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Direct comparison of sterile neutrino constraints from cosmological data, electron neutrino disappearance data and muon neutrino to electron neutrino appearance data in a 3+1 model

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We present a quantitative, direct comparison of constraints on sterile neutrinos derived from neutrino oscillation experiments and from Planck data, interpreted assuming standard cosmological evolution. We extend a $1+1$ model, which is used to compare exclusions contours at the 95% CL derived from Planck data to those from ν_e-disappearance measurements, to a $3+1$ model. This allows us to compare the Planck constraints with those obtained through $\nu_\mu \rightarrow \nu_e$ appearance searches, which are sensitive to more than one active-sterile mixing angle. We find that the cosmological data fully exclude the allowed regions published by the LSND, MiniBooNE and Neutrino-4 collaborations, and those from the gallium and rector anomalies, at the 95% CL. Compared to the exclusion regions from the Daya Bay ν_e-disappearance search, the Planck data are more strongly excluding above $|\Delta m^2_{41}| \approx 0.1\,\mathrm{eV}^2$ and $m^{\mathrm{sterile}}_{\mathrm{eff}} \approx 0.2\,\mathrm{eV}$, with the Daya Bay exclusion being stronger below these values. Compared to the combined Daya Bay/Bugey/MINOS exclusion region on $\nu_\mu \rightarrow \nu_e$ appearance, the Planck data is more strongly excluding above $\Delta m^2_{41} \approx 5 \times 10^{-2}\,\mathrm{eV}^2$, with the exclusion strengths of the Planck data and the Daya Bay/Bugey/MINOS combination becoming comparable below this value.

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