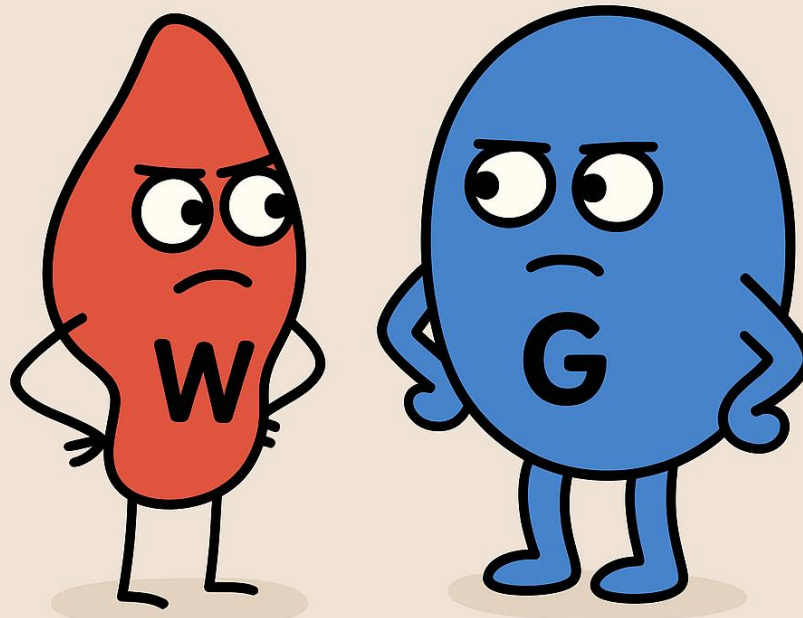




UNIVERSITY
of York

DARK MATTER: RED OR BLUE?



Asli Acar, **Mikhail Bashkanov**, Dan Watts



Science and
Technology
Facilities Council

Dark Matter: Red or Blue?




Physics Letters B

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Letter

Dark matter: Red or blue?

[A. Acar](#), [C. Isaacson](#), [M. Bashkanov](#)  , [D.P. Watts](#)

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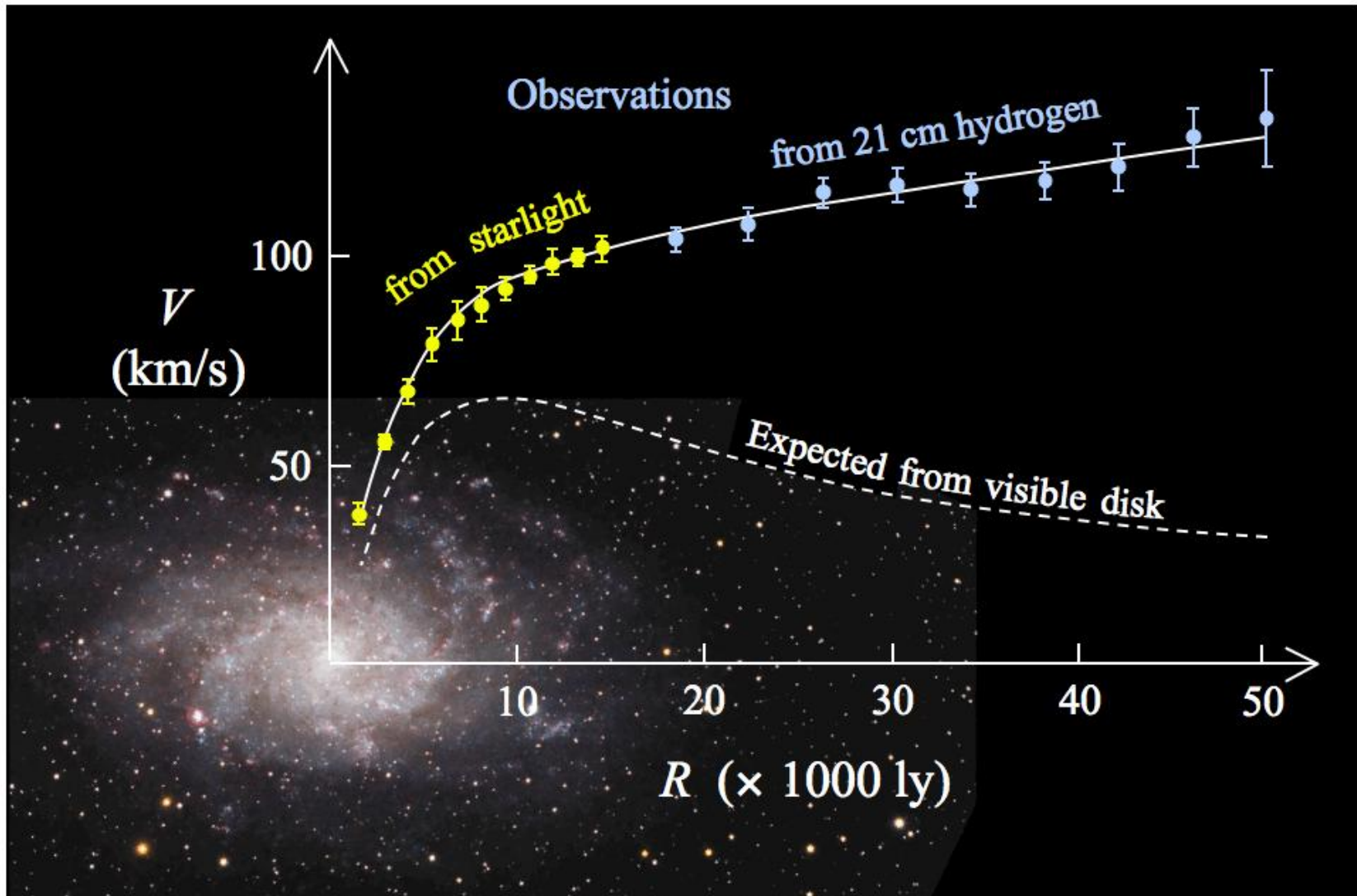
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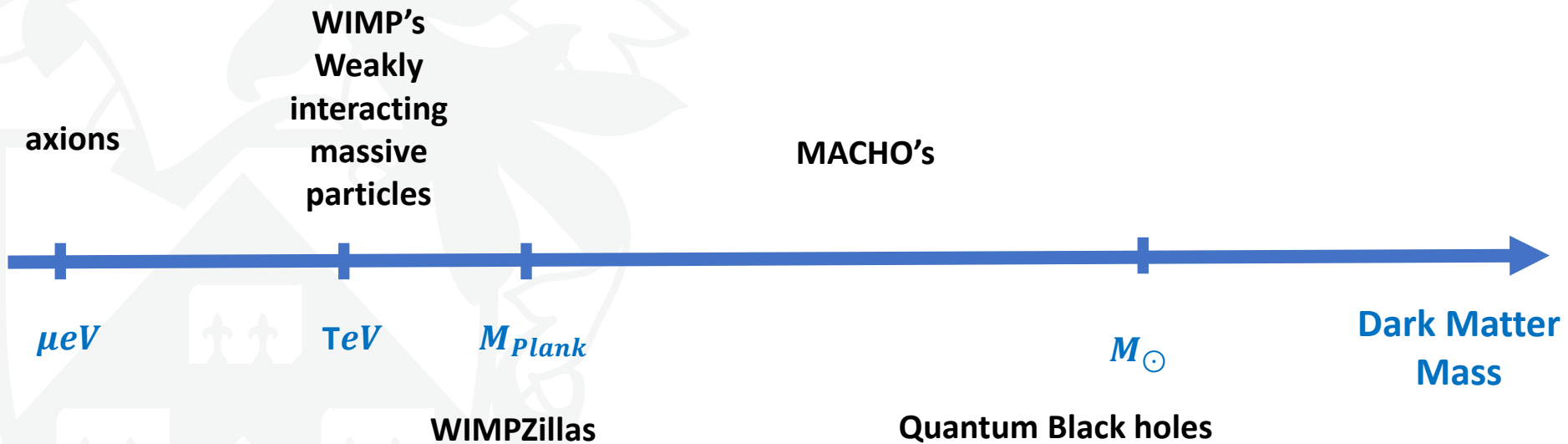
Dark Matter – Why?



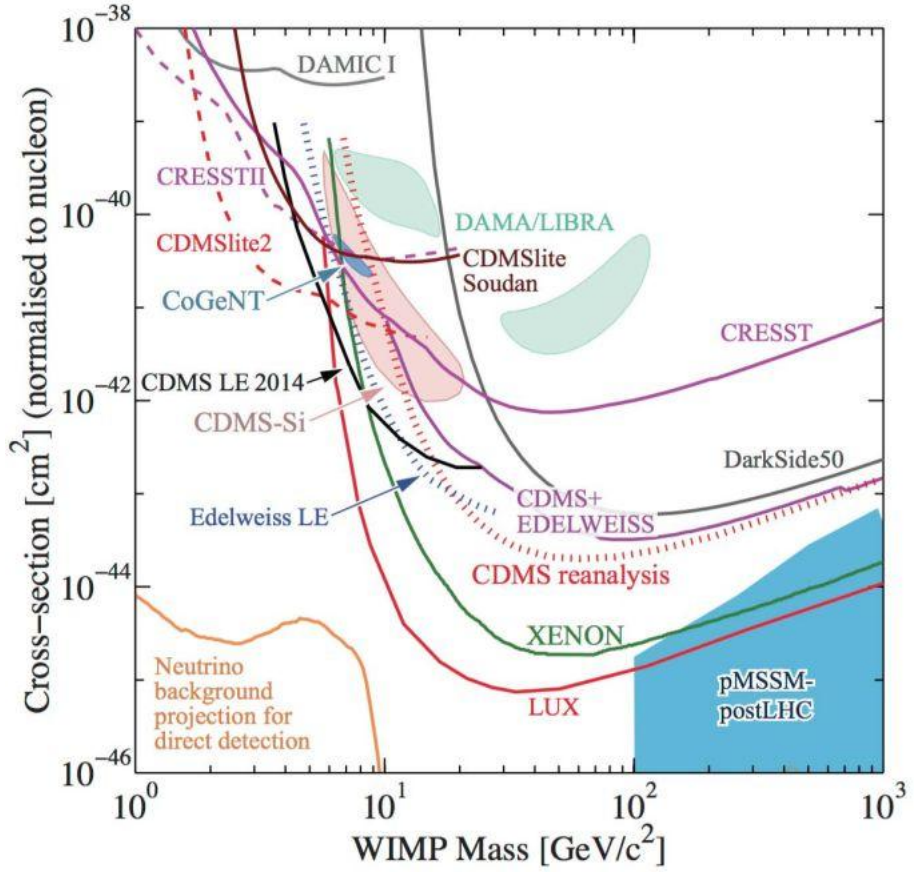
Dark Matter

The image features a deep blue, starry night sky as a background. Overlaid on this are intricate, dark, branching structures that resemble a complex web or a dense network of fibers. These structures are more prominent in the center and become sparser towards the edges. The overall effect is one of a vast, interconnected cosmic structure.

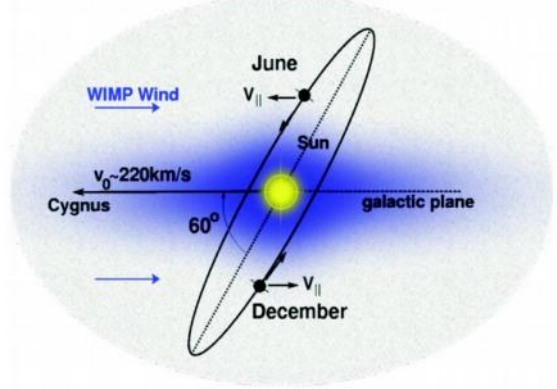
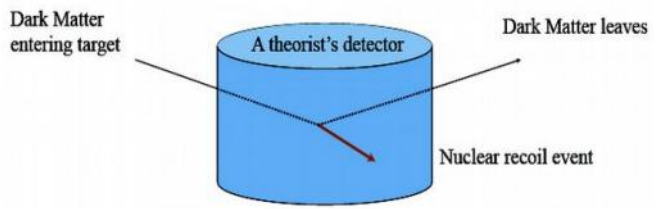
Dark Matter – How?



Direct WIMP searches

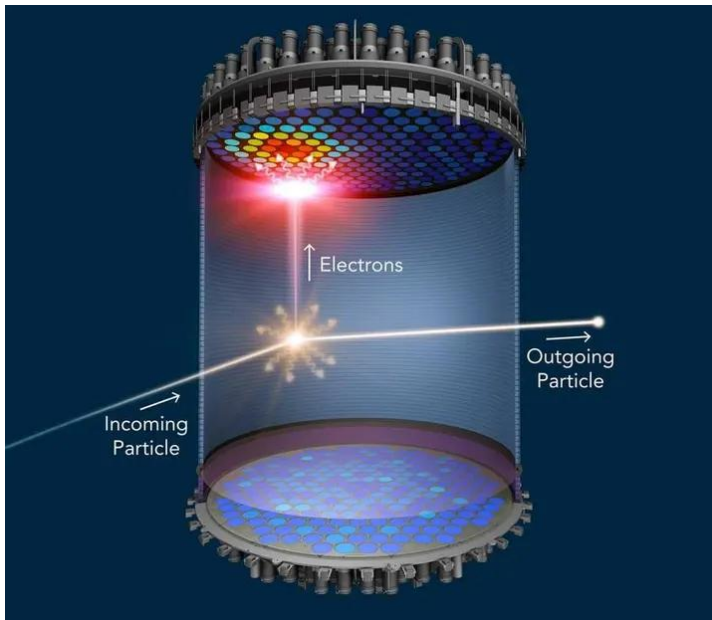


$$M_{\chi} \sim 1 \text{ TeV}$$

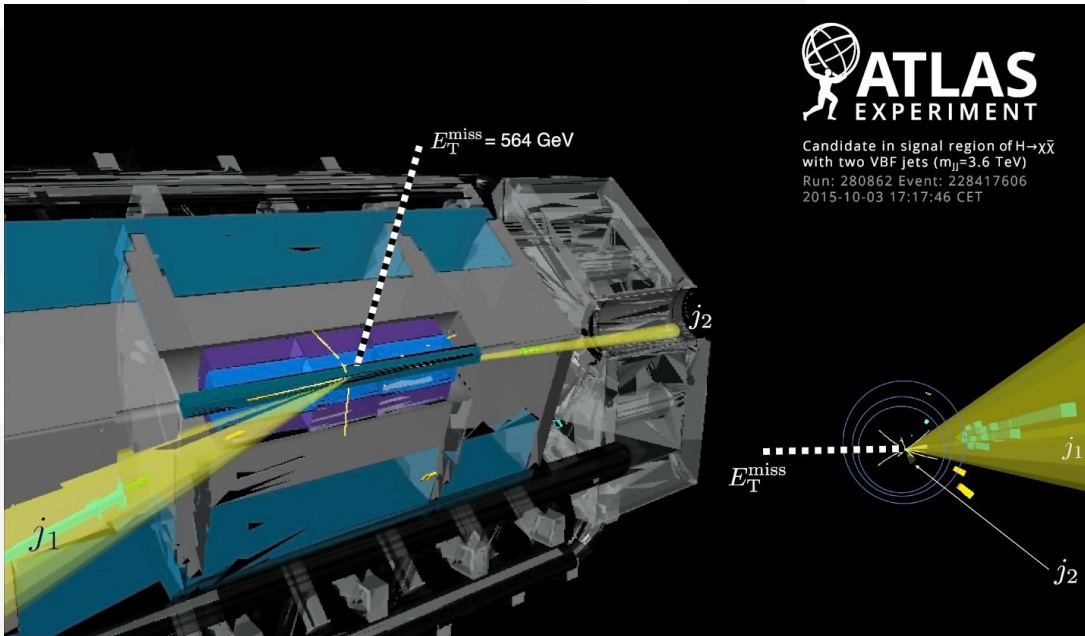


Annual modulations in the event rate should be present!

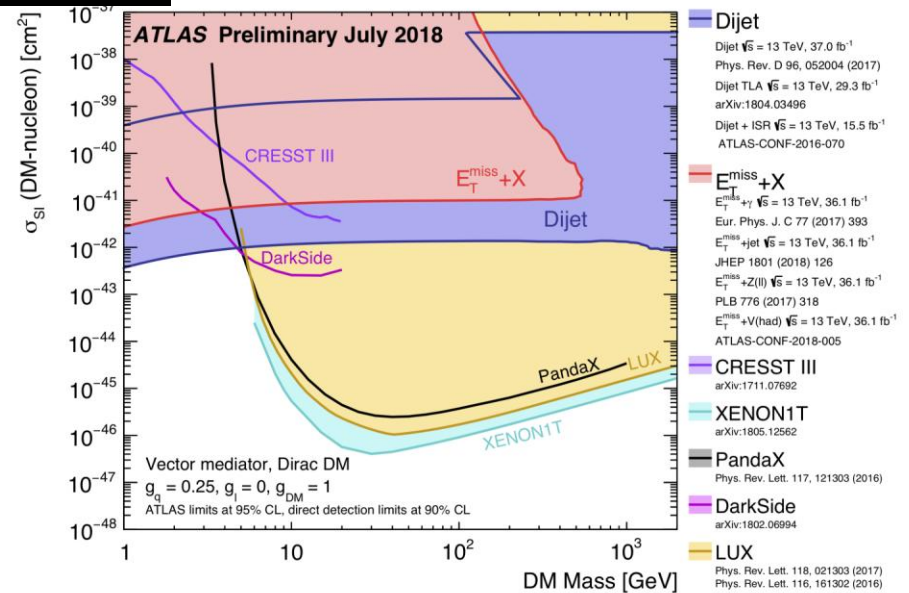
Directionality
=> annual modulation of the signal



WIMP searches at LHC



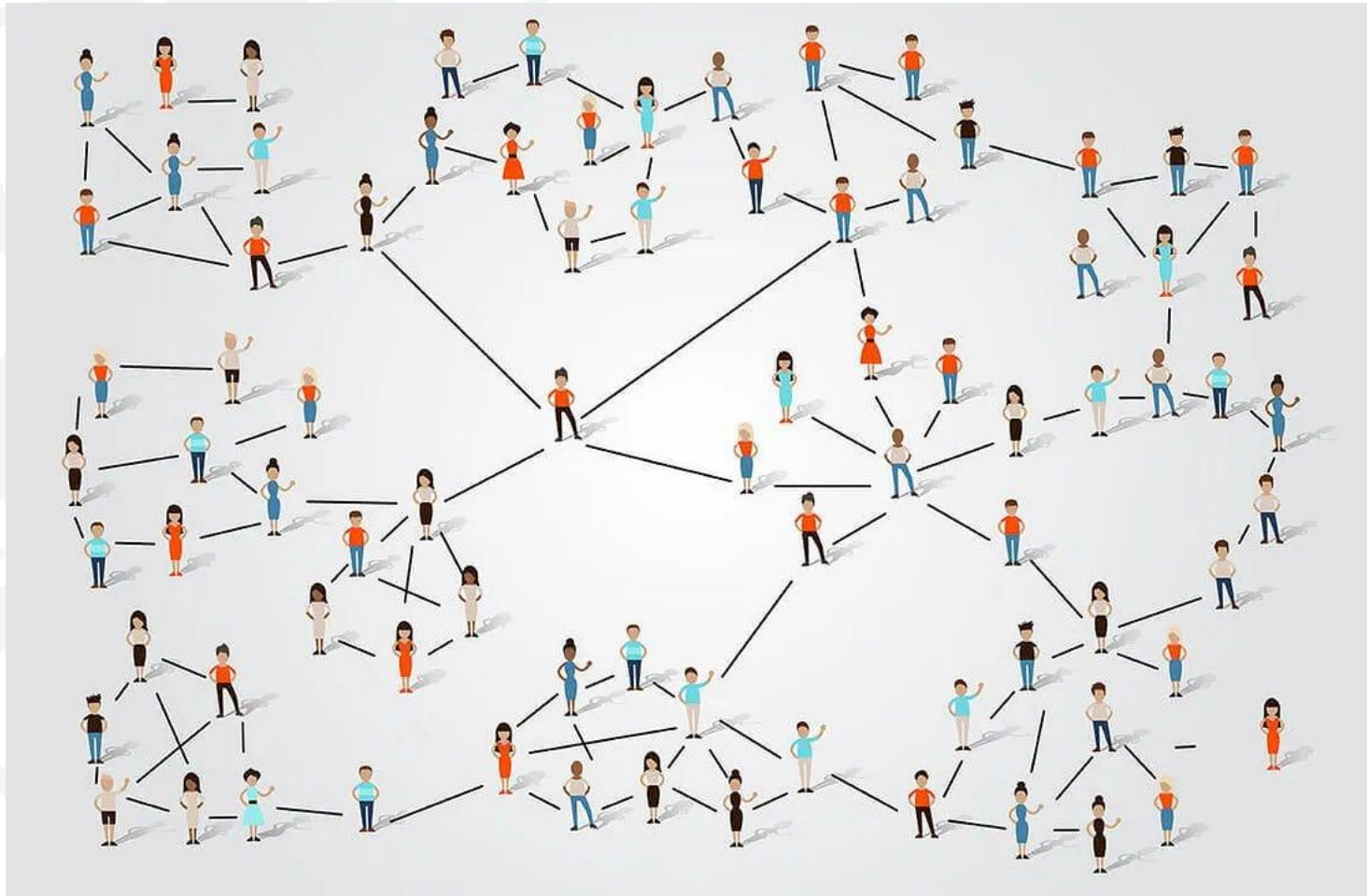
$$M_\chi \sim 1 \text{ TeV}$$



WIMP – light interactions



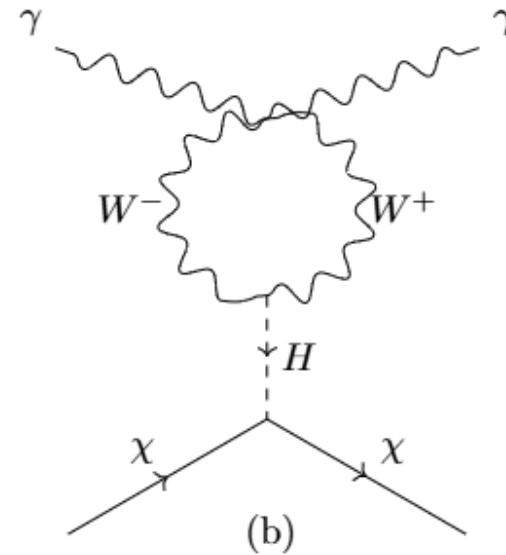
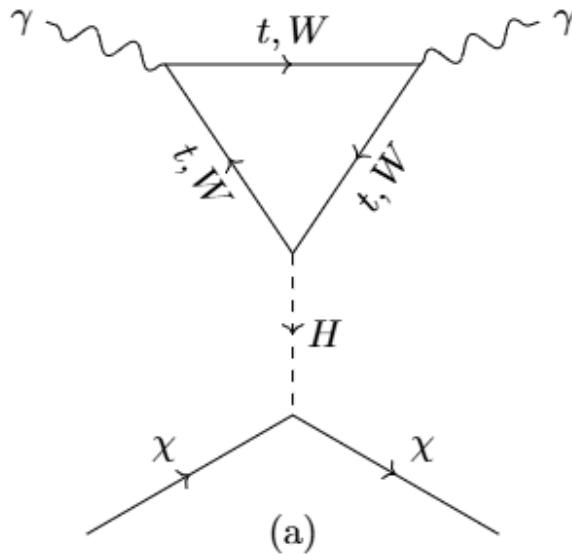
- Six handshake rule



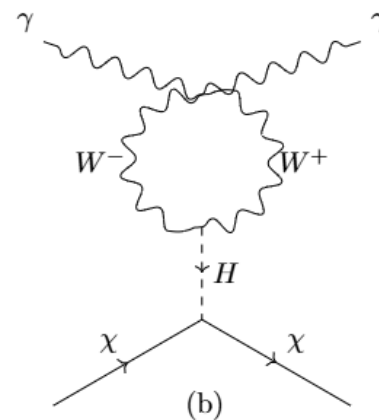
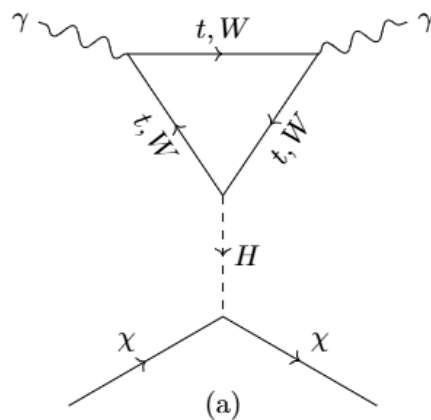
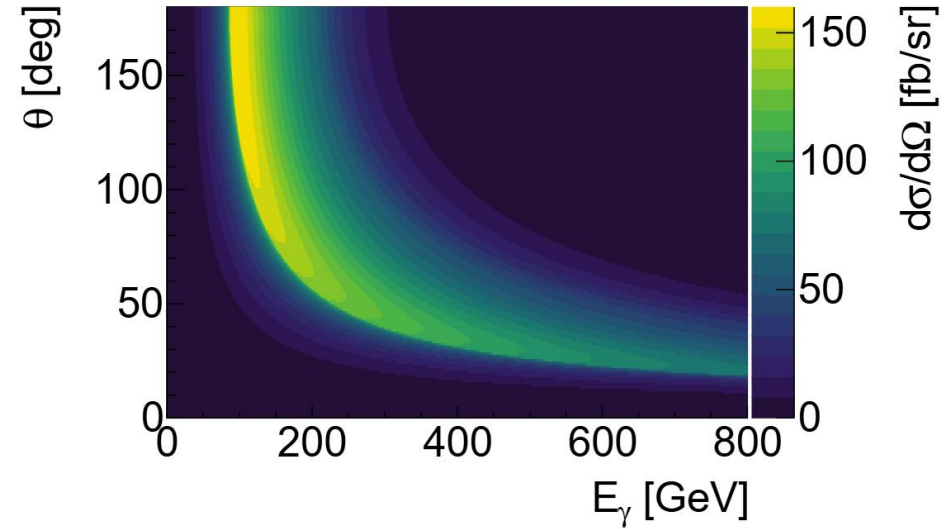
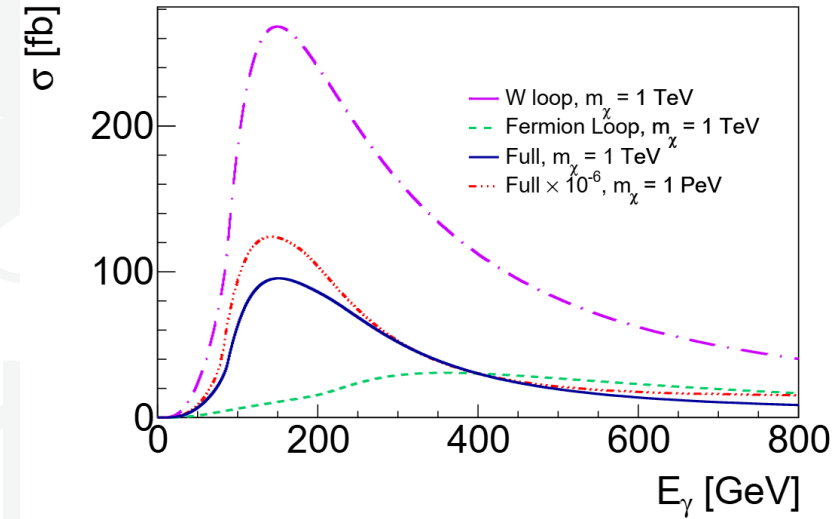
WIMP – light interactions



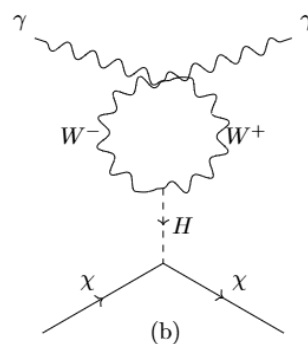
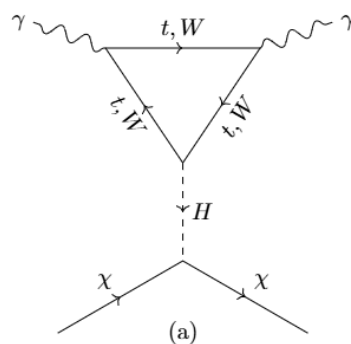
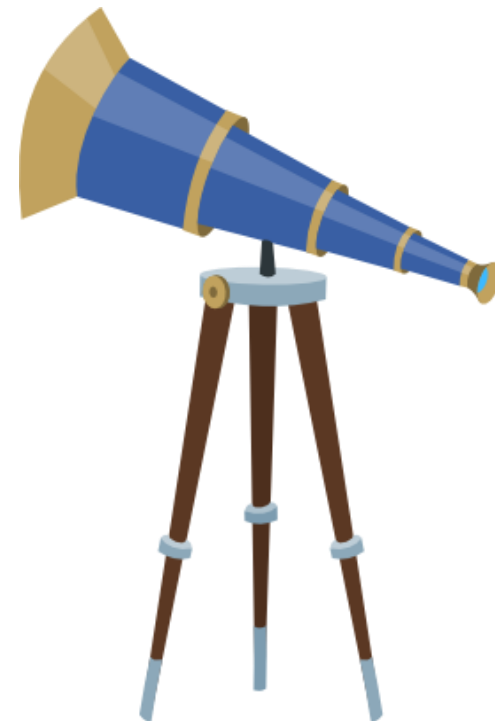
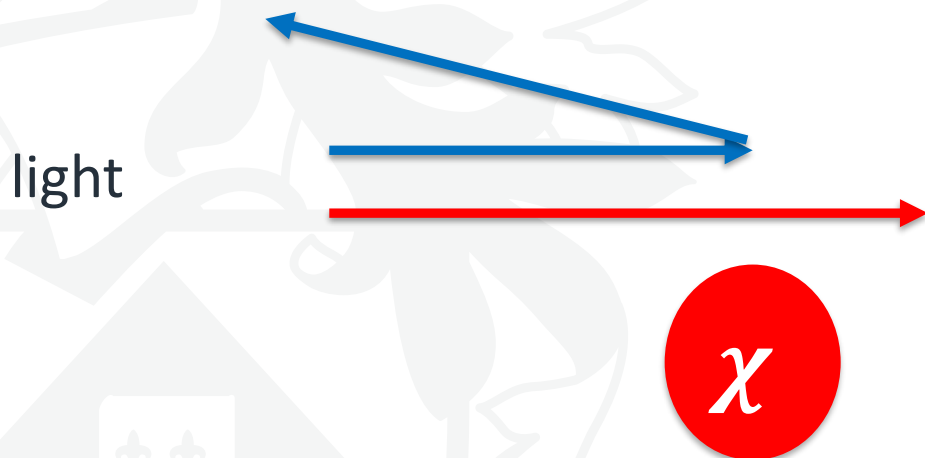
- Six handshake rule in particle physics



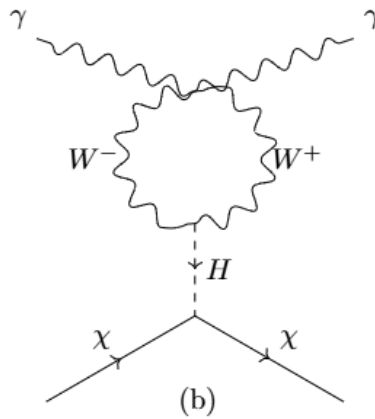
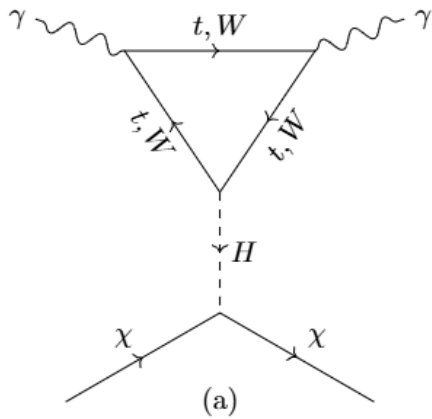
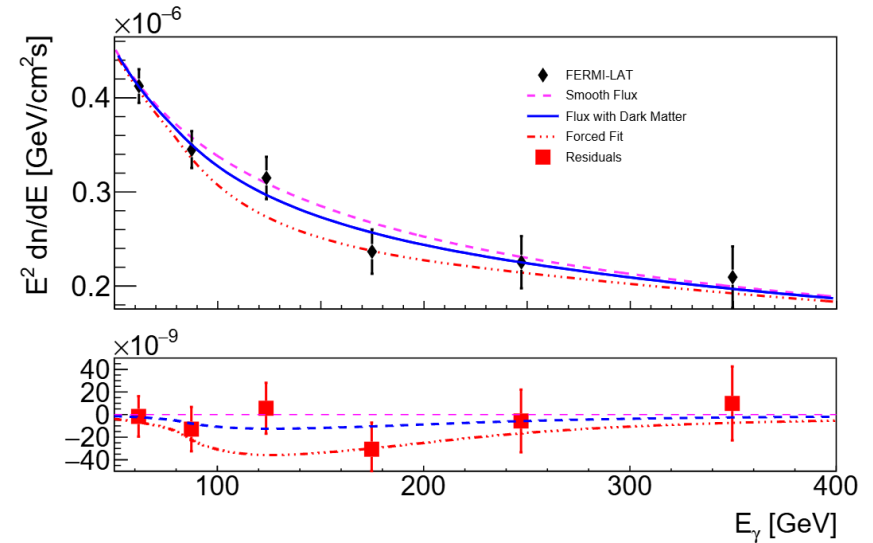
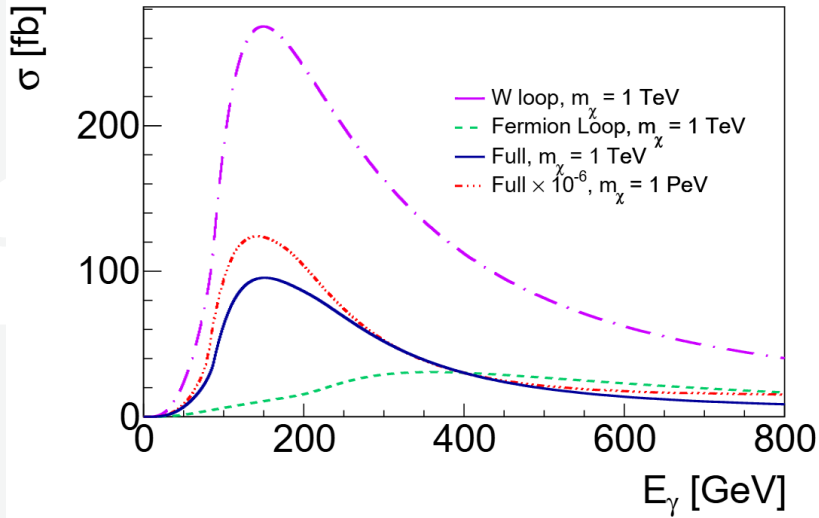
WIMP – light interactions



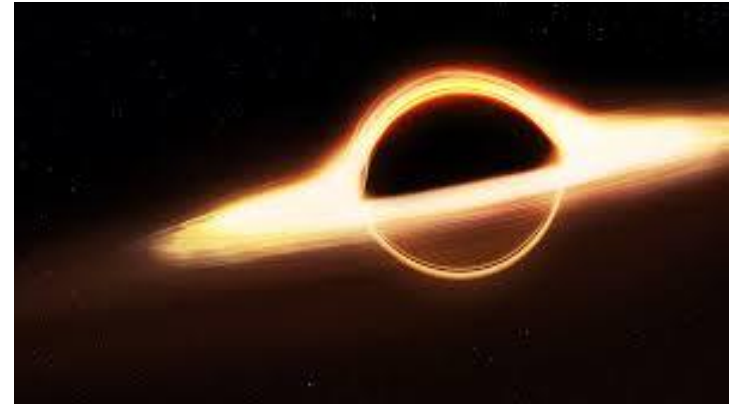
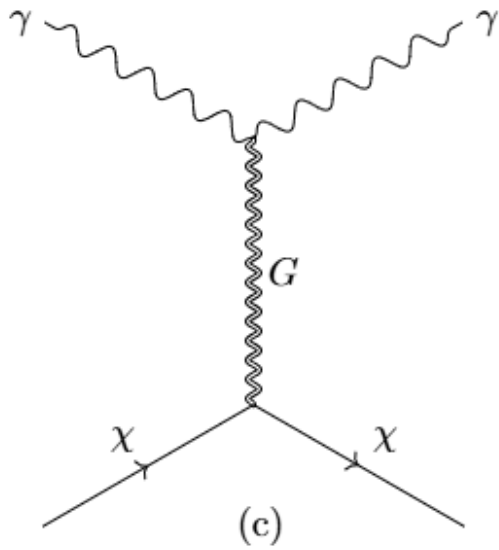
WIMP – light interactions



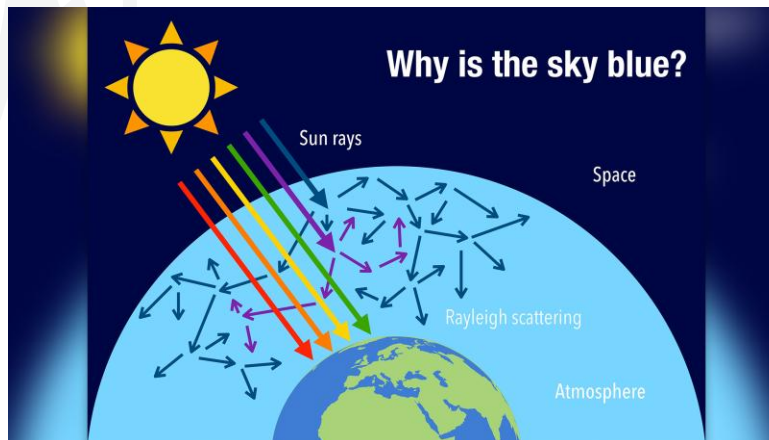
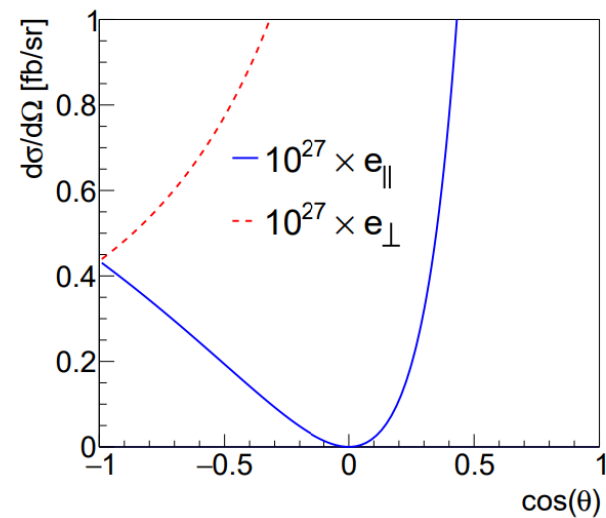
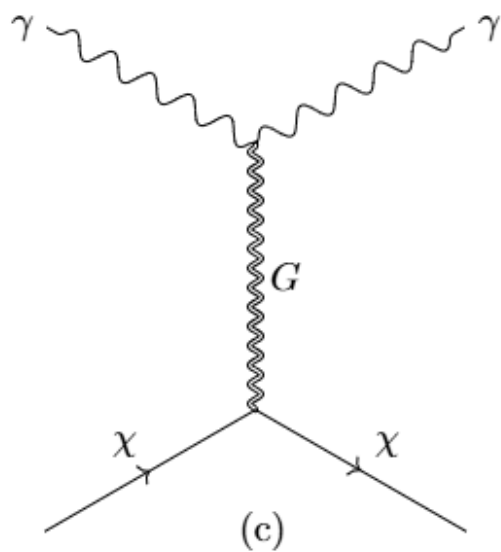
WIMP – light interactions: high energy gamma rays?



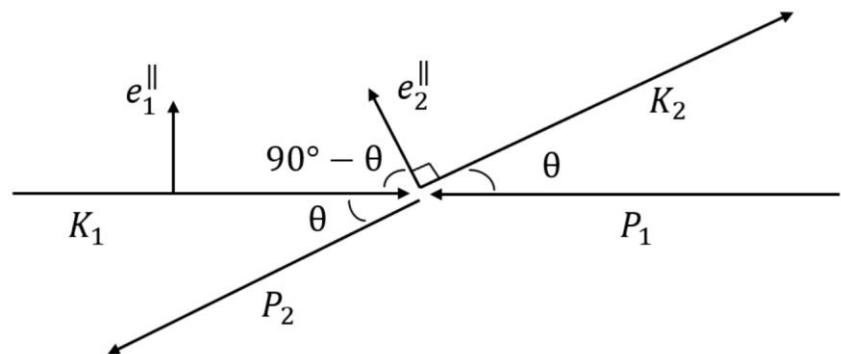
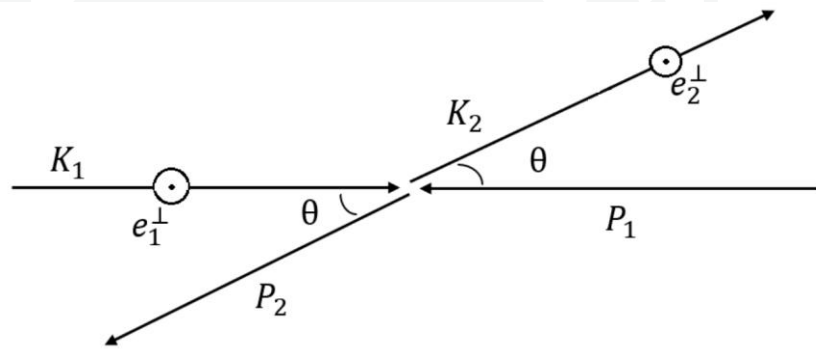
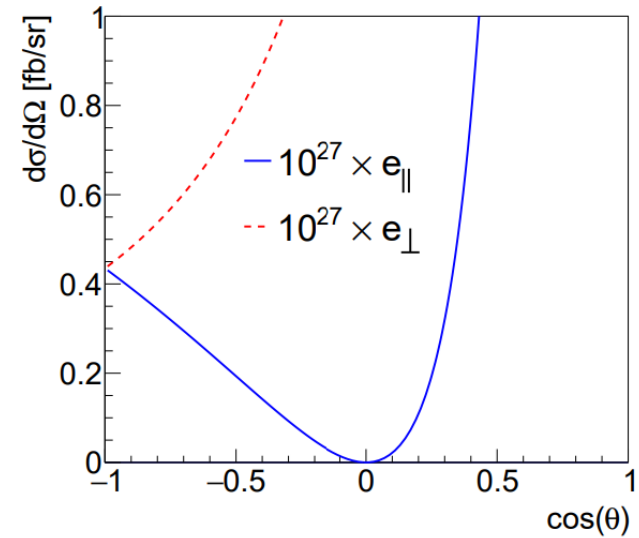
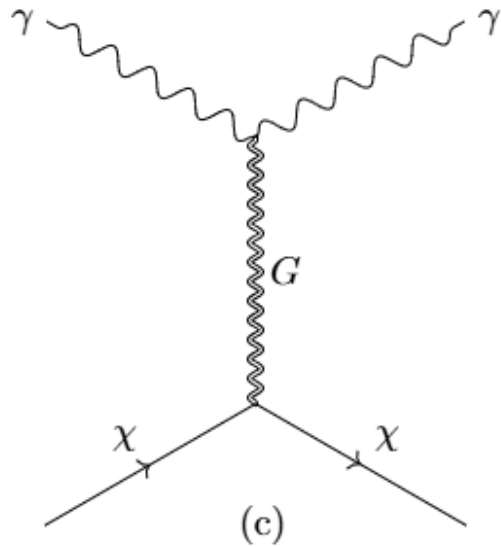
Gravitational dark matter?



Gravitational dark matter?

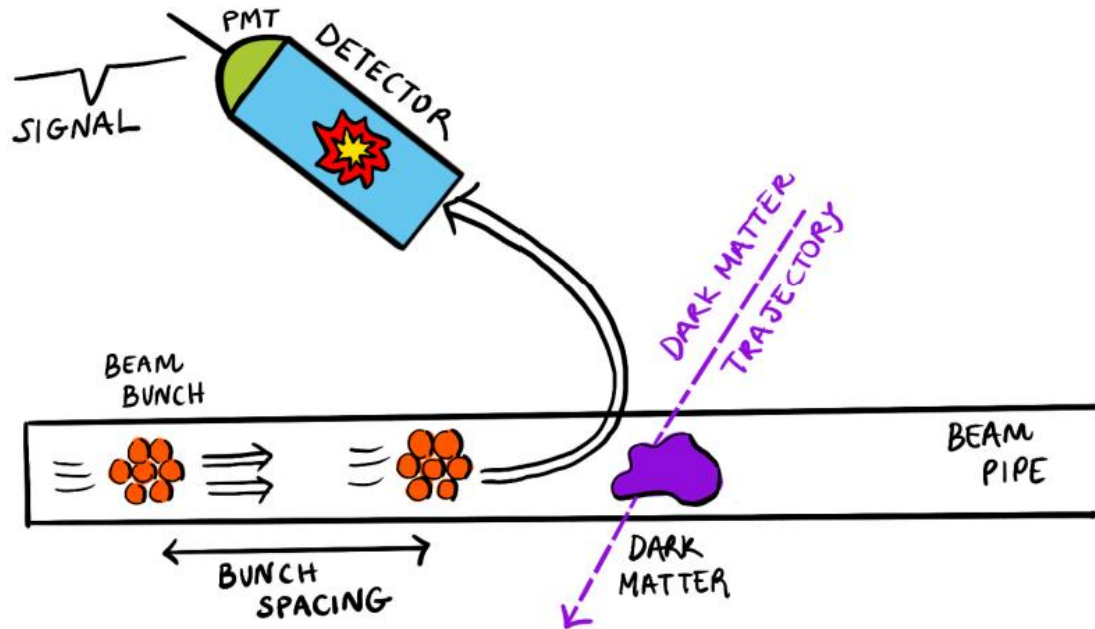


Gravitational dark matter – polarisation effects.



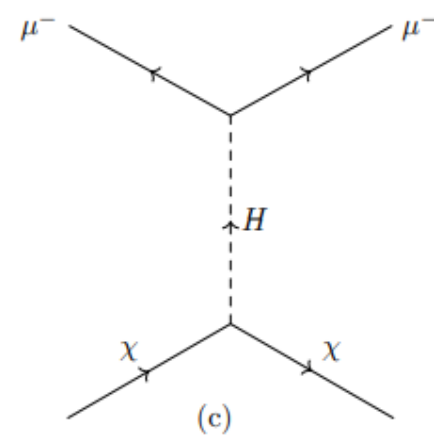
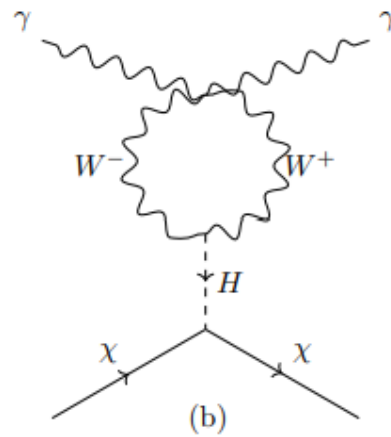
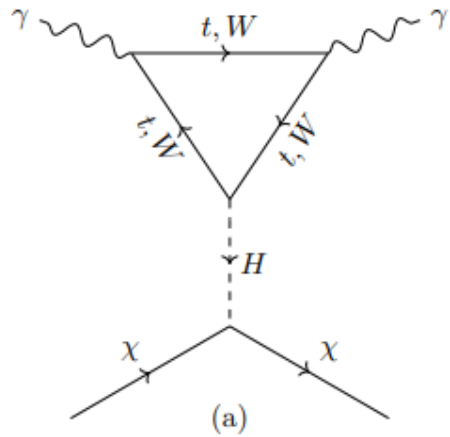
**Dark Matter detection
@
Accelerators?**

DM vs intense beams

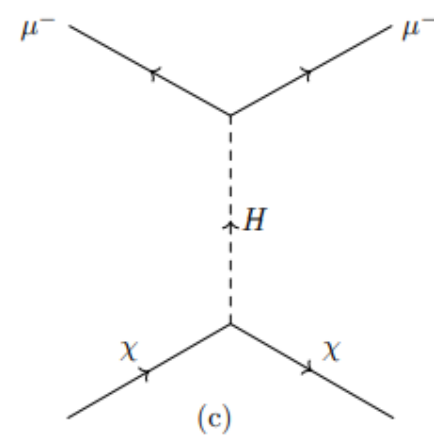
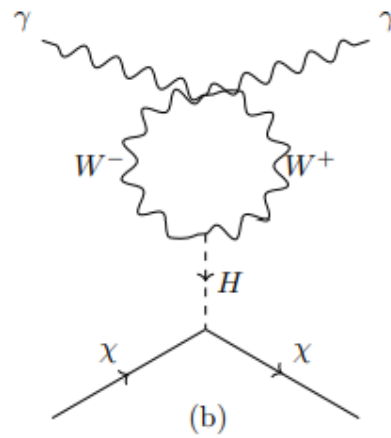
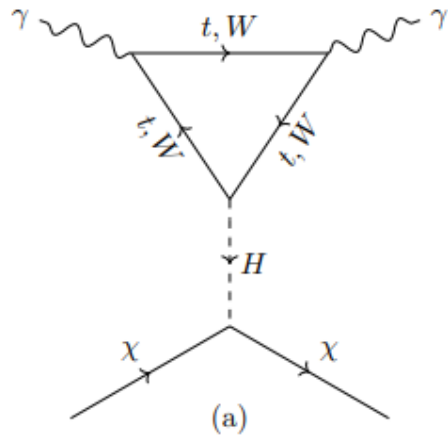


arXiv: [2603.03011](https://arxiv.org/abs/2603.03011)

WIMP – particles interactions

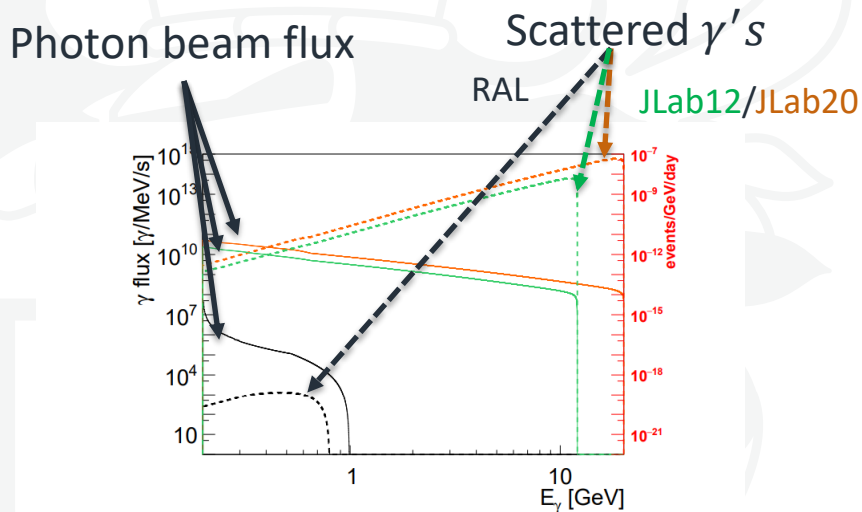
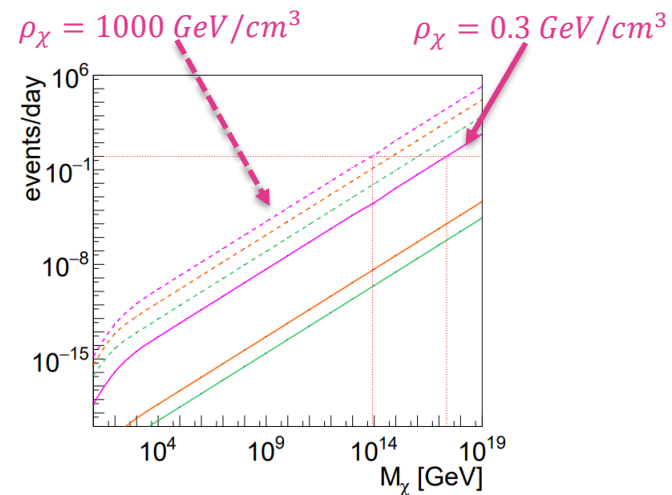


WIMP – particles interactions

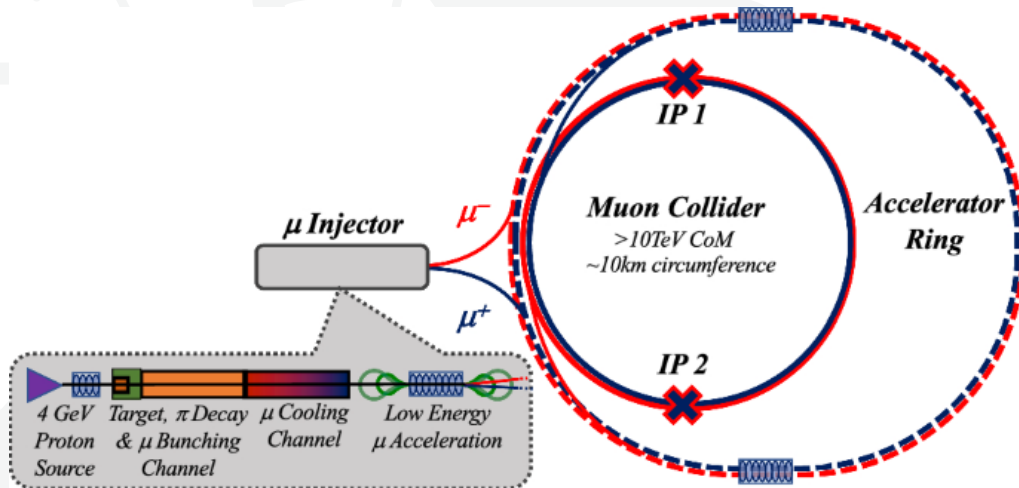


WIMP's at accelerators

Muon collider



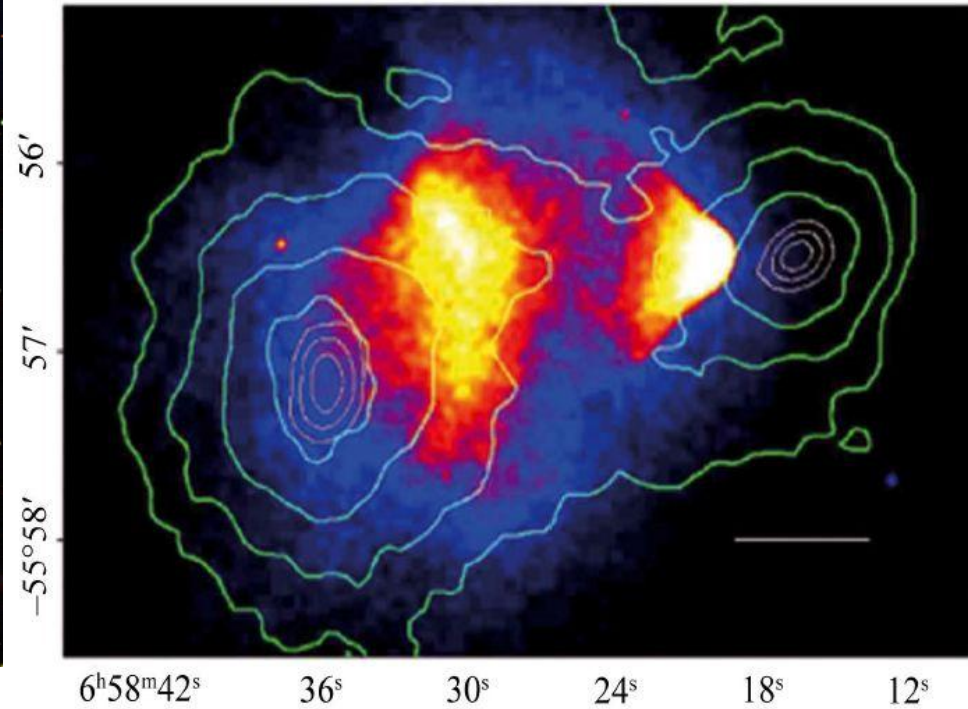
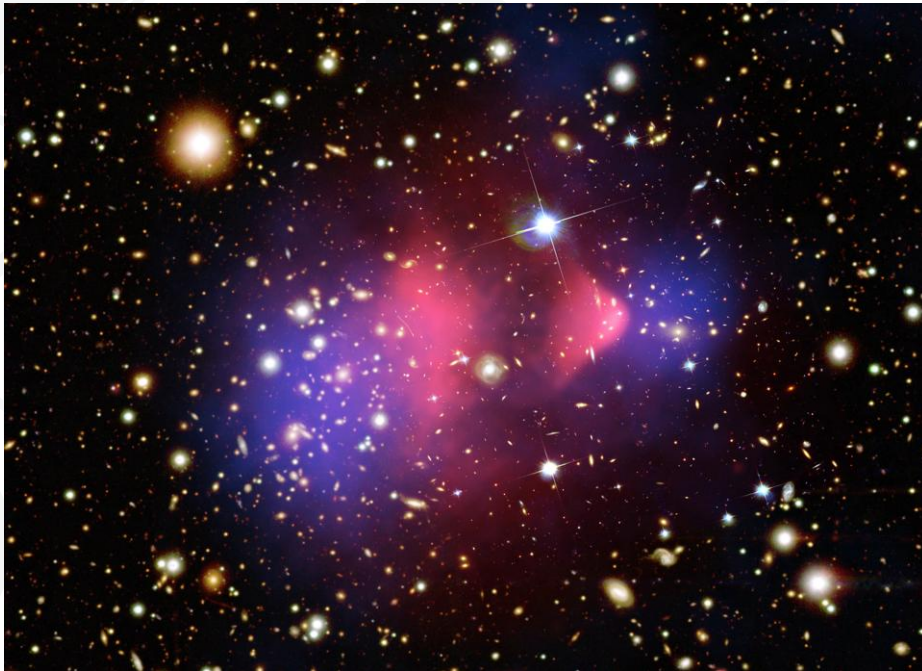
Muon collider as DM “weather” monitor



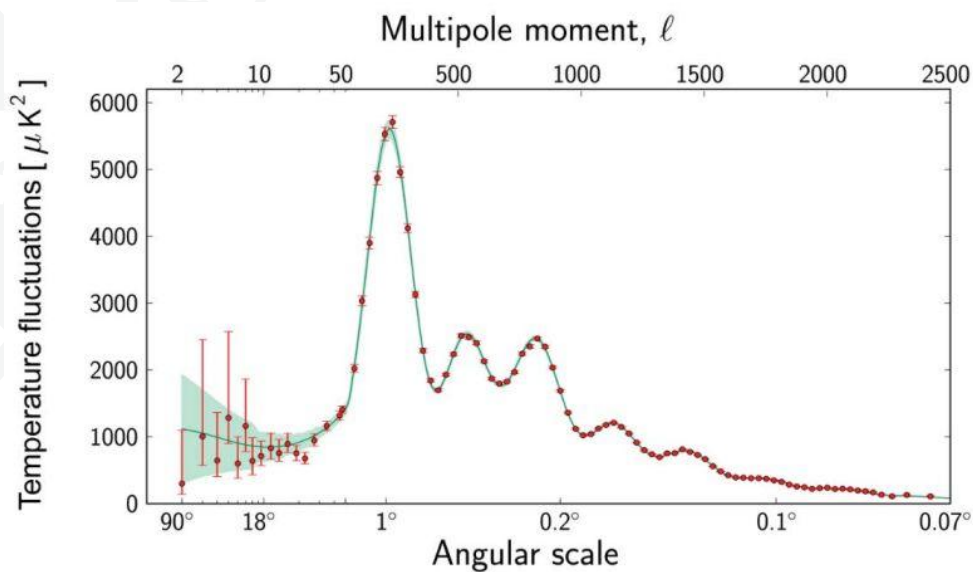
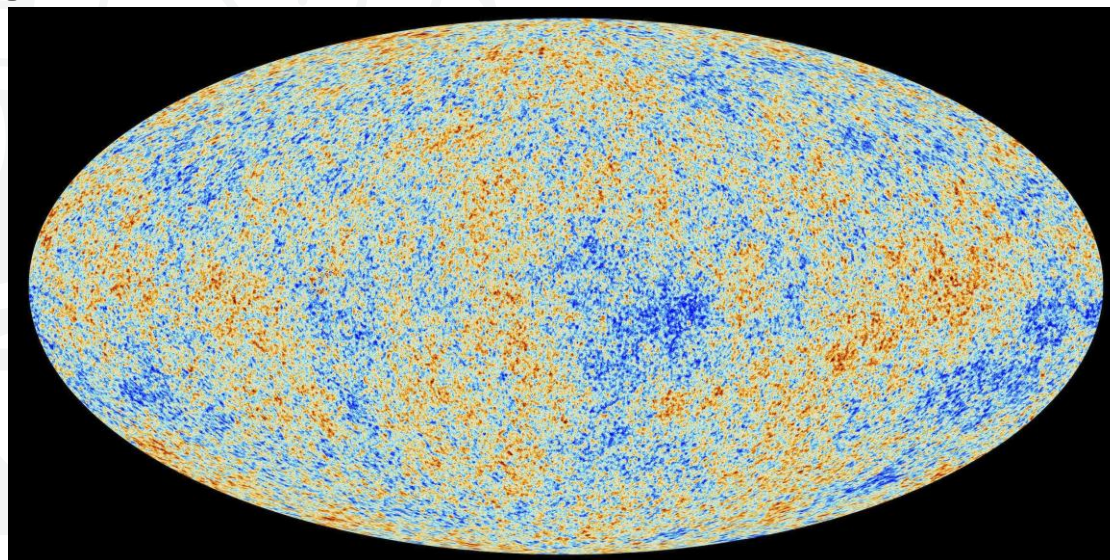
Conclusion

- Dark matter is not so dark!
- WIMP – red
- Gravitational – blue
 - Polarisation effects
- Strong dependence on M_χ - upper limits on DM masses
- Strong dependence on photon energy
 - Next generation gamma ray telescopes
 - Accelerators

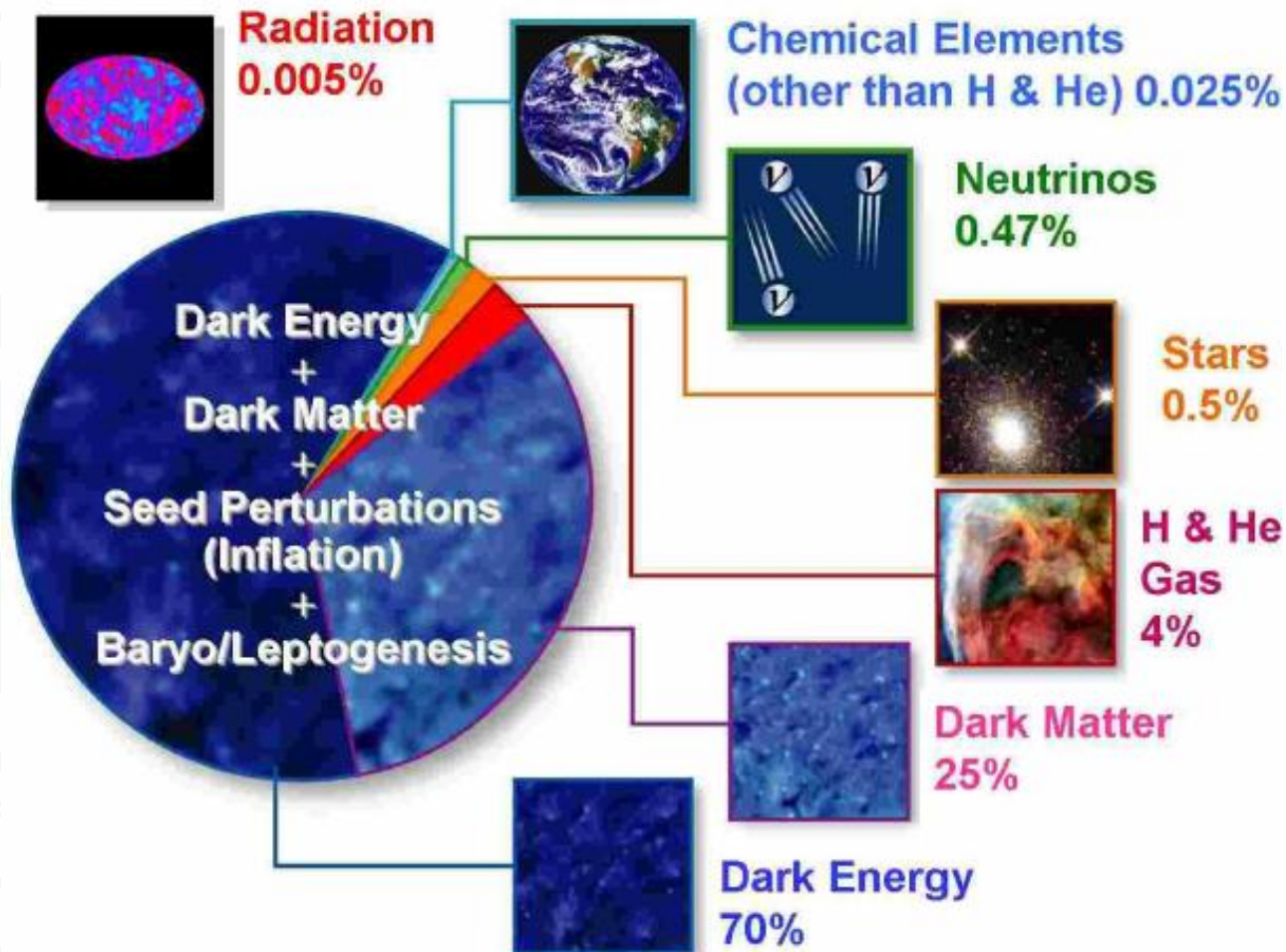
The Bullet Cluster – A smoking gun for dark matter



Cosmic microwave background radiation

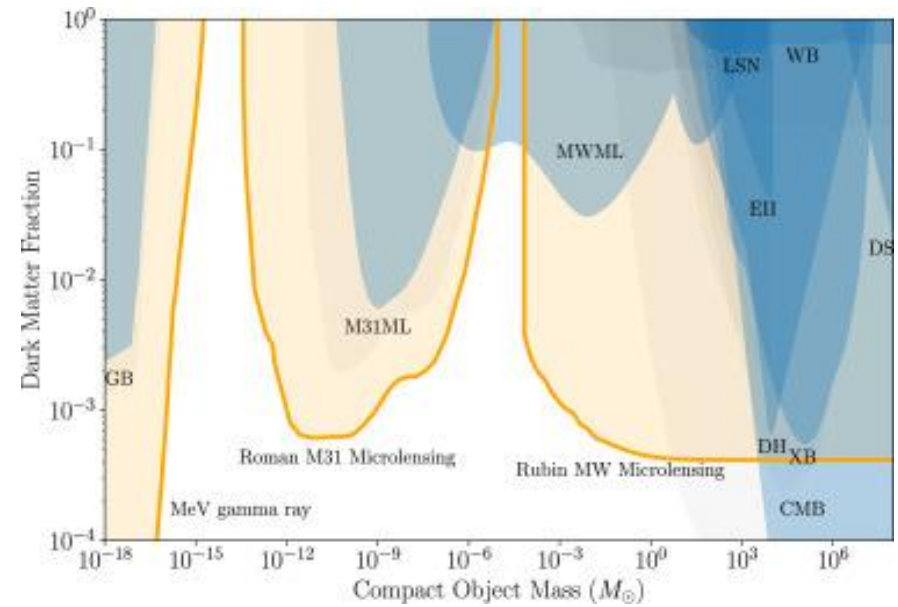
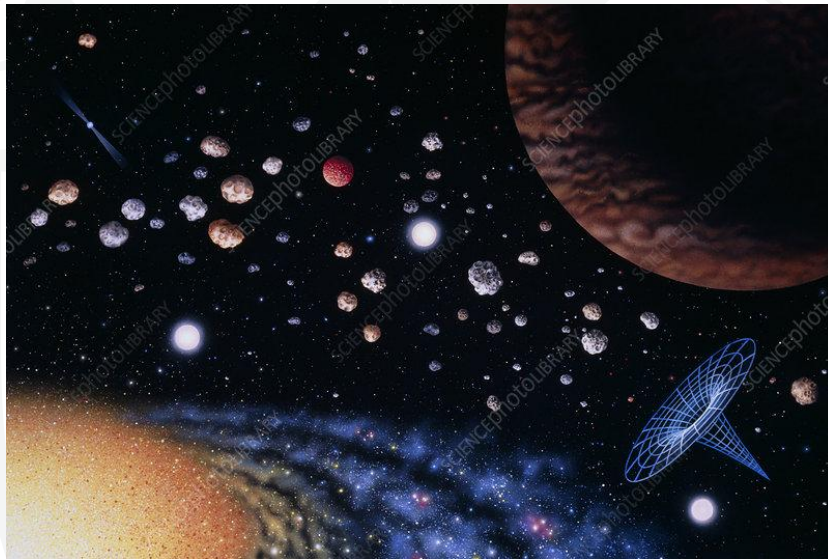


The standard model of cosmology



Macho's?

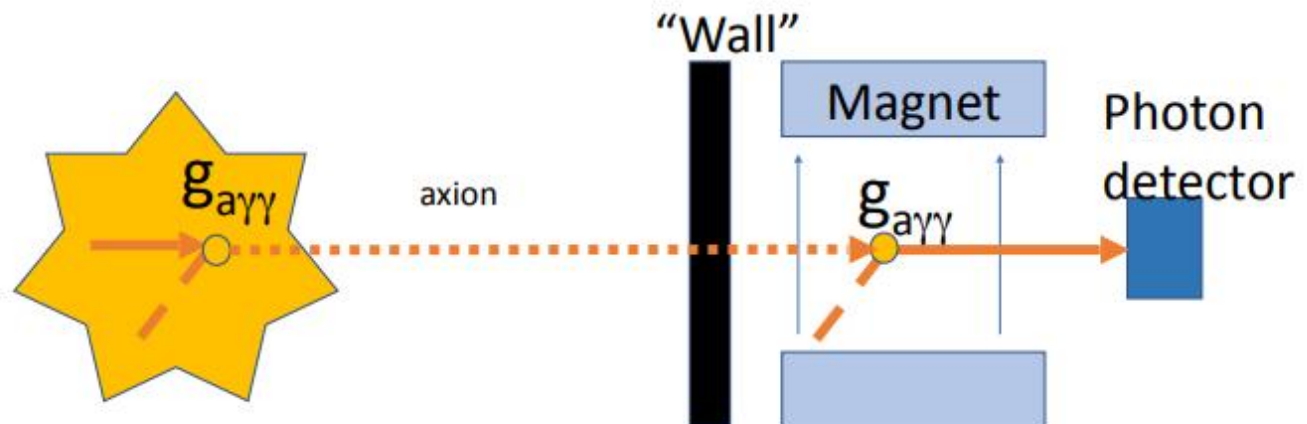
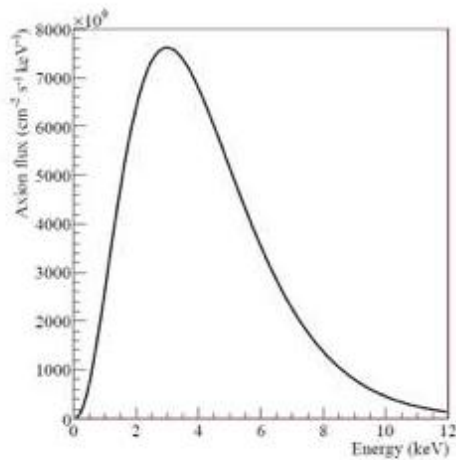
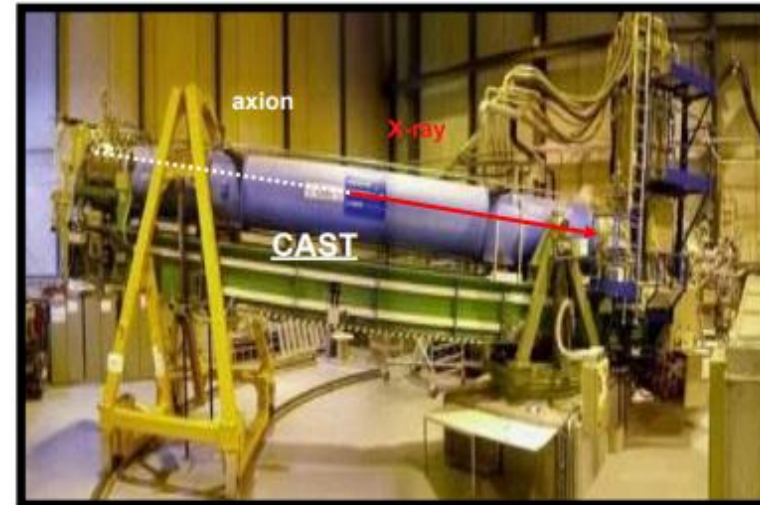
MASSIVE Compact Halo Object (**MACHO**)



$$M_{\chi} \sim < 1M_{\odot}$$

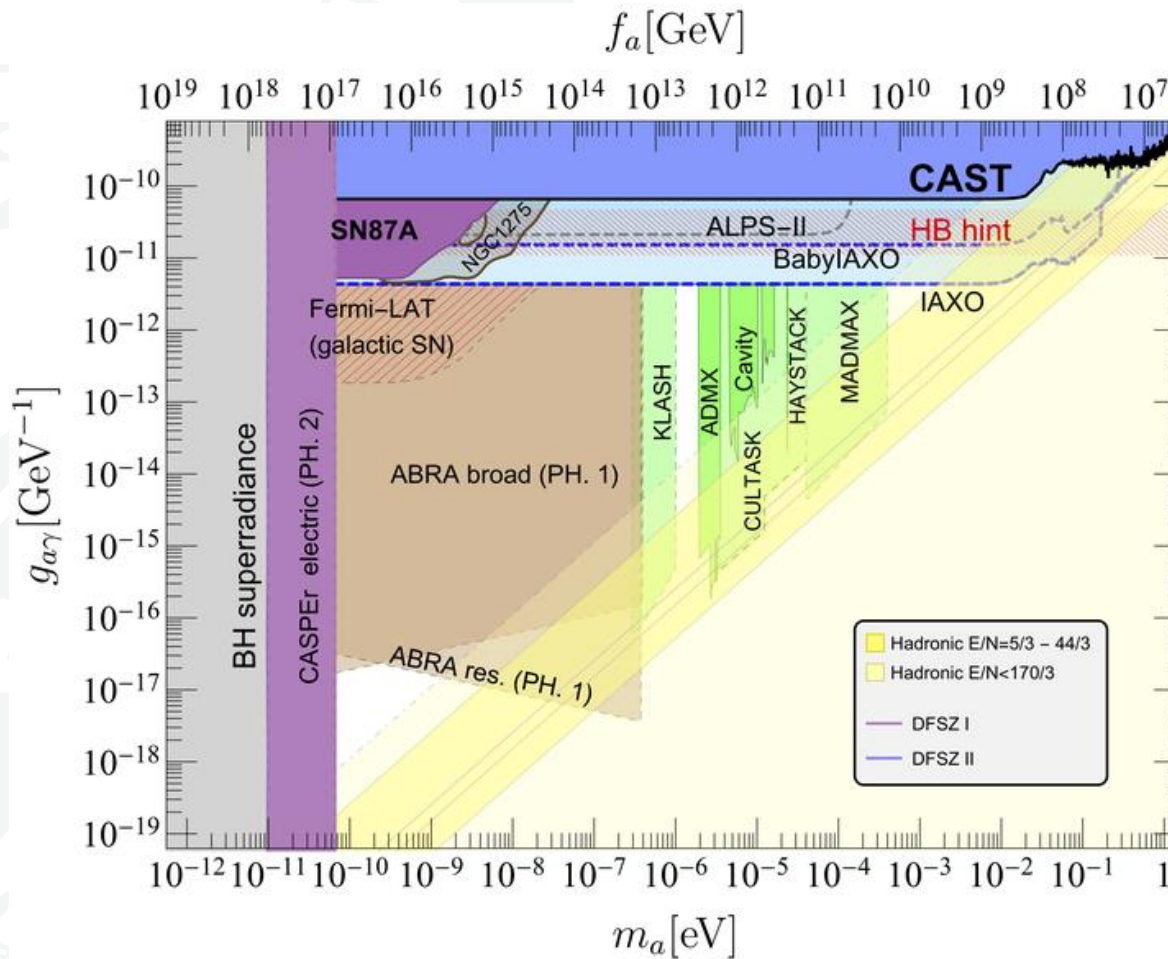
Solar Axions

- Similar to “light shining through walls”, but replace laser with the Sun.
- Electromagnetic fields in solar plasma convert X-ray photons to axions.
- Solar axion flux: $0.2\% L_{\text{solar}}$ or $3.75 \times 10^{11} \text{ cm}^{-2} \text{ s}^{-1}$ for $g_{a\gamma\gamma} = 10^{-10} \text{ GeV}^{-1}$ (Raffelt, 2006)



$$M_\chi \sim 1 \mu\text{eV}$$

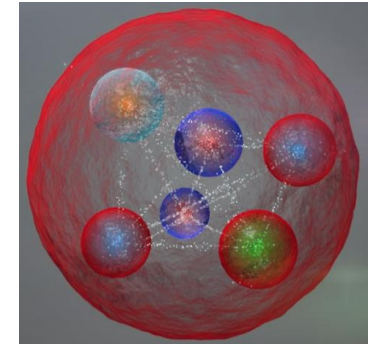
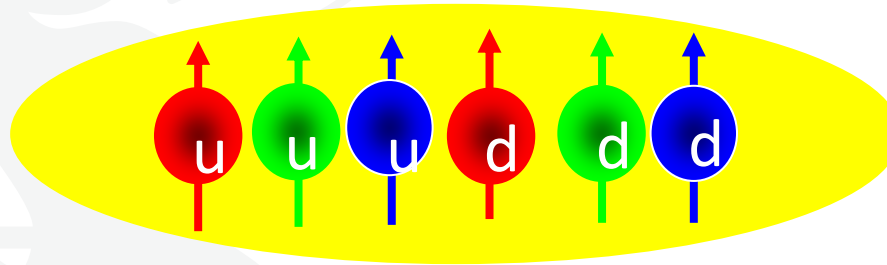
Axions?



Hexaquark dark matter

$$I(J^P) = 0(3^+)$$

Hexaquark d^* (2380)



Smaller than proton

- Hexaquarks in BEC

Journal of Physics G: Nuclear and Particle Physics

LETTER • OPEN ACCESS

A new possibility for light-quark dark matter

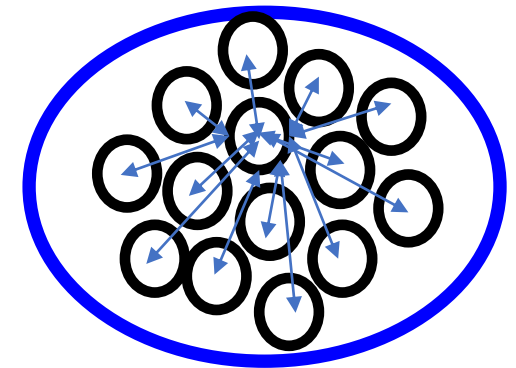
M Bashkanov and D P Watts

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[Journal of Physics G: Nuclear and Particle Physics, Volume 47, Number 3](#)

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Dark matter – too many options

