Contribution of the iDMEu project to the search for dark matter

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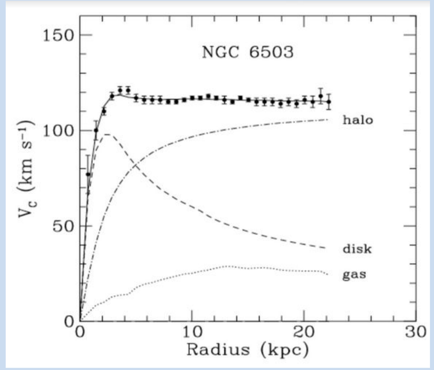
Dark matter: overview

Dark matter is an enigmatic and elusive component of the universe that plays a crucial role in its structure and evolution. While ordinary matter accounts for only about **5%** of the total energy density of the universe, dark matter constitutes more than five times that amount. Despite extensive research, our understanding of dark matter remains limited, and its nature and origin remain unknown. The primary justification for the presence of dark matter arises from the **rotation curves of stars in spiral galaxies**, which were measured in the 1970s. These curves can only be elucidated by the existence of imperceptible matter.



Rotation curves of NGC 6503, an evidence for the existence of dark matter

IDMEU Project

Since the 20th century, extensive research using satellites and telescopes has been conducted to better comprehend dark matter. To optimize detection systems, it is crucial to control relevant parameters. The scientific community need to **collaborate** and **share** resources, exemplified by the "Initiative for Dark Matter in Europe and beyond" (iDMEu) project, highlighting the complementarity among research communities studying dark matter. The iDMEu project aims to:

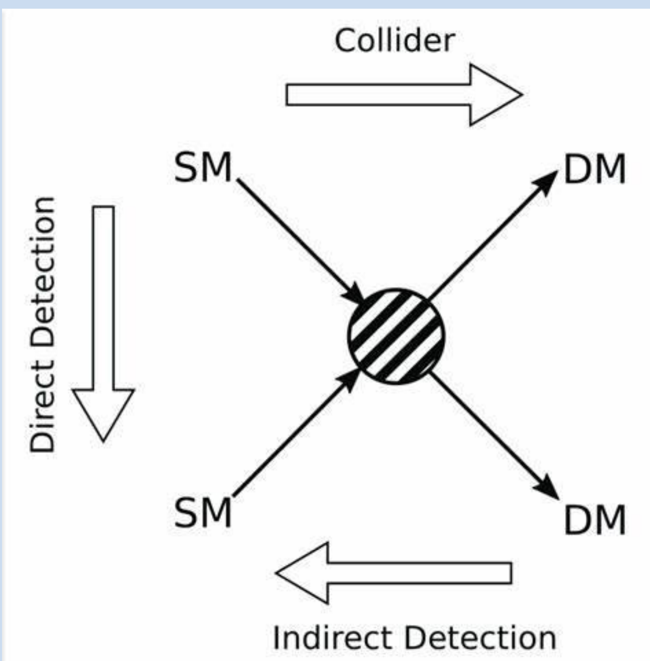
- Create an **online database of dark matter resources** as a centralized repository for related information and data.
- Arrange regular **town-hall meetings** to address challenges faced by each community and explore paths forward, promoting cross-community communication.
- Help communicate a unified dark matter narrative to **different audiences**, ensuring a common understanding.

Indirect detection

Of the three main dark matter detection mechanisms - **direct, indirect, and collider detections** - indirect detection is considered a very promising method.

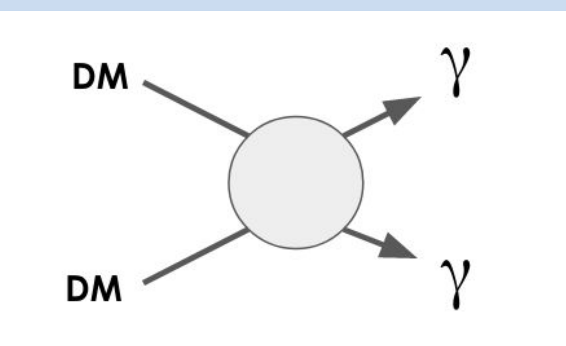
➔ Annihilation,
➔ Decay …
… of dark matter particles into potentially detectable Standard Model particles.

However, these excesses can be explained by other astrophysical phenomena. It is therefore necessary to impose **constraints** on the parameters taken into account in the indirect detection of dark matter, such as the **cross-section** for annihilation and the **half-life** for decay.

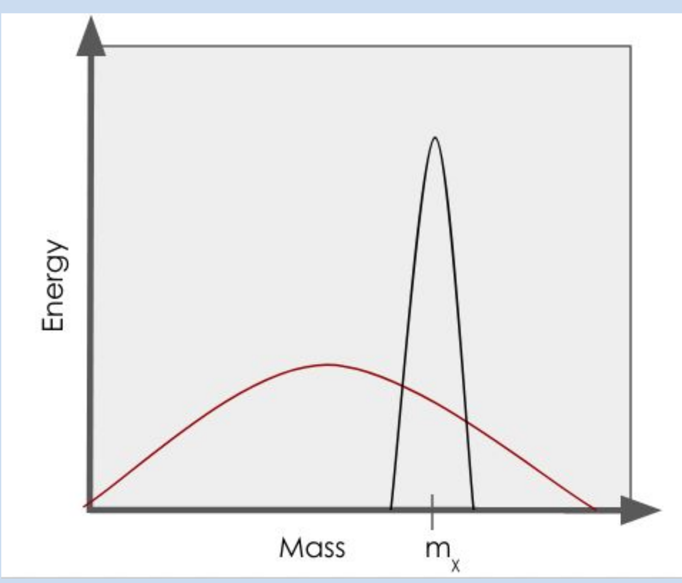


Dark matter production processes and the associated type of detection.

The special case of photons



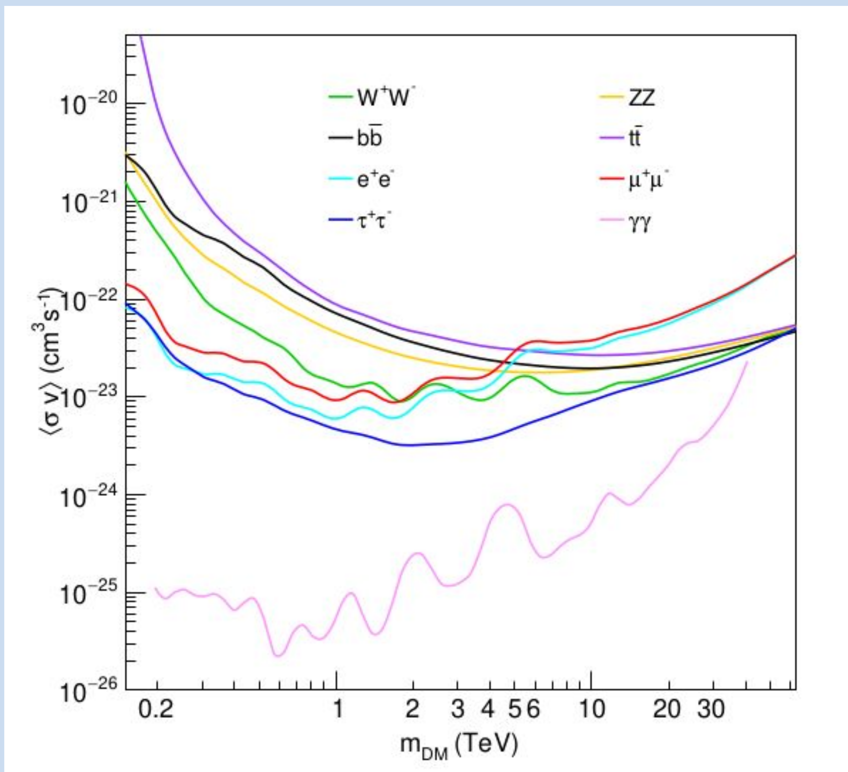
Photons directly produced …



… peak centered around the mass of the DM particle!

Compilation of Constraints for different channels

- **Why are constraints so useful ?**
  - Determine the boundaries and characteristics of dark matter particles.
  - Specify the methods of detection
  - Restrict the possibilities of behavior of dark matter



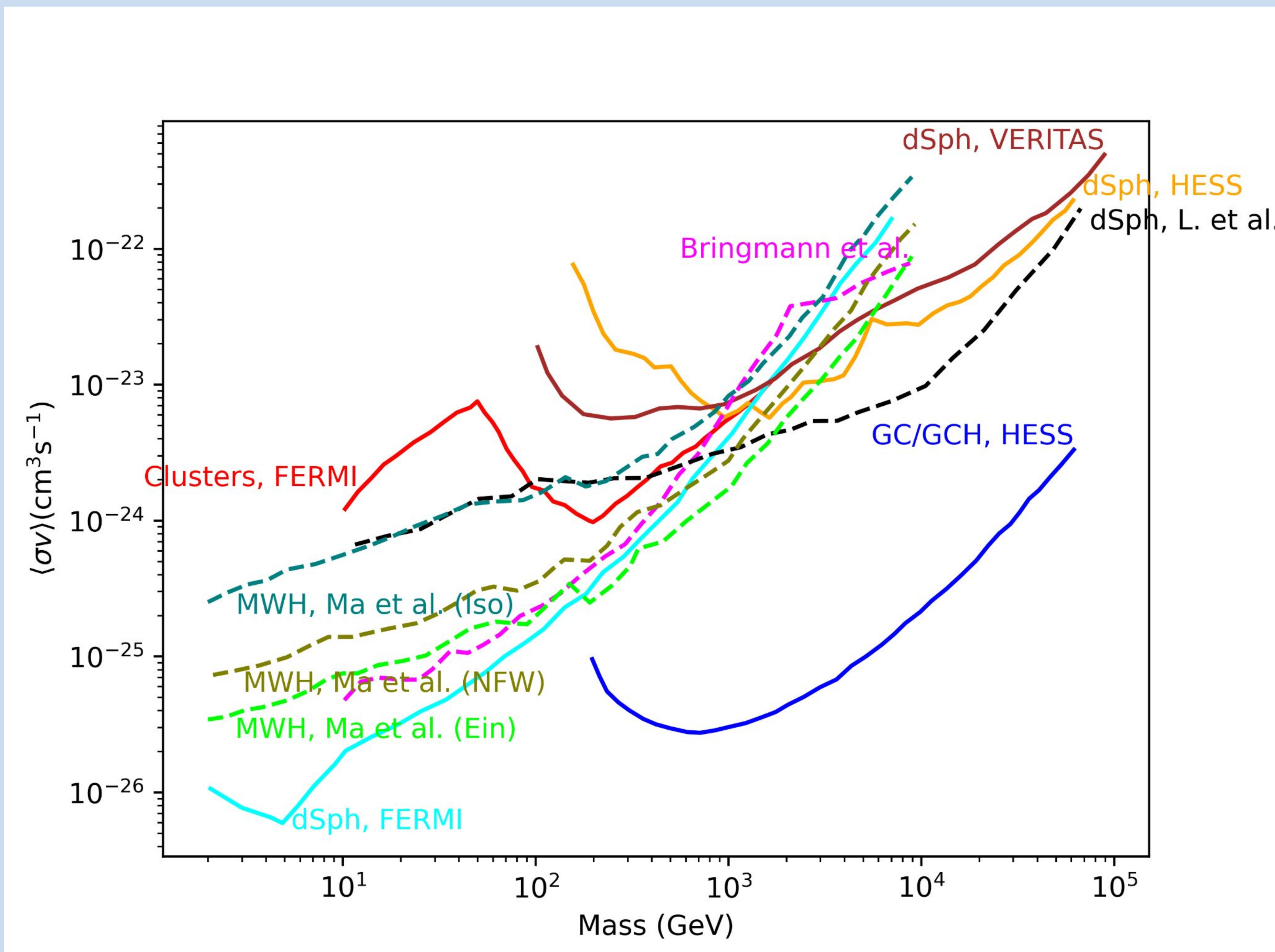
Scientists strive to compile the constraints to determine:

➔ the tightest **upper** bound
➔ the tightest **lower** bound

On the left: combined 95% C.L. observed upper limits on the annihilation cross section measured by H.E.S.S.

- **Survey of existing constraints**

➔ Searching for neutrinos or gamma rays
➔ Considering various locations for dark matter exploration
➔ Using distinct profiles (NFW, Einasto …) : it is advisable to adjust the profiles with the available parameters in order to facilitate better comparison between the curves.



This figure shows the exclusion limits on dark matter self-annihilation cross-section for the DM → $e^+ e^-$ channel. Dotted lines represent the neutrinos searches, those in solid lines represent the gamma-ray searches.

Channels involved in dark matter production

Leptons : neutrinos, e^+e^-, $\mu^+\mu^-$, $\tau^+\tau^-$

Gauge bosons : photons, W^+W^-

Quarks : $b\bar{b}$

To learn more about the project, visit the iDMEu website : https://idmeu.org

QR Code of poster pdf (for links and contact)