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Multipolar electromagnetic fields around neutron stars: exact vacuum solutions and related properties.

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The magnetic field topology in the surrounding of neutron stars is one of the key questions in pulsar magnetospheric physics. A very extensive literature exists about the assumption of a dipolar magnetic field but very little progress has been made in attempts to include multipolar components in a self-consistent way. In this talk, we study the effect of multipolar electromagnetic fields anchored in the star. We give exact analytical solutions in closed form for any order˜l and apply them to the retarded point quadrupole˜(l=2), hexapole˜(l=3) and octopole˜(l=4), a generalization of the retarded point dipole˜(l=1). We also compare the Poynting flux from each multipole and show that the spin down luminosity depends on the ratio R/rL, R being the neutron star radius and rL the light-cylinder radius. Therefore the braking index also depends on R/rL. As such multipole fields possess very different topology, most importantly smaller length scales compared to the dipolar field, especially close to the neutron star, we investigate the deformation of the polar cap induced by these multipolar fields. Such fields could have a strong impact on the interpretation of the pulsed radio emission suspected to emanate from these polar caps as well as on the inferred geometry deduced from the high-energy light-curve fitting. Discrepancies between the two-pole caustic model and our new multipole-caustic model are emphasized with the quadrupole field. To this respect, we demonstrate that working with only a dipole field can be very misleading.

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