



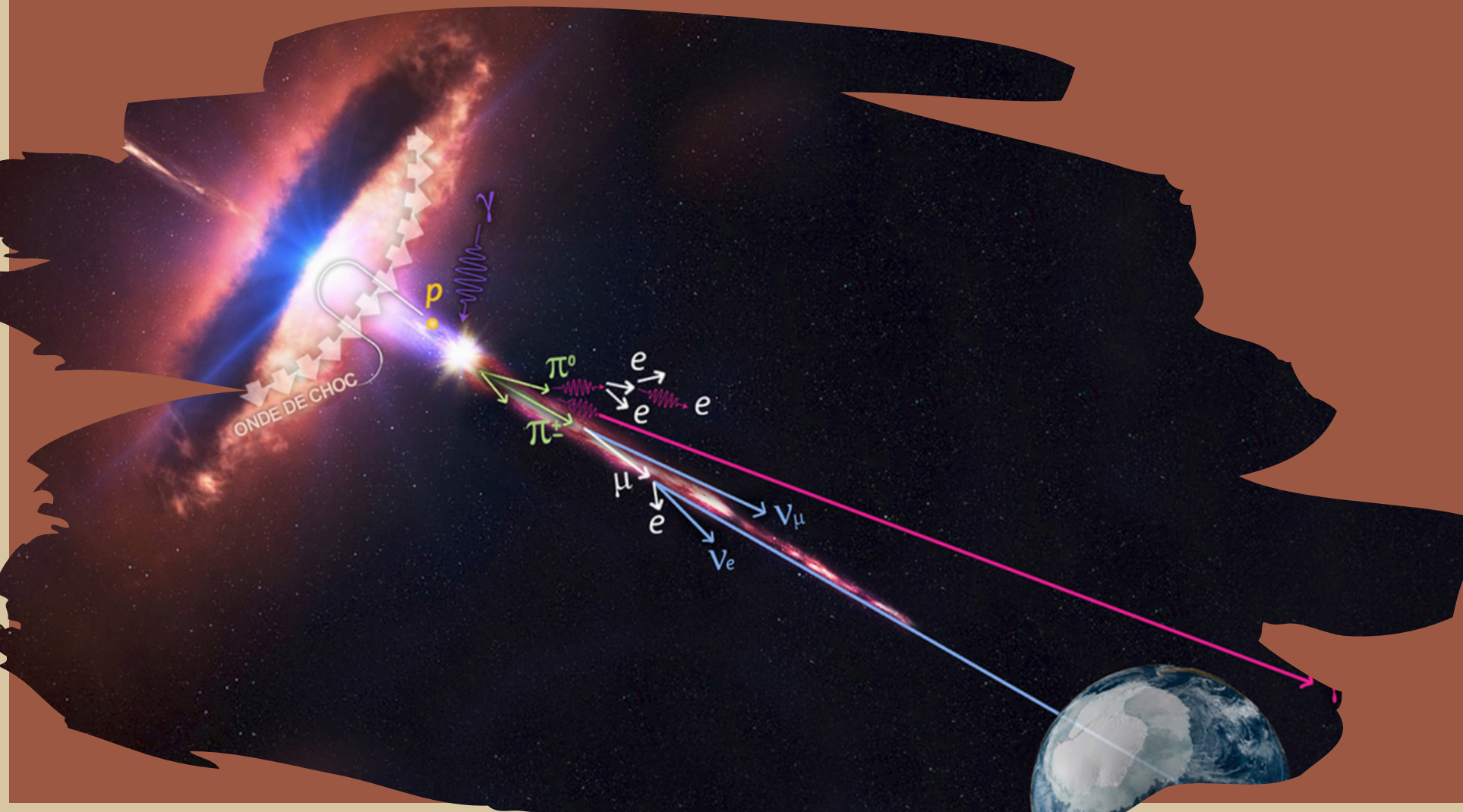
# MY PHD: OBSERVATION OF HIGH ENERGY $\gamma$ BY CTA

Dubos Coline

A2C pole (Astroparticules,  
Astrophysique et Cosmologie)  
CTA team

Study of the origin of galactic cosmic rays of energies up to the PeV

*Supervisor : Pr. Tiina Suomijarvi*



Analysis of NectarCAM data from the MST telescope

*Co-supervisor : Ing. Giulia Hull*

IJCLab-CEA



# MY 1<sup>ST</sup> YEAR OF PHD

**NOVEMBER 2022**

**DECEMBER 2022**

**MAY 2023**

CTA meeting, Naples

**JUNE 2023**

**AUGUST 2023**

**SEPTEMBER 2023**

**OTHER PROJECTS**



# CTA meeting, Naples





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CTA meeting, Naples

Contribution on the PeVatrons  
SNRs article

**JUNE 2023**

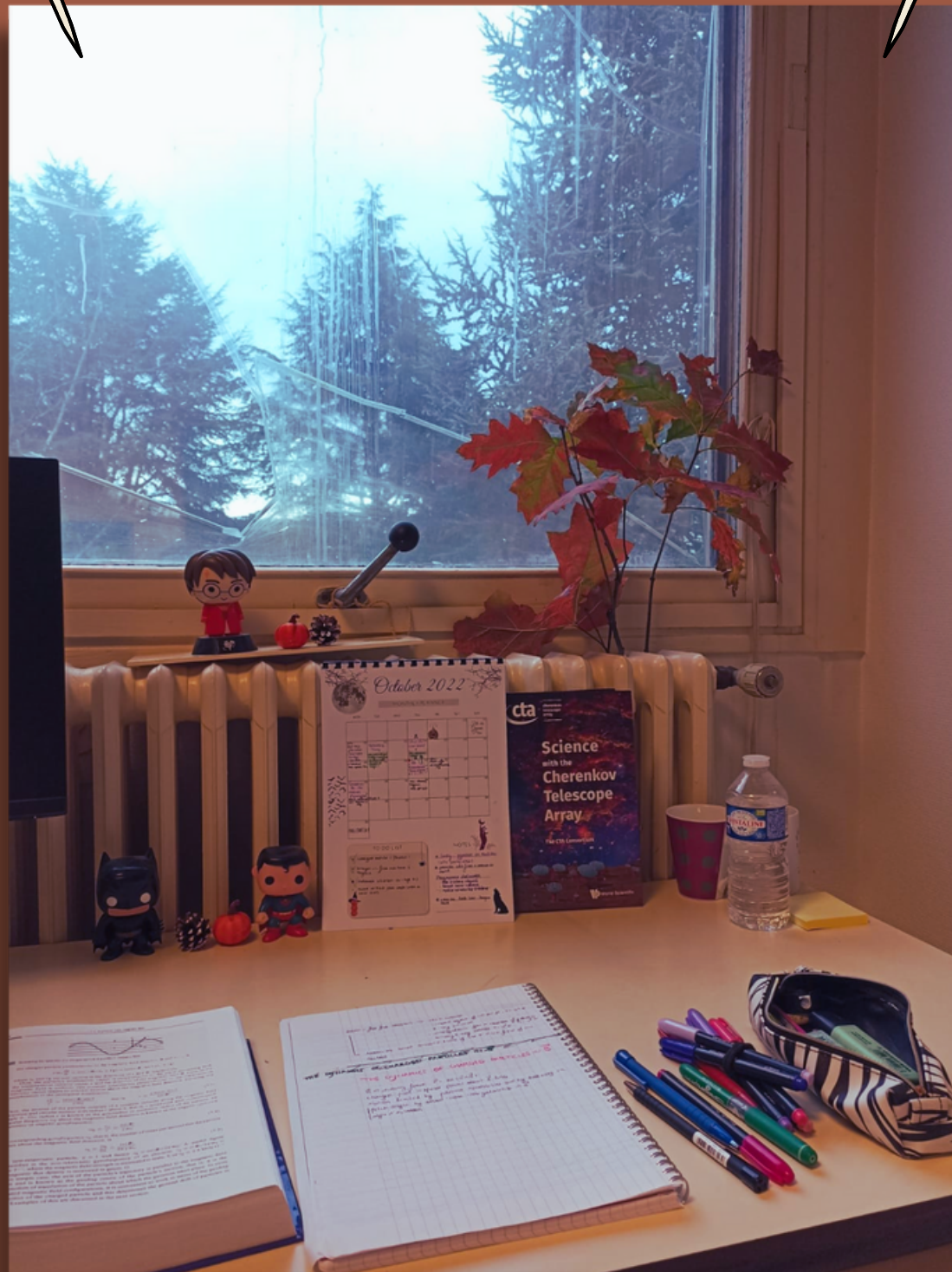
**AUGUST 2023**

**SEPTEMBER 2023**

**OTHER PROJECTS**



# Contribution on the PeVatrons SNRs article



## Multiwavelength analysis of Galactic Supernova Remnants

P. Sharma,<sup>a,1</sup> Z. Ou,<sup>b</sup> C. Henry-Cadrot,<sup>a</sup> C. Dubos<sup>a</sup>  
and T. Suomijärvi<sup>a</sup>

<sup>a</sup>Université Paris-Saclay, CNRS/IN2P3,  
IJCLab, 91405 Orsay, France

<sup>b</sup>School of Physics and Astronomy, Sun Yat-sen University,  
519082 Zhuhai, China

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**Abstract.** The origin of Galactic Cosmic Rays (CRs) and the possibility of Supernova Remnants (SNRs) being potential CR accelerators is still an open debate. The charged CRs can be detected indirectly by the  $\gamma$ -ray observatories through the  $\pi^0$  production and consequent decay, leading to the generation of high-energy  $\gamma$ -rays. The goal of the study is to identify qualitative and quantitative trends in favour of hadronic scenario and search for SNRs which could be potential accelerators up to PeV energies (PeVatrons).

We have performed a Multiwavelength (MWL) study using different radiative models to evaluate the hadronic contribution. The spectral energy distributions (SEDs) of selected SNRs are modeled using the Naima [1] package. Two different radiative scenarios are considered, pure leptonic and lepto-hadronic scenarios and different methods are used to evaluate their importance.

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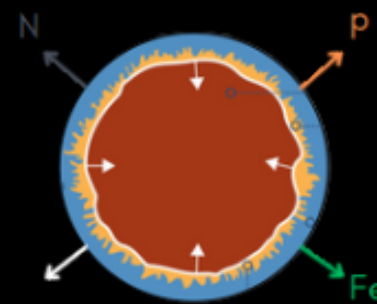
# Talk CTA France

## INTRODUCTION

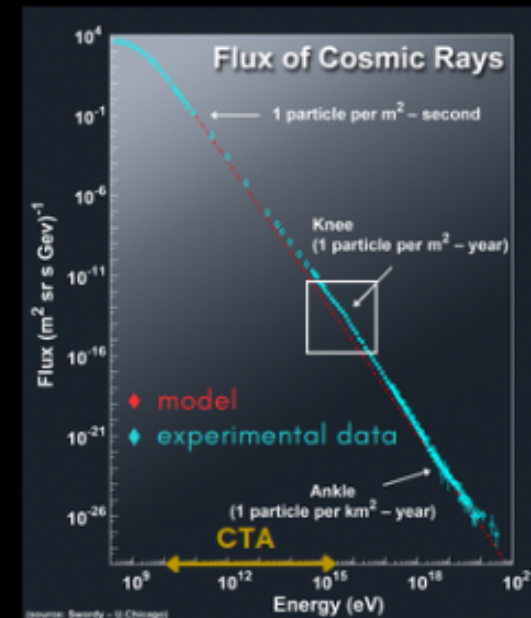
What are the sources for galactic cosmic rays of energies up to the PeV?

### SUPERNOVA REMNANT (SNR)

- One of pevatron candidates (galactic sources)
- Galactic cosmic rays abundances: **protons** (~88%) + **N** (~0.18%) + **Fe** (~0.09%) + ... + electrons + ...
- Acceleration of CRs by strong SNR shock waves\*



### COSMIC RAY SPECTRUM

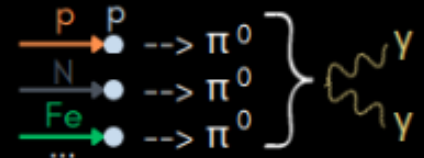


PeV energies: hadronic (protons) and heavier nuclei contribution?

\*Thoudam and Horandel (2014)

### PION DECAY PROCESS

- Interaction of nuclei with the medium

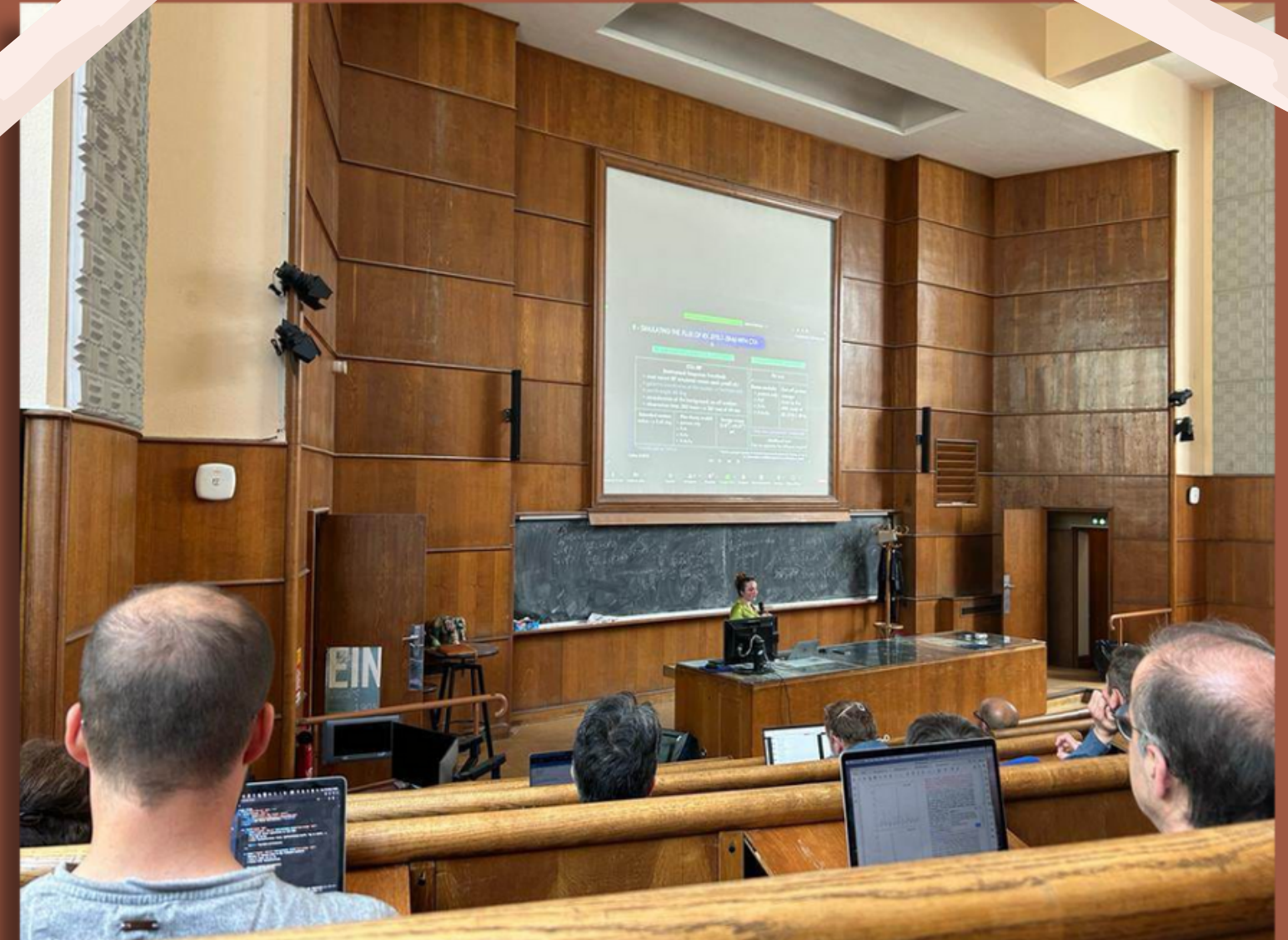


### γ SPECTRUM

### INDIRECT DETECTION BY CTA



Coline DUBOS





# Summer school “Transient Universe”, Corse



Institut d'Etudes Scientifiques de Cargèse





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**AUGUST 2023**

Contribution ICRC on the  
NectarCam calibration

**SEPTEMBER 2023**

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Flash talk Journées PNHE,  
IAP

**OTHER PROJECTS**



# Origin of galactic cosmic rays of energies up to the PeV: the Pevatrons

2<sup>nd</sup> year of PhD: Dubos Coline - Supervisor: Pr. Tiina Suomijärvi



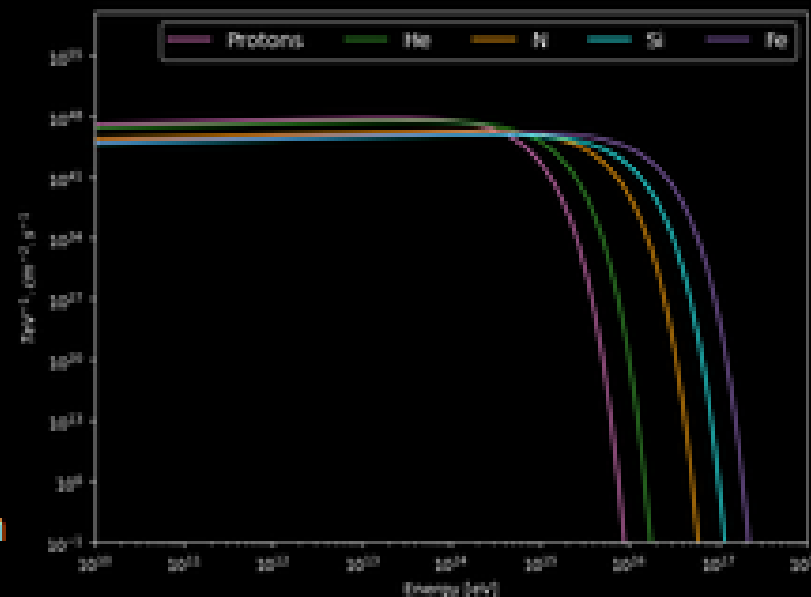
**Supernova Remnant**

RX J1713.7-3946

Are protons and **heavier nuclei** accelerated efficiently by **SNRs**?

Particle spectrum

Cosmic-ray energy spectrum and composition up to the ankle (Thoudam et al.)

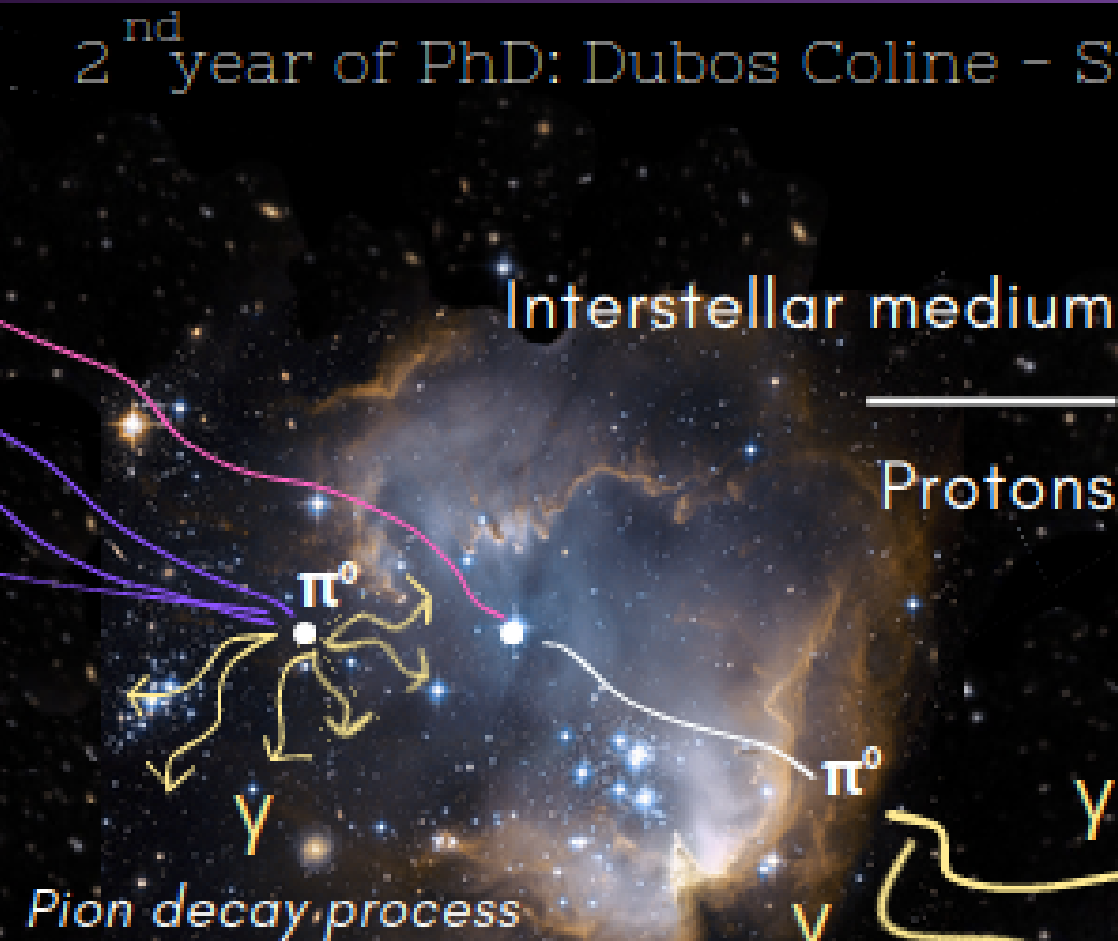
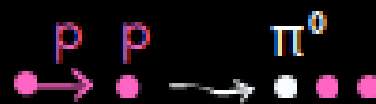


Particle distribution

Abundances of GCRs

$$f(E) = f_0 \cdot A_p \cdot (E/E_0)^{-\alpha} \cdot e^{-(E/Z \cdot E_c/A)^\beta}$$

Cross section



Can we see **cosmic rays** from **SNRs** by measuring **γs** with **CTA**?

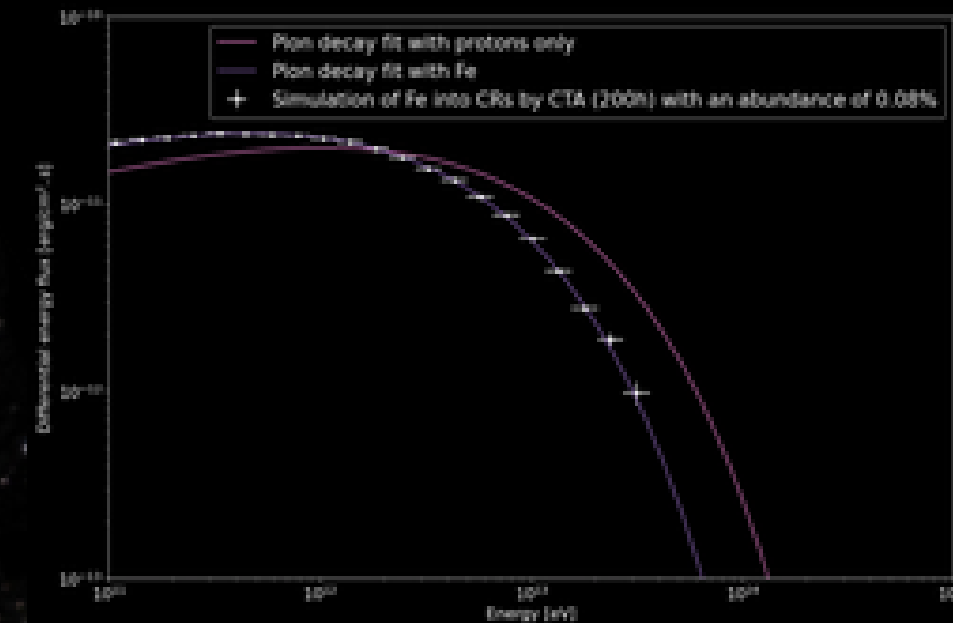
Simulation for CTA

IRF - prod5 v0.1

Pion decay models - Naima (Gammapy)

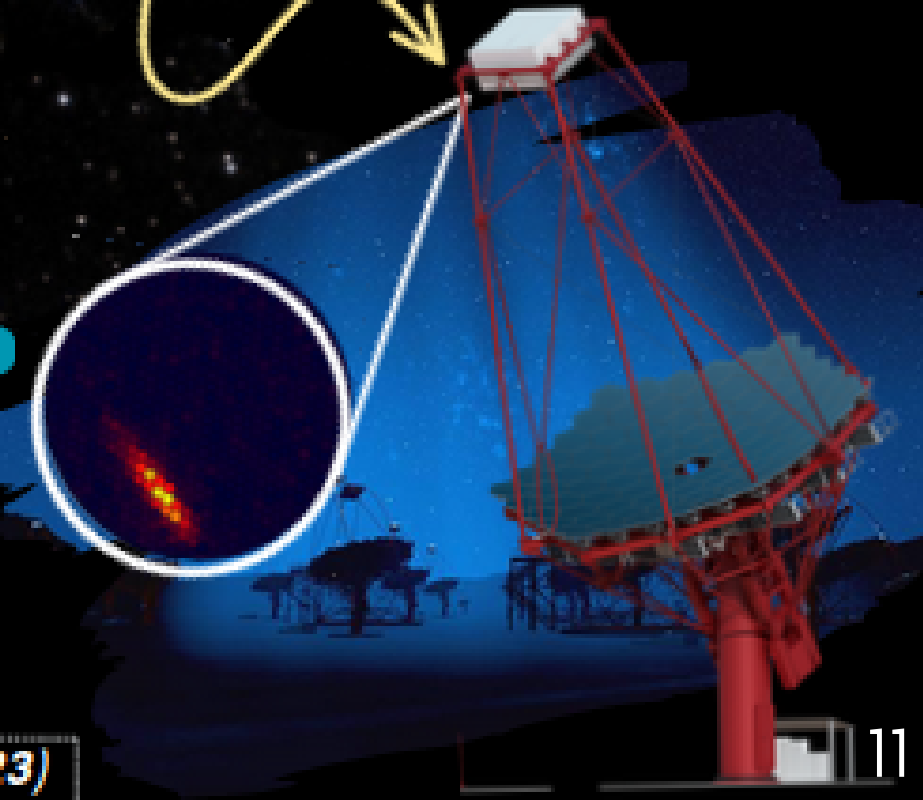
**Fixed parameters**

Fits - TS (Fe-P)  $\approx$  6755



**CTA is sensitive to CRs composition!**

Cherenkov Telescope Array  
20 GeV-300 TeV



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## OTHER PROJECTS

Teaching mission

CE1 class: astrophysics initiation

Associations: D2i2 / BDE



# Teaching mission

- 64h/yr
- TDs/TPs L1 Polytech  
mécanique du point
- TPs Physique L2 Université  
Paris-saclay



# CE1 class: astrophysics initiation

Videos / quizz / experiences  
(outside...)

Classe de CE2

## INITIATION À L'ASTROPHYSIQUE

COLINE DUBOS

**UC Lab**  
Laboratoire de Physique  
des 2 Infinis

**Métier :** laboratoire de recherche astrophysique et  
enseignante à l'Université

université  
PARIS-SACLAY



# D2i2

- Secretary
- Monthly Meet&Drink
- Yearly Workshop Perspectives

# BDE

Halloween's party / Fresher's day / Christmas party ...





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**OTHER PROJECTS**

Troupe SUAPS (contemporary dance at the University) / Hip Hop group

Teaching mission

CE1 class: astrophysics initiation

Associations: D2i2 / BDE

# Troupe SUAPS





# WHAT'S NEXT FOR THIS 2 YEAR?

## FORMATIONS TO DO

## MY PHD

## NEW PROJECTS

- 
- ☒ Ethics
  - ☐ Ecological
  - ☐ Sexism
  - ☒ Professional integration
  - ☒ Knowledge diffusion
  - ☒ Summer school or teaching
  - ☒ In-depth course

Redaction of an article:  
"Sensitivity of the Cherenkov Telescope Array (CTA) to different cut-off shapes and to heavy Cosmic-Rays coming from Supernova Remnants"

Workshop Perspectives, *D2i2*

"50 nuances de scientifiques",  
*ENS*

Both, *IES Cargèse* and  
*Polytech/Paris-Saclay*

PHY651J - Astroparticles and  
Astrophysics, *Polytechnique*

- ILE\_project :  
intervention in primary classes: scientific workshops, the profession of researcher, project artisticXscience...
- Ma Thèse en 180s ?