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Sterile Neutrinos in Astrophysical Environments : Big Bang Nucleosynthesis and Supernova Neutrino Process

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Albeit great success in the discovery of neutrino oscillations, inconsistency between three-neutrino model and observed neutrino data has left a conundrum in neutrino physics called "neutrino anomalies". The sterile neutrino, as a hypothetical particle, coined to resolve the anomalies. Although some ambiguities related to the nuclear physics in reactors should be disentangled, the sterile neutrino, as a possible solution, has aroused lots of intensive discussions in the astrophysics as well as the neutrino physics.

In this presentation, we show effects of the sterile neutrino on two astrophysical environments; one is big bang nucleosynthesis (BBN) and the other is supernova (SN) neutrino process. First, in BBN, we assume that sterile neutrinos can propagate the five-dimensional bulk space [1]. In this model, the effective mixing angle between sterile and active neutrinos depends on energy, which may give rise to a resonance effect. By solving a rate equation including the mixing effects, we determine the energy density of sterile neutrinos in the early universe and constrain sterile-active mixing parameters by using the observational data of primordial abundances [2].

Second, we investigate the sterile-active neutrino oscillation effects on the SN neutrino process [3]. In this study, adopting 3+1 mixing parameters in IceCube and shortbase line experiments [4], we find multiple resonances in SN environments. For the source of sterile neutrinos, we use two scenarios [5]; the first one is that sterile neutrinos can be produced only by mixing with active neutrinos and the second one is that sterile neutrinos can be produced via scattering between electron neutrinos and matter. Our result shows that the analysis of observed SiC X grains [6] excludes the first scenario, while the viability of the second scenario depends on the sterile neutrino temperature and the neutrino mass hierarchy.

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Working Group

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