CPT violation

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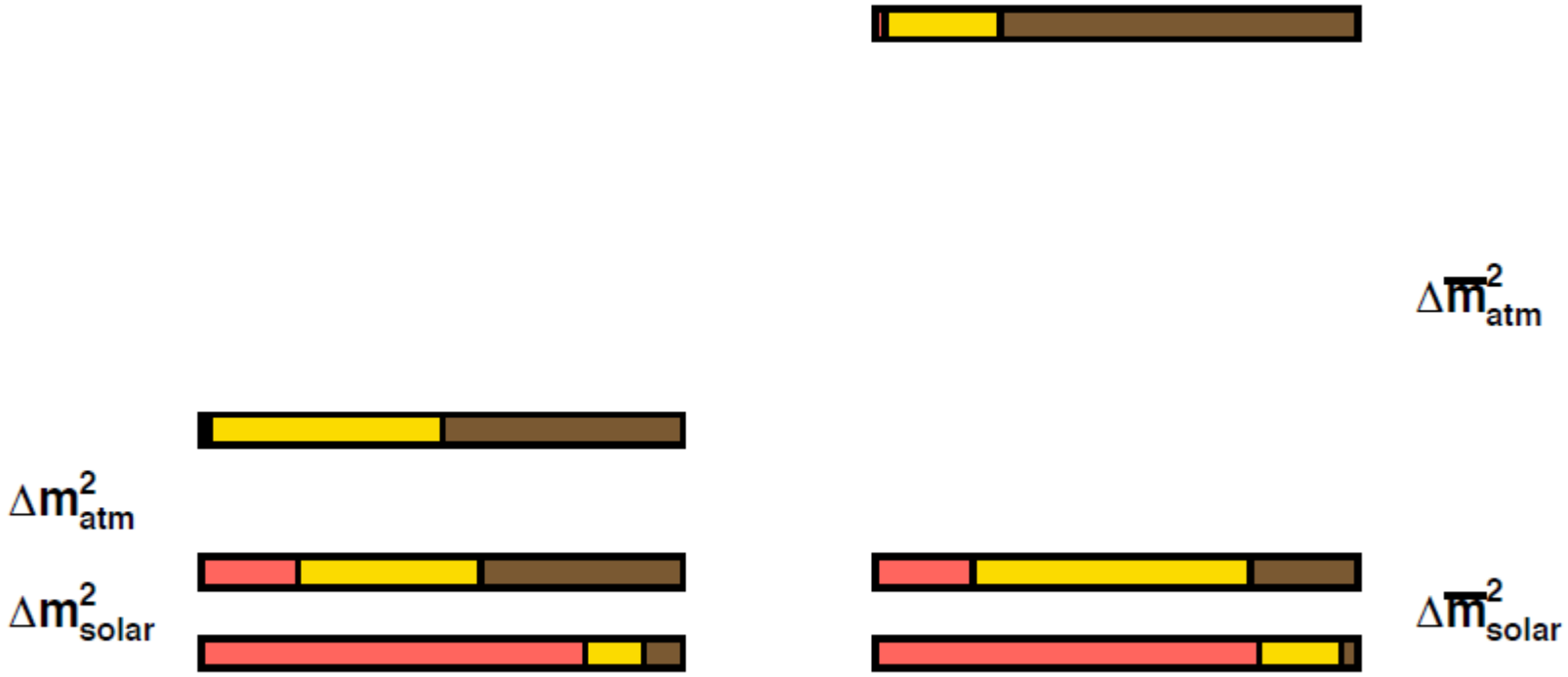
UV and IFIC



$$\frac{|\, m(K_0) - m(\overline{K_0}) \,|}{m_{K-av}} < 10^{-18}$$

$$m_{K-av} \approx \frac{1}{2}\ 10^9\ \text{eV}$$

$$(m(K_0) - m(\overline{K_0}))(m(K_0) + m(\overline{K_0})) < 2\ \ 10^{-18}\, m_{K-av}{}^2$$

$$|m^2(K_0) - m^2(\overline{K_0})| \qquad \approx \frac{1}{2}\ \text{eV}^2$$

$$|\, \Delta m^2 - \overline{\Delta m^2}\, | \approx\ 10^{-6} - \ 10^{-3}\ \text{eV}^2$$

Current bounds

- We can use data of various experiments to calculate the neutrino and antineutrino oscillation parameters:
  - Solar neutrino data: $\theta_{12}, \Delta m^2_{21}, \theta_{13}$
  - Neutrino mode in LBL: $\theta_{23}, \Delta m^2_{31}, \theta_{13}$
  - KamLAND data: $\overline{\theta}_{12}, \Delta \overline{m}^2_{21}, \overline{\theta}_{13}$
  - SBL reactors: $\overline{\theta}_{13}, \Delta \overline{m}^2_{31}$
  - Antineutrino mode in LBL: $\overline{\theta}_{23}, \Delta \overline{m}^2_{31}, \overline{\theta}_{13}$
- No bounds on CP-phases since all values are allowed

Current bounds

.We use the same data (except atmospheric neutrinos) as for the global fit arXiv:1708.01186 to obtain

$$
\begin{aligned}
|\Delta m^2_{21} - \Delta \overline{m}^2_{21}| &< 4.7 \times 10^{-5} \mathrm{eV}^2, \\
|\Delta m^2_{31} - \Delta \overline{m}^2_{31}| &< 3.7 \times 10^{-4} \mathrm{eV}^2, \\
|\sin^2\theta_{12} - \sin^2\overline{\theta}_{12}| &< 0.14, \\
|\sin^2\theta_{13} - \sin^2\overline{\theta}_{13}| &< 0.03, \\
|\sin^2\theta_{23} - \sin^2\overline{\theta}_{23}| &< 0.32,
\end{aligned}
$$

G.B., C. Ternes and M. Tortola, ArXiv:1712.01714

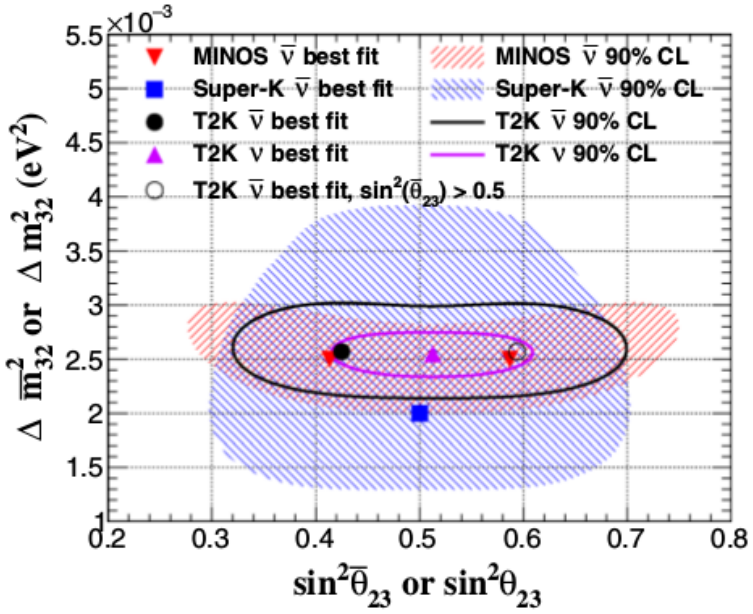
T2K results, a hint ?

.T2K studied neutrino and anti-neutrino oscillations separated

$$\sin^2\theta_{23} = 0.51, \quad \Delta m^2_{32} = 2.53 \times 10^{-3}\mathrm{eV}^2$$

$$\sin^2\overline{\theta}_{23} = 0.42, \quad \Delta \overline{m}^2_{32} = 2.55 \times 10^{-3}\mathrm{eV}^2$$

.Results are consistent with CPT-conservation



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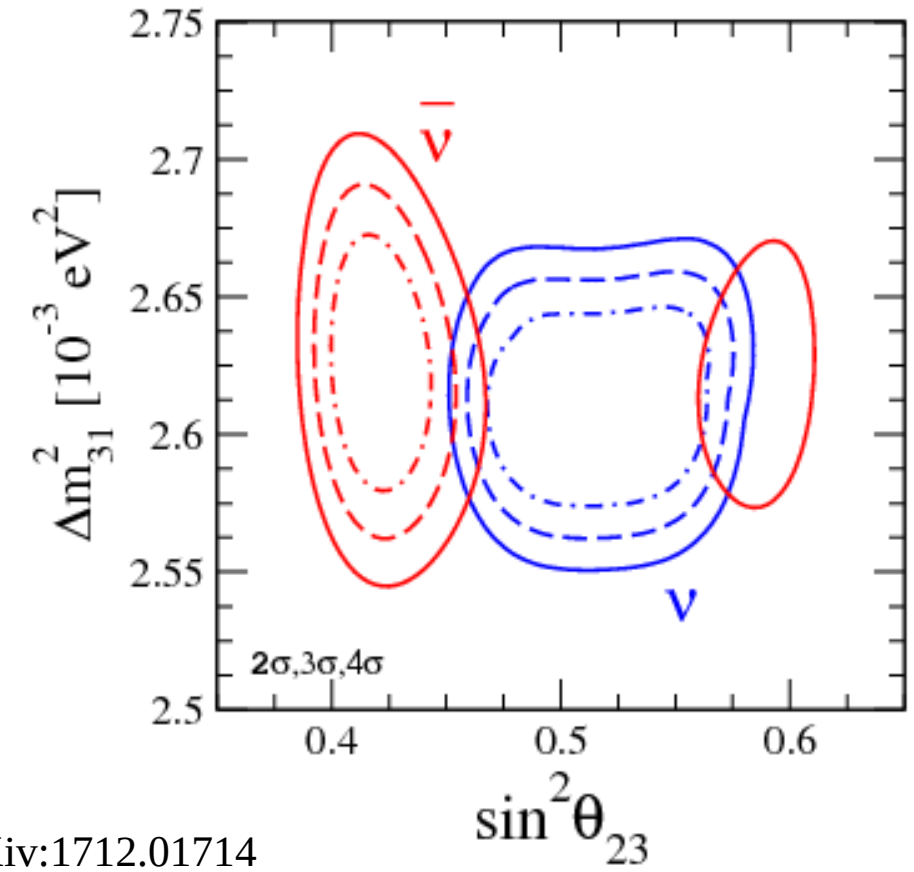
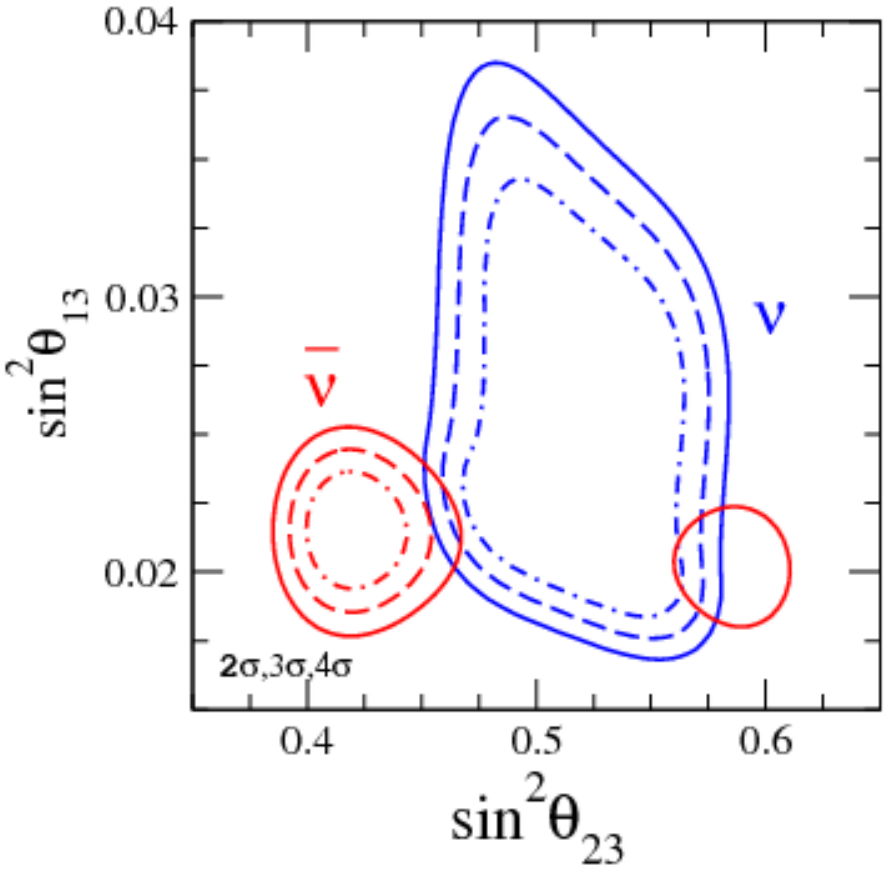
DUNE about T2K

.We find, that if these values turn out to be the true values, DUNE would measure CPT-violation at more than 3σ confidence level





ArXiv:1712.01714

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- To perform the standard fit you would calculate $\chi^2_{\rm total} = \chi^2(\nu) + \chi^2(\overline{\nu})$

- and then minimize this function

$$h(x,y) = f(x) + g(y)$$

$$\partial_x f(x) = 0 \qquad \partial_y g(y) = 0$$

$$x = y$$

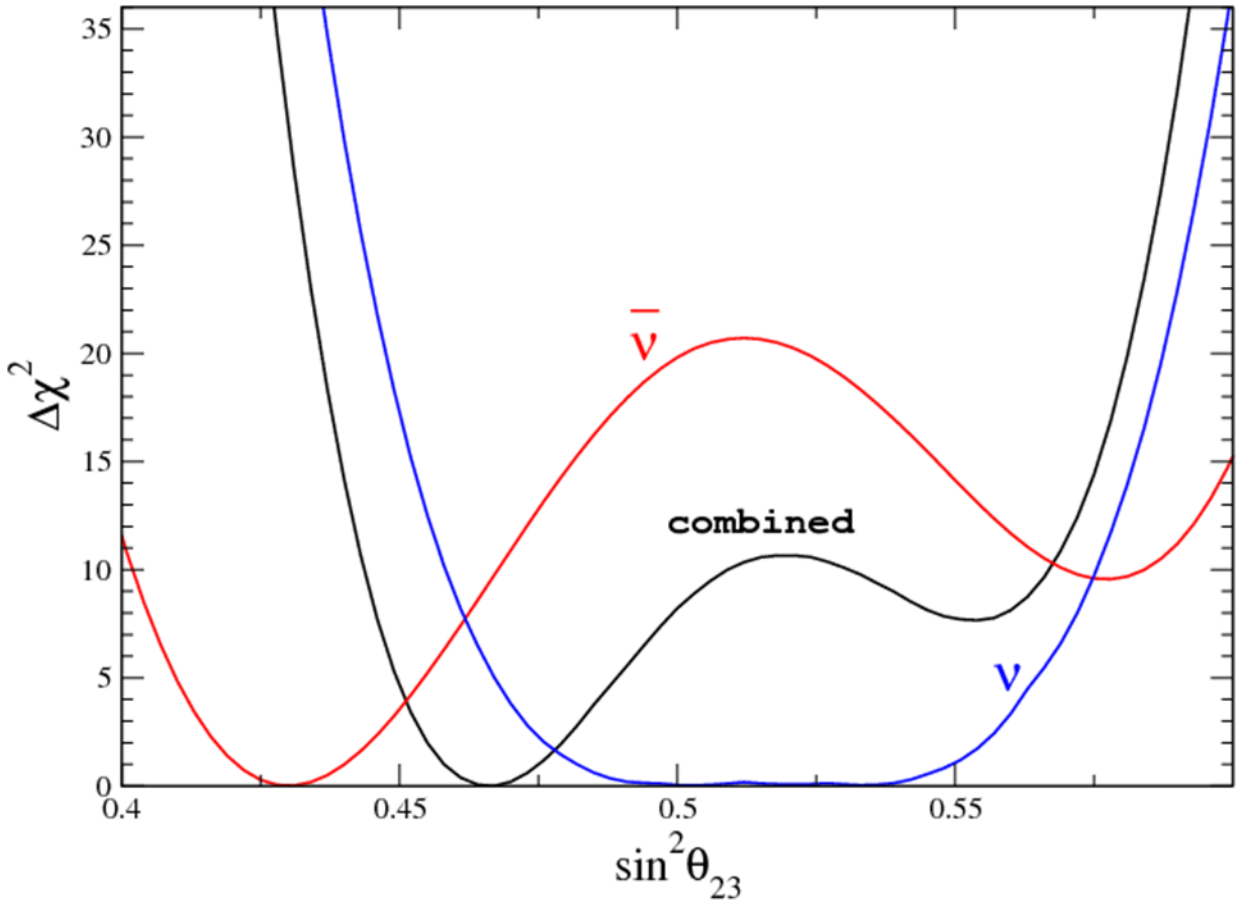
$$h(x) = f(x) + g(x)$$

$$\partial_x f(x) = \partial_x g(x) = 0$$

$$\partial_x f(x) = -\partial_x g(x)$$

Obtaining impostor solutions

.This was done for $\sin^2(\theta_{23}) = 0.5,\ \sin^2(\overline{\theta}_{23}) = 0.43$



.Combined best fit value is now

$$\sin^2(\theta_{23}^{\mathrm{comb}}) = 0.467$$

.Real true values are disfavored at close to 3σ and more 5σ confidence levels

Conclusions

- The best places to test CPT are neutrino experimets

- Joint neutrino-antineutrino analysis may get impostor solutions

- Watch out for misinterpretation between CPT-violation and nonstandard neutrino interactions. Distinction is possible.