

Higgs boson pair production at a photon-photon collision in the two Higgs doublet model

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The Higgs sector is the last unknown part of the standard model (SM). In the SM, the tree level Higgs self-coupling $\lambda_{hhh} = 3m_h^2/v$ and $\lambda_{hhhh} = 3m_h^2/v^2$ are uniquely determined by the Higgs boson mass m_h , where v is vacuum expectation value (VEV) of the Higgs boson. The effective Higgs potential is written as

$$V = \frac{1}{2}m_h^2 h^2 + \frac{1}{3!}\tilde{\lambda}_{hhh}h^3 + \frac{1}{4!}\tilde{\lambda}_{hhhh}h^4 + \dots,$$

where the effective Higgs self-couplings $\tilde{\lambda}_{hhh}$ and $\tilde{\lambda}_{hhhh}$ are given by precision measurement of hhh and $hhhh$ couplings. If the deviation from the SM tree level Higgs self-coupling (λ_{hhh} and λ_{hhhh}) is found, it can be regarded as an evidence of new physics beyond the SM. The origin of the spontaneous electroweak symmetry breaking (EWSB) would be experimentally tested after the discovery of a new scalar particle by measuring its mass and self-couplings. The structure of the Higgs potential depends on the scenario of new physics beyond the SM, so that precision measurement of the hhh coupling can be a probe of each new physics scenario[1].

We consider the new particle effects on the $\gamma\gamma \rightarrow hh$ process in the two Higgs doublet model (THDM), in which additional CP-even, CP-odd and charged Higgs boson appear. It is known that non-decoupling loop effect of extra Higgs bosons shift the hhh coupling value from the SM by $\mathcal{O}(100)\%$ [1]. In the $\gamma\gamma \rightarrow hh$ helicity amplitudes, there are additional one-loop diagrams by the charged Higgs boson loop to the ordinary SM diagrams (the W-boson loop and the top quark loop). It is found that both the charged Higgs boson loop contribution to the $\gamma\gamma \rightarrow hh$ amplitudes and the non-decoupling effect on the hhh coupling can enhance the cross section from its SM value significantly[2]. We discuss the extra Higgs bosons effects of $\gamma\gamma \rightarrow hh$ process and the impact of these corrections on the hhh coupling measurement at the Photon Linear Collider[3].

References

- [1] S. Kanemura, S. Kiyoura, Y. Okada, E. Senaha and C. P. Yuan, Phys. Lett. B **558**, 157 (2003) [arXiv:hep-ph/0211308]; S. Kanemura, Y. Okada, E. Senaha and C. P. Yuan, Phys. Rev. D **70**, 115002 (2004) [arXiv:hep-ph/0408364].
- [2] E. Asakawa, D. Harada, S. Kanemura, Y. Okada and K. Tsumura, Phys. Lett. B **672**, 354 (2009) [arXiv:0809.0094 [hep-ph]]; E. Asakawa, D. Harada, S. Kanemura, Y. Okada and K. Tsumura, arXiv:0902.2458 [hep-ph].
- [3] E. Asakawa, D. Harada, S. Kanemura, Y. Okada and K. Tsumura, talk given by D. Harada at Progress in Particles Physics 2008.