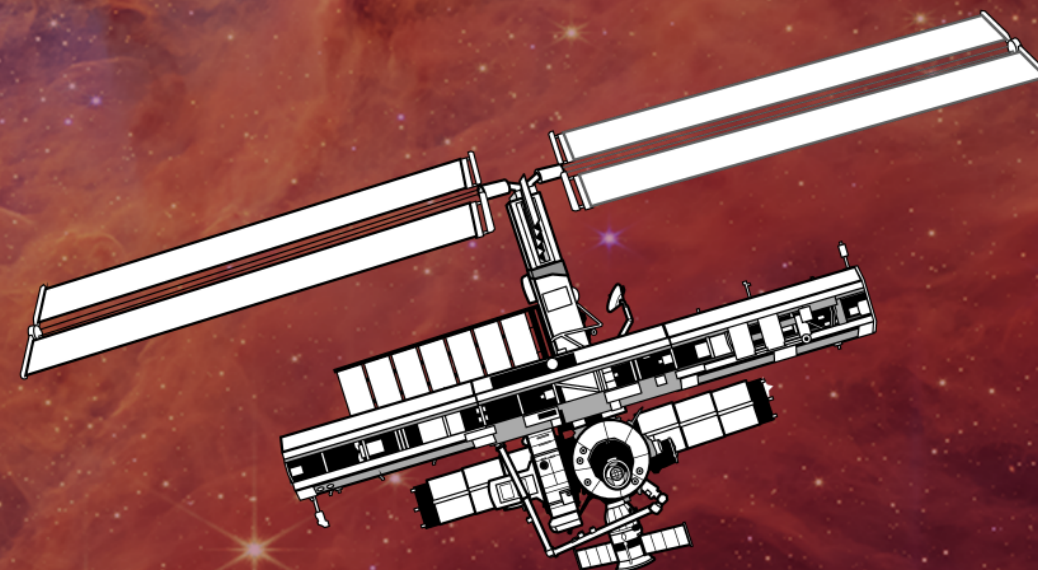


# From antideuteron to PBHs

## Exploring the exotic components of the Universe

Agnese Tolino  
IFIC (CSIC-UV)  
October 8th, 2024



Premio Nazionale “Milla Baldo Ceolin”  
GGI Arcetri, Firenze



# ANTIDEUTERONS IN COSMIC RAYS

A new evaluation of the secondary component

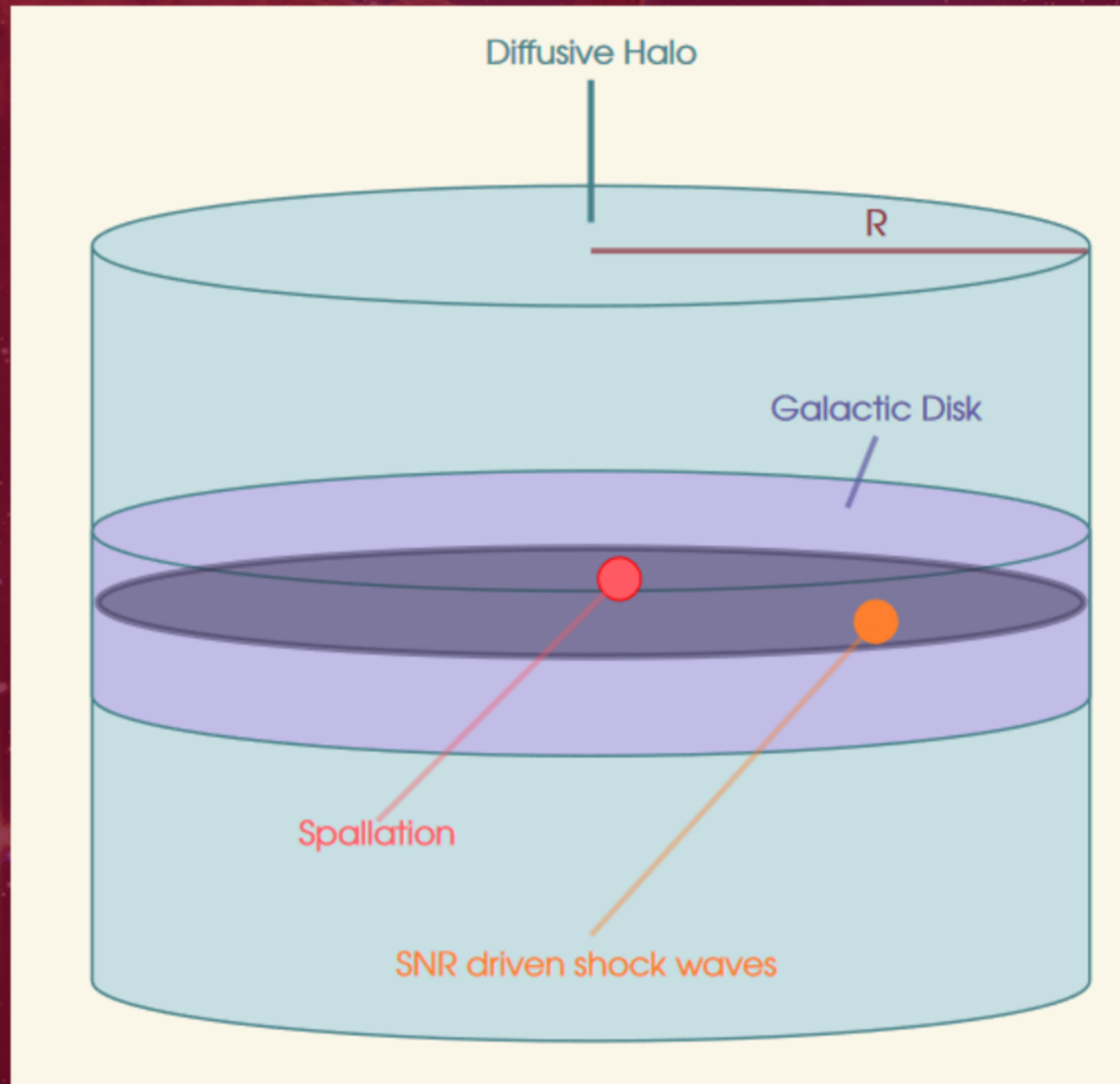
## **Goal (and result) of my MSc Thesis:**

providing a new evaluation of the secondary component of antideuterons in Cosmic Rays (CRs), given updated propagation models & hadronic cross sections

MSc supervisor: Prof. Fiorenza Donato, INFN & Università degli Studi di Torino



# GALACTIC COSMIC RAYS IN A NUTSHELL



Original Fig. of my thesis

- Cosmic Rays (CRs) are particles accelerated to min 0.1 MeV/n
- **Galactic CRs** (GCRs) originate and propagate in the Galaxy
- Known GCRs sources in the Galactic Disk: **spallation** (secondary CRs) and shockwaves from supernovae
- GCRs diffuse in the **Diffusive Halo** due to inhomogeneous magnetic fields
- **Exotic sources** as Dark Matter (DM) or Primordial Black Holes (PBHs)?



# ANTIDEUTERONS IN GALACTIC COSMIC RAYS

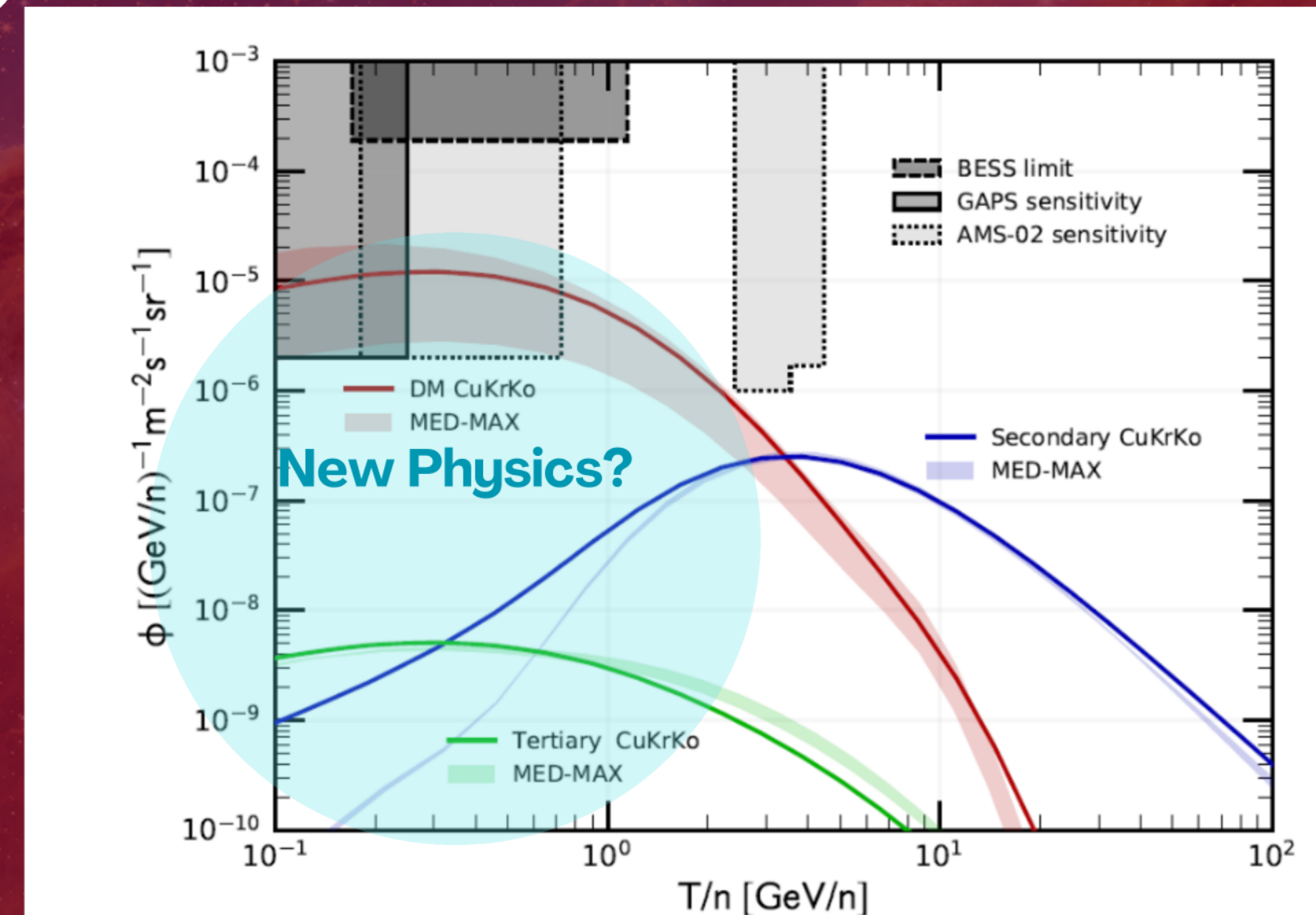


Secondary production

CR protons collide over the Interstellar medium, producing antiprotons and antineutrons

Antiprotons and antineutrons merge to create antideuterons

- Low-energy antideuterons are less likely to be produced through spallation: leaves room to exotic sources like Dark Matter!
- Not observed yet, hint at AMS-02, waiting for GAPS



Korsmeier, Donato, Fornengo 2018



1

Updated the antideuterons cross sections with the most recent antiproton spallation cross section of Korsmeier et al. 2018

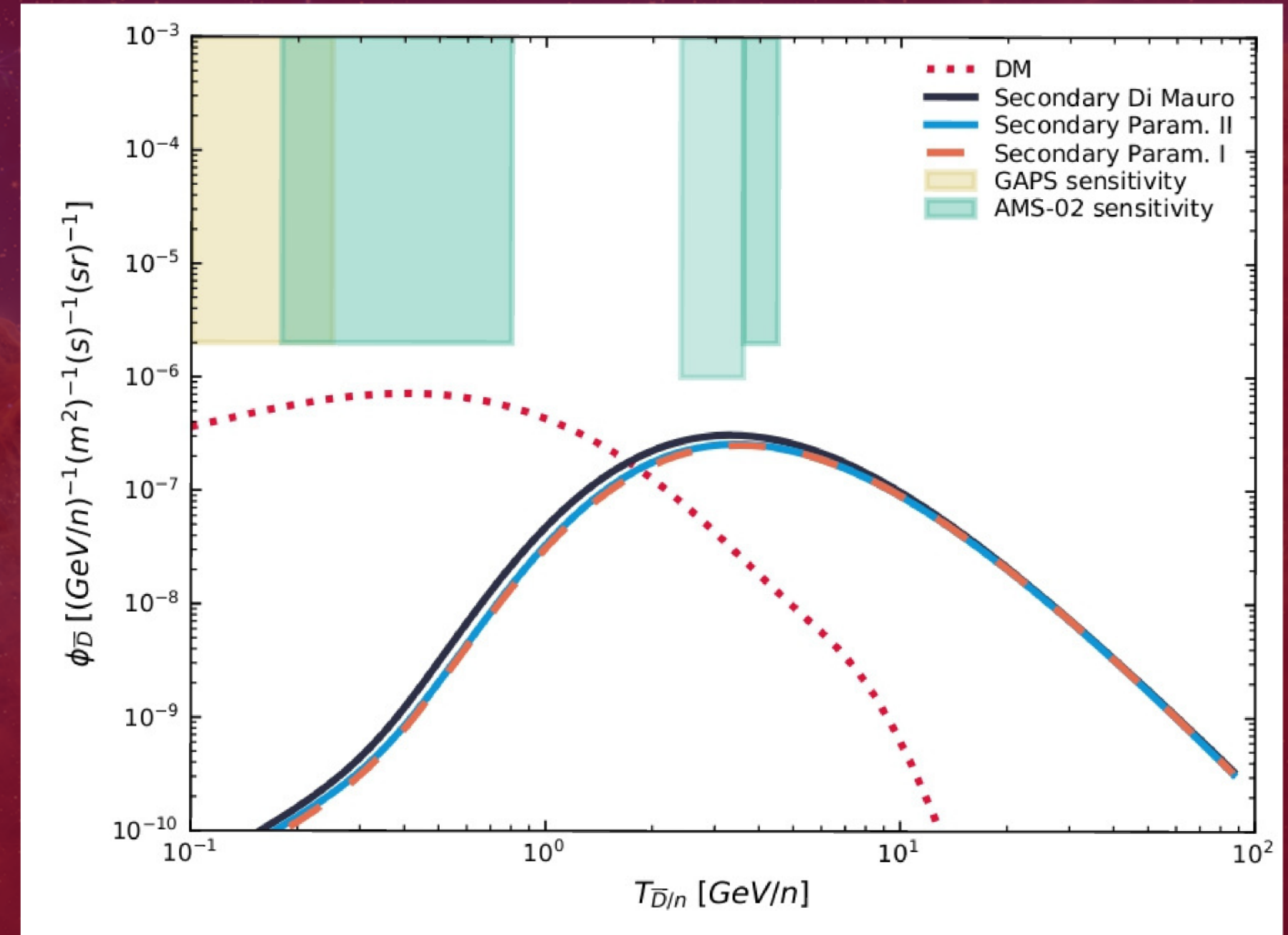
Implemented the MED SLIM transport configuration of Genolin et al. 2021

New reliable prediction of antideuteron secondary source term & flux, reduction up to 30% with respect to the previous literature!

2

3

# MY WORK & MY RESULTS



Original plot of my thesis:  
antideuteron secondary (color, solid –  
dashed) and DM (dotted) flux



# FUTURE PERSPECTIVES

Our predictions may allow to identify antideuterons among GAPS and AMS-02 data, and maybe contribute in improving indirect detection of DM signals.



# FROM TORINO TO VALENCIA



Fiorenza Donato,  
professor & INFN associate  
@ University of Torino

MSc supervisor



Valentina De Romeri,  
junior researcher  
@ IFIC Valencia, AHEP group

PhD supervisor



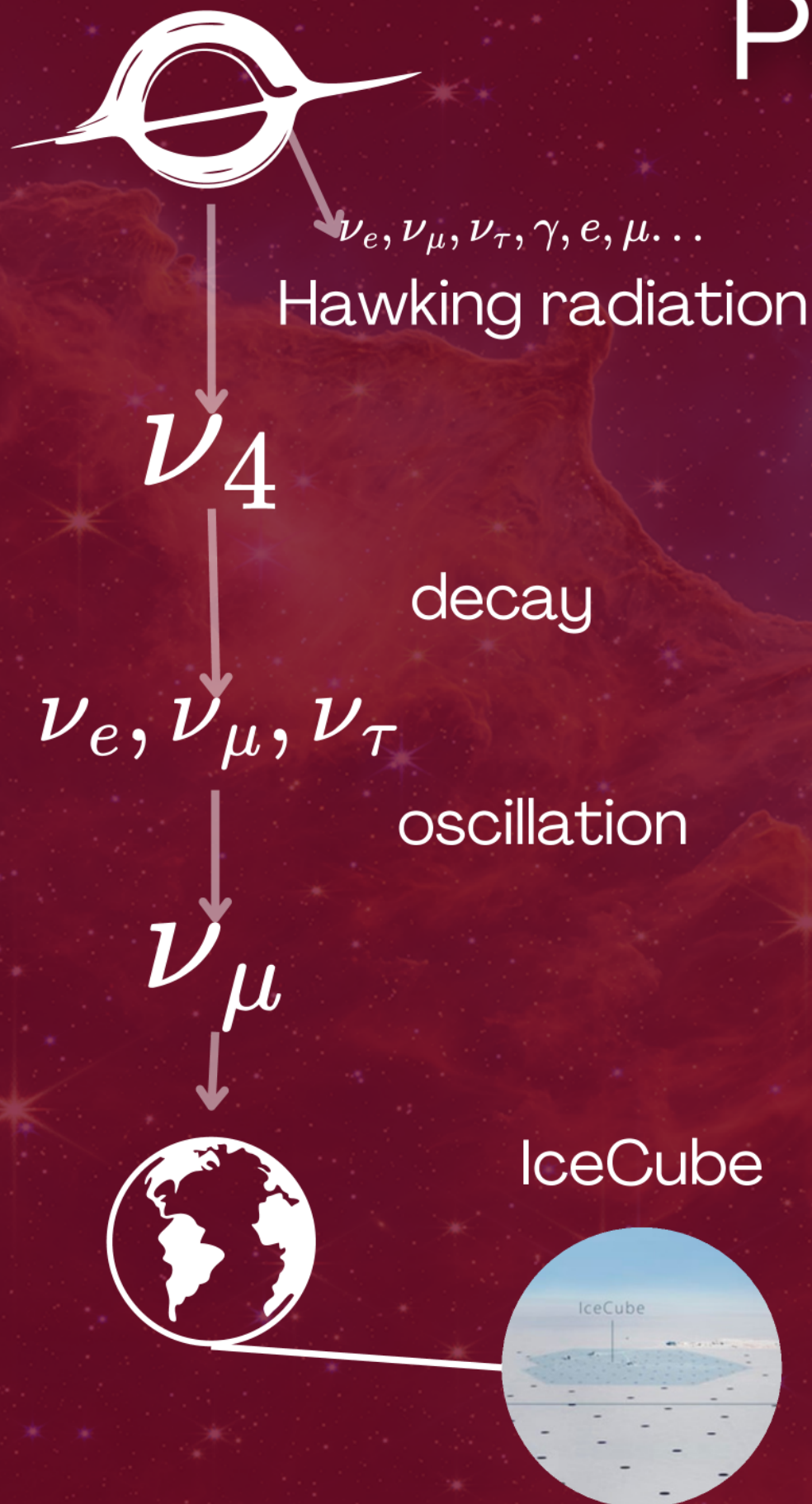
Agnese Tolino (me),  
PhD student  
@ IFIC Valencia, AHEP  
group



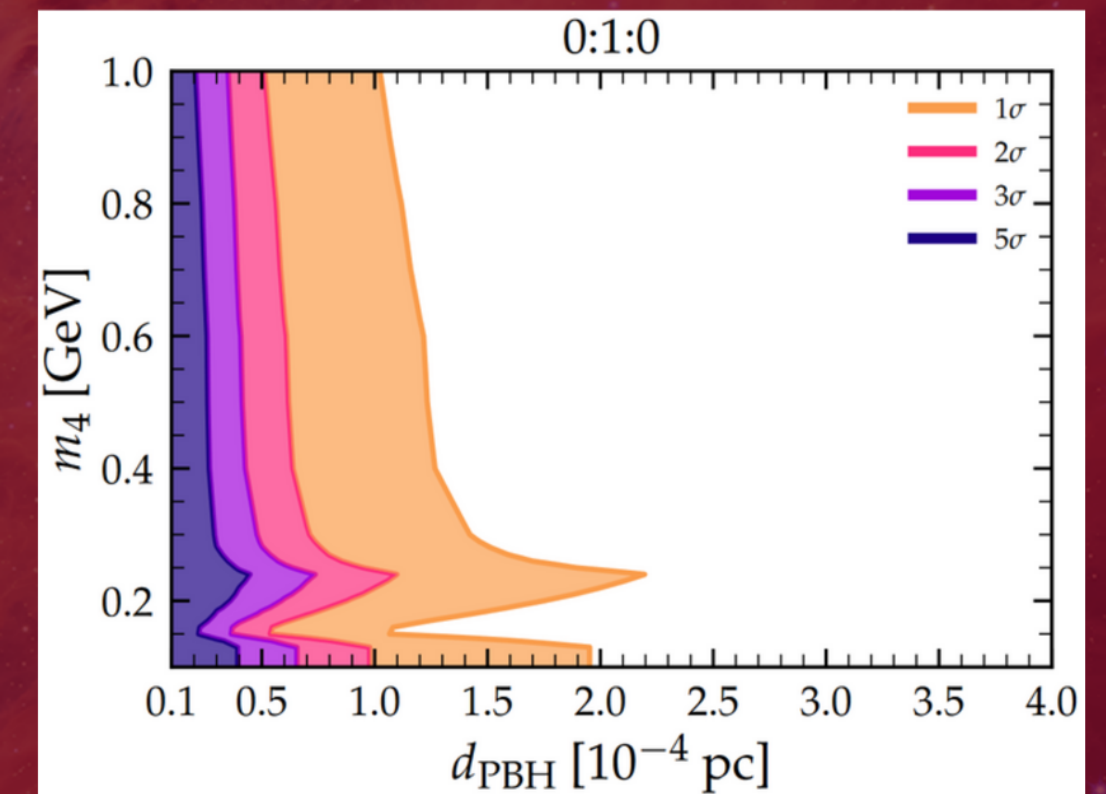
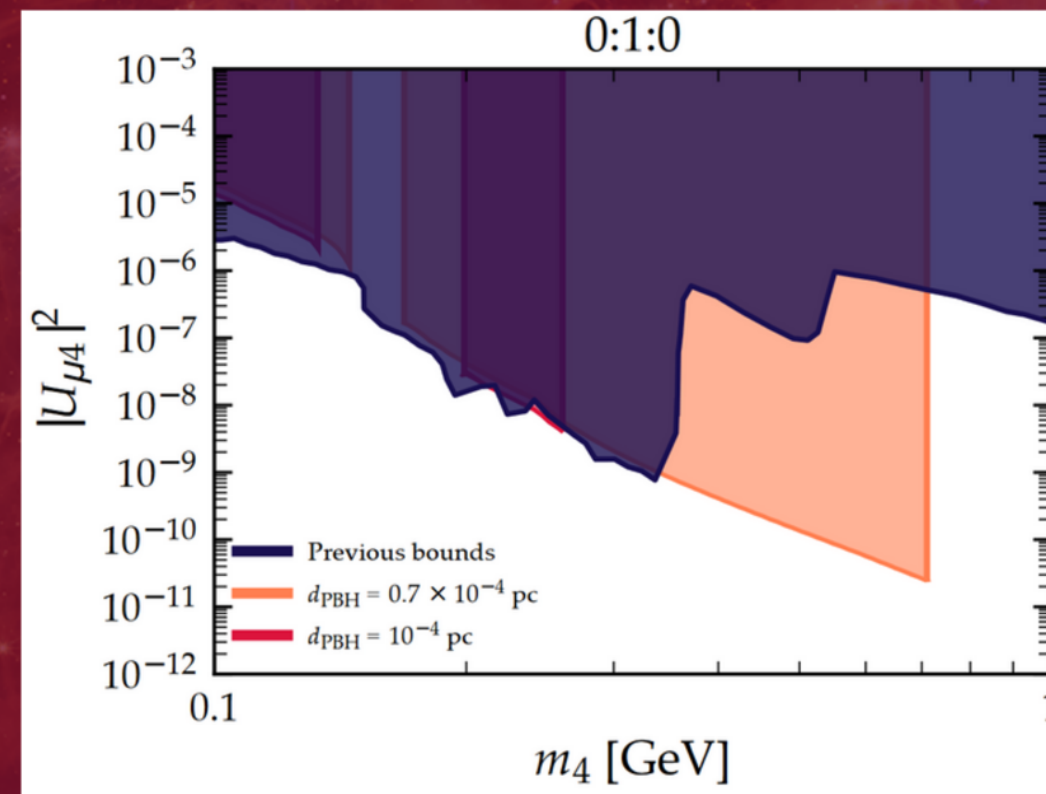
A “WWF-protected” story of women supervisors



# PBH PROBES OF HNLS



In arXiv:2405.00124, we estimated the sensitivity of IceCube to Heavy Neutral Leptons (HNLS) decays from a 100s Primordial Black Hole (PBH) burst



Expected IceCube sensitivities for a 100s PBH burst.  
From arXiv:2405:00124



# FUTURE PROJECTS & CURRENT INTERESTS

- PBHs as source of cosmic rays and BSM particles
- DM structures with PBHs
- PBH signatures at detectors
- Formation of PBHs



# FUTURE PROJECTS & CURRENT INTERESTS

*Thank you!*

- PBHs as source of cosmic rays and BSM particles
- DM structures with PBHs
- PBH signatures at detectors
- Formation of PBHs