INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

A core-collapse supernova (SN) explosion is one of the gigantic stellar events. It is accompanied with the release of a huge number (∼ 10^58) of MeV energy neutrinos which carry major portion of the total gravitational energy released. The search for the actual cause of this huge explosion is currently into extensive research. The current hydrodynamical simulations provide a hint towards neutrinos being the driving factor. Moreover, nucleosynthesis of trans-iron elements occurs during a supernova explosion, thus increasing their abundance in the interstellar gas which is very useful from the observation point of view. So, the neutrinos from a core-collapse supernova is an exciting field of study. The neutrinos are known to change their flavor from one to another due to the different flavor and mass eigenstates and the process is known as neutrino oscillations. Due to the high density of neutrinos in a supernova medium, in addition to the usual Mikheyev-Smirnov-Wolfenstein effect, another phenomenon known as collective oscillations take place. In this thesis, we focus on these self induced neutrino flavor conversions in the context of both slow and fast regime. The fast conversions are independent of the neutrino mass and they grow at the scale of the large neutrino-neutrino interaction strength (10^5 km−1) of the dense SN core. The slow collective modes, on the other hand grow at a slower rate as they are driven by the smaller vacuum oscillation frequencies (10^0 km−1). In the literature, these flavor conversions have been exclusively studied in the standard two flavor scenario (three species). We carry out the linear and nonlinear study of the collective fast oscillations beyond the two flavor scenario (six species), i.e., taking into account all the three flavors of neutrinos. Our three flavor results

demonstrate the incompleteness of the standard two flavor case and thus emphasizes on the need to go beyond the simplistic approximation of the three species while studying fast flavor oscillations. Finally, we investigate the phenomenological implication of the fast oscillations on the diffuse supernova neutrino background.