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Extending the sensitivity of heavy sterile neutrino searches with solar neutrino experiments

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A sensitivity study of the search for heavy sterile neutrinos (ν_H) in the MeV mass range using solar neutrino experiments is presented. ν_H with masses ranging from a few MeV up to 15 MeV can be produced in the Sun through ^{8}B decay and subsequently decay into $\nu_L + e^+ + e^-$, where its flux and lifetime strongly depend on the mixing parameter $|U_{eH}|^2$ and mass m_{ν_H}. The ν_H signal can be detected via its decay products—either the $e^+ + e^-$ pair or ν_L—depending on whether ν_H decays inside or outside the detector. Expected signal yields for both detection methods are presented across the full $|U_{eH}|^2$ and m_{ν_H} parameter space. These two methods are found to be complementary in different regions of the $|U_{eH}|^2$ and m_{ν_H} phase space. By combining both approaches, we anticipate observing at least a handful of signal events in nearly all regions of the parameter space of $10^{-6} < |U_{eH}|^2 < 1$ and $2\,\mathrm{MeV} < m_{\nu_H} < 14\,\mathrm{MeV}$, assuming a 500-ton solar neutrino experiment operating for one year. Key discriminative variables—such as the energy spectra of ν_L or $e^+ + e^-$, as well as the ν_L solar angle—are also presented to aid in the rejection of major backgrounds such as solar neutrino events.

Collaboration you are representing

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