Dark Matter

leaving no stone unturned

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Energies, not forms, not figures (chant)

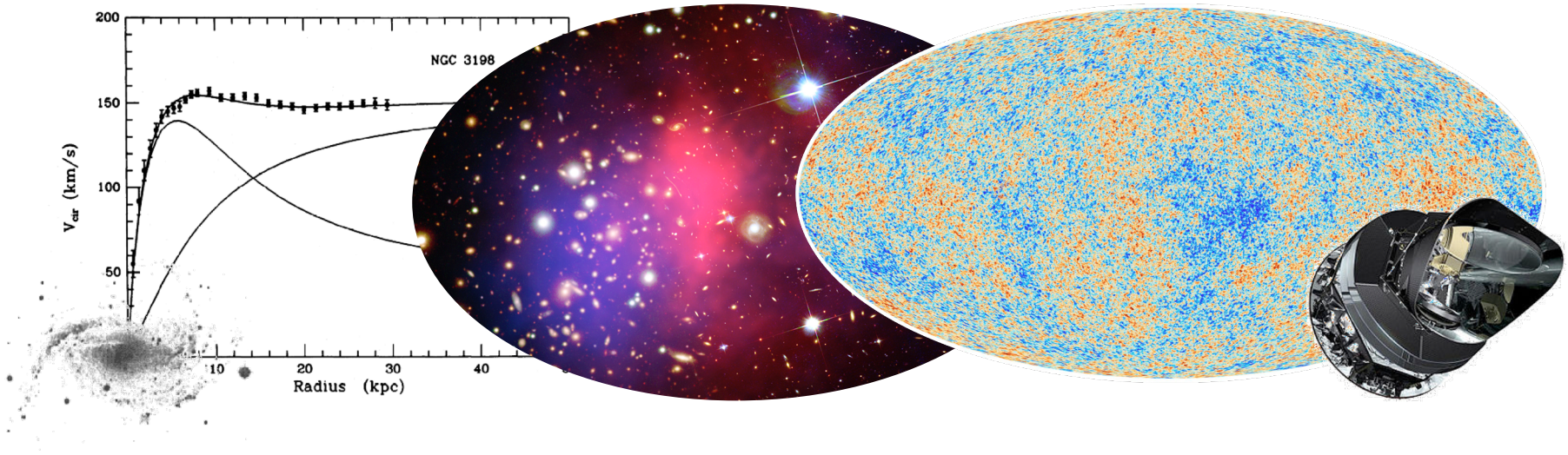
Comunidad de Madrid

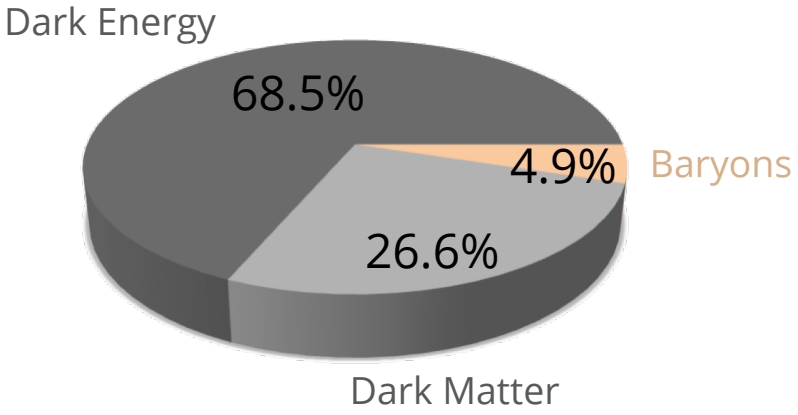
GOBIERNO DE ESPAÑA

AGENCIA ESTATAL DE INVESTIGACIÓN

Dark Matter is a necessary and very abundant component in our Universe

We have observed its gravitational effects at different scales





A **plausible** hypothesis is that dark matter is a **new type of particle** (stable, neutral, weakly-interacting).

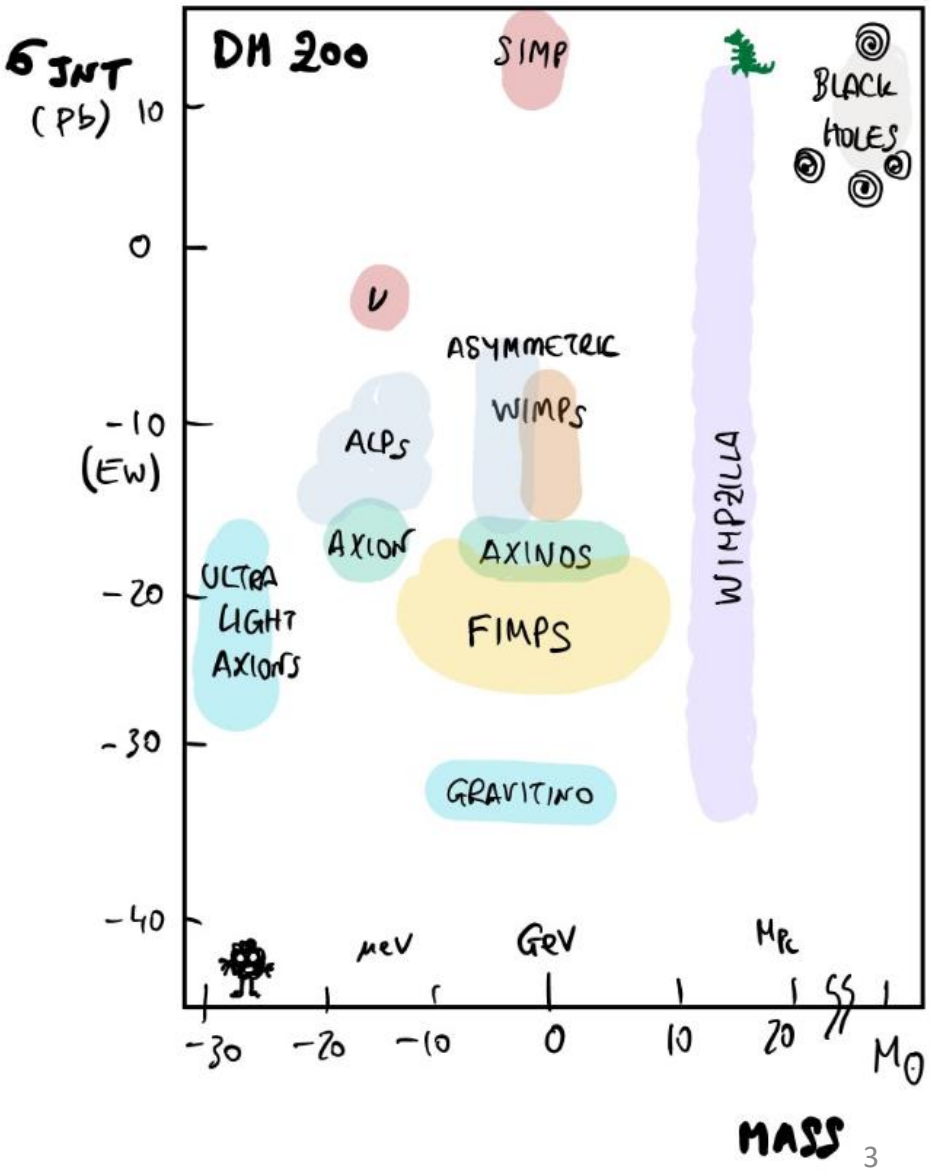
But it might also be in the form of **primordial black holes** (formed before BBN).

We should not rule out the possibility that DM is **multicomponent**.

There are plenty of viable candidates, which imply very different **cosmological histories**

- **"Thermal" candidates**: **WIMPs** (weakly-interacting massive particles)
- **Out of equilibrium production**
- **Axions**
- **Asymmetric Dark Matter**
- **Ultra-light Dark Matter**
- **Primordial Black holes**

Finding the dark matter might give us information about **how the Universe came to be**



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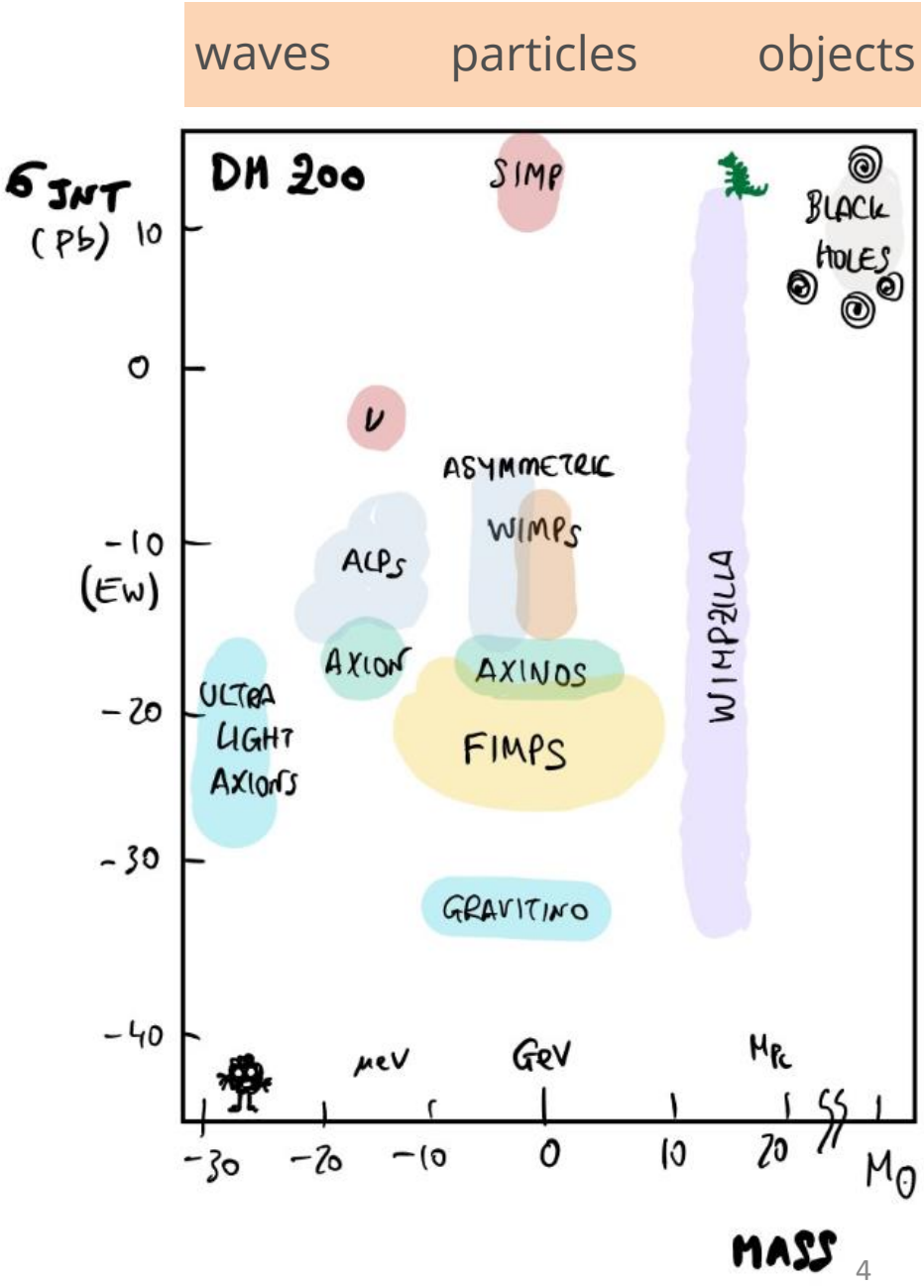
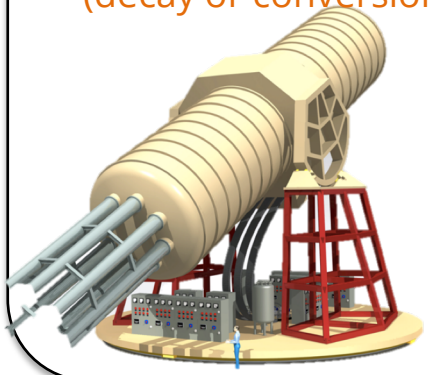


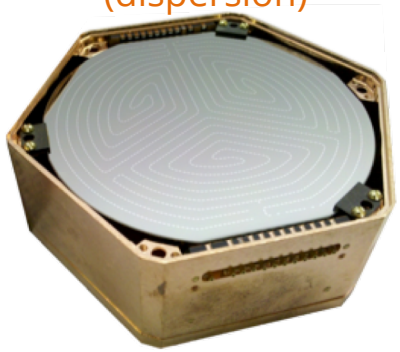
Dark matter can be searched for in different ways

These explore **complementary** properties of dark matter particle models

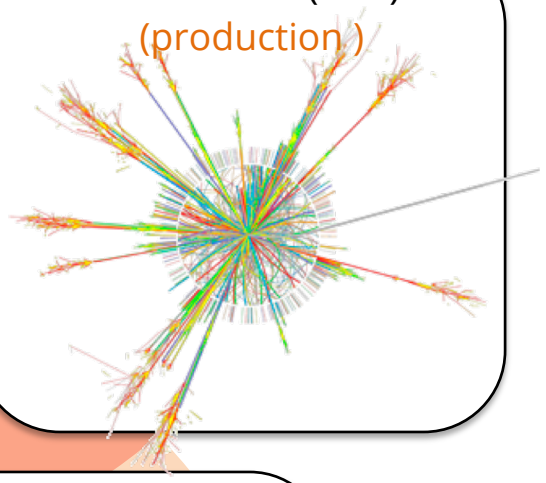
Axion Searches
(decay or conversion)



Direct Detection
(dispersion)



Accelerators (LHC)
(production)



Astrophysics and Cosmo
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Indirect searches
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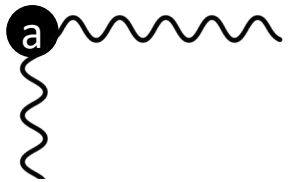

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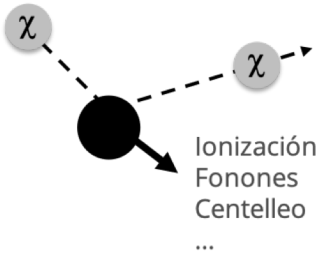

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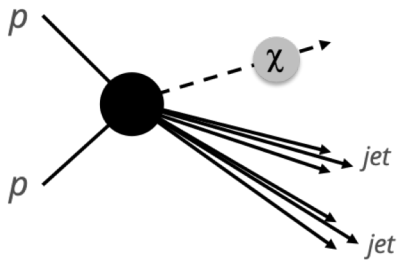

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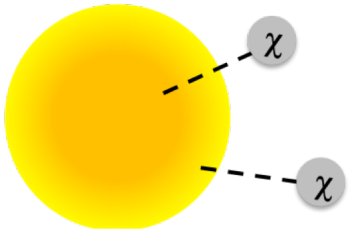

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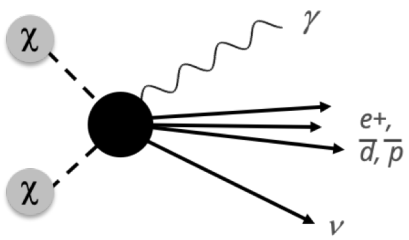

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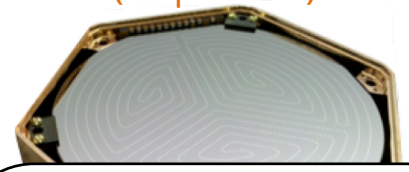

Accelerators (LHC)
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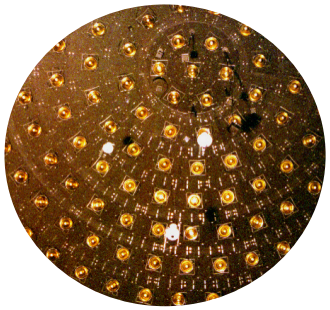
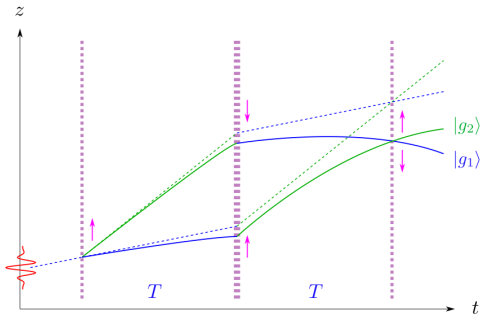
Neutrino detectors



Gravitational waves

Quantum Technologies



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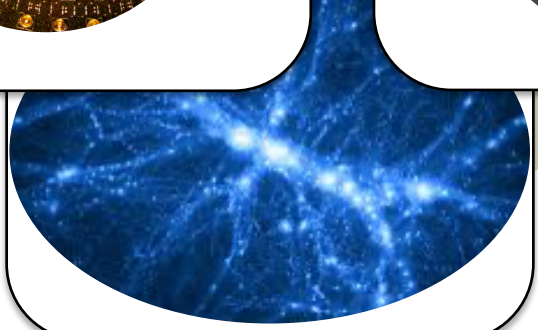

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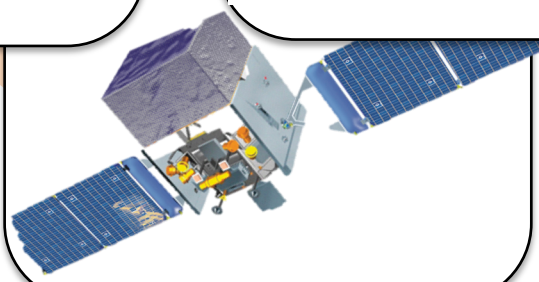

The search for DM is inextricably linked to the efforts in other areas (and benefits from advances in them)

Axion Searches
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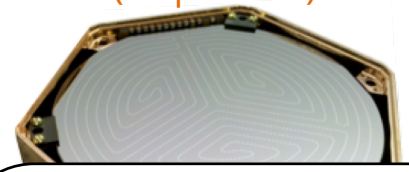
Direct Detection
(dispersion)



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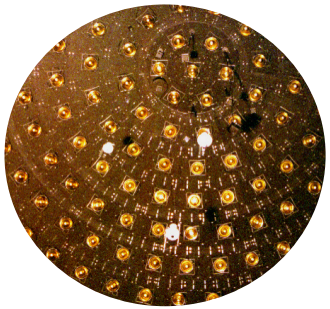

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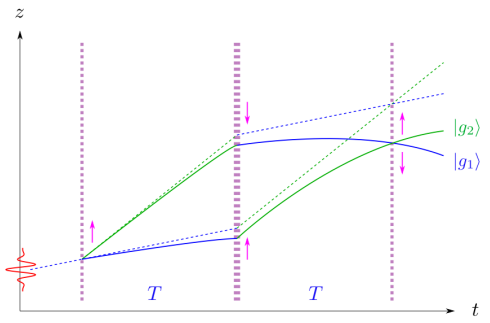

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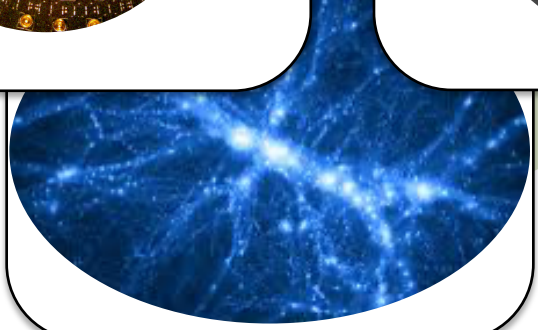

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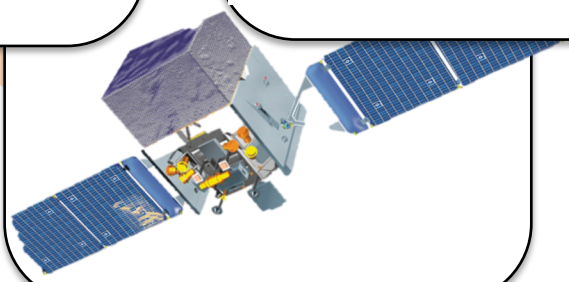
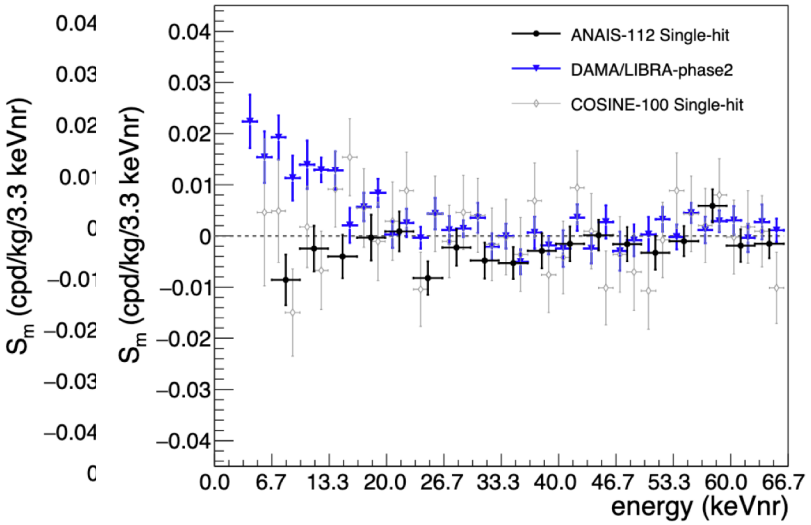
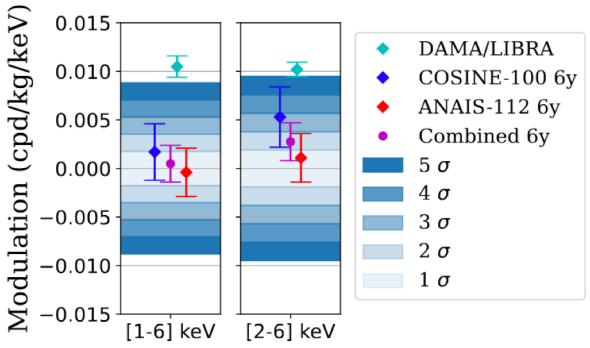


There is no confirmed hint for DM (other than gravitational)

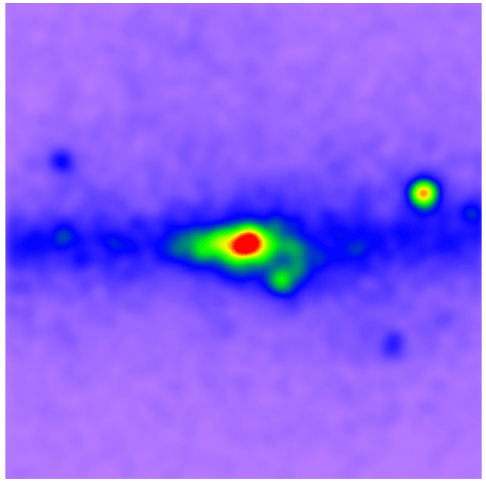
The ANAIS collaboration has done an excellent job in putting the DAMA/LIBRA signal to the test and virtually excluded the DM interpretation of its annual modulation.





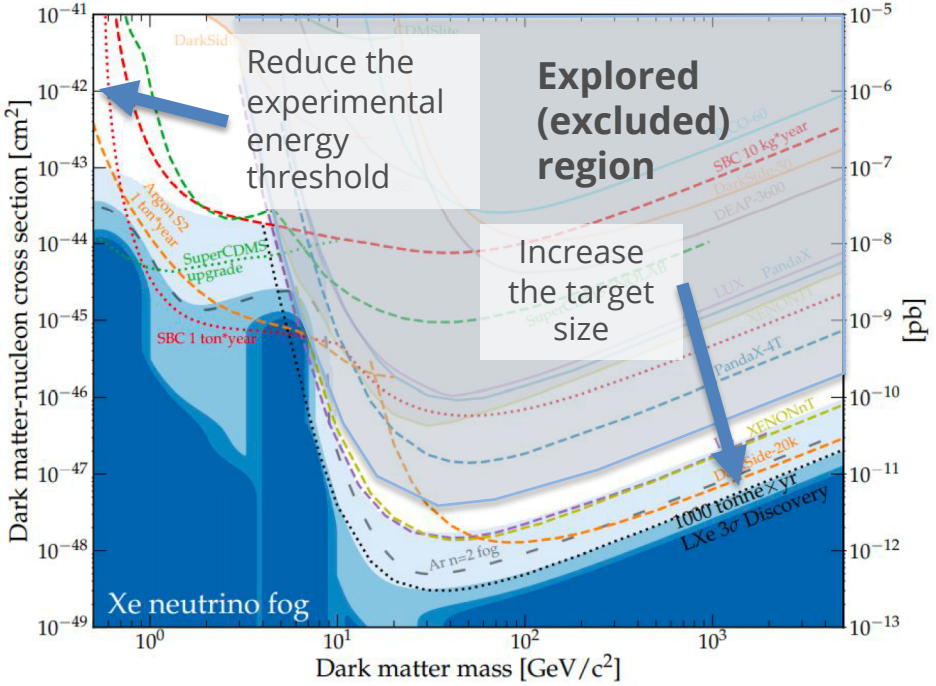
Persistent Galactic Centre Excess in gamma rays (Fermi-LAT) but DM interpretation is unclear and constrained by searches in other objects (e.g. dSphs)

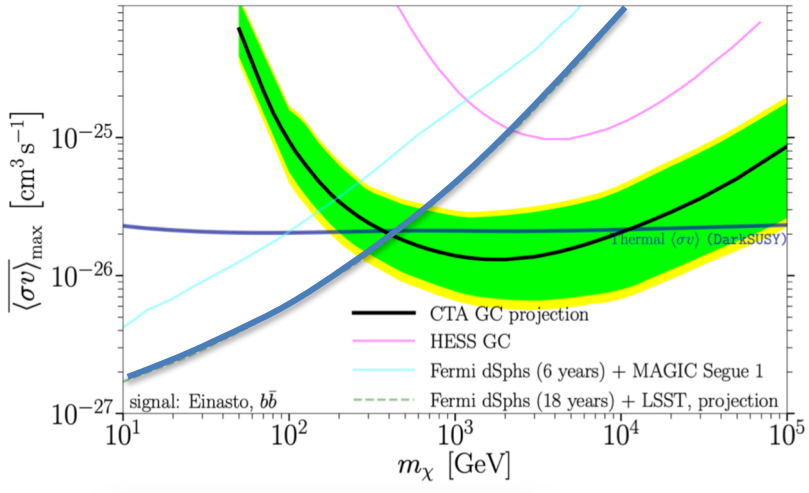
Cosmic ray positrons and antiprotons in AMS still needing improvement in the model uncertainties.

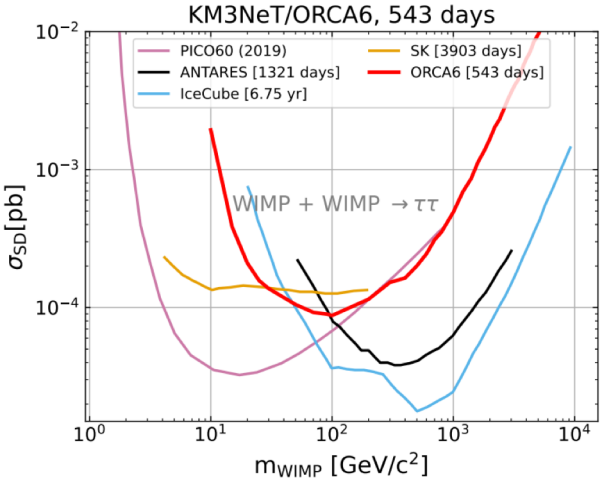


Some considerations and prospects

- Effort in closing (as much as possible) the WIMP window (combined larger direct + indirect + collider). Pushing towards the ”neutrino fog” – investigating effective operators – annual modulation – directionality







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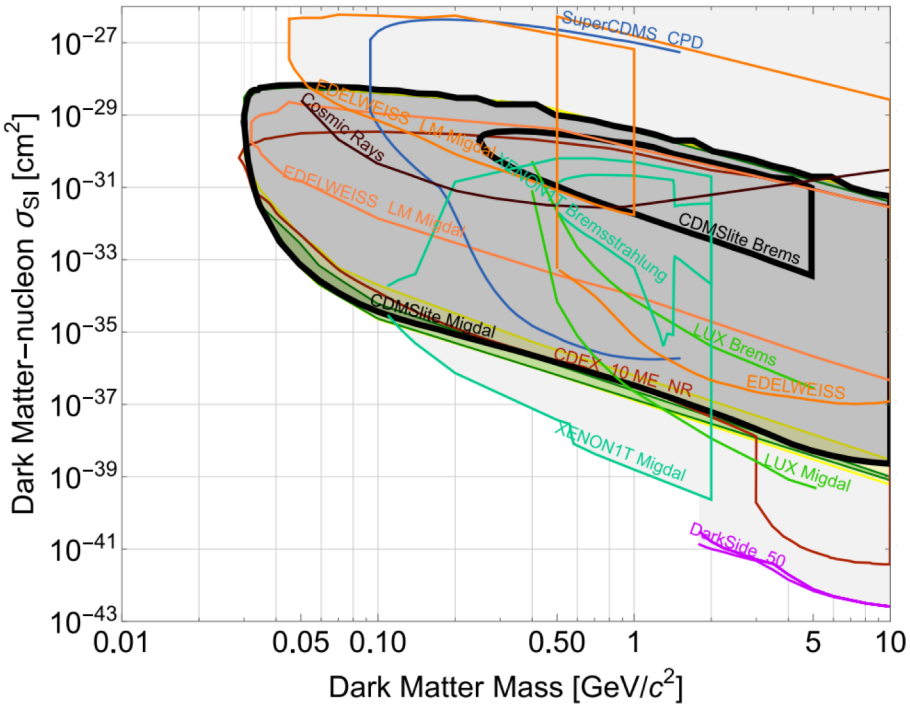

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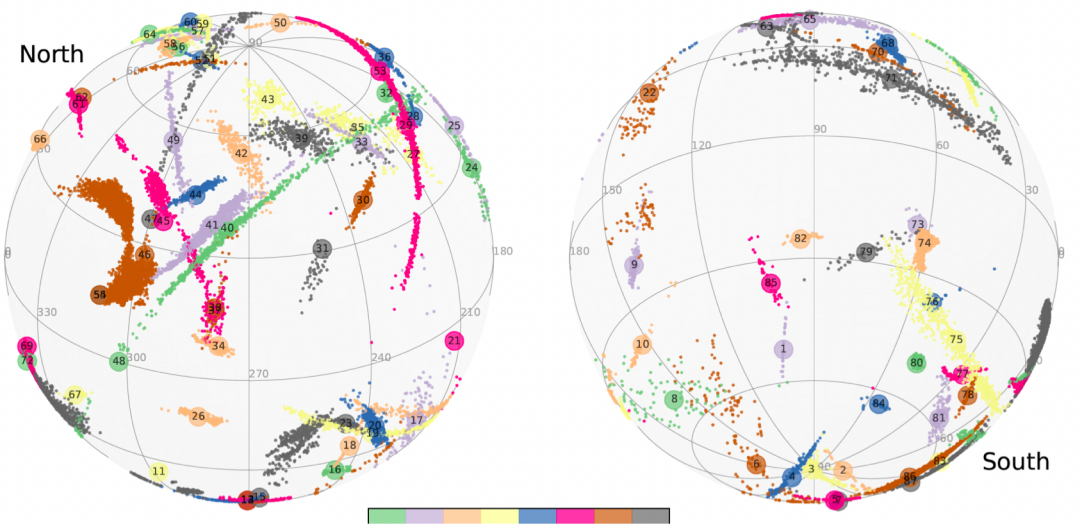

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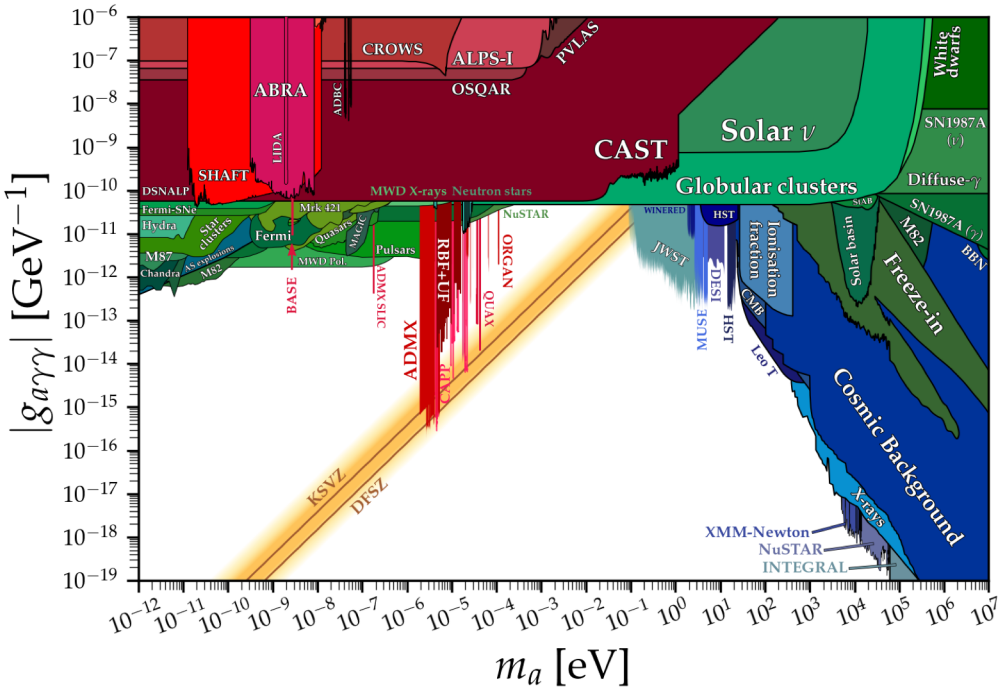

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- Ultralight DM search with Gravitational Wave technologies and atom interferometry

- Effect of DM in stellar objects – supernovae, neutron stars, white dwarves: can they contain DM? Can they boost DM?

UPDATES FROM

- Axion Searches: Igor Irastorza
- Direct Detection: Vicente Pesudo
- Indirect Searches: Bryan Zaldívar (online)