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Synthesis of p-Nuclear in Kilonova

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In kilonova, two neutron stars merge or a black hole absorbs neutron star. In this case, extreme physical conditions arise: in a kilonova substance it can be extremely high temperatures (up to 10^{10} K) and high densities (up to $10^{10}\ g \cdot cm^{-3}$). The consequence of such an extreme state of matter may be the intensification of nuclear fusion processes. This also applies to the synthesis of p-nuclei (otherwise, bypassed nuclei). To date, the problem of their synthesis in stars has not found a generally accepted solution. This applies to the quasiequilibrium stages of the evolution of massive stars (s-processes), and to the explosive stages during the transition of a massive star to a supernova (r-processes, collision processes involving protons, α-particles, etc.). The individual successes of the private order do not give significant progress in solving the problem of all 33 p-nuclei [1].

In this work, we simulate the reactions of the synthesis of chemical elements during the absorption of a neutron star by a black hole, including p-nuclei. We took collisional beta decay (CBD) as the basis for the synthesis of the latter. This process was first proposed in [2], and was used in [3] to solve the problem of the origin of p-nuclei. The reaction cross sections were calculated using data from the REACLIB open library. The basis of the calculations is the procedure for approximating the temperature dependence of the cross sections by a special function, including seven parameters unique to each reaction [4]. For a number of isotopes, we calculated the cross sections of the CBD induced by collisions of nuclei with protons. The parameters of their temperature approximation were determined in the format of the REACLIB library. The CBD process with the obtained cross sections was included in the set of reactions that can take place when a neutron star is absorbed by a black hole. We examined the application of CBD to the synthesis of some p-nuclei. This was done on the basis of kinetic theory. We used a computational experiment method using the open SkyNet library [5]. We have shown that for the synthesis of p-nuclei the contribution of CBD induced by collisions with protons is significant.

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