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Supernova limit on a light CP-even scalar and implications for the KOTO anomaly

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A light CP-even scalar S can be produced abundantly in the supernova core, via the nucleon bremsstrahlung process $NN \rightarrow NNS$ due to its mixing with the standard model (SM) Higgs boson. Taking into account the decay and re-absorption of S , we obtain the supernova luminosity constraints on the scalar mass m_S and mixing angle $\sin \theta$ of S with the SM Higgs. $\sin \theta$ is excluded in the range of 3.5×10^{-7} to 2.5×10^{-5} , depending on the scalar mass up to around 270 MeV. Such a light scalar can be used to explain the KOTO anomaly in flavor-changing rare decay $K_L \rightarrow \pi^0 \nu \bar{\nu}$.

Summary

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