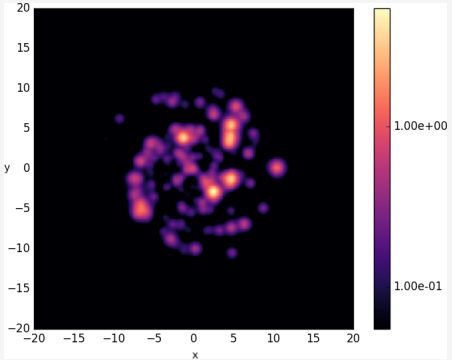
Simulation of Galactic CR Transport

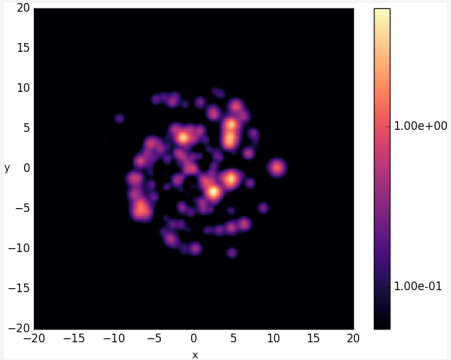
CR Distribution



(Thaler (2019))

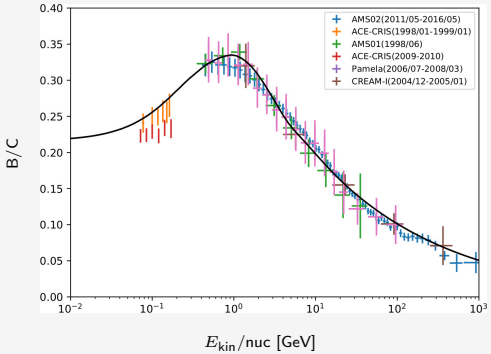
Simulation of Galactic CR Transport

CR Distribution



(Thaler (2019))

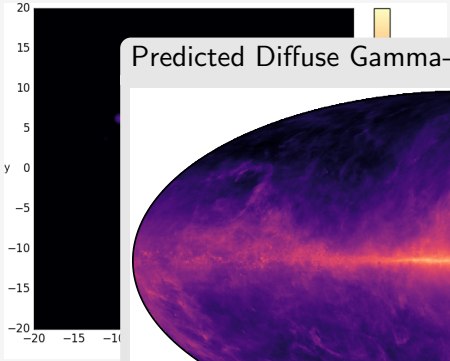
Simulated CR Spectra



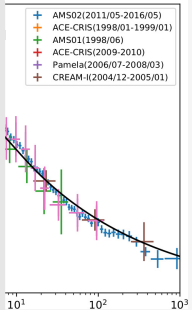
(Picard (2018))

Simulation of Galactic CR Transport

CR Distribution



Simulated CR Spectra



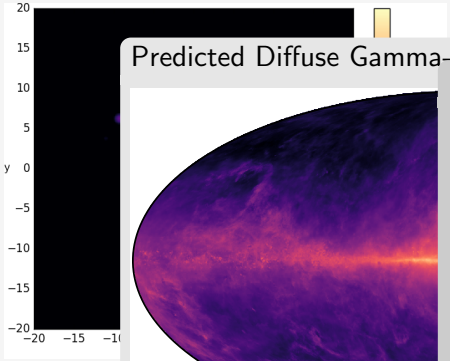
(Picard (2018))

Predicted Diffuse Gamma-Ray Emission

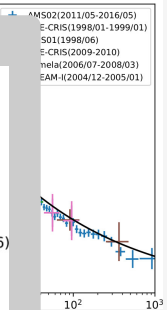
(Thaler (2019))

Simulation of Galactic CR Transport

CR Distribution



Simulated CR Spectra



(Picard (2018))

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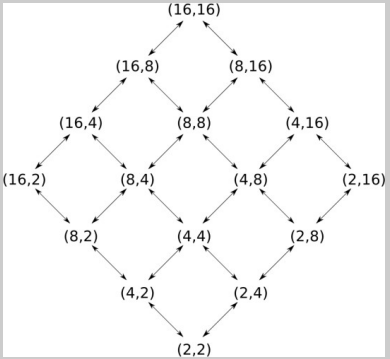
(Thaler (2019))

Numerics: Multigrid



(Steinlechner (2021))

Simulation of Galactic CR Transport

CR Di…

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Quantifying Dependencies in Cosmic-Ray Transport

Context: Numerical Simulations; Cosmic-Ray Transport;

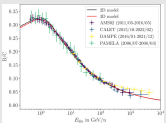
Supervisor: S. Grandis & R. Kissmann

Abstract

Cosmic rays in our Galaxy are subject to diffusive transport, advection with Galactic gas, energy losses, etc. These effects are combined in the cosmic-ray transport equation, where they are described via different physical parameters like, e.g., the strength of spatial diffusion, the speed of advection, and others. Correspondingly, searching for a fit to observations of cosmic-ray spectra means to adapt different of these parameters, so the simulated spectra correspond to the observed ones. This bachelor topic aims to make this fitting procedure more systematic. For this, the student will analyse the numerical results for different simulation, to determine the gradient in the solution with respect to different of these transport parameters. This will quantify how the cosmic-ray spectra depend on different parameters, thus making finding a good fit easier than before.

Helpful Skills

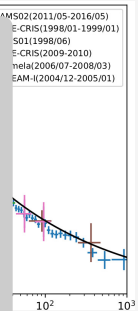
- Interest in statistical analysis
- Interest in numerical modelling (C++ and Python)



Comparison of data and simulation result for B/C ratio in Galactic cosmic-rays.

-Ray Emission

Simulated CR Spectra



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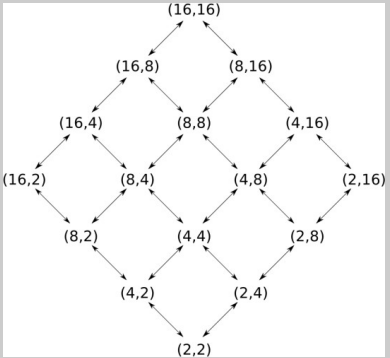

(Steinlechner (2021))

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Simulation of Galactic CR Transport

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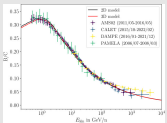

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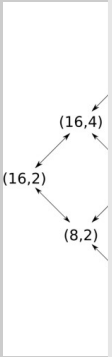
Numerics:



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New Gas Distribution for Cosmic-Ray Transport Modelling

Context: Numerical Simulations; Cosmic-Ray Transport; Interstellar Medium

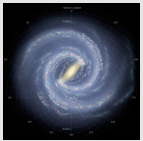
Supervisor: Ralf Kissmann

Abstract

Cosmic-rays travel from their sources to the observer. During their propagation they interact with the interstellar gas, the interstellar magnetic field, and the interstellar radiation field. Related to the gas, this interaction consist on the one hand of continuous energy losses and on the other hand of nuclear reaction between cosmic-rays and nuclei in the interstellar medium. Here, we will focus specifically on the distribution of the ionised gas in our Galaxy. The focus of this bachelor topic is to implement a three-dimensional analytical model for the distribution of ionised gas in the Galaxy. With this model, the student will run a range of simulations to compare this model to more simple models for the distribution of the ionised gas.

Helpful Skills / Interest

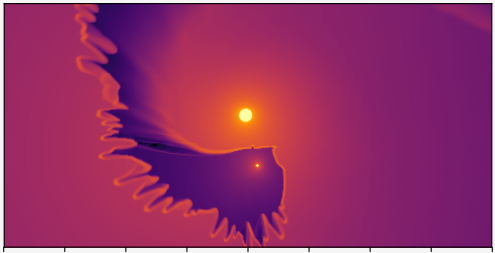
- Basic programming skills
- Interest in numerical modelling
- Interest in Galactic structure



Structure of the Milky Way. Credit: NASA

Simulation of Cosmic-Ray Sources

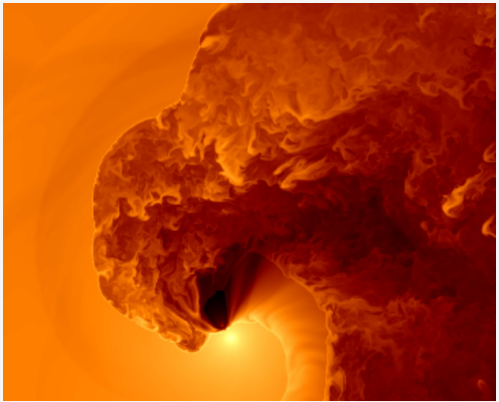
A Collinding-Wind Binary



(Kissmann (2019))

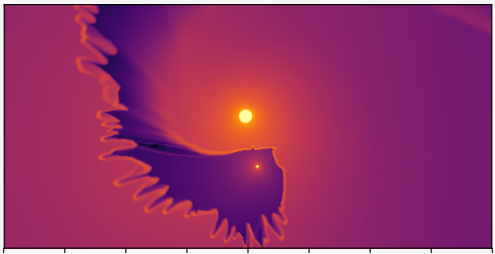
Simulation of Cosmic-Ray Sources

Simulated Gamma-Ray Binary



(Huber & Kissmann (2021))

A Collinding-Wind Binary



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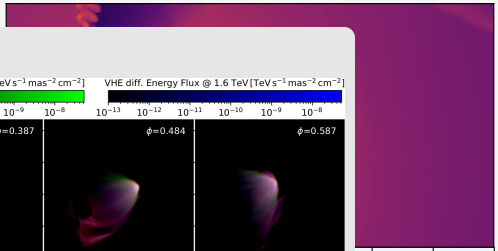
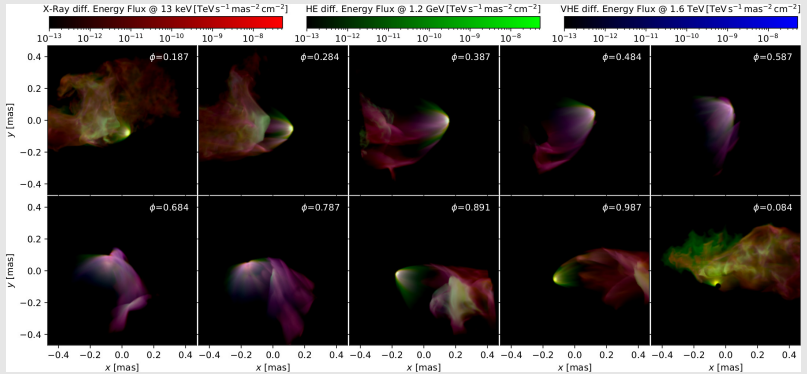


(Kissmann (2019))

Related High-Energy Emission



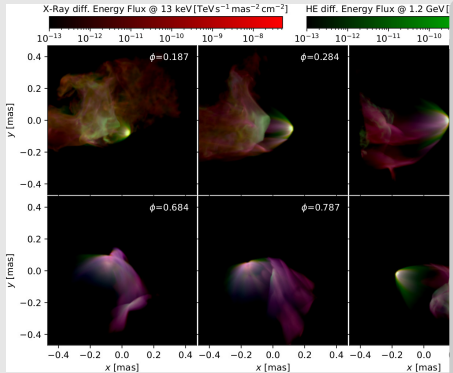
(Huber, Kissmann & Reimer (2021))

Simulation of Cosmic-Ray Sources

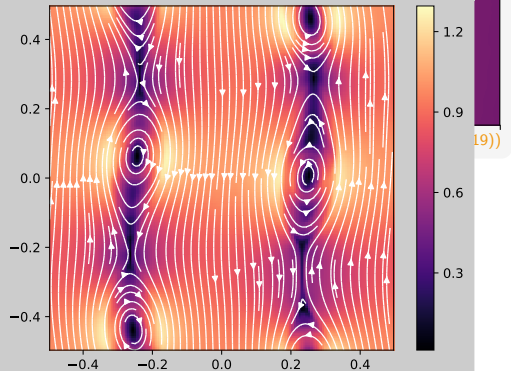
Simulated Gamma-Ray Binary

A Collinding-Wind Binary

Related High-Energy Emission



Numerics: MHD / Relativistic HD



(Kissmann (2020))

Simulation of Cosmic-Ray Sources

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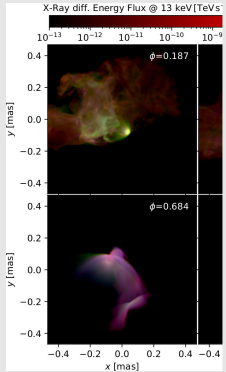

nd Binary

19))

/ Relativistic HD

(Kissmann (2020))

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Numerical Tests for the GARAK code

Context: Astrophysical plasmas; Numerical Simulations;

Supervisor: Ralf Kissmann

Abstract

In a joint effort with colleagues from the computer-science department, we are currently developing a new code for the modelling of astrophysical plasmas. This code is meant to be optimised both from the physics and the computer-science point of view. Currently, the code can solve problems from hydrodynamics and from magneto-hydrodynamics. For such a new code it is essential to thoroughly test all relevant routines, to make sure they function correctly. In this bachelor thesis, a student has the opportunity to join the group working on this code. The aim will be to implement new numerical verification tests in the context of the code framework of Garak.

Helpful Skills

- Basic programming knowledge
- Interest in fluid mechanics and numerical simulations

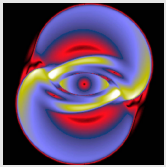

Illustration of magnetic-rotor test. Credit: Kissmann et al. (2018)