論文の内容の要旨

Collider Phenomenology of Metastable Particles with Sub-Millimeter Displaced Vertices

（１ミリ以下の崩壊長をもつ準安定粒子に関する加速器現象論）

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Among various candidates of new physics, supersymmetry (SUSY) has been considered to provide answers to problems which have not been explained in the standard model (SM). In this thesis we first review SUSY extension of the SM (SSM). However, besides null results of searches for supersymmetric particles at the LHC, it has been pointed out that the SSM with light sfermions has several phenomenological difficulties. After reviewing such difficulties, we see that the Minimal Supersymmetric SM (MSSM) with sfermions as heavy as $\sim 10^3$ TeV may evade such difficulties without elaborate model buildings. One of the characteristic features of the MSSM with heavy sfermions is that gluinos become metastable. We see that if the mass scale of squarks is about $\sim 10^3$ TeV, the decay length of the gluino (*i.e.*, the product of the mean lifetime $\tau_{\tilde{g}}$ and the speed of light c) can be $c\tau_{\tilde{g}} \sim \mathcal{O}(100)$ μm. Although our main concern in this thesis is metastable gluinos, particles with a sub-millimeter decay length also appear in many models of physics beyond the SM. After reviewing theoretical motivations for metastable gluinos, we review existing LHC searches for metastable particles. We see that longevity of metastable particles with sub-millimeter decay length has been often ignored in the LHC searches and they have been regarded as promptly-decaying particles. In this thesis, we show that, by requiring displaced vertices on top of the event selection criteria used in the ordinary search strategies for promptly-decaying particles, we can considerably extend the LHC reach for metastable particles with a decay length of $\gtrsim 100$ μm. We discuss a way of reconstructing sub-millimeter displaced vertices by exploiting the same technique used for the primary vertex reconstruction on the assumption that the metastable particles are always pair-produced and their decay products contain high-p_{T} jets. We show that, by applying a cut based on displaced vertices on top of

standard kinematical cuts for the search of new particles, the LHC reach can be significantly extended if the decay length is $\gtrsim 100$ μm. In addition, we may measure the lifetime of the target particle through the reconstruction of displaced vertices, which plays an important role in understanding the new physics behind the metastable particles. We also study the prospects of searches for metastable particles at a future 100 TeV pp collider.