



# Perspective on Dark Matter detection in cosmic rays of electrons and positrons

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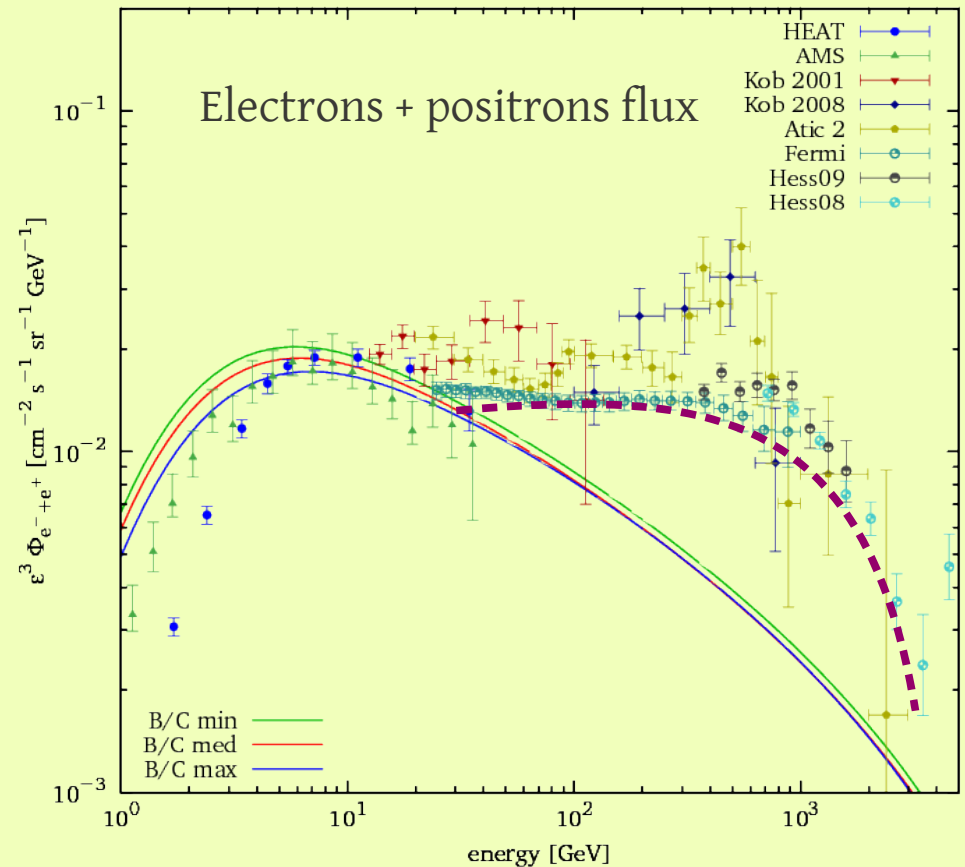
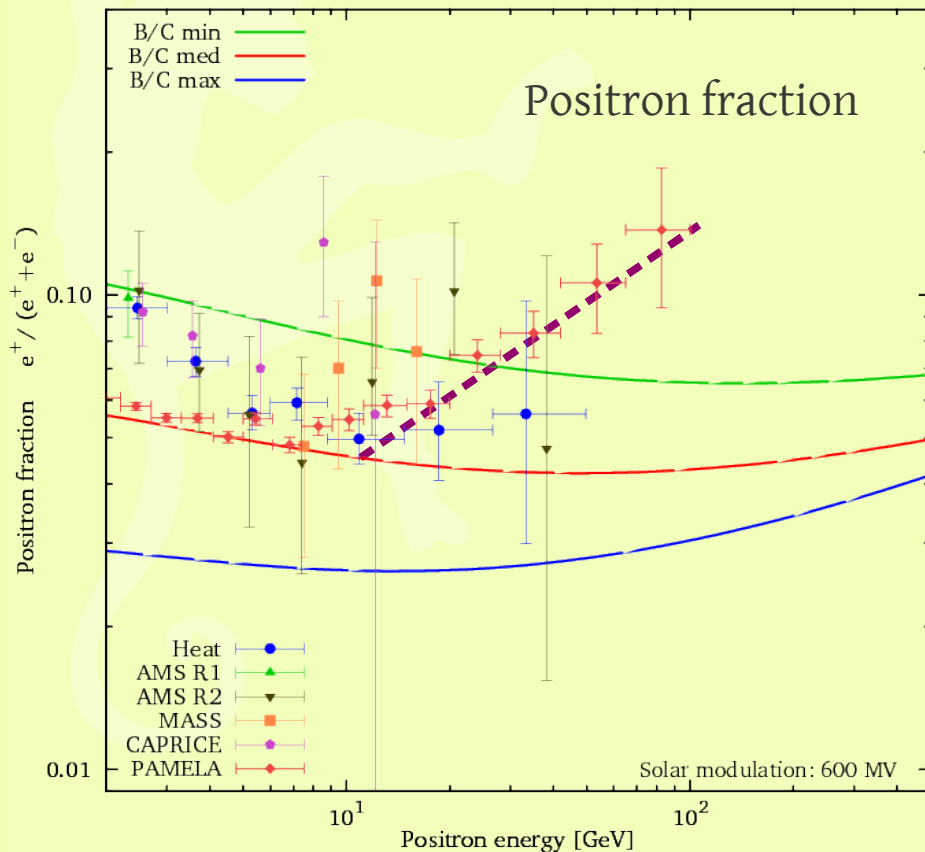
Collaboration with:

F. Donato, N. Fornengo and J. Lavalle – Torino U.

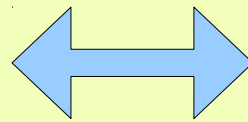
T. Delahaye, P. Salati and R. Taillet – Savoie U.

# Motivation

(To understand) latest observations on cosmic rays electrons and positrons



Standard estimations **do not** reproduce current observations

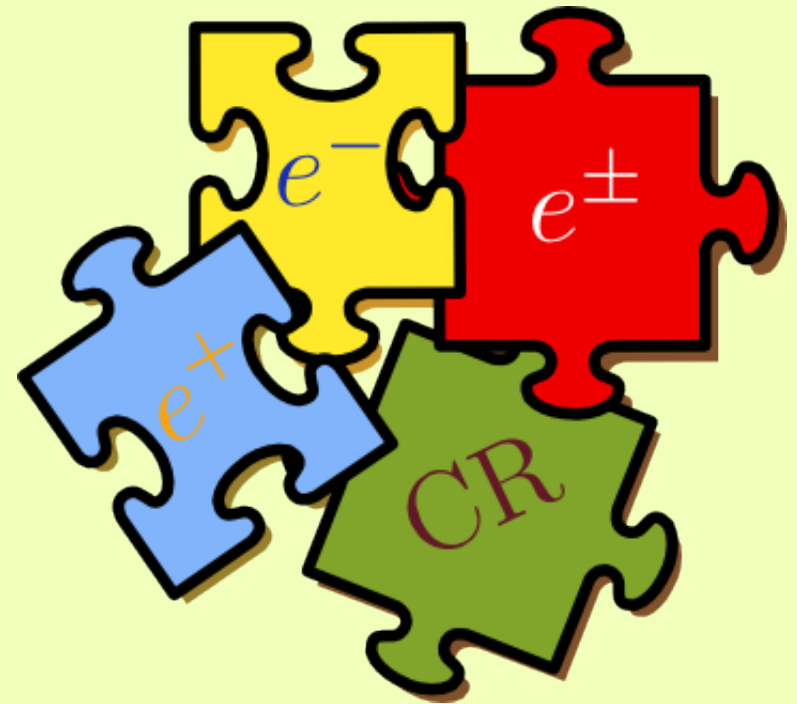


**Misunderstanding** of known sources?

**Unconsidered** sources?

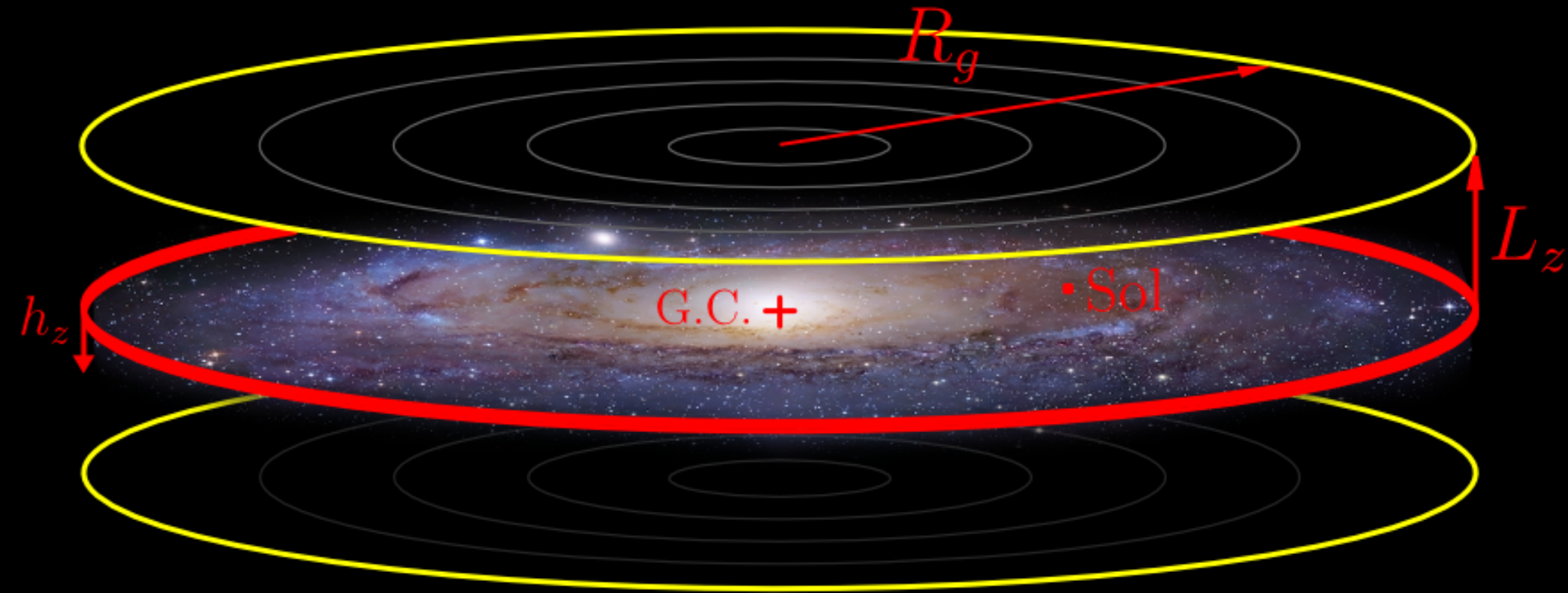
# Outline

- Cosmic rays propagation
- Dark Matter as source
- Astrophysical sources
- Conclusions



# Cosmic rays propagation

(two—zone propagation model)



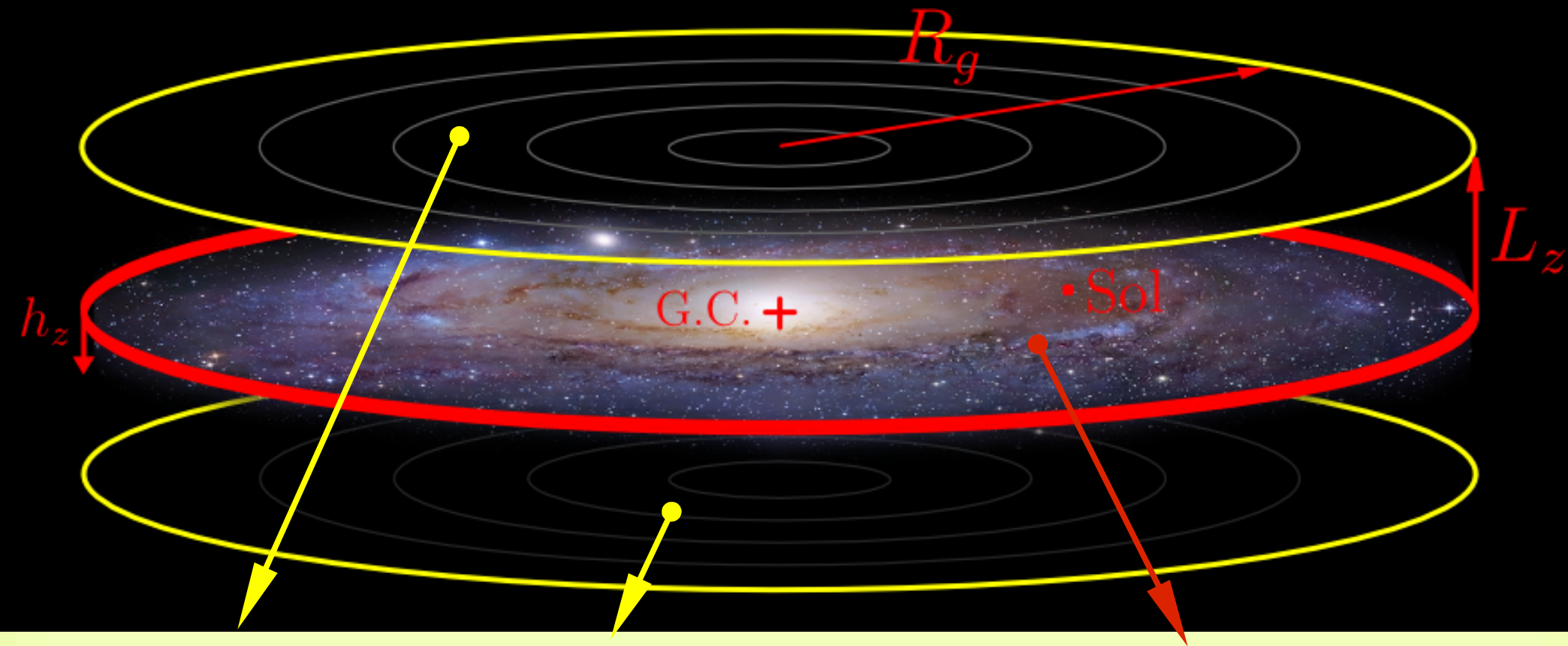
(Ginzburg and Syrovatskii. 1964)

The propagation is modeled in a cylinder where many physical processes take place.

$$R_g = 20 \text{ kpc} \quad h_z \approx 100 \text{ pc} \quad L_z = 1 - 20 \text{ kpc}$$

# Cosmic rays propagation

(two-zone propagation model)

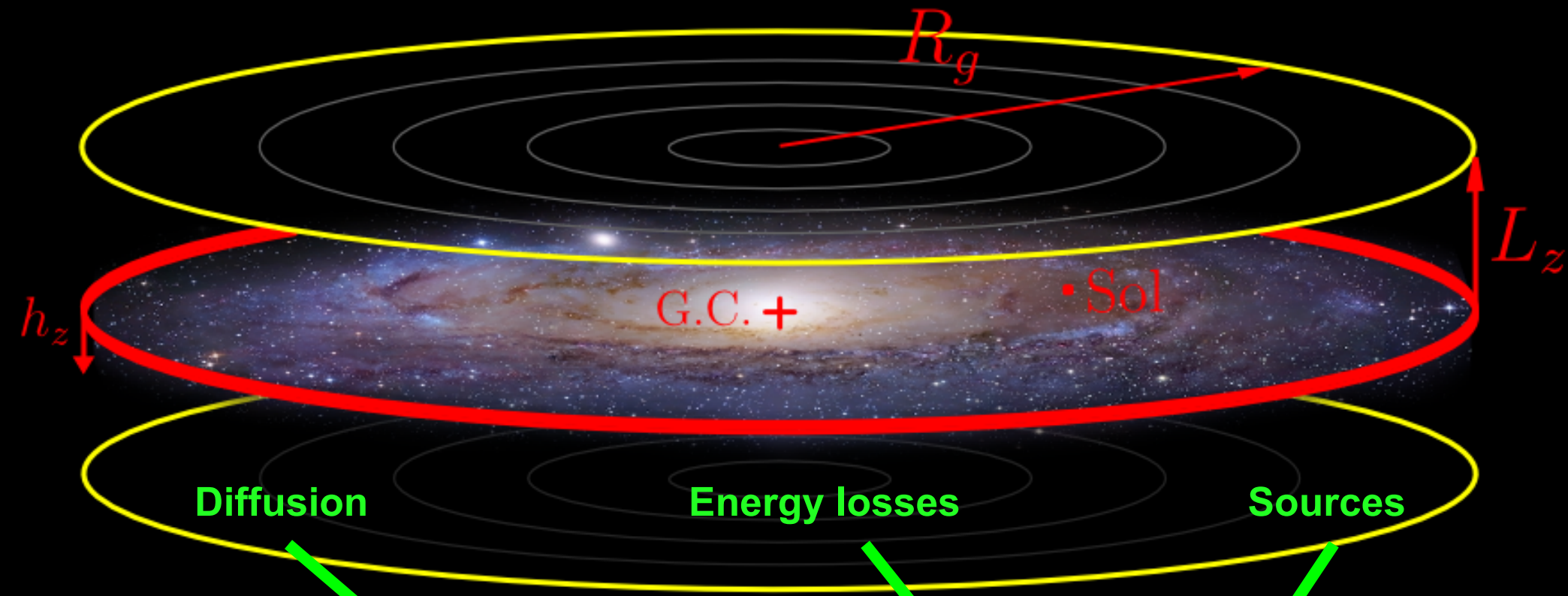


A **cylinder-- $L_z$**  defines the zone where inhomogeneous magnetic field are present (i.e. diffusive propagation dominates)

A **thin--disk** models the galactic plane: sources, interactions with the ISM and reacceleration.

# Cosmic rays propagation

(two—zone propagation model)



The evolution of cosmic rays density are contained in the **transport equation**:

$$\frac{\partial \psi}{\partial t} + \nabla \cdot \left( -K_0 \epsilon^\delta \nabla \psi + \mathbf{V}_c \psi \right) + \frac{\partial J_\epsilon}{\partial \epsilon} = q_{\text{src}}$$



# Dark Matter (as source of *electrons*)

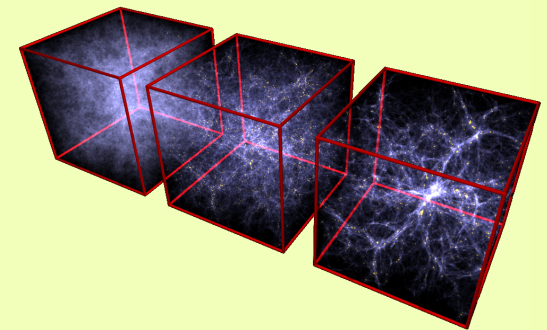
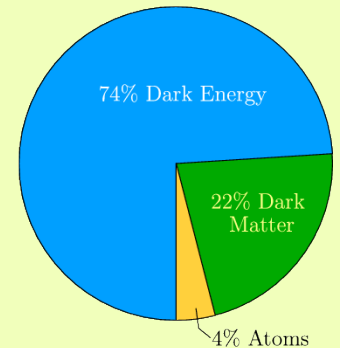
Several observations point towards the presence of Dark Matter:

- Structure formation
- Dynamics for clusters and galaxies
- Anisotropy of CMB
- Baryon Acoustic Oscillations

Moreover, some theories beyond the Standard Model provide “dark matter” particles (e.g. Neutralino, KK “photons”)

... of course, these theories will be tested in LHC.

We expect that a fraction of observed positrons/electrons is due to **annihilation/decay** of Dark Matter.



# Dark Matter (as source of *electrons*)

How persistent is the signal of DM annihilation in the positron fraction?

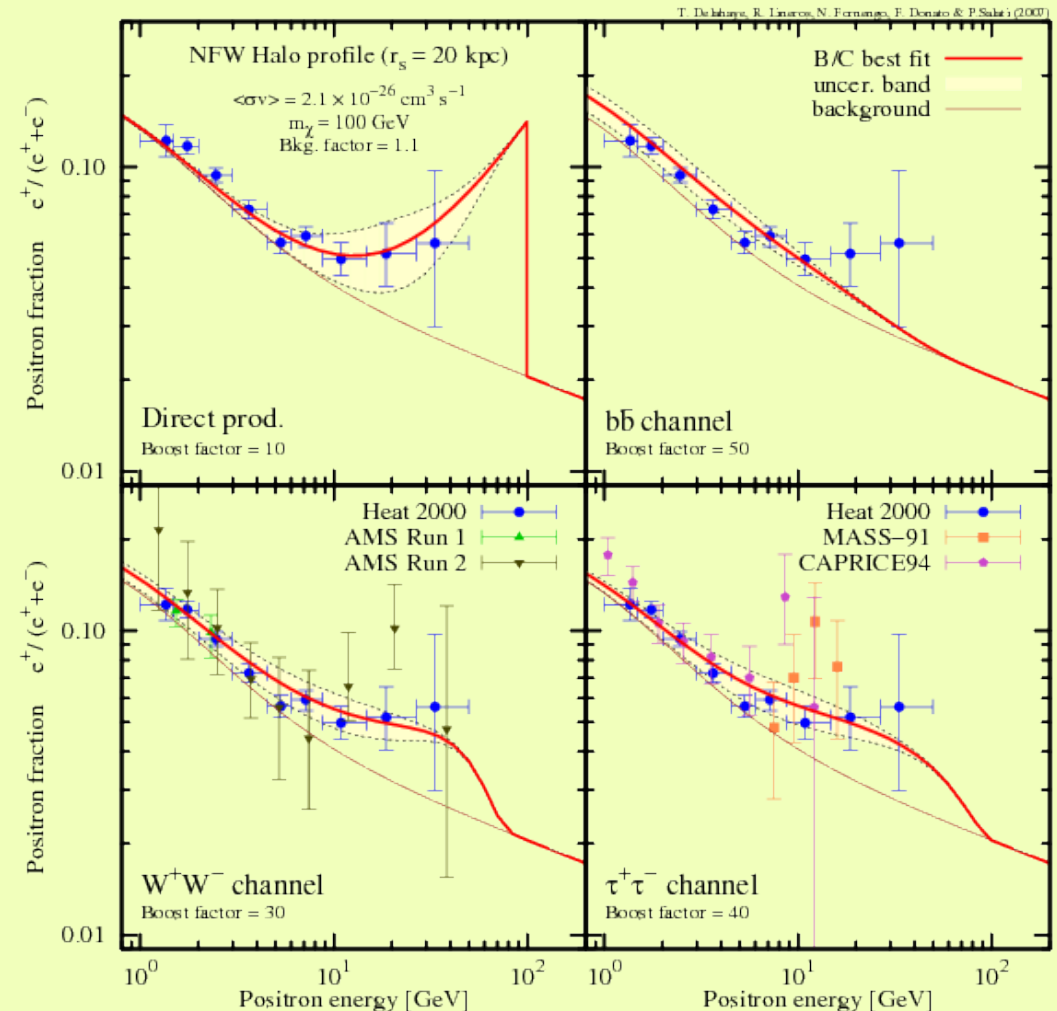
We studied the impact of theoretical uncertainties:

- Cosmic rays propagation
- DM distribution
- DM annihilation channel
- DM mass

The signal **is persistent** in most of the cases.

It maintains spectral properties and **makes possible** to discriminate from the background

(Delahaye, R.L., Fornengo, Donato, Salati. 2007)





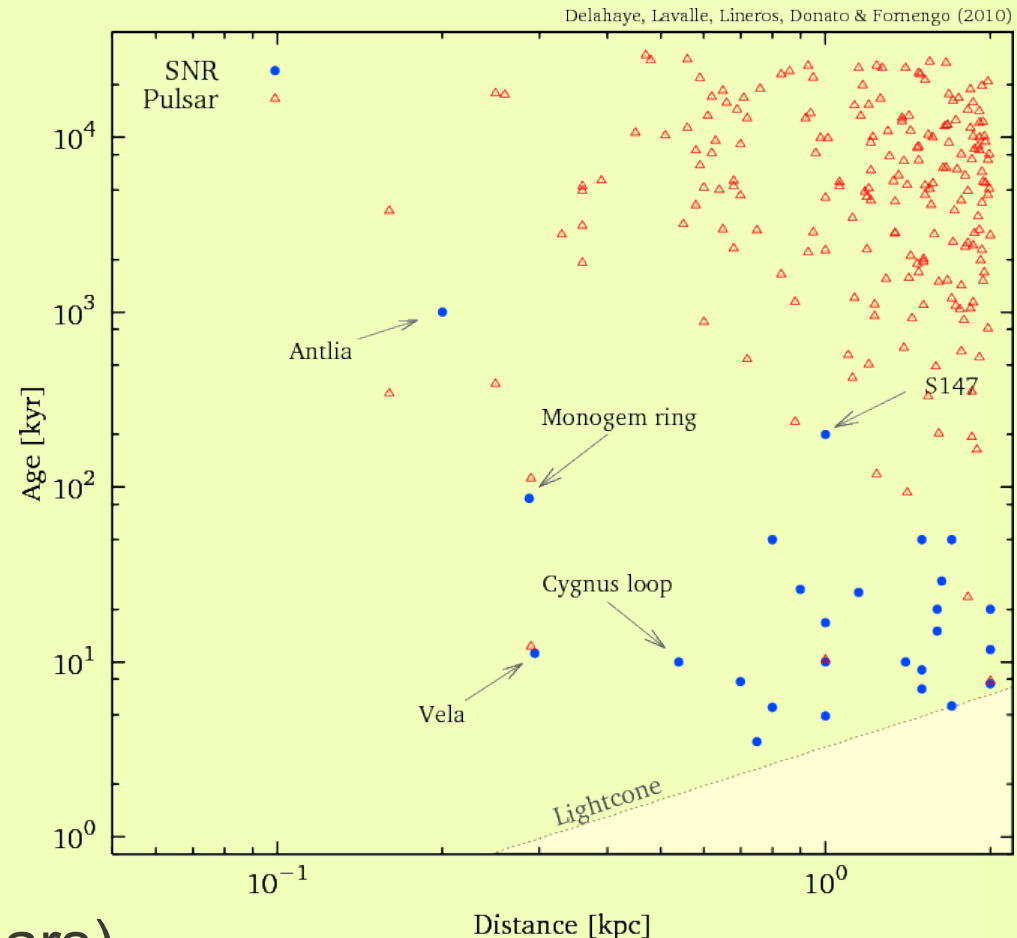
# Astrophysical sources

(Delahaye, Laval, R.L., Donato, Fornengo. 2010)

Why to study them?

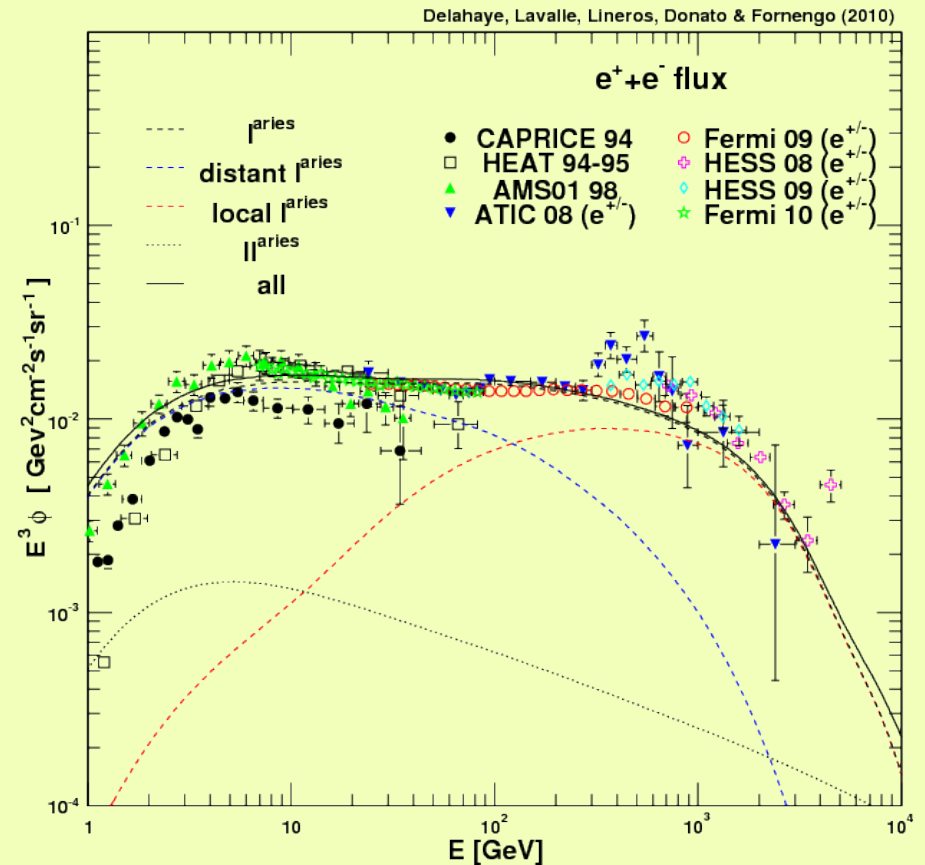
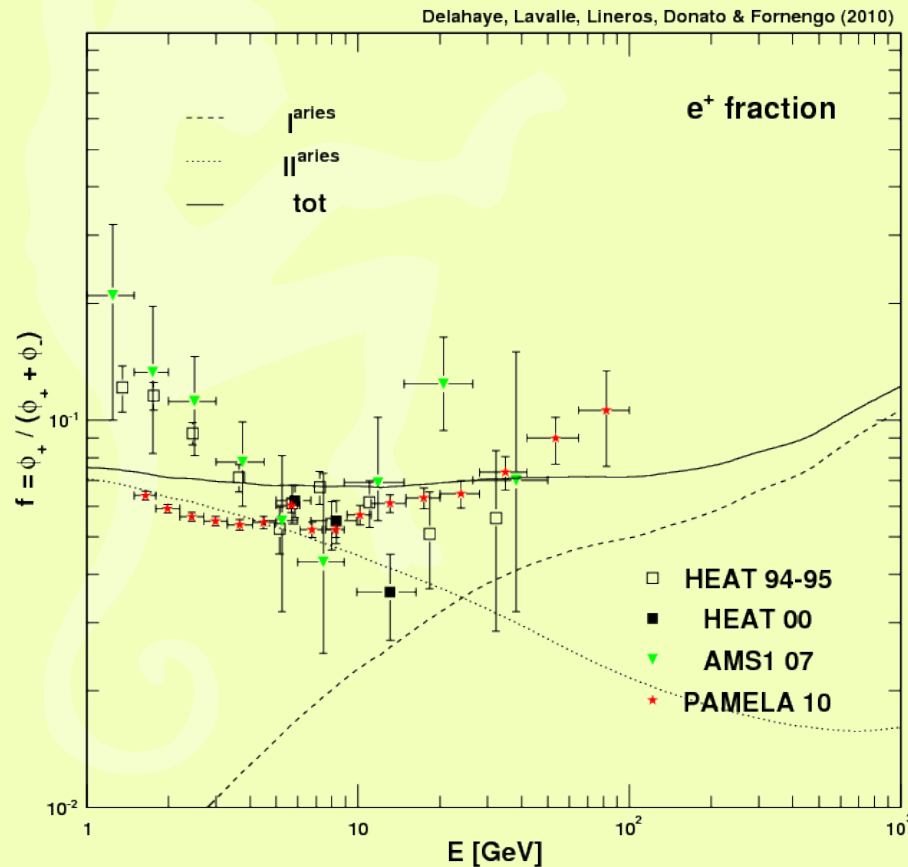
The signal coming from dark matter would be enhanced or smeared respect to the **known background**

Supernovae (remnants and pulsars) are **sources** of nuclei **cosmic rays**, electrons, and positrons.



# Astrophysical sources

(Delahaye, Laval, R.L., Donato, Fornengo. 2010)



Under conservative assumptions, electrons and positrons produced by SNe+Pulsars **encompasses** current observations.

# Conclusions

- The contribution from annihilation of Dark Matter is far the most exciting solution to the electron/positron puzzle.
- This contribution is persistent under theoretical uncertainties.
- Uncertainties related to cosmic rays propagation should be considered in the discrimination of possible new signal and for refining the propagation model.
- The standard sources, SNe and Pulsars, provides a conservative explanation to the observations.

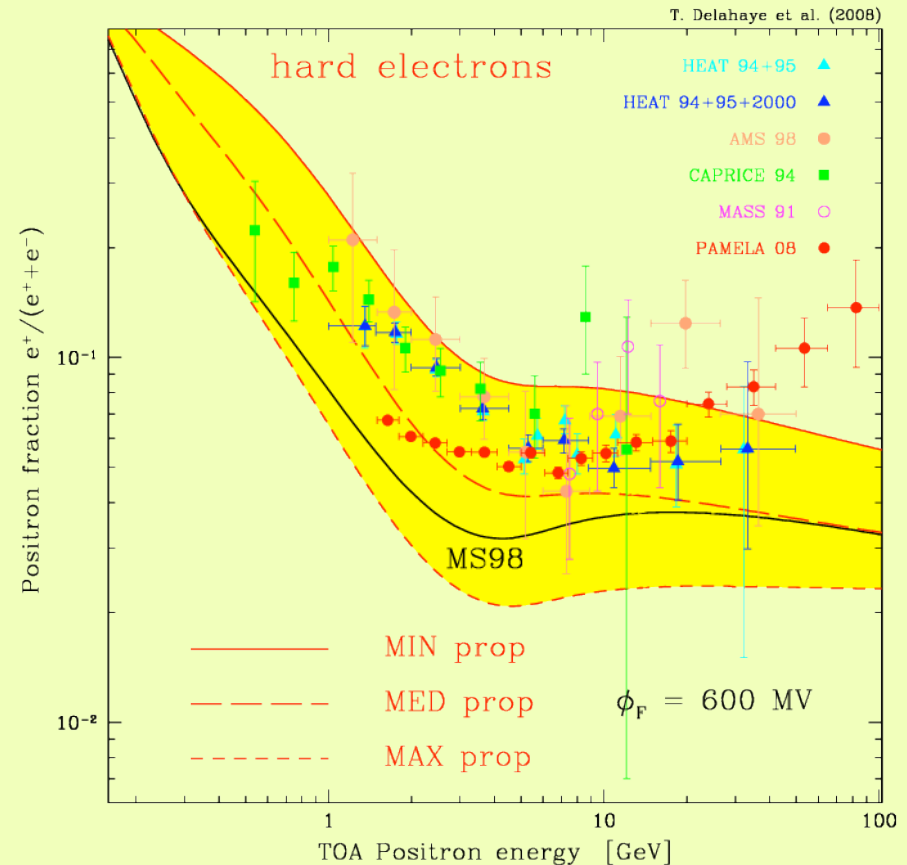
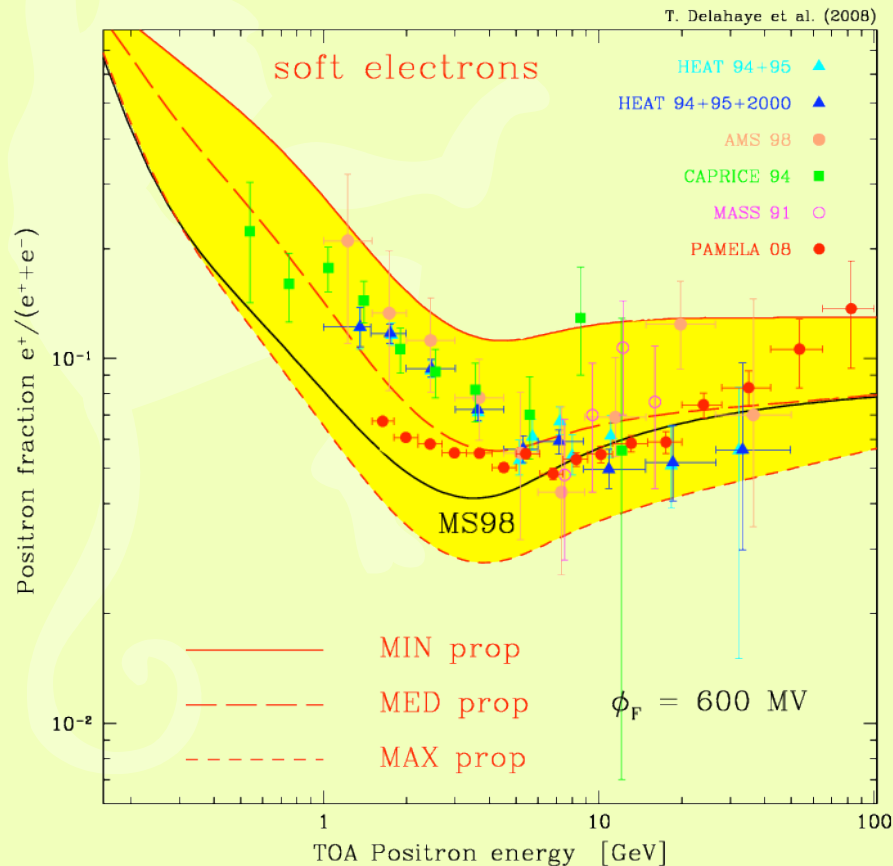




# Backup slides

# Sensitivity of positron fraction

(Delahaye, Donato, Fornengo, Laval, R.L., Salati, Taillet. 2009)



Depending on the spectrum of electrons, the positron fraction is bigger or lower at the “positron excess” energy.

# Secondary positrons

(Delahaye, Donato, Fornengo, Laval, R.L., Salati, Taillet. 2009)

The secondary component is in **agreement** with available data

**Consistency** among propagation models

