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Magnetic field evolution of neutron stars

Neutron stars are incredibly dense compact objects having the strongest magnetic field in the universe known to date. To study the field evolution in real-time, we performed magnetohydrodynamic simulations using the publicly available code PLUTO. The field undergoes a cataclysmic rearrangement in few Alfven timescales which develops a toroidal component with field strength 50% of the poloidal component. This field reaches a pseudo-equilibrium as the instability of the poloidal component leads to the development of turbulence, which in turn gives rise to an inverse helicity cascade determining the final "twisted torus"setup. A complex multipolar structure emerges at the surface while the external field remains dipolar. We are further developing numerical codes for studying the evolution with Hall effect and Ohmic dissipation and for calculating equilibrium models. These studies will help in modeling neutron stars' emission of gravitational waves. We are presently modifying the POLGRAW search codes to analyze LIGO's Observation run 3 (O3) data.

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