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Beta Decay of Neutron in Heat Field and Neutron Anomaly

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We investigated the effect of two processes on the natural beta decay of a neutron: photobeta decay and inverse internal bremsstrahlung. The diagram of the latter process is topologically equivalent to that of internal bremsstrahlung in beta decay, but only with absorption of a photon by the beta electron. Both processes make it possible to take into account the effect of the thermal field of the medium on beta decay and complement the process of natural beta decay, in which two leptons (an electron and an antineutrino) are emitted. We calculated the neutron beta-decay rate in the temperature range from 300 K to $(0.5 \div 1.0) \times 10^{10}$ K.

We found that the thermal effect on the neutron beta decay at room temperature is negligible. Such a result is obtained only after eliminating the infrared divergence. This was done when calculating the total rate of the decay process (compare with the results of [1]). We can say that the processes of photo-beta decay and inverse internal bremsstrahlung do not contribute to the theoretical lifetime of the neutron. Therefore, they are not related to the problem of neutron anomaly (see [2]).

In strongly heated matter of massive stars, neutron decay can occur at an increased rate [3]. This can affect the rate of reactions involving neutrons in the synthesis of chemical elements in stellar matter. In particular, in a medium heated to temperatures of $(3 \div 5) \times 10^9$ K, the neutron lifetime can be reduced by up to 3%. Such temperatures are characteristic of the stages of combustion of the oxygen layer and silicon core in massive stars at the quasiequilibrium stages of their evolution. A large decrease in the lifetime to 32% occurs at temperatures of about 10^{10} K. Such extremely high effective temperatures can be reached in kilonova when a black hole absorbs a neutron star or two neutron stars are combined into one. A decrease in the neutron lifetime during thermal exposure to the medium can affect the physical processes in kilonova matter.

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