論文の内容の要旨

Concrete Models and Phenomenologies of Composite Asymmetric Dark Matter
(複合的非対称暗黒物質の具体的模型とその現象論)

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Asymmetric dark matter (ADM) is a framework relating the observed baryon asymmetry of the Universe to the dark matter number density by generating an asymmetry component in DM via baryogenesis. Thus ADM naturally explains the coincidence of the baryon and DM density for DM with an $\mathcal{O}(1)$ GeV mass and a large annihilation cross section.

In order to construct the ADM model with mass in the GeV range and with a large annihilation cross section, a composite particle in a new strong dynamics is a possible and simple candidate in two reasons. First, the strong dynamics naturally explains the ADM mass in the GeV range. Second, its large annihilation cross section due to the strong dynamics leaves the asymmetric component to be dominant over the symmetric component. In such composite ADM scenarios, the dark sector, which contains the DM, has a relatively large number of particles emerging from the confinement of the strong dynamics. The large degrees of freedom in the dark sector results in the overclosure of the Universe or contradicts with the observations of the cosmic microwave background (CMB) and the successful Big-Bang Nucleosynthesis. Thus, in order to construct a cosmologically safe composite ADM model, we need a portal to transfer the excessive energy in the dark secto to the Standard Model (SM) sector

In this thesis, we consider composite ADM models with a dark photon portal, which has a sub-GeV mass and kinetic mixing with the SM photon. We investigate the viable parameter space of the dark photon in detail, considering the constraints from the CMB observation of the effective number of neutrinos and direct detection experiments. We also discuss the testability of the model in indirect detection experiments. Finally, we construct a chiral composite ADM model which dynamically generates $\mathcal{O}(100)$ MeV mass of the dark photon.