《Beyond the Standard Model - Search for a New Physics》 Glossary

Anti-particle and CP Violation 【反粒子と、粒子・反粒子の対称性の破れ】

All elementary particles have their anti-particles. Positron is an anti-particle of electron, and it has a positive charge while its mass is the same as of electron. The universe is filled with particles while anti-particles are rare. This implies that CP symmetry, a symmetry between particles and anti-particles, is violated in the universe. The violation of CP symmetry in quark sector was predicted by the Kobayashi-Maskawa model, to which the Nobel Prize was awarded on 08'.

Dark matter 【宇宙の暗黒物質】

There is a large amount of the dark matter in the universe. It is found that the dark matter plays an important role in the structure formation of the universe. It is expected that it is undiscovered elementary particles. Physicists are trying to resolve nature of the dark matter by direct production of dark matter at the LHC and by direct detection of dark matter in the universe.

Grand Unified Theories (GUTs) 【大統一理論】

Three fundamental forces are independent in the standard model, while they are unified to one force at short distance in the GUTs. Quarks and leptons are also indistinguishable to each other there. It is found by experimental searches for proton decay that the GUTs should be realized at shorter distance than 10^{-31} to 10^{-32} meters.

Naturalness problem 【自然さの問題】

The standard model is considered to be an effective theory derived from more fundamental ones at shorter distances. One of the candidates for the more fundamental theories is the GUTs. In the GUTs, it is "natural" from a theoretical viewpoint that the Higgs particle should be much heavier than expected from observations. This implies that there should be severe fine turning in parameters in nature. It is "unnatural" while it is not inconsistent. Many particle physicists consider that there must be some mechanism to control the Higgs particle mass. One of the leading candidates is the supersymmetric standard model. It is expected new particles in the model to be discovered tat the LHC experiments.

Neutrino oscillation【ニュートリノ振動】

There are three species of neutrinos. When they have finite masses, three neutrinos transform into each other in flight. This phenomenon is called as neutrino oscillation, and it was discovered on 98' by the SuperKamiokande experiments. In the standard model, the neutrino masses are exactly zero.

The Standard Model【標準模型】

Proton and neutron are composed of more fundamental matter particles, quarks. Electron and neutrino are also fundamental matter particles called as leptons. The standard model in the elementary particle physics is a theory of quarks and leptons, and three fundamental forces in nature, electromagnetic, weak, and strong forces, generated by exchange of force mediating particles. The standard model is described with a mathematical and self-consistent method under a simple principle, and it can explain phenomena with typical length larger than 10^{-18} meters with finite numbers of input parameters in the theory. All particles in the standard model have been discovered in experiments, except for the Higgs particle. The discovery for the Higgs particle is a key to establish the standard model, since it is associated with origin of the elementary particle in the standard model.