Contribution ID : **193** Type : **Oral talk**

Crust of accreting neutron stars

Wednesday, 23 October 2024 17:00 (12)

The report summarize results of a series of papers on modelling the nuclear-physical evolution of the outer layers (crust) of neutron stars in low mass X-ray binaries. In these systems, material is transferred from the companion star to the neutron star, a process known as 'accretion' in astrophysical literature. As a result, the original crust is replaced by accreted material.

We demonstrate that the presence of free neutrons (unbound in atomic nuclei) in the inner crust plays a crucial role in the nuclear physical process of forming the accreted crust. Neutrons redistribute rapidly between the layers of the inner crust due to superfluidity and diffusion (with diffusion being important near the boundary between the outer and inner crust, where neutrons are not superfluid). This effect was not considered in previous models developed over approximately 40 years, leading to a radical change in the nuclear reactions chains and the composition of the crust. Consequently, several previously accepted statements are shown to be incorrect. For instance, it was previously believed that the main reactions in the inner crust were electron capture and neutron emission, and the transition to the inner crust was associated with reaching the neutron drip line. In our work, we demonstrate that reverse reactions occur in the inner crust (neutron capture and electron emission), and the boundary between the inner and outer crusts is determined by the redistribution of free neutrons in the crust and the star's core, maintaining diffusion-hydrostatic equilibrium.

We propose and apply a general, convenient formula based on the energy conservation law for calculating the heating efficiency of the crust, which is shown to be several times lower than previously estimated. These findings are then applied to interpret observations of accreting neutron stars.

The work was supported by the Russian Science Foundation, grant 22-12-00048.

Primary author(s) : CHUGUNOV, Andrey (Ioffe Institute); Dr. GUSAKOV, Mikhail (Ioffe Institute); Dr. KANTOR, Elena (Ioffe Institute); Dr. POTEKHIN, Alexander (Ioffe Institute); Mr. SHCHECHILIN, Nikolai (Universite Libre de Bruxelles)

Presenter(s) : CHUGUNOV, Andrey (Ioffe Institute)

Session Classification : Astroparticle

Track Classification : Astroparticle physics