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Decays $A \to Z\gamma\gamma$ and $\phi \to Z\gamma\gamma$ ($\phi = h, H$) in two-Higgs doublet models

The one-loop contributions to the decays of the CP-odd and CP-even scalar bosons $A \to Z\gamma\gamma$ and $\phi \to Z\gamma\gamma$ ($\phi = h, H$) are calculated within the framework of CP-conserving THDMs, where they are induced by box and reducible Feynman diagrams. The behavior of the corresponding branching ratios are then analyzed within the type-II THDM in a region of the parameter space around the alignment limit and still consistent with experimental data. It is found that the $A \to Z\gamma\gamma$ branching ratio is only relevant when $m_A > m_H + m_Z$, but it is negligible otherwise. For $m_A > 600$ GeV and $t_\beta \simeq O(1)$, $BR(A \to Z\gamma\gamma)$ can reach values of the order of 10^{-5}, but it decreases by about one order of magnitude as t_β increases up to 10. A similar behavior is followed by the $H \to Z\gamma\gamma$ decay, which only has a non-negligible branching ratio when $m_H > m_A + m_Z$ and can reach the level of 10^{-4} for $m_H > 600$ GeV and $t_\beta \simeq O(1)$. Since the properties of the h scalar boson are nearly identical to the SM Higgs boson, the $h \to Z\gamma\gamma$ branching ratio does not deviates significantly from the SM prediction, where it is negligibly small, of the order of 10^{-9}. This result is in agreement with previous calculations.

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