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A FISSION FLASH IN THE INNER CRUST OF AN EXPLODING LOW-MASS NEUTRON STAR

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Among the scenarios for the evolution of various astrophysical objects in which the conditions necessary for the r-process to occur can be realized, the process of neutron star mergers in a close binary system is currently considered the main one [1]. This scenario largely depends on the masses of the objects included in the system and can develop in different ways: 1) If neutron stars have approximately the same mass, a merger occurs, accompanied by the ejection of neutron-rich matter in the equatorial plane and in the wind from the hot, massive neutron star [2]; 2) If the masses of the neutron stars differ significantly, the evolution of the neutron star system follows a stripping scenario [3], in which, in particular, the nucleosynthesis of heavy elements proceeds differently [4,5]. The first ideas about the merger of a neutron star (NS) and a black hole associated with short gamma-ray bursts (GRB) were put forward by Lattimer and Schramm [6]. The scenario of the merger of two neutron stars was developed by Clark and Eardley [3]. In the last paper not only the merging of two neutron stars was discussed, but also proposed a stripping scenario involving the loss of mass by a minimum mass star. In both scenarios, two neutron stars orbiting each other must come closer due to the loss of angular momentum caused by the emission of gravitational waves. What is the difference between the merger and tidal disruption mechanisms? The merger mechanism is as follows: having approached each other to a sufficient distance, the neutron stars merge into a single object — a black hole or a rapidly rotating neutron star — over several orbits. At the same time, part of the matter may be ejected from the system due to tidal interaction. Furthermore, due to the extreme acceleration of the rotation of the matter and its heating, a highly collimated ejection of matter can form — a jet — and part of the matter of the merged neutron star can evaporate in the form of a wind. This picture of neutron star mergers is currently generally accepted, although many of its details remain unclear. The fundamental difference between the stripping mechanism and a rapid merger lies in the prolonged (many orbits of the binary system) transfer of matter from one star to the other. Note that for this scenario to be realized, a sufficient asymmetry in the masses of the components of the binary system is required. As the neutron stars approaches, the component with the smaller mass first fills its Roche lobe, since it has a larger radius, and begins to transfer mass to the more massive companion through the inner Lagrange point. The asymmetry of the system increases, and the distance between the stars increases due to the approximate conservation of the system's angular momentum. However, the transfer does not stop (it is stable) due to the loss of angular momentum through the emission of gravitational waves and the increase in the radius of the NS with the smaller mass. As a result of the exchange, the mass of the heavier star (M1) increases, while its radius remains approximately constant or decreases, and the mass of the lighter NS (M2) decreases while its radius increases. When M2 reaches the value corresponding to the minimum possible mass of the NS (about 0.1 solar masses), an explosion occurs, which leads to the destruction of the low-mass NS. This report examines the nucleosynthesis of heavy nuclei under the influence of neutrons (the r-process) in the inner crust of a low-mass neutron star (LMSN), which loses mass due to the transfer of matter onto a more massive companion neutron star (the stripping scenario) and explodes upon reaching a hydrodynamically unstable configuration [7]. It has been shown that the schock wave generated during the destruction of the MMNZ heats the outer shell of the inner core to high temperatures, and the r-process transforms into explosive nucleosynthesis. Since the cross-sections of induced fission increase by orders of magnitude when the temperature rises to values of T9>5, and given the persistently high neutron density, an instantaneous (t˜3–5 ms) fission flash of the actinides formed in the r-process occurs. The composition of the resulting fission product nuclei largely depends on the model of the mass distribution of fission products and

represents a new initial composition for the r-process, which resumes after further expansion of the matter and a drop in temperature. The work was carried out as part of fulfilling the state assignment of the National Research Center “Kurchatov Institute”. LITERATURE 1. J. J. Cowan, et al. // Rev. Mod. Phys. 2021. V. 93. id. 15002. 2. S. Rosswog, Philosophical Transactions of the Royal Society A. 2013, V. 371, № 1992, 20120272. 3. J. P. A. Clark and D. M. Eardley // Astrophys. J. 1977. V. 215. P. 311. 4. I.V. Panov, A.V. Yudin // Astronomy Letters. 2020. V. 46. P. 518. 5. A. Yudin, N. Kramarev, I. Panov, A. Ignatovskiy // Particles. 2023. V. 6. P. 784. 6. J.M. Lattimer, D.N. Schramm // Astrophys. Lett. 1974. V. 192. P. 145. 7. S. I. Blinnikov, D. K. Nadyozhin, N. I. Kramarev, A. V. Yudin // Astronomy Reports. 2021. V. 65. P. 385.

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