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ULXs as accreting magnetized neutron stars

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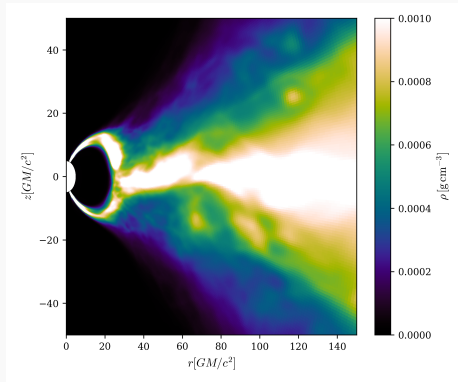


Motivation:

- ▶ Since the 1980s, **Ultraluminous X-ray sources (ULXs)** have gained significant attention in the field of astrophysics due to their high luminosities.
- ▶ In 2014, the first detection of **pulsating ULX with the neutron star-like period** (Bachetti et al.) confirmed that many ULXs are neutron stars.
- ▶ Luminosity is beamed in ULXs (*Coming talk: Jean-Pierre Lasota*)
- ▶ Modeling the accretion onto neutron stars is challenging due to their **strong magnetic field and hard surface**.
- ▶ We perform the simulations of super Eddington accretion onto magnetized neutron stars as ULXs, using **radiative general relativistic MHD (GRRMHD) code KORAL**.

Numerical setup

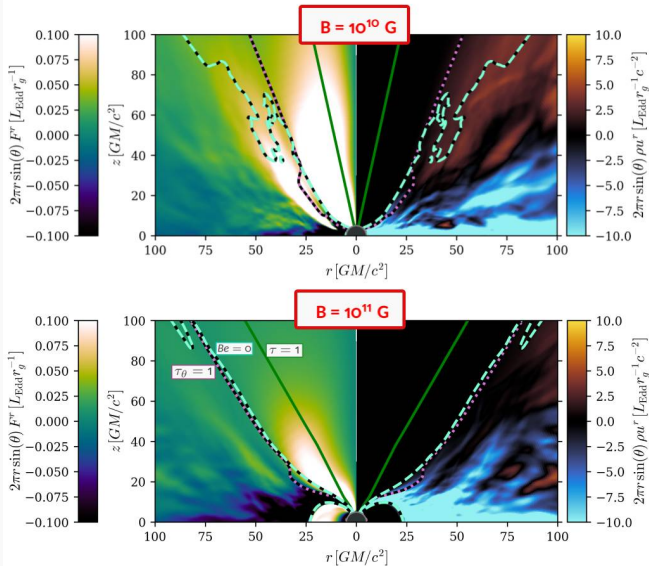
- ▶ Neutron star mass $1.4M_{\odot}$ non-rotating with dipolar magnetic field.
- ▶ Weakly magnetized equilibrium torus
- ▶ Axisymmetric spherical grids with logarithmic spacing in radius, and increased resolution near the equatorial plane.
- ▶ Simulation domain stretches from $r = 5r_g$ to $r = 1000r_g$, where $r_g = GM/c^2$.
- ▶ Simulations evolve for $\approx 40000 - 60000t_g$, where $t_g = GM/c^3$



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Papers/Projects

1- [Energy dissipation in astrophysical simulations](#)

Published: Kayanikhoo, et al. MNRAS, 527, 2024, 10151–10167.

2- [Modeling the strange quark stars as millisecond pulsars](#)

In collaboration with student Mateusz Kapusta (Paper in preparation)

3- [Parameter study of accreting magnetized neutron star](#)

In collaboration with Dr. David Abarca (Paper in preparation)

Teaching activity

* [Supervising 2 summer internship students](#), “The last stable orbit of a neutron star quark star binary”, Summer 2023

Other activities

* Poster presentation: [Particle astrophysics in Poland conference](#),

* Poster presentation: [EAS meeting 2023](#),

* Workshop: [Kolan-Mandre workshop](#) Organized by Dr. Miljenko Čemeljić, Summer 2023

Talks in International conferences/seminars

1- **The World Nicolaus Copernicus Congress**, “Strange quark star”, Toruń - Poland, February 2023, (*Invited talk*)

2- **Seminar in Silesian University in Opava**, “Strange quark star: The maximum gravitational mass and deformation of rigidly rotating magnetized strange quark stars”, Opava-Czech Republic, June 2023 (*Invited talk*)

3- **Disk, tori, spheres/Accretion onto compact objects workshop**, “ULXs as accreting neutron stars: the effect of magnetic field strength in GRRMHD simulations”, Opava-Czech Republic, June 2023

4- **European Astronomical Society Annual Meeting** , “Super-Eddington accretion onto magnetized neutron star: effect of magnetic field strength”, Kraków - Poland, July 2023

5- **RAGtime25**, “Beamed emission of super- Eddington accreting magnetized neutron stars”, December 2023 (*Proceeding paper is published*)