Proton Cyclotron Feature in Thermal Spectra of Ultra-magnetized Neutron Stars

R. Turolla (*Dept. of Physics, University of Padova, Padova, Italy*), S. Zane (*Mullard Space Science Laboratory, University College London, UK*), L. Stella (*Osservatorio Astronomico di Roma, Roma, Italy*), A. Treves (*Dept. of Sciences, University of Insubria, Como, Italy*)

Abstract

Great interest has been recently raised in connection with the possibility that soft γ-ray repeaters (SGRs) and anomalous X-ray pulsars (AXPs) contain *magnetars*, young neutron stars endowed with magnetic fields $\gtrsim 10^{14}$ G. Current evidence in favor the magnetar interpretation relies mainly upon measured spin-down rates, which imply magnetic fields in the $\sim 10^{14} - 10^{15}$ G range and rotational energy losses much smaller than the source luminosity. Models involving accretion are not completely ruled out yet. The X-ray spectra of AXPs and SGRs are characterized by a power-law, high-energy component of probable magnetospheric origin. In addition to this, thermal emission (plausibly originating from the star surface) has been detected in all AXPs but one, and in SGR 1900+14. We have calculated thermal spectra from ultra-magnetized neutron stars for values of the luminosity and magnetic field believed to be relevant to SGRs and AXPs. Emergent spectra, computed solving the full (angle and energy dependent) transfer equations, are found to be close to a blackbody at the star effective temperature and exhibit a distinctive absorption feature at the proton cyclotron energy $E_{c,p} \simeq 0.63 y_G (B/10^{14}\,\mathrm{G})$ keV, where $y_G \sim 0.8$ is the gravitational redshift factor. The proton cyclotron features (PCFs) are conspicuous (equivalent width of up to many hundreds eV) and relatively broad ($\Delta E/E \sim 0.05 - 0.2$). The detection of the PCFs is well within the capabilities of present X-ray spectrometers, like the HETGS and METGS on board Chandra. Their observation would provide a direct measurement of the surface magnetic field and a remarkable confirmation of the magnetar model.

CATEGORY: SUPERNOVAE, SUPERNOVA REMNANTS AND ISOLATED NEUTRON STARS