Basic radiation from an off-centred rotating dipole

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When a neutron star forms, after the collapse of its progenitor, a strong magnetic field survives in its interior. This magnetic topology is usually assumed to be well approximated by a dipole located right at the centre of the star. However, a slight shift from the stellar centre has strong implications for the surrounding electromagnetic field configuration leading to distinct observational signatures. We study the effect of the most general off-centred dipole anchored in the neutron star interior. Exact analytical solutions are given in vacuum outside the star to any order of accuracy in the small parameter $\epsilon = d/R$, where d is the displacement of the dipole from the stellar centre and R the neutron star radius. As a simple diagnostic of the decentred dipole, the spin-down luminosity and the torque exerted on its crust are computed to the lowest leading order in ϵ. Results are compared to earlier works and a discussion on repercussions on pulsar braking index and multi-wavelength light curves is proposed [1].

Moreover, radio polarization measurements of pulsed emission from pulsars offer a valuable insight into the basic geometry of the neutron star: inclination angle between the magnetic and rotation axis, inclination of the line of sight and magnetic topology. So far, all studies about radio polarization focused on the standard rotating vector model with the underlying assumption of a centred dipole. This model is generalized to an off-centred dipole with an exact analytic expression for the phase-resolved polarization angle. Contrary to the rotating vector model, for an off-centred dipole, the polarization angle also depends on the emission altitude. Although the fitting parameter space increases from two to six (position of the dipole, altitude and shift of the zero phase), statistical analysis remains tractable and are applied to several radio pulsar observations. An evolution of the polarization angle with frequency would undeniably furnish a strong hint for the presence of a decentred magnetic dipole in neutron stars [2].

References

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