

Ph.D. thesis

**Theoretical studies on extended Higgs
sectors towards future precision
measurements**

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Abstract

We investigate the extended Higgs models especially focusing on the following three topics, the physics of the discovered Higgs boson, that of additional Higgs bosons, and the global symmetry of the Higgs sector. The discovered Higgs boson is a probe of new physics, and detailed studies of its nature are one of the central interests of current and future high energy physics. The Higgs strahlung process from an electron-positron collision is the dominant production process at the early stage of the future lepton colliders such as the International Linear Collider (ILC), and the production cross section will be measured with a few percent accuracies. We study the higher-order corrections for the Higgs strahlung process in various extended Higgs models. We find that the extended Higgs models can be classified by measuring the pattern of deviations from the standard model (SM) prediction in the cross section times decay branching ratio. The direct search of additional Higgs bosons is also the key program especially at the current Large Hadron Collider (LHC) experiment and its luminosity upgraded operation (HL-LHC). We find that indirect and direct studies play a complementary role. If the couplings of the discovered Higgs boson are slightly different from those in the SM, the decay modes into the discovered Higgs boson are quite useful to search additional Higgs bosons at the HL-LHC. On the other hand, theoretical arguments such as perturbative unitarity and vacuum stability put an upper bound for the typical mass scale of additional Higgs bosons if deviations are measured at the ILC. Thus, the synergy between indirect and direct searches enables us to explore the wide range of the parameter space of the extended Higgs models. The decay patterns of additional Higgs bosons are drastically changed depending on the size of deviations in the discovered Higgs boson couplings. We find that the Higgs to Higgs decays are sensitive to the radiative corrections. Therefore, it is important to include the higher-order corrections for the direct searches of additional Higgs bosons. Finally, we propose a new scenario, where the current experimental data are explained as a consequence of the global symmetry of the Higgs potential at a high energy scale. We find that there are characteristic predictions on the mass spectrum of the additional Higgs bosons and on the coupling constants of the discovered Higgs boson. These features can be tested at the collider experiments such as the HL-LHC and the ILC.