Session 3: Diagnostics of High Gravity Objects with X- and Gamma Rays

3-1. White Dwarfs and Neutron Stars

https://doi.org/10.1017/S0074180900115451 Published online by Cambridge University Press

SPIN-DOWN OF NEUTRON STARS AND COMPOSITIONAL TRANSITIONS IN THE COLD CRUSTAL MATTER

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Transitions of nuclear compositions in the crust of a neutron star induced by stellar spin-down are evaluated at zero temperature. We construct a compressible liquid-drop model for the energy of nuclei immersed in a neutron gas, including pairing and shell correction terms, in reference to the known properties of the ground state of matter above neutron drip density, 4.3×10^{11} g cm^{-3}. Recent experimental values and extrapolations of nuclear masses are used for a description of matter at densities below neutron drip. Changes in the pressure of matter in the crust due to the stellar spin-down are calculated by taking into account the structure of the crust of a slowly and uniformly rotating relativistic neutron star. If the initial rotation period is of the order of milliseconds, these changes cause nuclei, initially being in the ground-state matter above a mass density of about 3×10^{13} g cm^{-3}, to absorb neutrons in the equatorial region where the matter undergoes compression, and to emit them in the vicinity of the rotation axis where the matter undergoes decompression. Heat generation by these processes is found to have significant effects on the thermal evolution of old neutron stars with low magnetic fields; the surface emission predicted from this heating is compared with the *ROSAT* observations of X-ray emission from millisecond pulsars and is shown to be insufficient to explain the observed X-ray luminosities (Iida and Sato, 1997).

References

Iida, K. and Sato, K. (1997), *Astrophys. J.* **Vol. 477**, pp. 294–312

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