Simulation of a planet in highly relativistic pulsar wind

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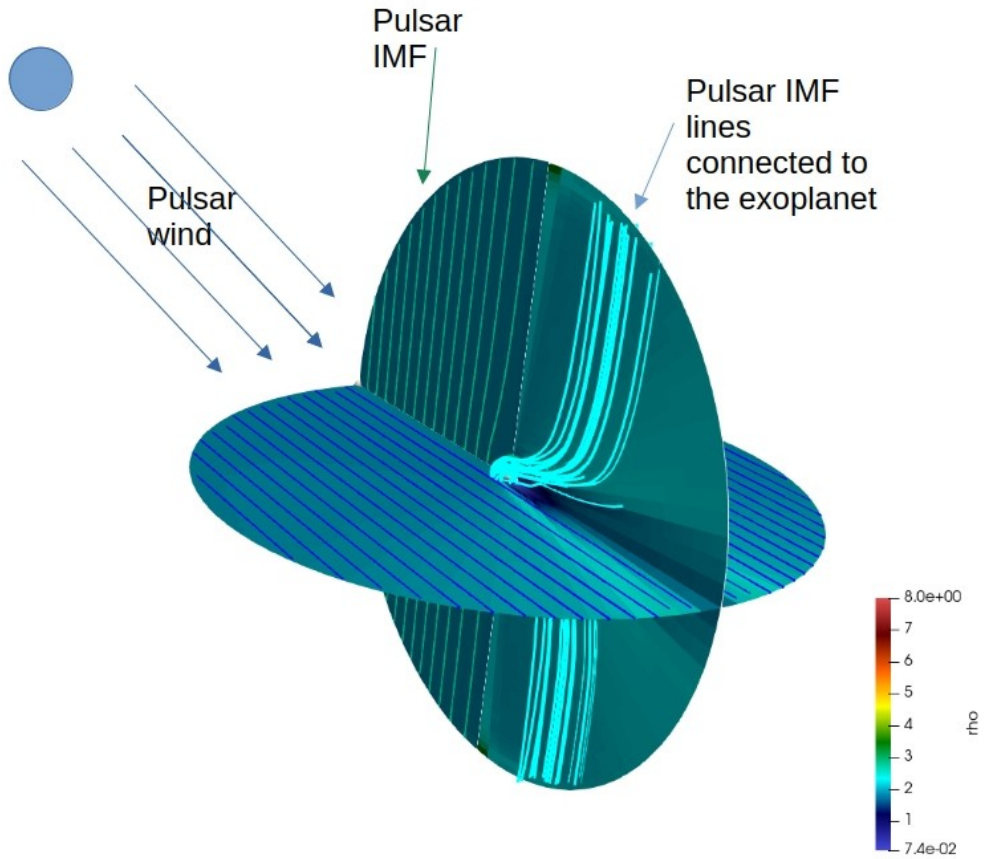
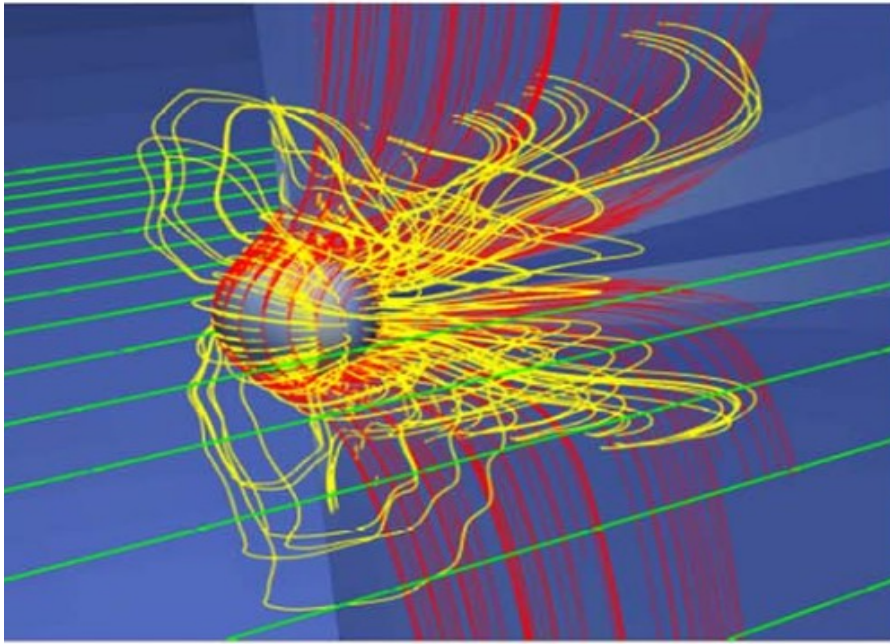
Setup

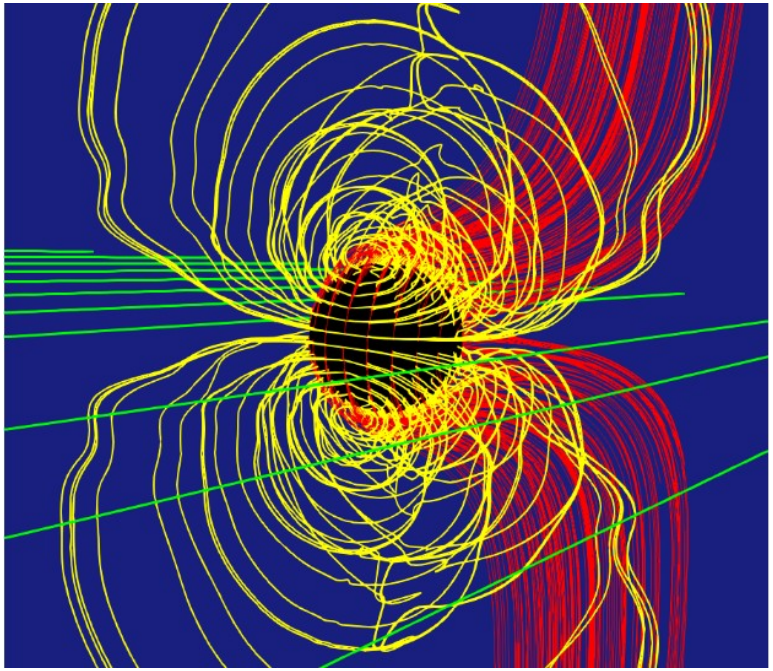

Pulsar
IMF
Pulsar IMF
lines
connected to
the exoplanet
Pulsar
wind
8.0e+00
7
6
5
4
3
2
1
7.4e-02
rho

Conductive



Mishra et al. 2023, v = 0.87c

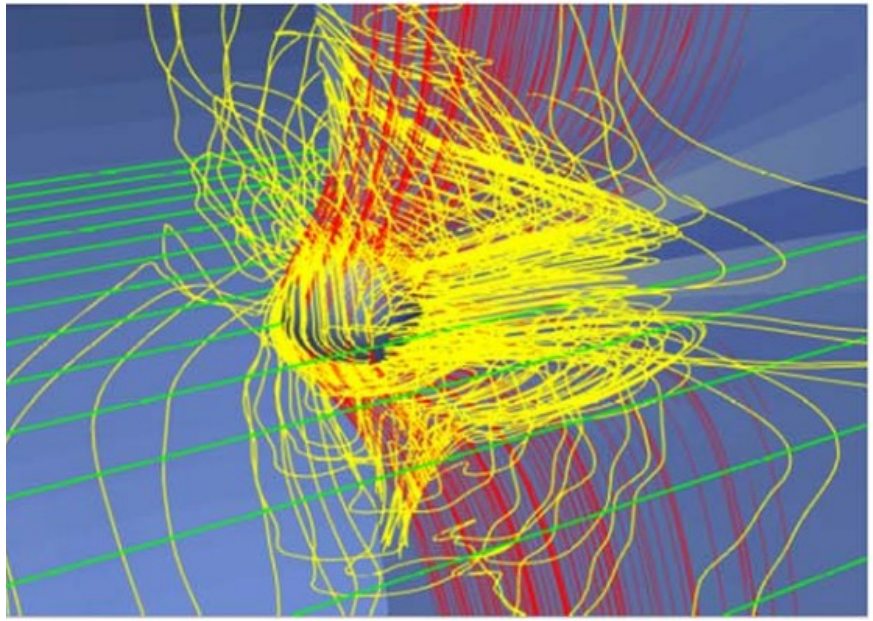
$\gamma = 2.0$



This work, v = 0.985c

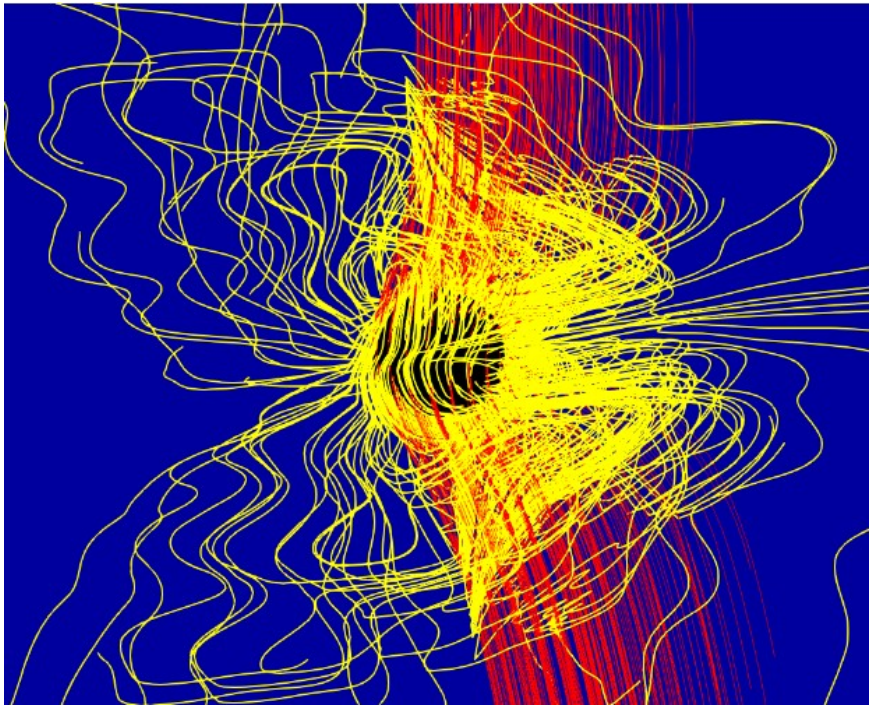
$\gamma = 5.8$

Ferromagnetic, v = 0.93c



Mishra et al. 2023, v = 0.87c

$\gamma = 2.0$



This work, v = 0.93c

$\gamma = 3.2$

Methodology improvements

- Increase of velocity

- Relativity
  - Calculation of kinetic energy dissipation is now relativistic
  - Calculation of radiation flux on earth now considers relativity
  - Synchrotron emission frequency used instead of cyclotron
  - Doppler shift applied when calculating frequency on earth

- Emission bandwidth measured instead of assuming broadband emission

- Emission direction measured in the simulation instead of using a flat value for the solid angle measured in the solar system

- Cuts improved to include night side

- Multiple planets considered, each with individual parameters

Result

- Whether a planet can be detected depends only on the ambient magnetic field since it controls
  - Brightness
  - Emission frequency
- Can detect the planet PSR J0636+5129 b, but not the planets in the PSR B1257+12 system (conductive and ferromagnetic case agree on this)
- Emission is concentrated in a narrow line region aligned with the magnetic field, not a classical light cone

What comes next?

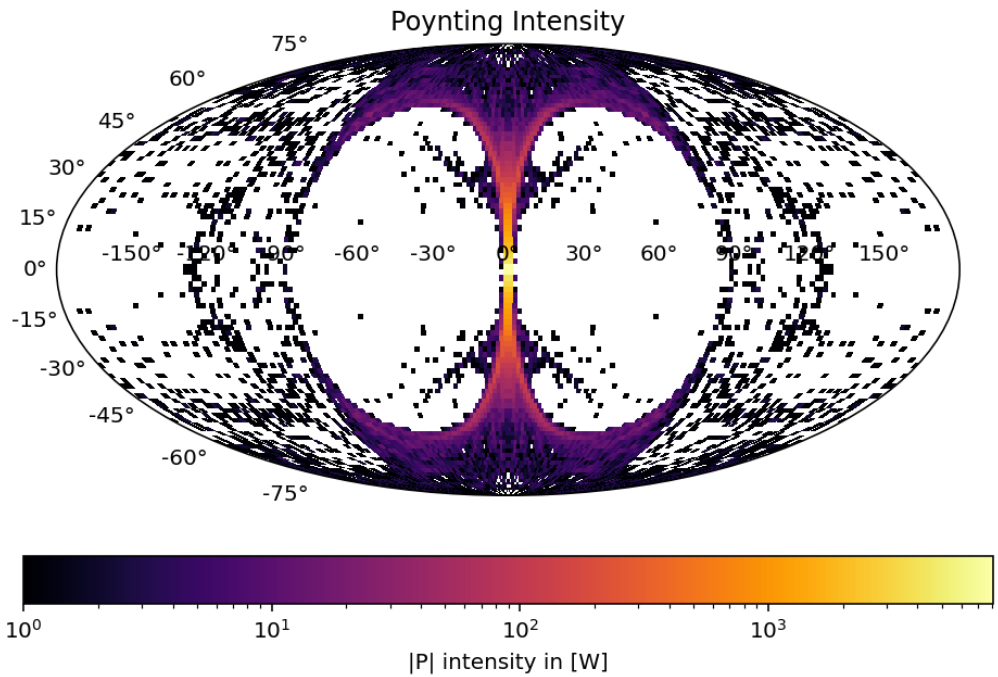
- For the project: Simulation side is done, observers plan to do a blind study

- For me: new project, tidal disruption near a wormhole

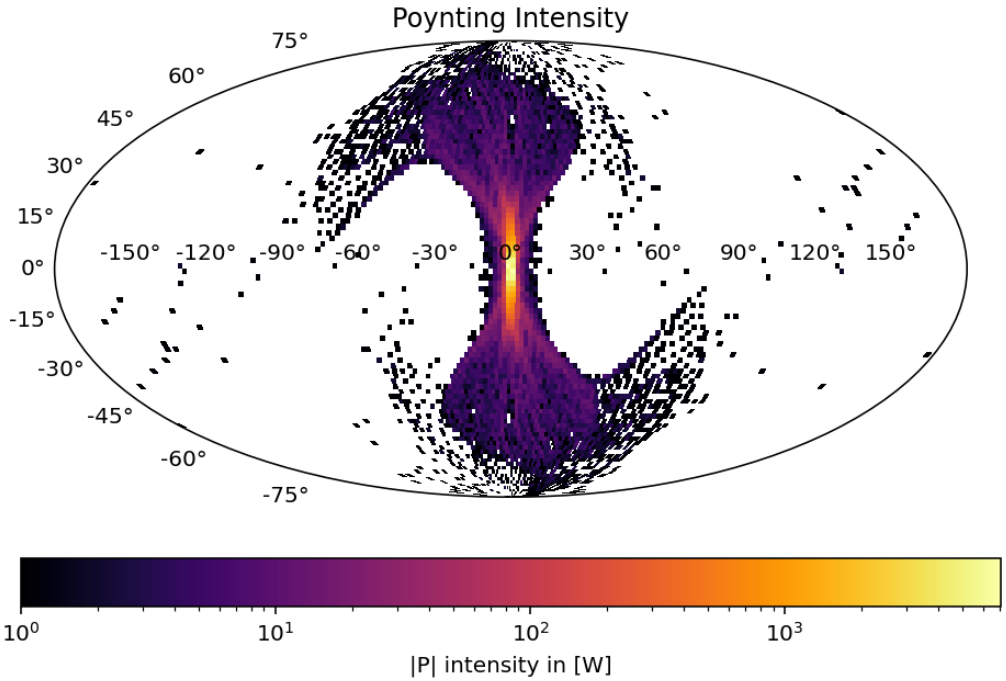
Courses and conferences

- Conferences
  - Relativistic Fluids around Compact Objects, CAMK PAN, Warsaw
  - EAS, Cork, Ireland
  - 42. Zjazd Polskiego Towarzystwa Astronomicznego, Warsaw
  - Ragtime, Opava
  - Following in Einstein's footsteps, Prague
- Courses
  - Physical optics and application to long baseline interferometry, V. Hodge
  - Philosophy of science, L. Lamza
  - Aspects of X-ray data analysis, P. Zycki (Exam pending)
  - Computational methods for ODE and PDE, T. Zand (Exam pending)

Extra slide: Emission distribution



Conductive



Ferromagnetic