

Tytuł projektu
Symulacje numeryczne propagacji promieniowania kosmicznego w galaktykach.
Project title
Numerical simulations of Cosmic Ray Propagation in galaxies.
Dyscyplina /Area of science
Astronomia/Astronomy
PROJECT DESCRIPTION
<p>Project goals</p> <ul style="list-style-type: none"> • To understand propagation of galactic cosmic rays (CRs) from the perspective of dynamically evolving interstellar medium (ISM). • To construct numerical models of production and propagation of primary and secondary CRs coupled to magnetohydrodynamical (MHD) models of galactic ISM. • To perform global galactic disk simulations with primary and secondary CRs. • To investigate CR propagation properties via confrontation of numerical models against observational data of galactic CRs. <p>Outline</p> <p>Cosmic radiation is an important part of galactic interstellar medium. Recent investigations clearly indicate their dynamical impact on galactic evolution through generation of galactic magnetic field and galactic winds (Hanasz et al., 2009, 2013; Girichidis et al., 2016, 2018). Their detailed impact on evolution of galaxies is difficult to estimate, however, because propagation properties of CRs are not fully understood. A standard approach to propagation of CRs in galactic magnetic field (see e.g. Strong et al 2007) assumes static magnetic field structure, while numerical MHD simulations demonstrate that interstellar medium is highly unsteady. Determination of galactic CR propagation properties in the framework of the static ISM model may be therefore highly inaccurate.</p> <p>The aim of the project is to construct a self-consistent MHD model combining CR-driven dynamics (Hanasz et al., 2009) of the ISM with the elaborated GALPROP model (Strong et al., 2007) of CR production and propagation in the Milky Way. The main part of the research plan is to incorporate production and propagation of secondary CR components (Li, Be, B) into the MHD model of the Milky Way in order to estimate CR propagation parameters in a novel selfconsistent way. The research plan includes development of numerical algorithms and numerical simulations with the aid PIERNIK MHD code and confrontation of simulation results against measurements of Galactic CRs.</p>

The project will be implemented in international collaboration.

Work plan

1. Mastering usage of PIERNIK MHD code.
2. Mastering magnetohydrodynamical simulations of galactic ISM.
3. Implementing production of secondary CRs in PIERNIK MHD code.
4. Numerical simulations of the dynamics of galactic interstellar medium with primary and secondary CRs.
5. Analysis of simulation results and tuning CR propagation parameters to match observational properties of Galactic CRs.

Literature

- Girichidis, P., Naab, T., Walch, S., Hanasz, M., 2016, *ApJL* 816, L19
- Girichidis, P., Naab, T., Hanasz, M., and Walch, S.: 2018, *MNRAS* 479, 3042
- Hanasz, M., Lesch, H., Naab, T., Gawryszczak, A., Kowalik, K., and Wóltański, D.: 2013, *ApJ* 777, L38
- Hanasz, M., Wóltański, D., and Kowalik, K.: 2009, *ApJ* 706, L155
- Longair, M. S.: 2011, *High Energy Astrophysics*, Cambridge, UK: Cambridge University Press
- Strong, A. W., Moskalenko, I. V., and Ptuskin, V. S.: 2007, *Annual Review of Nuclear and Particle Science* 57, 285

Required initial knowledge and skills of the PhD candidate

- ➔ Analytical thinking
- ➔ Eager to learn
- ➔ Eager to work hard
- ➔ Basic knowledge about high energy astrophysics, fluid dynamics, numerical methods for fluid dynamics.
- ➔ Theoretical inclinations
- ➔ Some experience in numerical simulations
- ➔ Programming skills

Zgłaszający projekt/ Author of the project

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stopień/tytuł, imię, nazwisko	Centrum Astronomii UMK jednostka organizacyjna
Proponowani promotorzy i mentorzy/prospective supervisors	
1) promotor główny/ main supervisor	
prof. dr hab. Michał Hanasz	e-mail: mhanasz@umk.pl
	Centrum Astronomii UMK jednostka organizacyjna
2) promotor pomocniczy / co-supervisor	