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An unambiguous test of positivity at lepton colliders

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The diphoton channel at lepton colliders, $e^+e^-(\mu^+\mu^-) \rightarrow \gamma\gamma$, has a remarkable feature that the leading new physics contribution comes only from dimension-eight operators. This contribution is subject to a set of positivity bounds, derived from fundamental principles of Quantum Field Theory, such as unitarity, locality, analyticity and Lorentz invariance. These positivity bounds are thus applicable to the most direct observable – the diphoton cross sections. This unique feature provides a clear, robust, and unambiguous test of these principles. We estimate the capability of various future lepton colliders in probing the dimension-eight operators and testing the positivity bounds in this channel. We show that positivity bounds can lift certain flat directions among the effective operators and significantly change the perspectives of a global analysis. We also perform a combined analysis of the $\gamma\gamma/Z\gamma/ZZ$ processes in the high energy limit and point out the important interplay among them.

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Author: GU, Jiayin (JGU Mainz)

Presenter: GU, Jiayin (JGU Mainz)

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