High Energy Physics - Phenomenology

Lepton flavor violating New Physics and supernova explosion

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Electrons and electron neutrinos in the inner core of the core-collapse supernova are highly degenerate and therefore numerous during a few seconds of explosion. In contrast, leptons of other flavors are non-degenerate and therefore relatively scarce. This is due to lepton flavor conservation. If this conservation law is broken by some non-standard interactions, electron neutrinos are converted to muon and tau-neutrinos, and electrons -- to muons. This affects the supernova dynamics and the supernova neutrino signal in several ways. In particular, the total neutrino luminosity in the first second of the collapse is increased due to the larger free path of the non-electron neutrinos. This effect may have important consequences as the increase of the neutrino luminosity is known to facilitate the explosion. We consider an extension of the Standard Model by scalar bileptons which mediate lepton flavor violation. It is shown that in case of TeV-mass bileptons the electron fermi gas is equilibrated with non-electron species inside the inner supernova core at a time-scale of order of (1-100) ms. In particular, a scalar triplet which generates neutrino masses through the see-saw type II mechanism is considered. Non-observation of rare decays and data on neutrino mixing and neutrino masses restrict possible lepton flavor violation effects in this case. However a region in the parameter space of the model exists which fits all the experimental constraints and provides lepton flavor violation sufficient for observable effects in supernova.

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