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"Phenomenological study of the radion in Randall-Sundrum model"

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A warped extra dimension model proposed by Randall and Sundrum (RS) is one of the attractive candidates to solve the gauge hierarchy problem in the Standard Model (SM) naturally.

In a simplest version of the RS model, there are only two extra particles beyond the Standard Model - a spin-2 graviton (and its Kaluza-Klein (KK) excitations) and a radion ϕ which is a spin-0 and electrically neutral particle. It is known that the interactions of the radion to the SM particles such as massive gauge bosons (W and Z bosons) and fermions are very similar to those of the Higgs boson h, except for the scale parameters in the couplings. On the other hand, the interactions of the radion to photons γ or gluons g are enhanced through so called "trace anomaly" of the energy-momentum tensor in addition to the 1-loop contributions from W boson and/or fermions as in the SM.

In this thesis, firstly we show the results of our study on the production and decay of the radion at the Large Hadron Collider (LHC) : We used $pp \to h \to VV$ ($V = W, Z, \gamma$) data from the LHC data on the Higgs boson searches. We have studied constraints on the model parameter space of the radion ($m_\phi,\ \Lambda_\phi$), where m_ϕ is the mass of radion and Λ_ϕ is the scale parameter which suppresses the interactions of radion to the SM particles.

As a result, we obtained a large excluded region from ZZ and W^+W^- channel. For example, $\Lambda_\phi = 2$ TeV is excluded when 150 GeV $\lesssim m_\phi \lesssim$ 1000 GeV. On the other hand, the $\gamma\gamma$ channel has less sensitivity for the radion in low-mass region ($m_\phi \sim 150$ GeV) is not constrained at the LHC, i.e., the Higgs boson search in the $\gamma\gamma$ channel at the LHC is less sensitive to a relatively light radion, since the $\phi \to gg$ mode dominates over the other decay modes in this region which suppresses the branching ratio of $\phi \to \gamma\gamma$. Then it is worth examining possibilities to search for the radion in the low-mass region in collider experiments.

Secondly, we discuss a possibility of discovering the radion at a photon collider, which has been considered as an option of e^+e^- liner collider. We focus on the $\phi \to gg$ channel, which is a dominant decay mode in the low-mass region of the radion. It is easily to find the signal $\gamma\gamma \to \phi \to gg$ because there are very few hadronic backgrounds in the photon collider.

We investigated the model parameter space of the radion ($m_\phi,\ \Lambda_\phi$) where the significance $S/\sqrt{B} > 5$, and found that it could be achieved for $\Lambda_\phi \lesssim 3$ TeV and $m_\phi \lesssim 150$ GeV, without conflicting the constraints from the LHC experiments.

Then, we find that the photon collider could be a good stage to look for the radion in the low-mass region ($m_\phi \lesssim 150$ GeV) which LHC experiment does not cover.