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Neutrino oscillations and quantum decoherence

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The phenomenon of neutrino oscillations emerges due to coherent superposition of neutrino mass states. An external environment can modify a neutrino evolution in a way that the coherence will be violated. Such violation is called quantum decoherence of neutrino mass states and leads to the suppression of flavor oscillations. In our previous paper [1] we presented a new theoretical framework, based on the quantum field theory of open systems applied to neutrinos. Within this framework we proposed and considered a new mechanism of the neutrino quantum decoherence engendered by the neutrino radiative decay in an electron background in an extreme astrophysical environment. In the present study we generalize our approach and investigate a novel mechanism for neutrino quantum decoherence, which arises due to the neutrino decay into a lighter neutrino state and a massless particle, as well as the inverse process of absorption of a massless particle by neutrino. We have derived the new evolution equation for the neutrino evolution that accounts for these processes. We demonstrate that studying of neutrino quantum decoherence through this evolution equation provides a unique possibility to determine or constraint the neutrino decay width.

[1] K. Stankevich, A. Studenikin, Neutrino quantum decoherence engendered by neutrino radiative decay, Phys.Rev. D 101, 056004 (2020).

Primary author(s) : STANKEVICH, Konstantin (Moscow State University)

Co-author(s) : STUDENIKIN, Alexander (Moscow State University); VYALKOV, Maxim (MSU Sarov, NCPHM)

Presenter(s) : STANKEVICH, Konstantin (Moscow State University)

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