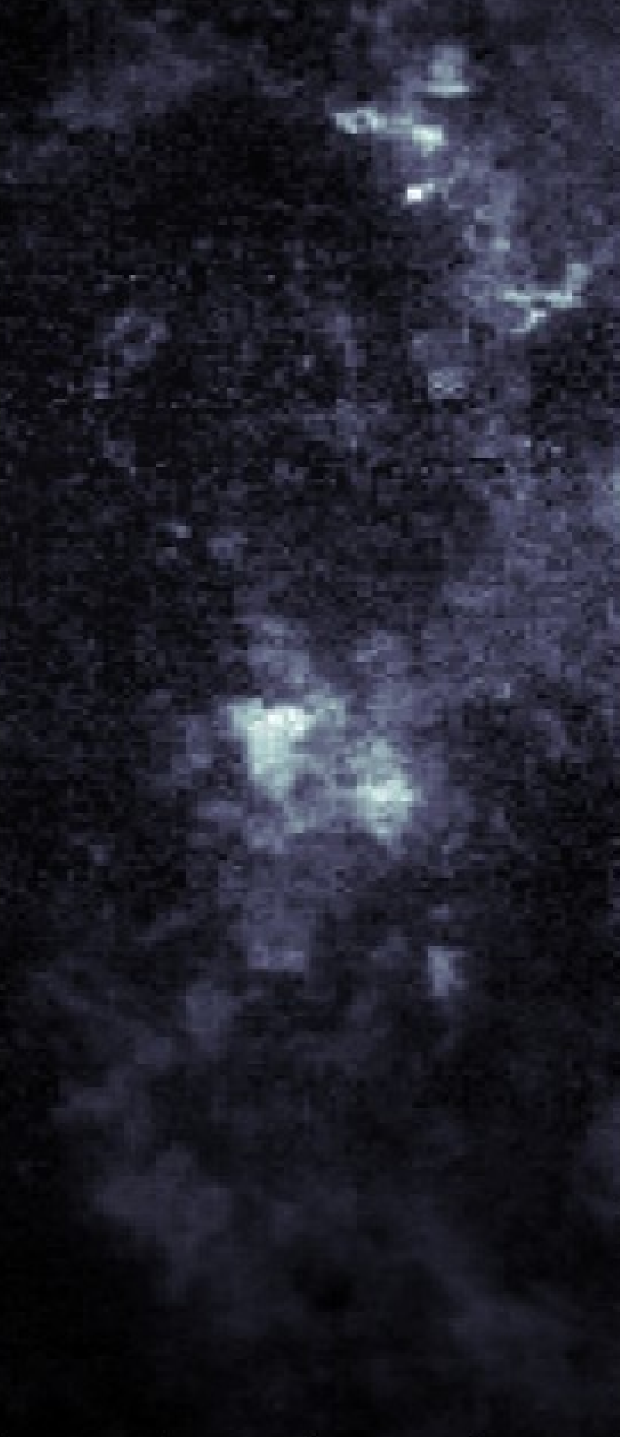


Modeling Particles in the ISM

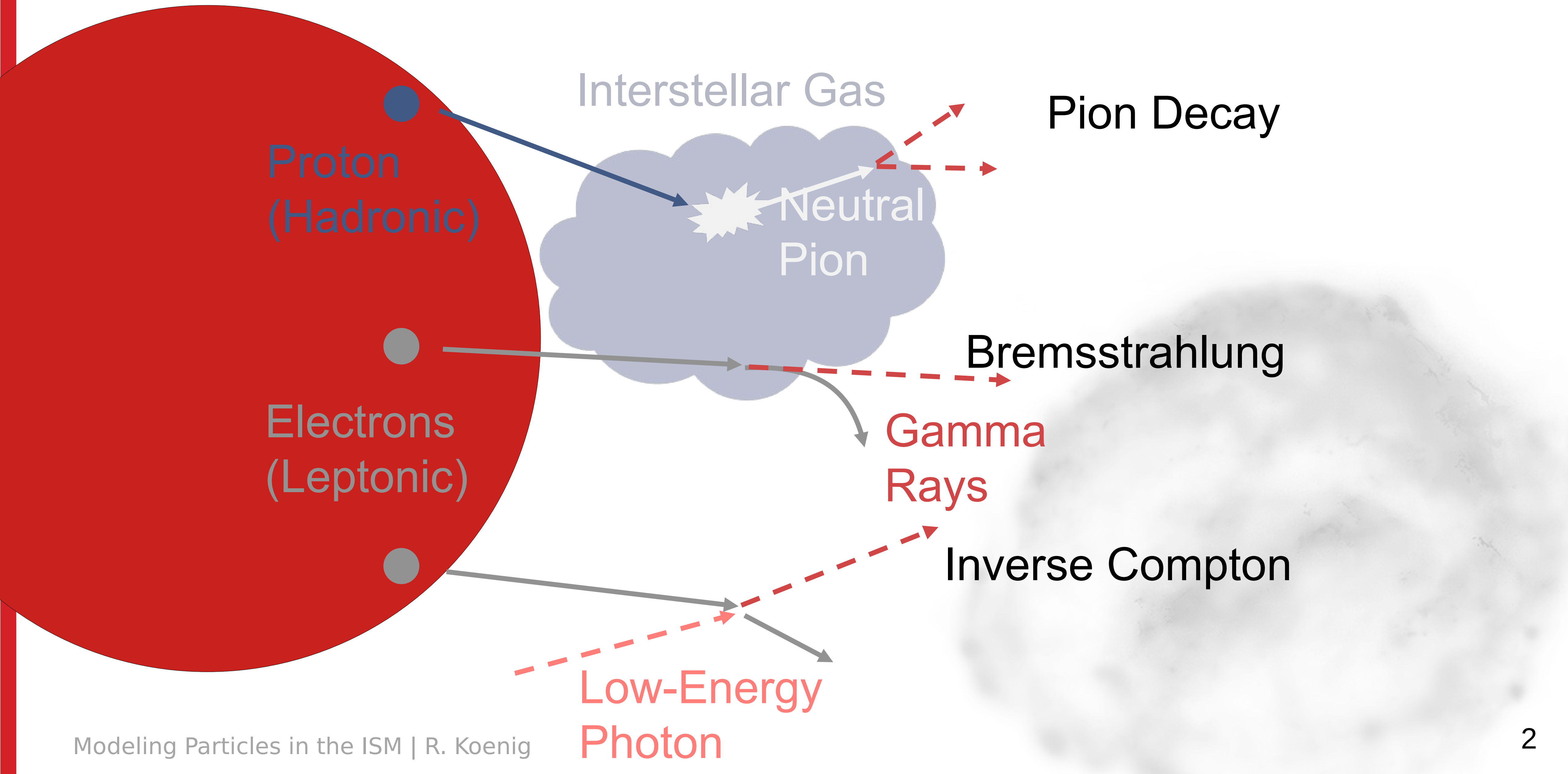
Including the ISM’s Influence on the Spatial Distribution of Protons

Robert Koenig

THE UNIVERSITY of ADELAIDE

April 13th, 2022

Gamma-Ray Production



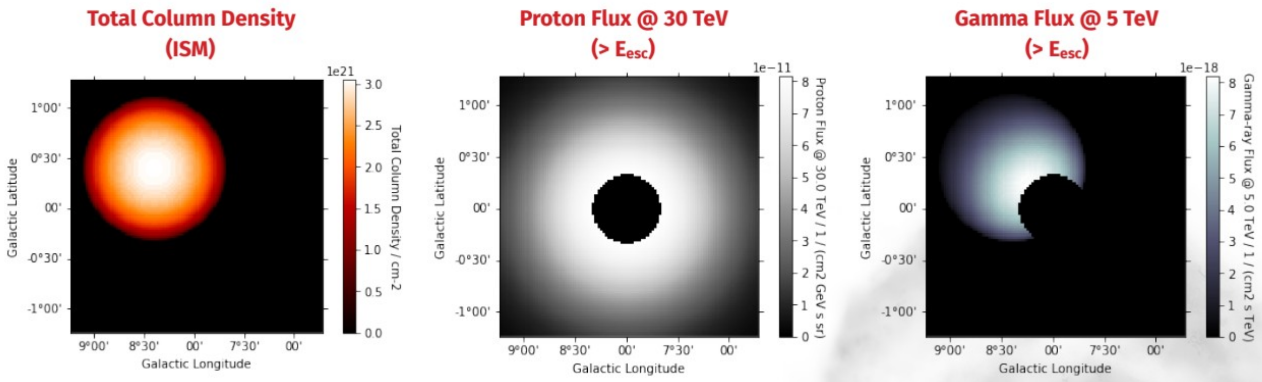
Modeling particles in the ISM

Sabrina Einecke @ CTA-Oz Nov. 2021
https://indico.cta-observatory.org/event/3712/contributions/31509/

Conclusion

- partISM:
  - Software framework to model particles (protons, gammas, neutrinos) in the ISM
  - 2D & 3D models: Morphology & spectra
- Future additions:
  - Non-constant diffusion length
  - Non-constant escape radius
  - Neutrinos
- Future plans:
  - Detailed modeling of few supernova remnants
  - General modeling of all supernova remnants and pulsars

Our Approach



→ Any ISM morphology can be used
→ Any proton distribution can be used
→ Gamma-ray spectrum from any region can be extracted

Motivation

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Current state:

Diffusion coefficient (and therefore diffusion lengths) the same for the whole map

Reality:

Diffusion coefficient position dependent

Expectation:

- Diffusion length decreases with increasing magnetic field
- Higher proton/gamma-ray density in areas of higher magnetic fields

Diffusion Coefficient

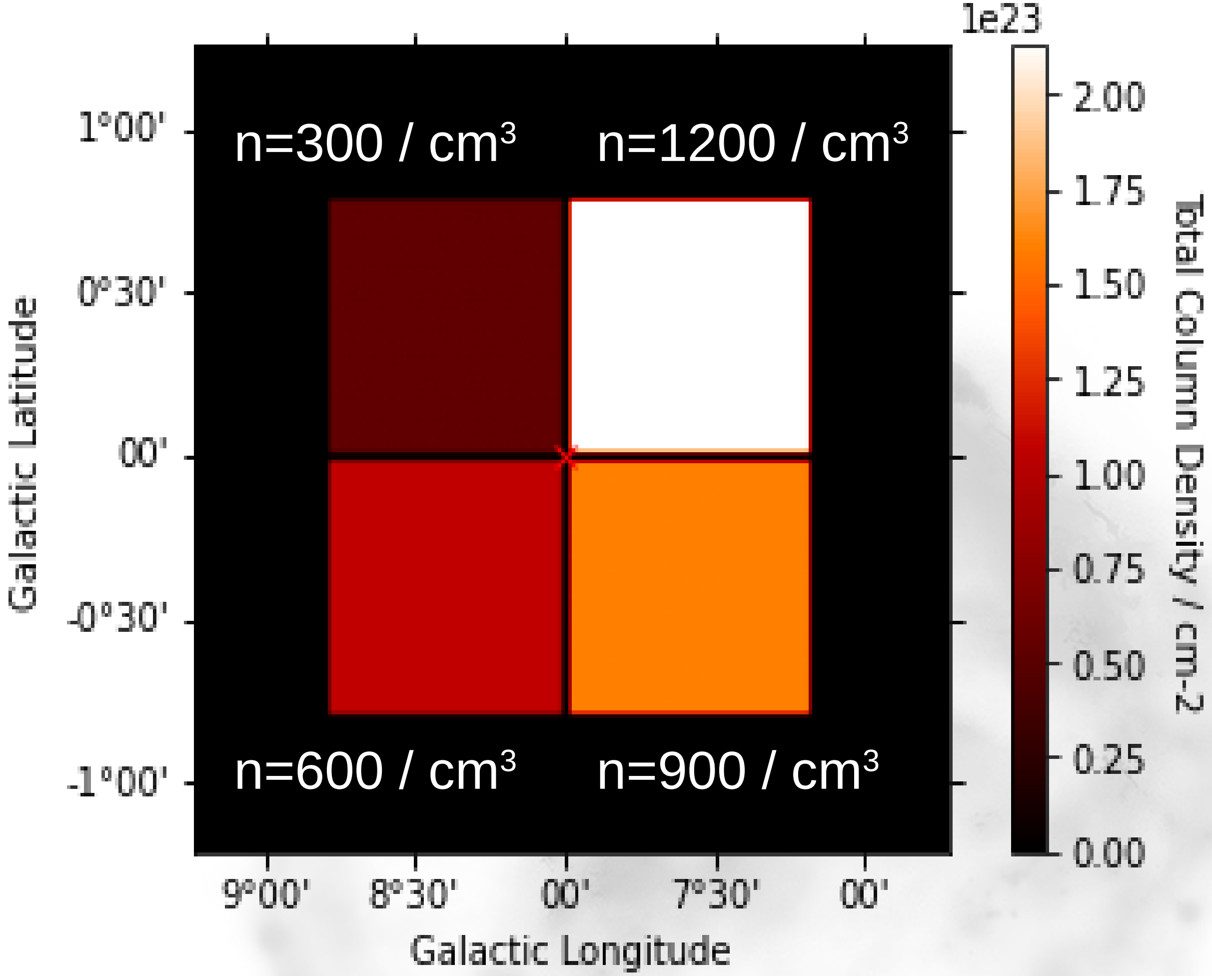
$$D = \chi D_0 \frac{E_P}{B}$$

Can be estimated by number density of ISM (Crutcher)

Comparison of models - Gas map

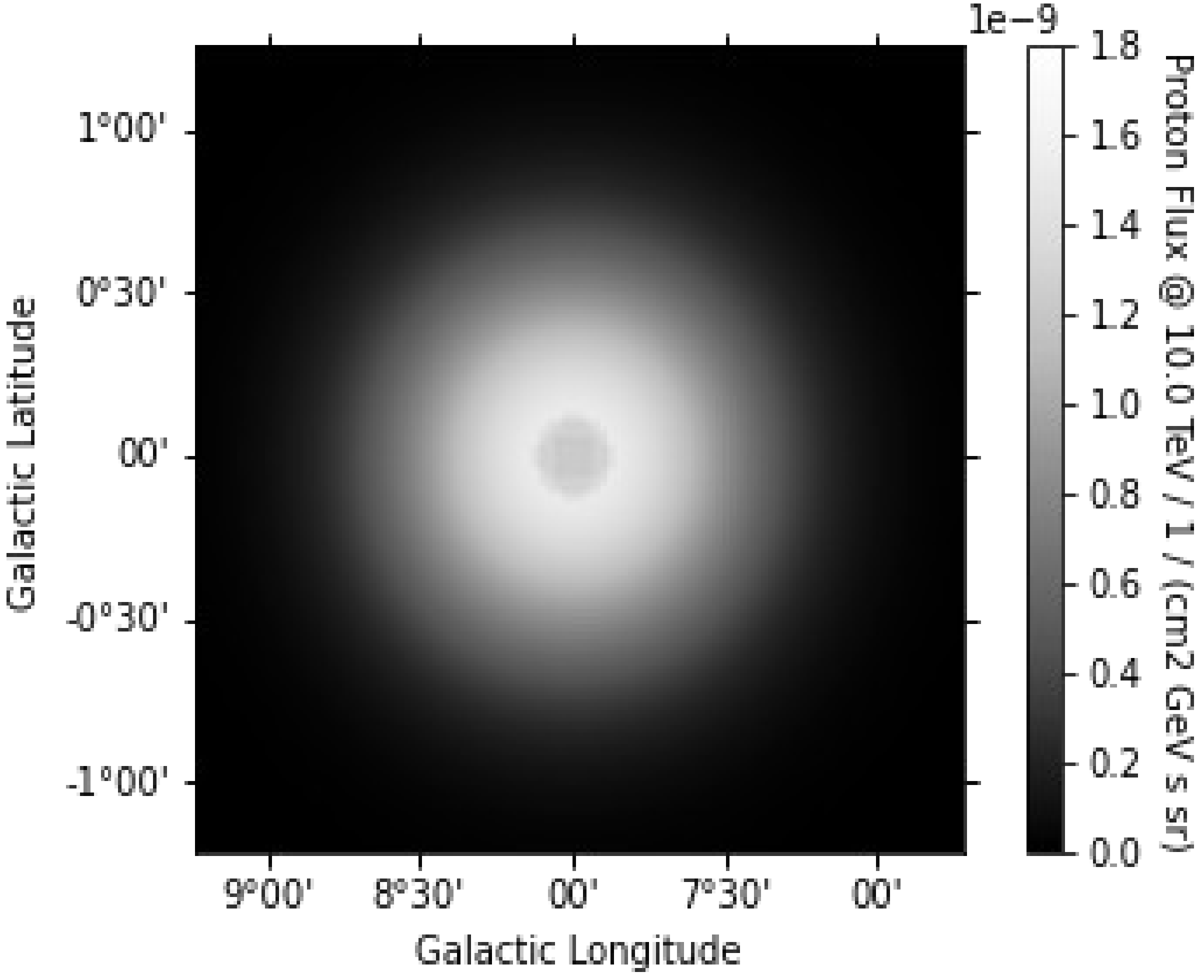
- Regions with different number densities

- Accelerator in the centre

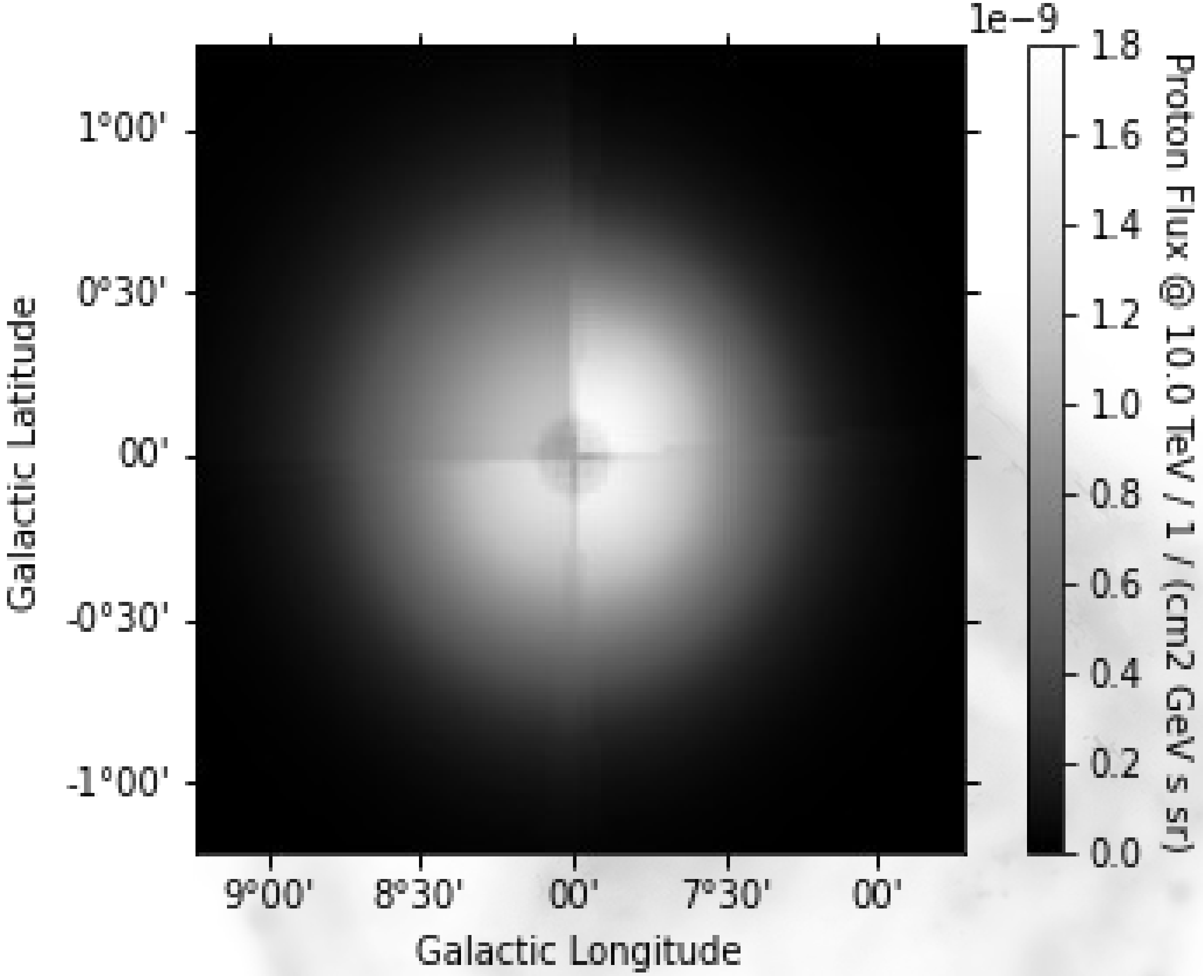


Comparison of models – Proton Distribution

Constant diffusion coefficient

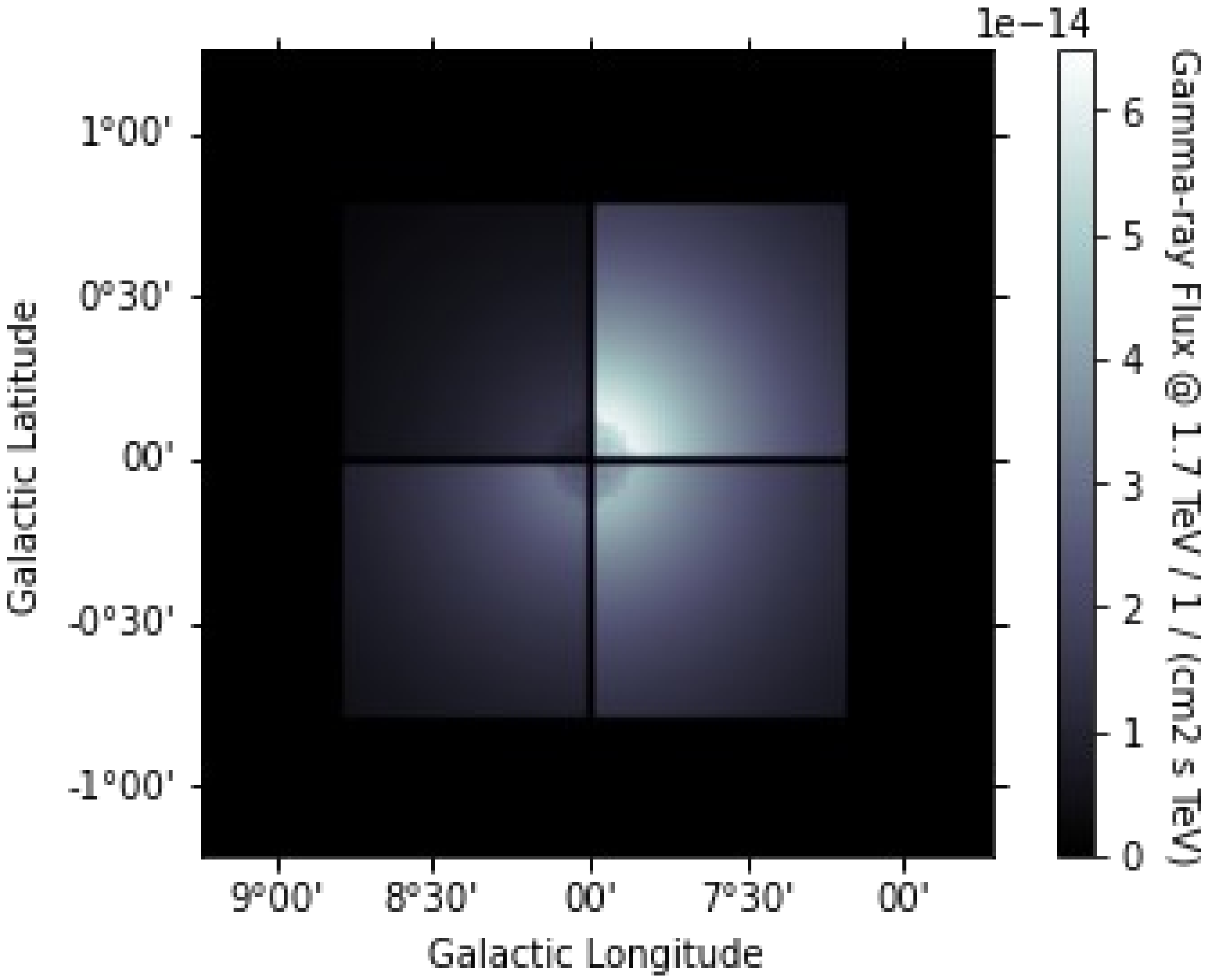


Position dependent diffusion coefficient

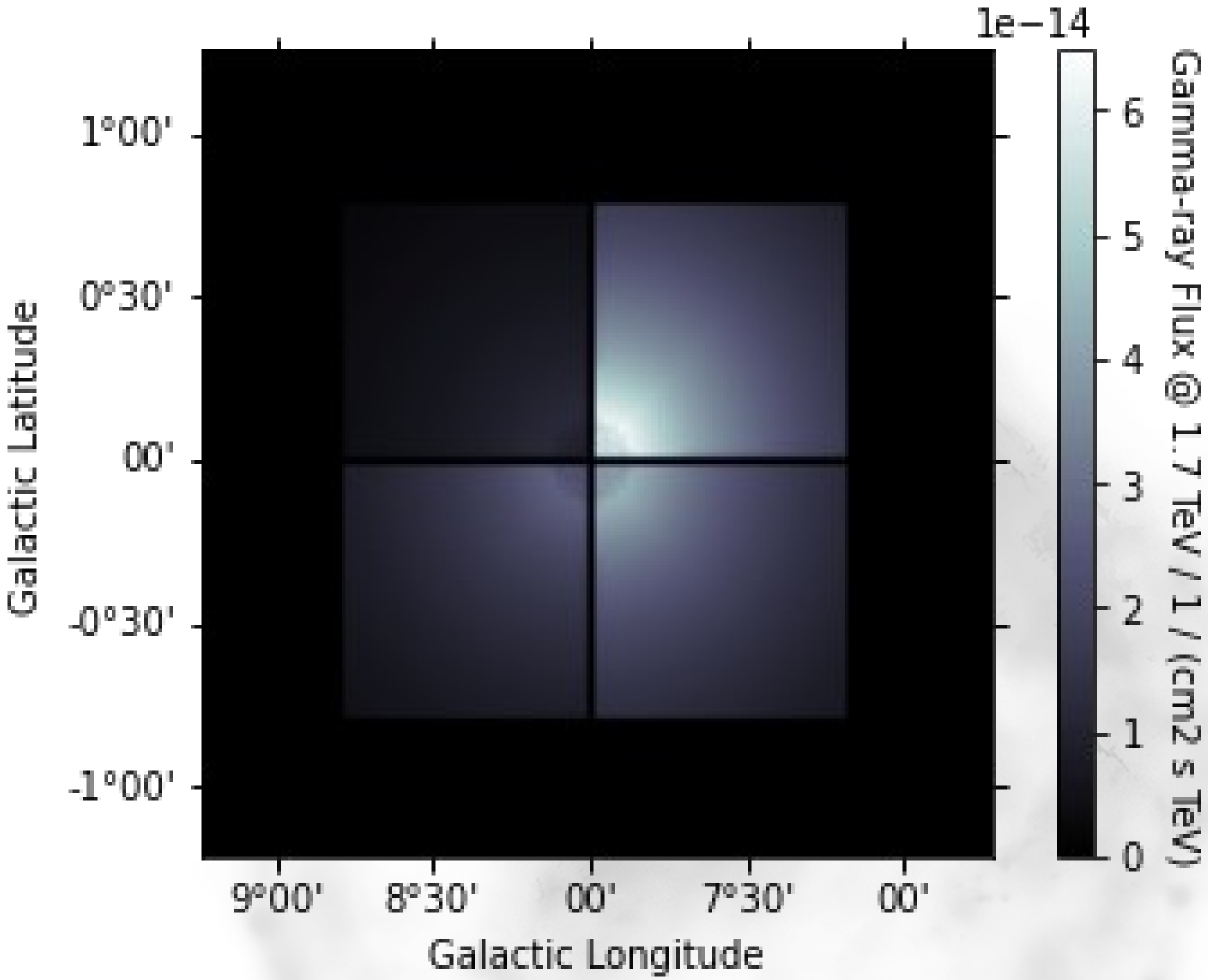


Comparison of models – Gamma-ray Flux

Constant diffusion coefficient



Position dependent diffusion coefficient



Conclusion

Achievments:

- Implementation of position-dependent diffusion lengths in partISM
- Obtaining a position-dependent proton distribution

Next steps:

- Use a numerical solution of the transport equation for a comparison model
- Validate my analytical model on the results of the numerical solution

Future plans:

- General modeling of all SNRs
- Detailed modeling of few regions with PeVatron candidate SNRs