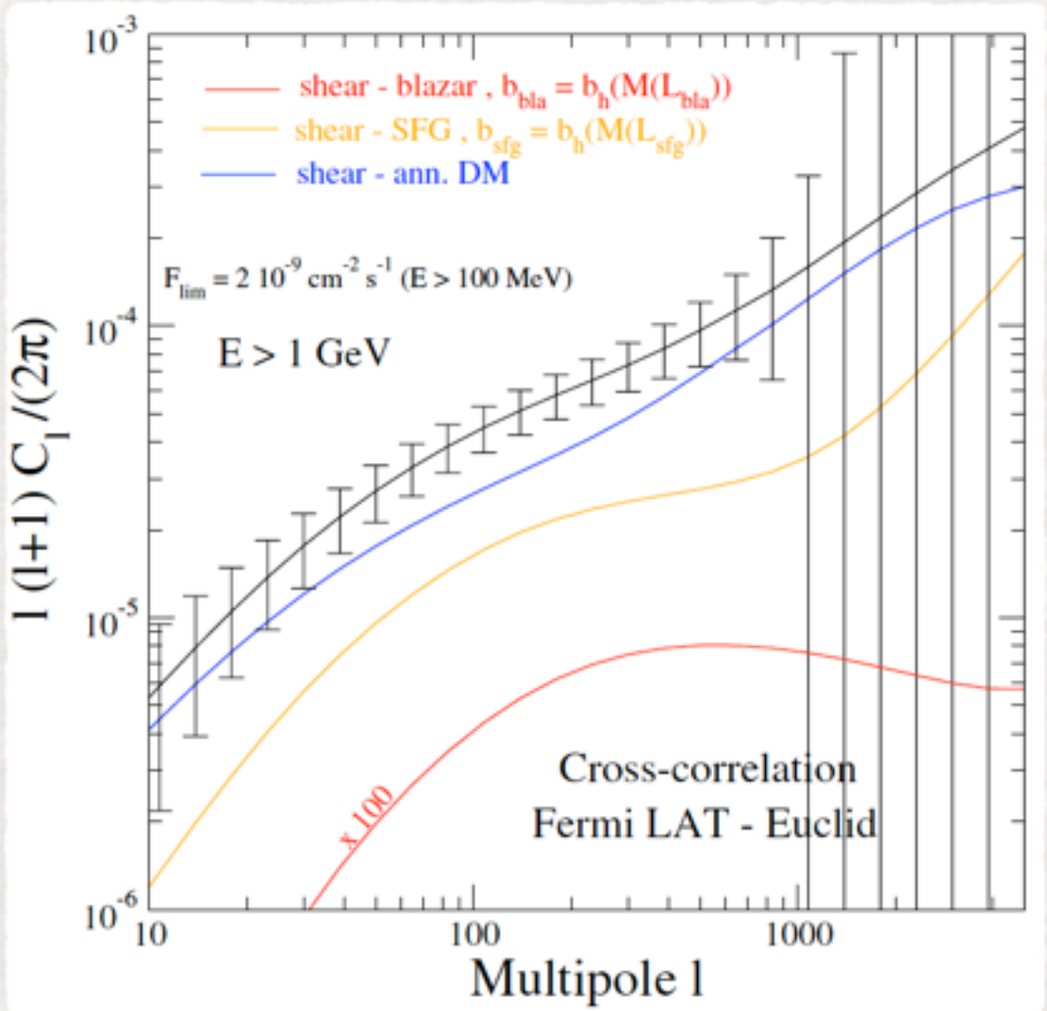

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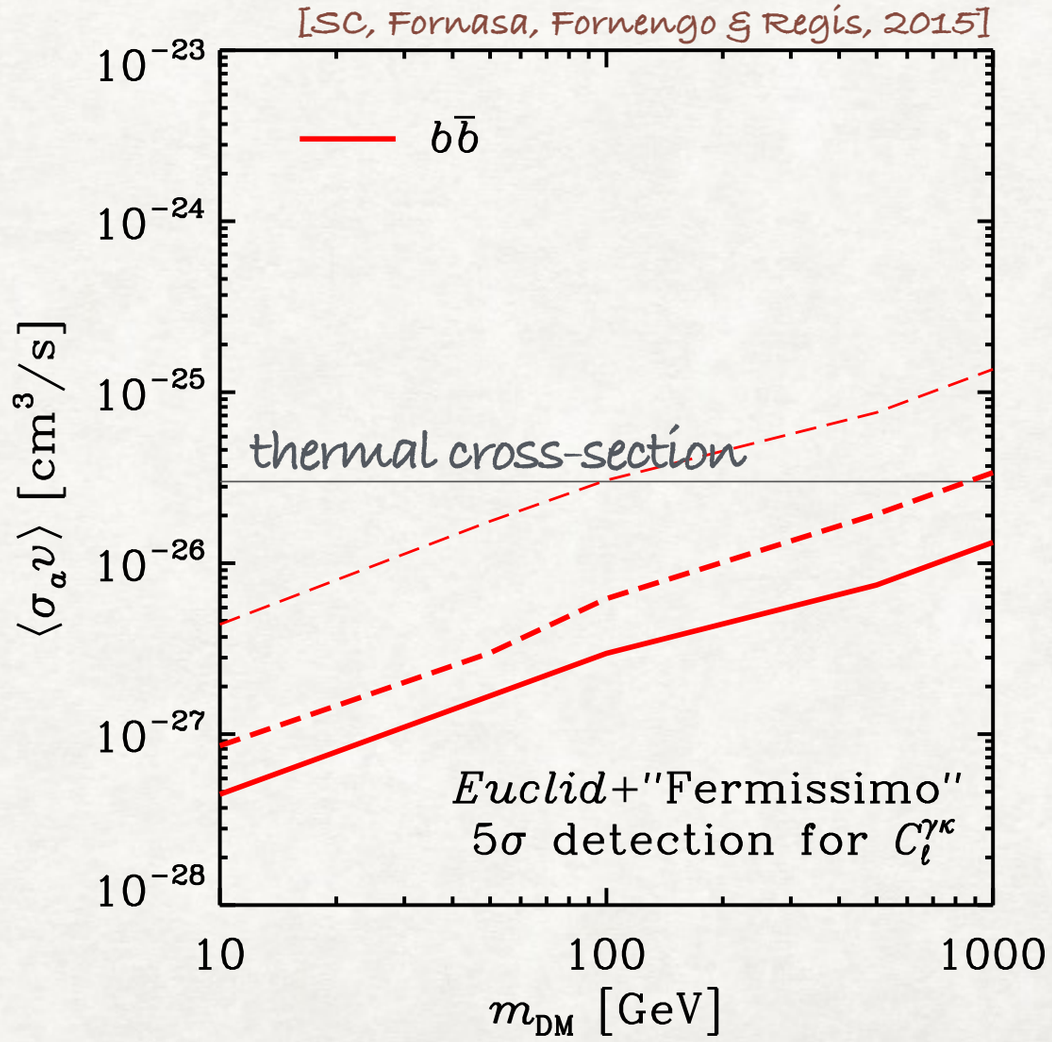

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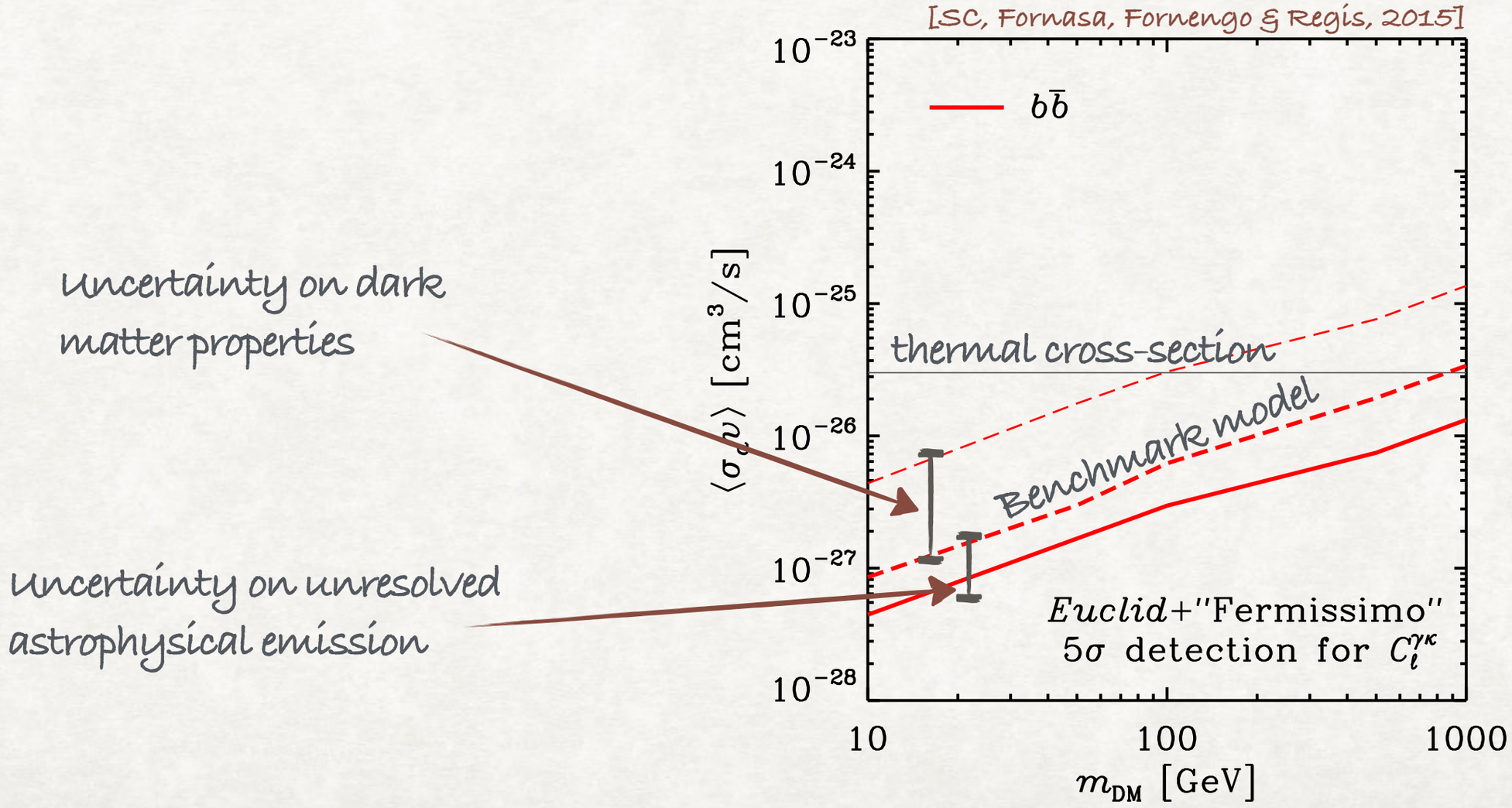

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- CMB lensing [Planck 2013 & 2015]
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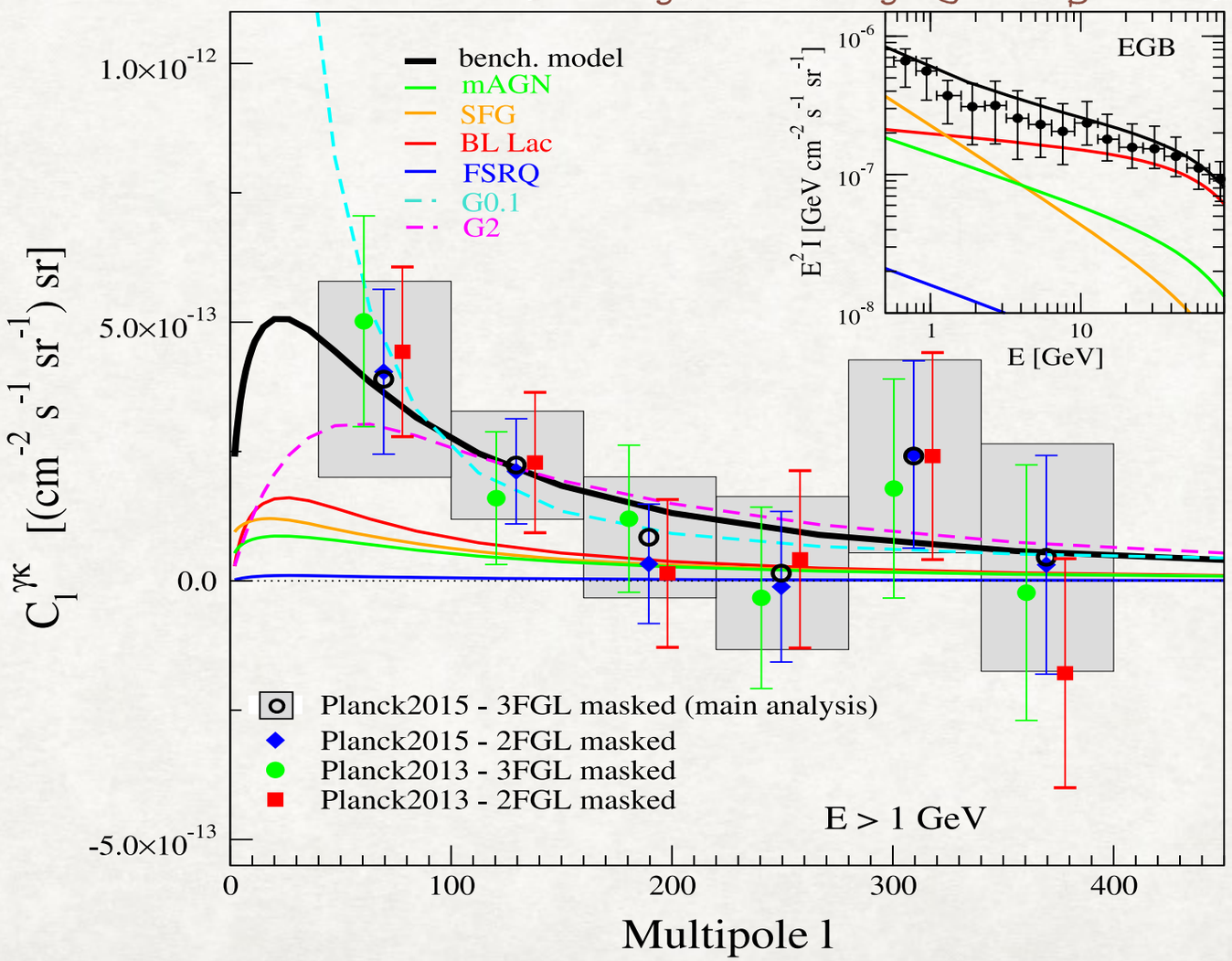

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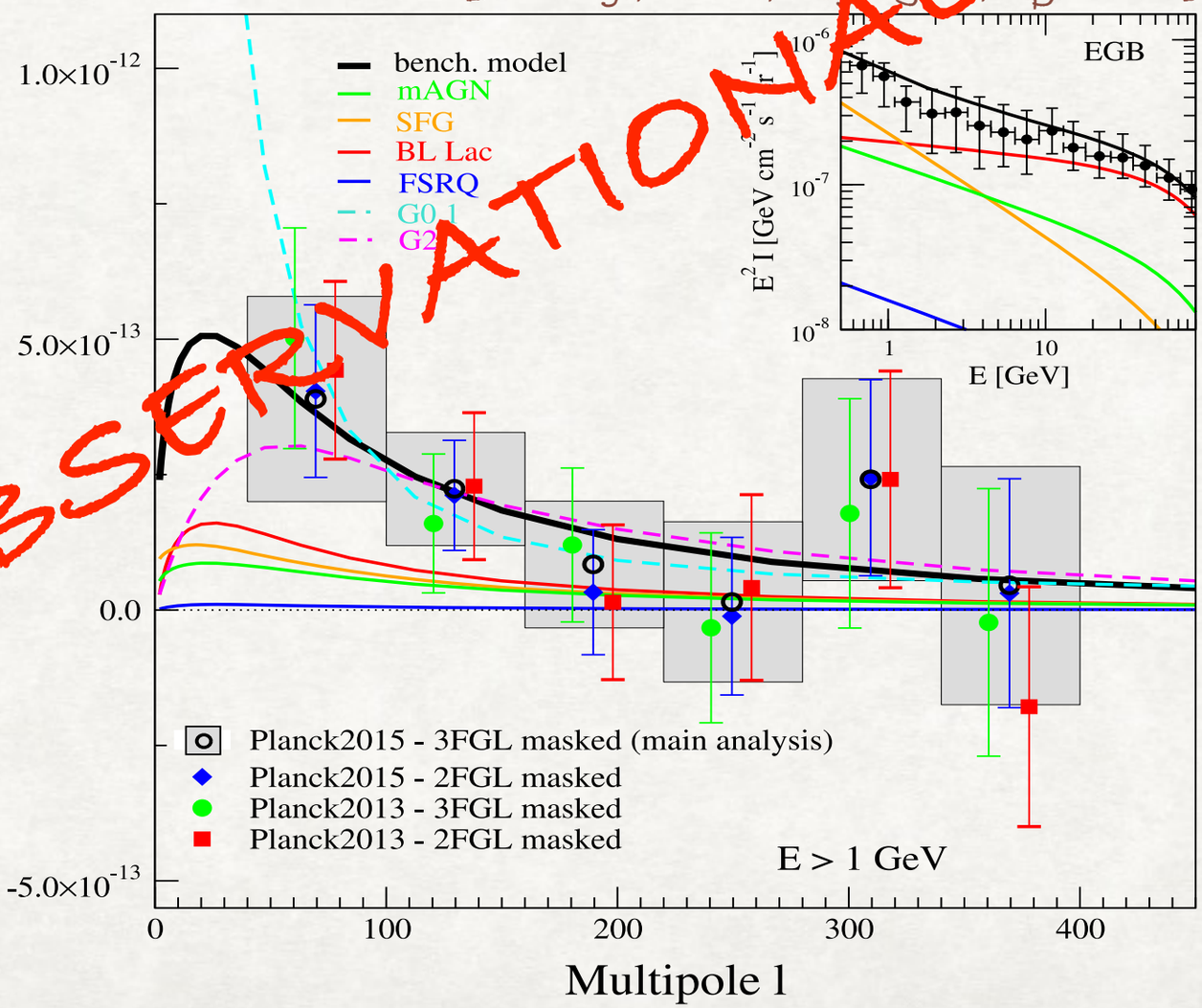

FIRST OBSERVATIONAL EVIDENCE

GAMMA RAYS & CLUSTERING

Fermi X 2MASS

- Clustering of galaxies [2MASS]
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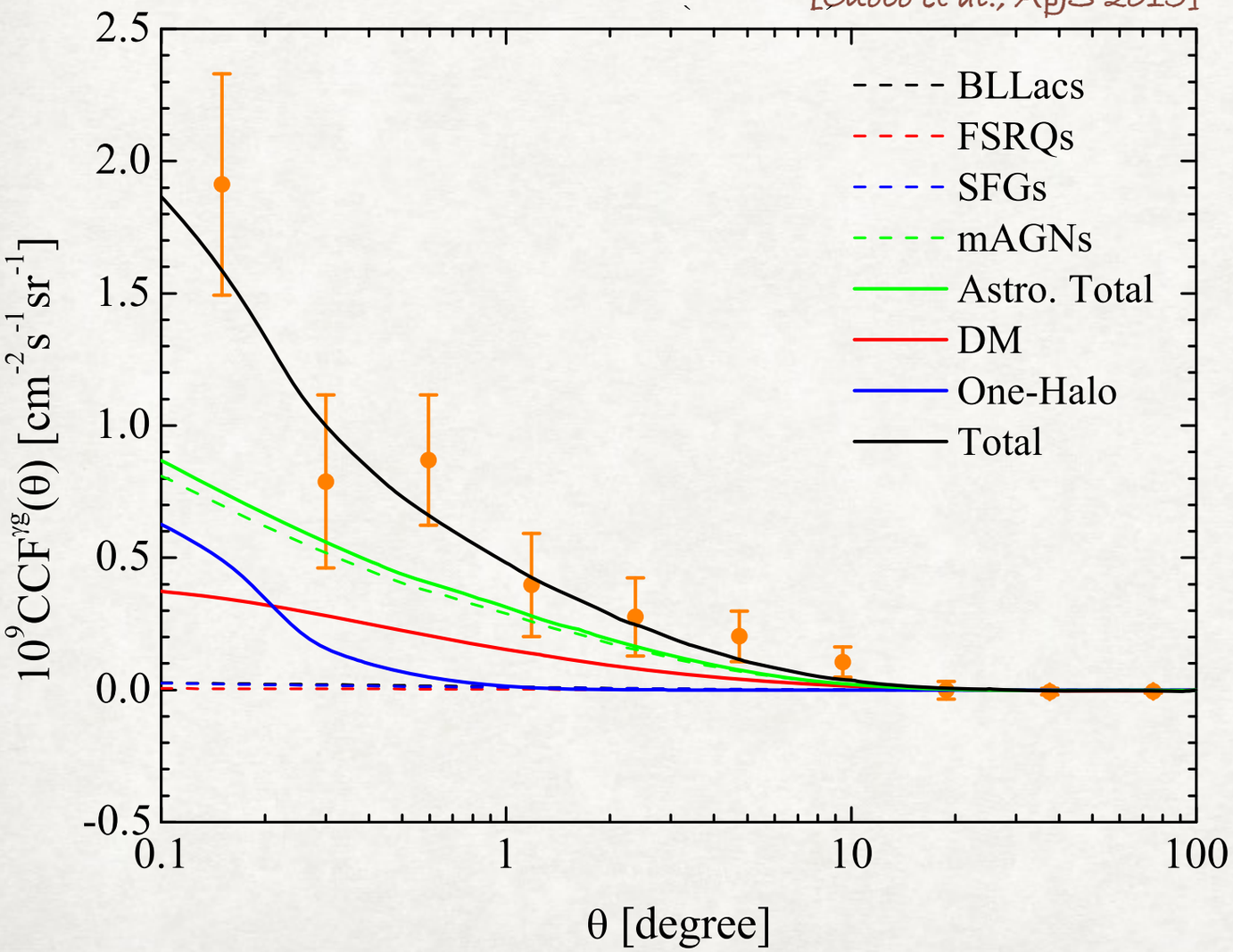

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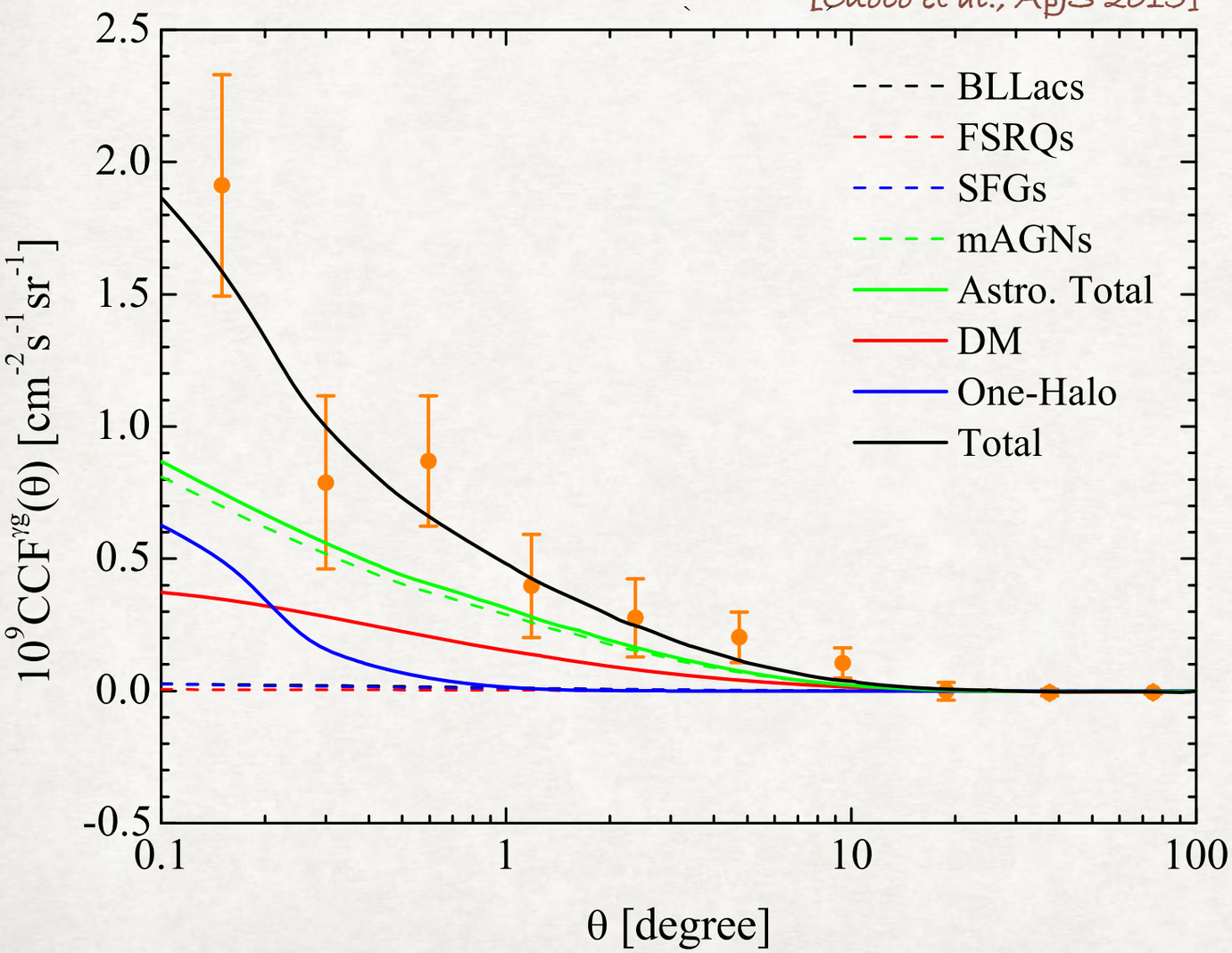
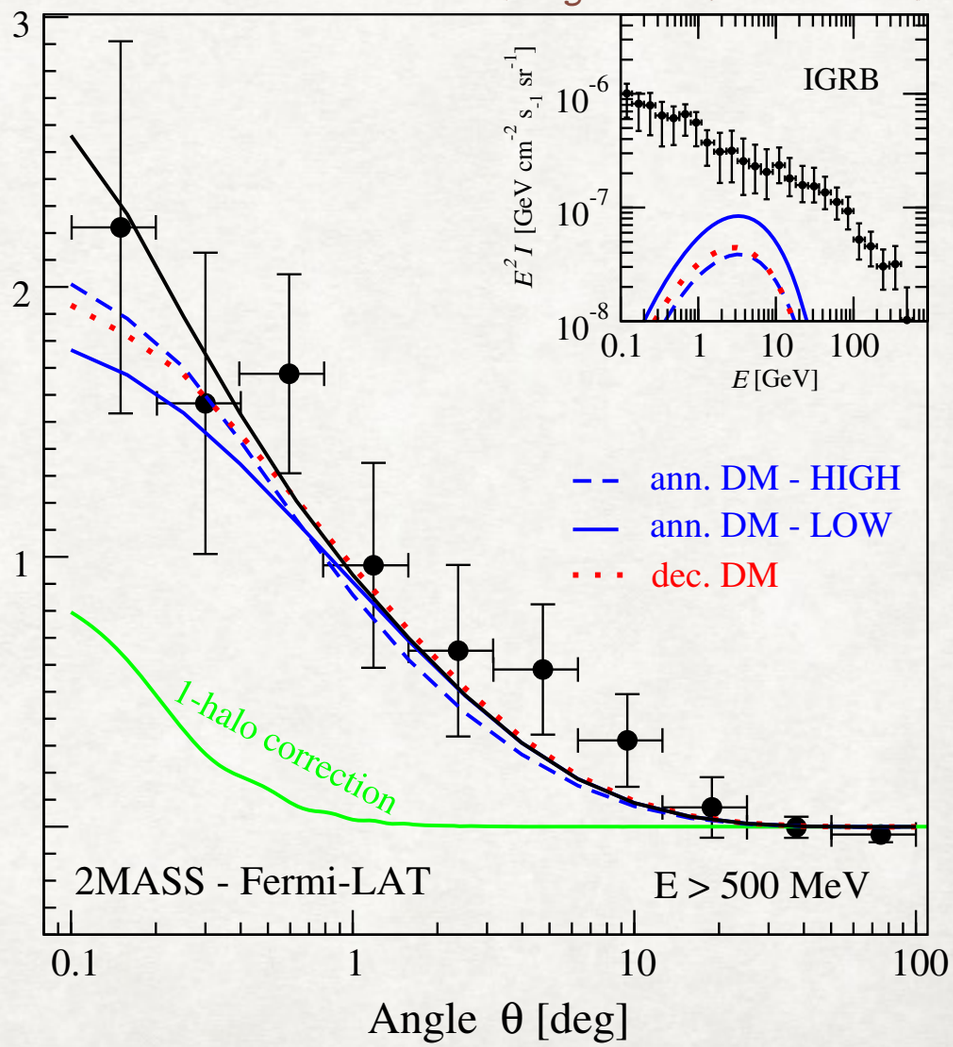


[Regis et al., PRL 2015]



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GAMMA RAYS & CLUSTERING

Fermi X WHL12/redMaPPer/PlanckSZ

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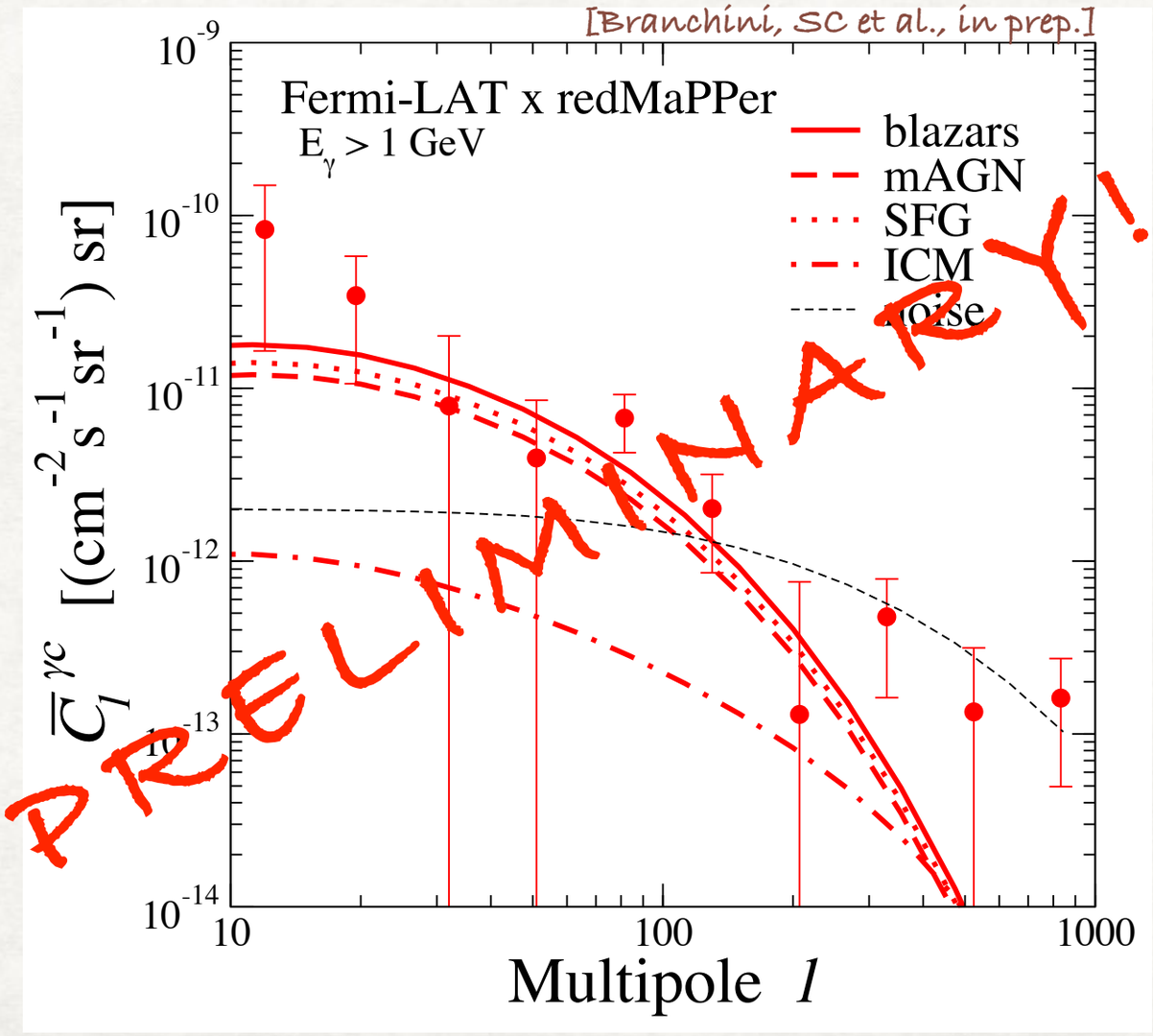

CONCLUSIONS

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THANKS!

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- Cross-correlation between gamma-ray anisotropies and weak lensing

[SC, Fornasa, Fornengo & Regis, ApJL 2013]

$$C^{\gamma\kappa} = \int \mathrm{d}\chi \, \frac{W^{\gamma}(\chi) W^{\kappa}(\chi)}{\chi^2} P^{s}\left(\frac{\ell}{\chi}, \chi\right)$$

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Weak lensing kernel

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Gamma ray kernel

- Dark matter (WIMP mass, gamma-ray production efficiency)
  - Annihilations (WIMP cross-section, clumping)
  - Decays (WIMP lifetime/decay rate)
- Astrophysical sources (source population, gamma-ray luminosity, modelling of unresolved emission)

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3D cross power spectrum of source fields

- Weak lensing: matter density
- Dark matter
  - Annihilations: dark matter density squared
  - Decays: dark matter density
- Astrophysical sources: unresolved source gamma-ray luminosity