

Improved stellar limits on a light CP-even scalar

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We derive improved stellar luminosity limits on a generic light CP-even scalar field S mixing with the Standard Model (SM) Higgs boson from the supernova SN1987A, the Sun, red giants (RGs) and white dwarfs (WDs). For the first time, we include the geometric effects for the decay and absorption of S particles in the stellar interior. For SN1987A and the Sun, we also take into account the detailed stellar profiles. We find that a broad range of the scalar mass and mixing angle can be excluded by our updated astrophysical constraints. For instance, SN1987A excludes $1.0 \times 10^{-7} < \sin\theta < 3.0 \times 10^{-5}$ and scalar mass up to 219 MeV, which covers the cosmological blind spot with a high reheating temperature. The updated solar limit excludes the mixing angle in the range of $1.5 \times 10^{-12} < \sin\theta < 1$, with scalar mass up to 45 keV. The RG and WD limits are updated to $5.3 \times 10^{-13} < \sin\theta < 0.39$ and $2.8 \times 10^{-18} < \sin\theta < 1.8 \times 10^{-4}$, with scalar mass up to 392 keV and 290 keV, respectively.

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