Strongly magnetized envelopes of neutron stars and their electromagnetic radiation

A. Y. Potekhin[1] *, G. Chabrier[2], Dong Lai[3], W. C. G. Ho[4], M. I. van Adelsberg[3]

[1]Ioffe Physico-Technical Institute, Politekhnicheskaya 26, 194021 St. Petersburg, Russia

[2]Ecole Normale Supérieure de Lyon (CRAL, UMR CNRS No. 5574), 46 allée d'Italie, 69364 Lyon Cedex 07, France

[3]Center for Radiophysics and Space Research, Department of Astronomy, Cornell University, Ithaca, NY 14853, USA

[4]Kavli Institute for Particle Astrophysics and Cosmology, Stanford University, PO Box 20450, Mail Stop 29, Stanford, CA 94309, USA

We develop models of neutron-star envelopes that take into account the nonideal plasma effects. The total thermal flux from the surface sensitively depends on chemical composition and in some cases on the magnetic field [1]. In order to calculate the spectral distribution of this flux, we construct models for the envelopes of strongly magnetized neutron stars in thermodynamic and radiative equilibrium [2–4]. We show that bound-bound and bound-free transitions give an important contribution to the opacities in the outer layers of neutron-star atmosphere and may strongly affect the polarization properties of normal waves in specific frequency ranges. Detailed calculations are performed for a model of a partially ionized nonideal hydrogen plasma. In this case, the full account of the coupling of the quantum mechanical structure of the atoms to their center-of-mass motion across the magnetic field is shown to be crucial for the correct evaluation of the polarization properties and opacities of the plasma.

It is however possible that the radiation (at least in some spectral ranges) emerges from a liquid or solid phase boundary, which lies below a thin atmosphere. This case is considered in Ref. [5], where the spectral flux from a condensed, strongly magnetized hydrogen or iron plasma is calculated. Using these results, we calculate the spectra and polarization of thermal radiation for magnetized neutron stars, which can be compared with observations.

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References

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*E-mail: palex@astro.ioffe.ru