Triggering magnetar outbursts in 3D force-free simulations

Federico Carrasco,[1,2] Daniele Viganò,[2] Carlos Palenzuela,[2] Jose A. Pons[3]

[1]Max Planck Institute for Gravitational Physics, Germany.
[2]Departament de Física & IAC3, Universitat de les Illes Balears, Spain.
[3]Departament de Física Aplicada, Universitat d'Alacant, Spain.

Abstract

In this talk, I will present results from [1] showing the first 3D force-free general relativity simulations of the magnetosphere dynamics related to the magnetar outburst/flare phenomenology. Starting from an initial dipole configuration, we adiabatically increase the helicity by twisting the footprints of a spot on the stellar surface and follow the succession of quasi-equilibrium states until a critical twist is reached. Twisting beyond that point triggers instabilities that results in the rapid expansion of magnetic field lines, followed by reconnection, as observed in previous axi-symmetric simulations. If the injection of magnetic helicity goes on, the process is recurrent, periodically releasing a similar amount of energy, of the order of a few % of the total magnetic energy. From our current distribution, we estimate the local temperature assuming that dissipation occurs mainly in the highly resistive outermost layer of the neutron star. We find that the temperature smoothly increases with injected twist, being larger for spots located in the tropical regions than in polar regions, and rather independent of their sizes. If the injection of helicity ceases, after reconnection occurs, the magnetosphere relaxes to a new stable state in which the persistent currents maintain the footprints area slightly hotter than before the onset of the instability. Some connections with observations pre- and post-outburst will be discussed.

References

[1] F. Carrasco, D. Viganò, C. Palenzuela, J. A. Pons. "Triggering magnetar outbursts in 3D force-free simulations". *Monthly Notices of the Royal Astronomical Society: Letters*, 484, 2019.