AIP Conference Proceedings 2011 vol.1379, pages 119-122

Absorption features in spectra of magnetized neutron stars

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Abstract

The X-ray spectra of some magnetized isolated neutron stars (NSs) show absorption features with equivalent widths (EWs) of 50-200 eV, whose nature is not yet well known. To explain the prominent absorption features in the soft X-ray spectra of the highly magnetized (B~1014G) X-ray dim isolated NSs (XDINSs), we theoretically investigate different NS local surface models, including naked condensed iron surfaces and partially ionized hydrogen model atmospheres, with semi-infinite and thin atmospheres above the condensed surface. We also developed a code for computing light curves and integral emergent spectra of magnetized neutron stars with various temperature and magnetic field distributions over the NS surface. We compare the general properties of the computed and observed light curves and integral spectra for XDINS RBS 1223 and conclude that the observations can be explained by a thin hydrogen atmosphere above the condensed iron surface, while the presence of a strong toroidal magnetic field component on the XDINS surface is unlikely. We suggest that the harmonically spaced absorption features in the soft X-ray spectrum of the central compact object (CCO) 1E 1207.4-5209 (hereafter 1E 1207) correspond to peaks in the energy dependence of the free-free opacity in a quantizing magnetic field, known as quantum oscillations. To explore observable properties of these quantum oscillations, we calculate models of hydrogen NS atmospheres with B~1010-1011G (i.e., electron cyclotron energy Ec,e~0.1-1keV) and Teff=1-3MK. Such conditions are thought to be typical for 1E 1207. We show that observable features at the electron cyclotron harmonics with EWs ≈100-200eV can arise due to these quantum oscillations. © 2011 American Institute of Physics.

http://dx.doi.org/10.1063/1.3629497

Keywords

pulsars: individual: (RBS 1223, 1E 1207.4-5209), radiative transfer, stars: magnetic fields, stars: neutron