Karlsruhe Institute of Technology
Institute for Nuclear Physics (IKP)
Theoretical Astroparticle Physics

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Status of the eV Sterile Neutrino Oscillations

Based on [1,2]

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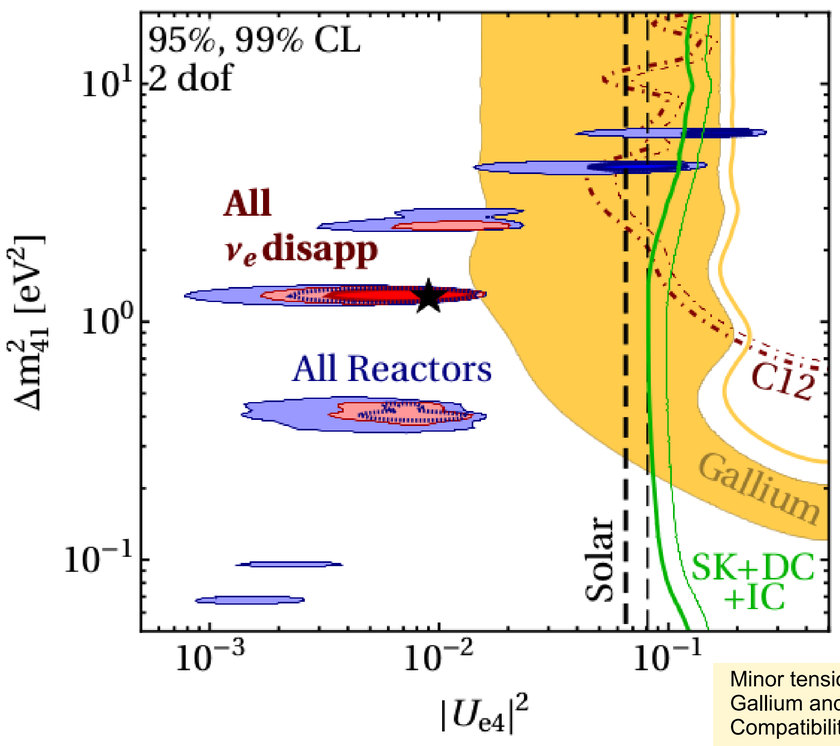
Global $\overset{(-)}{\nu}_e \to \overset{(-)}{\nu}_e$ analysis

$$P_{\overset{(-)}{\nu}_e \to \overset{(-)}{\nu}_e} = 1 - 4\,|U_{e4}|^2\left(1 - |U_{e4}|^2\right)\sin^2\left(\frac{\Delta m^2_{41} L}{4E}\right)$$

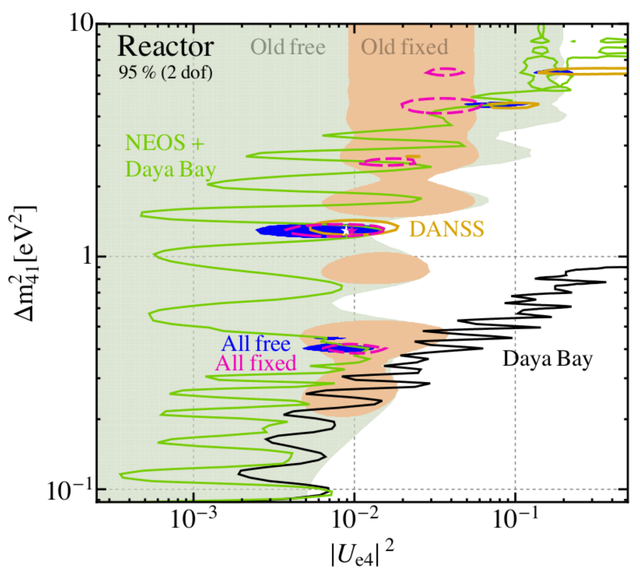


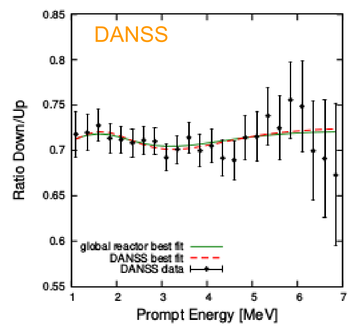
Minor tension between Gallium and Reactors. Compatibility: p-value of 9%

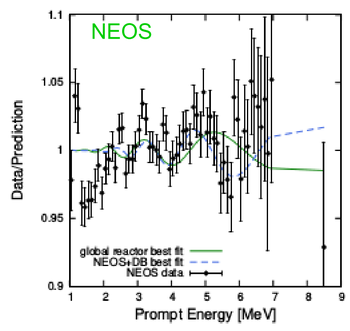
Analysis	Δm^2_{41} [eV^2]	$\lvert U^2_{e4}\rvert$	$\chi^2_{\min}$/dof	$\Delta\chi^2$(no-osc)	significance
DANSS+NEOS	1.3	0.00964	$74.4/(84-2)$	13.6	3.3σ
all reactor (flux-free)	1.3	0.00887	$185.8/(233-5)$	11.5	2.9σ
all reactor (flux-fixed)	1.3	0.00964	$196.0/(233-3)$	15.5	3.5σ
$\overset{(-)}{\nu}_e$ disap. (flux-free)	1.3	0.00901	$542.9/(594-8)$	13.4	3.2σ
$\overset{(-)}{\nu}_e$ disap. (flux-fixed)	1.3	0.0102	$552.8/(594-6)$	17.5	3.8σ

Reactor Anomaly

- Spectral information: Daya Bay, NEOS, DANSS (preliminary).
- Daya Bay flux contributions measurement.







Reactor anomaly confirmed by ratios of measured spectra - independent of flux predictions

- H_0: Sterile Oscillations & flux predictions
- H_1: No oscillation & free fluxes

Test statistics
$T \equiv \chi^2_{\min}(H_0) - \chi^2_{\min}(H_1)$

$T_{DB} = 6.3 = 2.7\sigma$ $\quad$ $T_{\text{all reactors}} = -1.3$

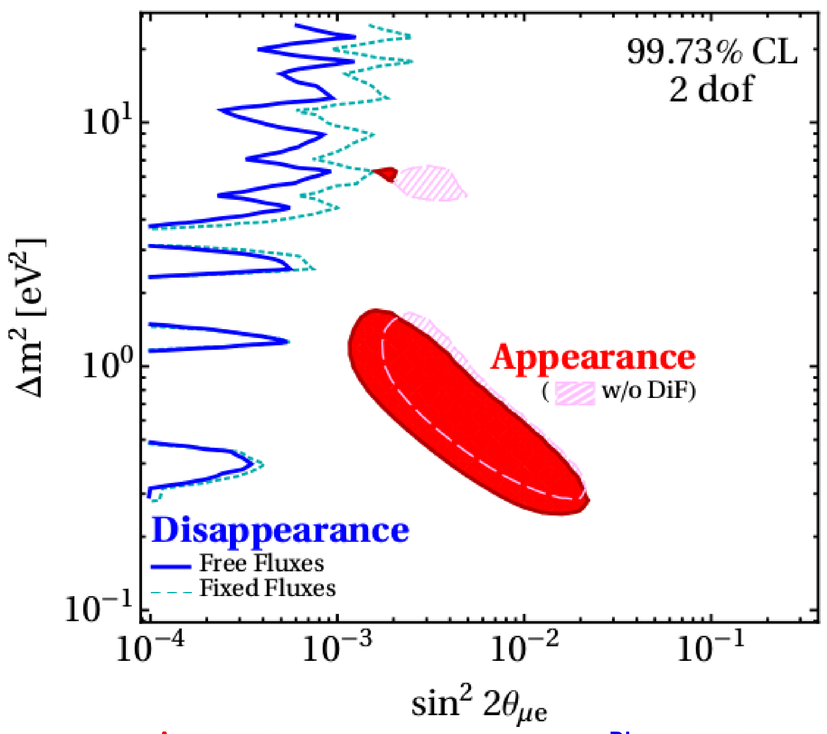
$\overset{(-)}{\nu}_\mu \to \overset{(-)}{\nu}_e$ vs $\overset{(-)}{\nu}_\mu \to \overset{(-)}{\nu}_\mu$ Tension

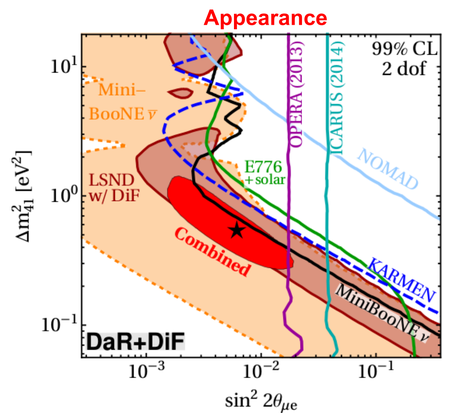
$$P_{\overset{(-)}{\nu}_\mu \to \overset{(-)}{\nu}_\mu} = 1 - 4\,|U_{\mu 4}|^2\left(1 - |U_{\mu 4}|^2\right)\sin^2\left(\frac{\Delta m^2_{41} L}{4E}\right)$$

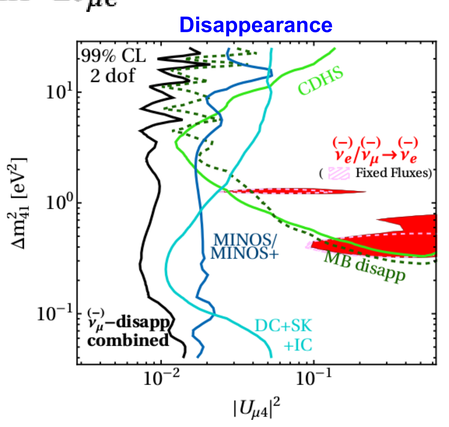
$$P_{\overset{(-)}{\nu}_\mu \to \overset{(-)}{\nu}_e} = 4\,|U_{\mu 4}|^2\,|U_{e4}|^2\sin^2\left(\frac{\Delta m^2_{41} L}{4E}\right)$$

The tension is independent of the Reactor Anomaly

Analysis	$\chi^2_{\text{min,global}}$	$\chi^2_{\text{min,app}}$	$\Delta\chi^2_{\text{app}}$	$\chi^2_{\text{min,disapp}}$	$\Delta\chi^2_{\text{disapp}}$	χ^2_{PG}/dof	PG
Global	1120.9	79.1	11.9	1012.2	17.7	29.6/2	3.71×10^{-7}
Removing anomalous data sets							
w/o LSND	1099.2	86.8	12.8	1012.2	0.1	12.9/2	1.6×10^{-3}
w/o MiniBooNE	1012.2	40.7	8.3	947.2	16.1	24.4/2	5.2×10^{-6}
w/o reactors	925.1	79.1	12.2	833.8	8.1	20.3/2	3.8×10^{-5}
w/o gallium	1116.0	79.1	13.8	1003.1	20.1	33.9/2	4.4×10^{-8}
Removing constraints							
w/o IceCube	920.8	79.1	11.9	812.4	17.5	29.4/2	4.2×10^{-7}
w/o MINOS(+)	1052.1	79.1	15.6	948.6	8.94	24.5/2	4.7×10^{-6}
w/o MB disapp	1054.9	79.1	14.7	947.2	13.9	28.7/2	6.0×10^{-7}
w/o CDHS	1104.8	79.1	11.9	997.5	16.3	28.2/2	7.5×10^{-7}
Removing classes of data							
$\overset{(-)}{\nu}_e$ dis vs app	628.6	79.1	0.8	542.9	5.8	6.6/2	3.6×10^{-2}
$\overset{(-)}{\nu}_\mu$ dis vs app	564.7	79.1	12.0	468.9	4.7	16.7/2	2.3×10^{-4}
$\overset{(-)}{\nu}_\mu$ dis + solar vs app	884.4	79.1	13.9	781.7	9.7	23.6/2	7.4×10^{-6}







[1] Mona Dentler, Alvaro Hernandez-Cabezudo, Joachim Kopp, Michele Maltoni, Thomas Schwetz et.al. *Sterile Neutrinos or Flux Uncertainties? - Status of the Reactor Anti-Neutrino Anomaly, JHEP* 11 (2017) 099, [arXiv: 1709.04294].
[2] Mona Dentler, Alvaro Hernandez-Cabezudo, Joachim Kopp, Pedro Machado, Michele Maltoni, Ivan Martinez-Soler, Thomas Schwetz. *Updated Global Analysis of Neutrino Oscillations in the Presence of eV-Scale Sterile Neutrinos* [arXiv: 1803.10661].