



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Despite the remarkable success of explaining the fundamental constituents of the visible universe via weak, electromagnetic and strong interactions, the Standard Model (SM) of particle physics fails to explain many observations, for example, the presence of a non luminous dark matter (DM), matter-antimatter asymmetry, tiny but non-zero neutrino masses amongst several other issues. In this thesis we primarily aim to address different possibilities of DM appearing in extensions of the SM, which has both theoretical and phenomenological implications. Amongst many possibilities of DM genesis, we focus mainly on Weakly Interacting Massive Particles (WIMPs), Feebly Interacting Massive Particles (FIMPs), and Strongly Interacting Massive Particles (SIMPs). Our interest mainly lies when we have more than one different kinds of DM present in the universe, and consequent phenomenology in direct, indirect and collider searches. We compare the consequence of DM freeze-out and freeze-in before and after Electroweak Symmetry breaking (EWSB), to show that it leaves an important imprint in DM mass, in an analysis involving a vector boson WIMP and a scalar FIMP. When the interaction between WIMP and FIMP exceeds a certain limit, the FIMP equilibrates to the thermal bath and freezes out, giving rise to a new kind of particle called pseudo-FIMP (pFIMP). The dynamics and detection possibilities of pFIMP through loop induced direct and indirect searches are studied. Leveraging its phenomenological advantages, we are also able to explain the non-observation of lepton flavor-violating (LFV) decays. The possibility of pFIMP appearing in presence of SIMP is also discussed. We also propose a UV-complete model that could show a distinct signal in the direct detection recoil rate spectrum, indicating the presence of two DM components, after addressing all the relevant cosmological and collider constraints. We also investigate the possibility of having two stable DM components under a single discrete symmetry, by taking kinematic constraints into account, which shows some remarkable possibilities. Apart, we demonstrate that two DM components can also play an important role in determining the small active neutrino masses and generating the CP violating decays in addressing baryon asymmetry of the universe.