Are T2K's oscillation constraints robust under flavour-texture priors?

The PMNS matrix is usually parameterised as a product of complex rotations

$$U_{PMNS} = (R_{23}) \times (R_{13,\delta}) \times (R_{12})$$

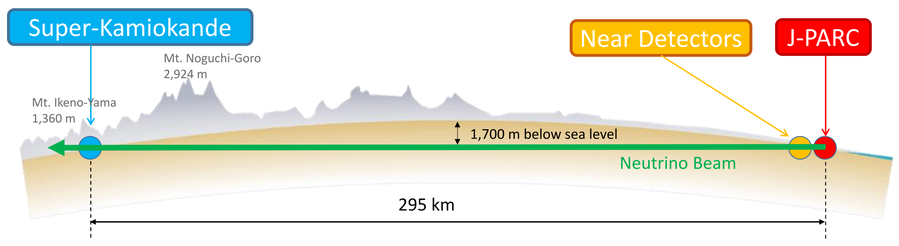
Rotation along a flavour plane — Intermediate rotation — Rotation along a mass plane

There are infinitely many parameterisations of this form accessible through a unitary transformation

$$U_{PMNS} = X^{\dagger} \times (R_{23}) \times (R_{13,\delta}) \times (R_{12}) \times X$$

Rotation along a plane in the $X \times \overrightarrow{\nu_f}$ basis — New intermediate rotation — Rotation along a plane in the $X \times \overrightarrow{\nu_m}$ basis

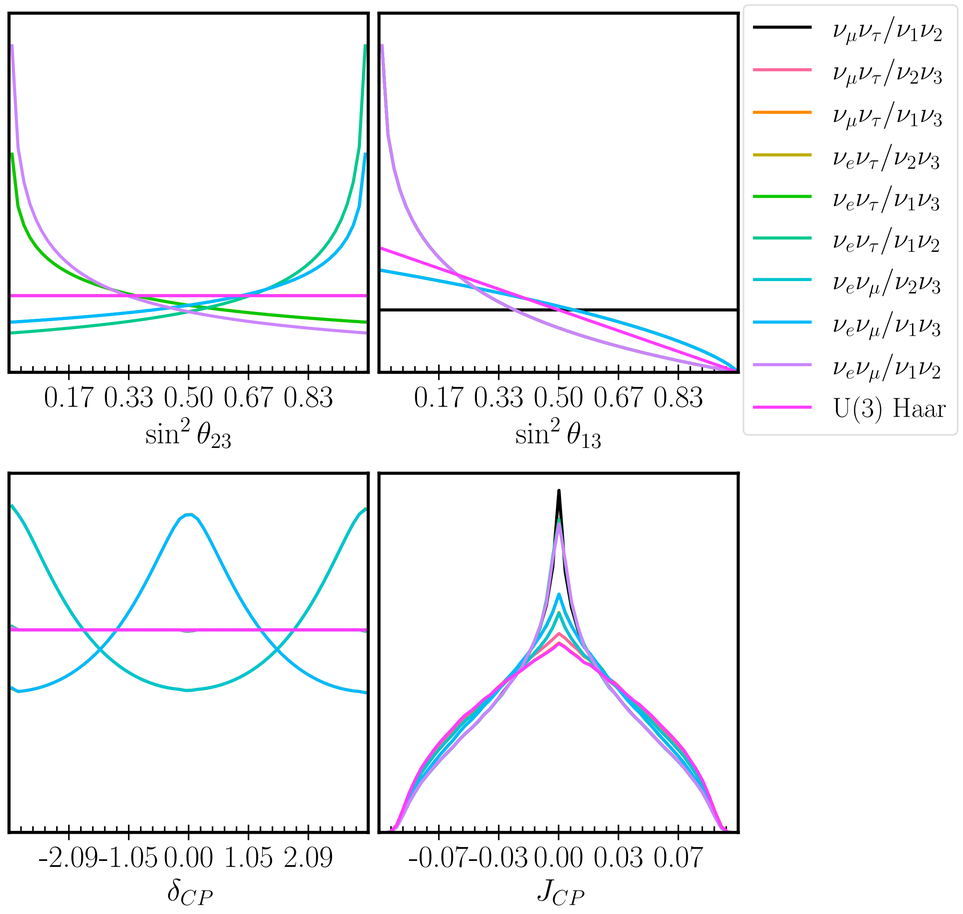
The T2K experiment measures oscillations in J-PARC's high-purity ν_μ neutrino beam



It has produced world-leading constraints on θ_{23} and δ_{CP} while fitting in the usual parameterisation

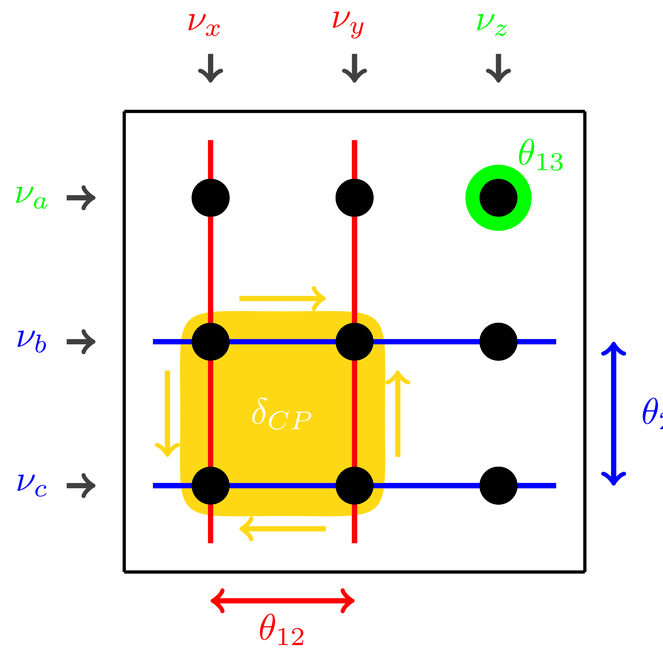
Current Bayesian analyses use a prior uniform in the usual parameterisation. It benefits $\nu_\mu\,\nu_\tau$ and $\nu_1\,\nu_2$ symmetries.

Benefitting other symmetries leads to new priors



Priors from 9 symmetry-benefitting rotational parameterisations, marginalised onto the parameters of the T2K experiment. J_{CP} is the Jarlskog invariant

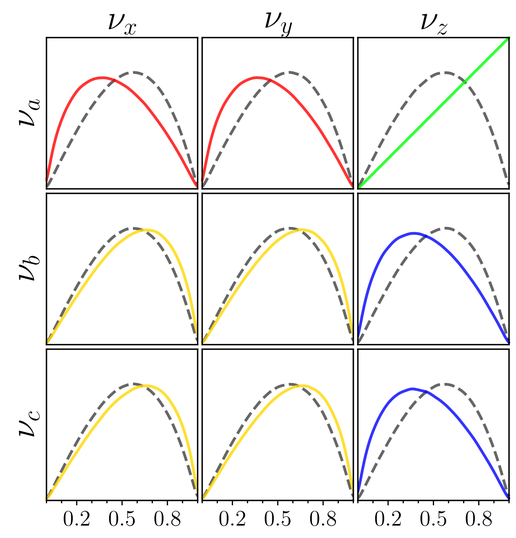
Anatomy of a rotation parameterisation



We interpret the mixing parameters in terms of their effect on the elements of the change of basis matrix between $X \times \overrightarrow{\nu_f}$ and $X \times \overrightarrow{\nu_m}$

A uniform distribution in these parameters is not uniform over the change of basis matrix

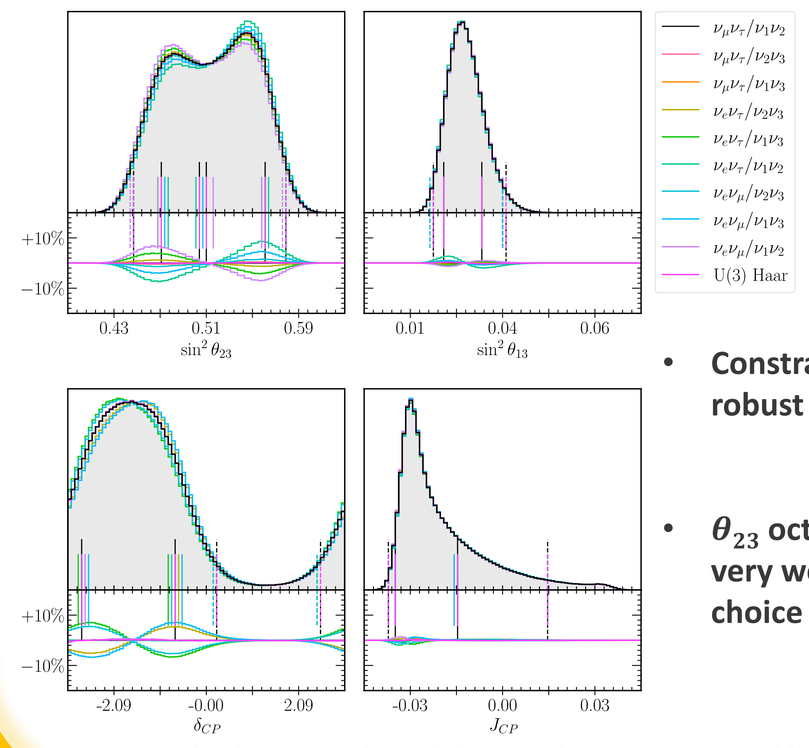
Uniform distributions over $\sin^2\theta_{ij}$ and δ_{CP} look different from the uniform distribution given by the Haar measure[1]. **They benefit symmetries along the rotational planes of R_{23} and R_{12}**



Uniform distribution over over $\sin^2\theta_{ij}$ and δ_{CP} (coloured) versus uniform distribution over the U(3) Haar measure (grey) projected onto the elements of the change of basis matrix.

There are only 9 distinct parameterisations that benefit symmetries between mass and flavour states

Credible intervals show little change!



- **Constraints on CPV stay robust**
- **θ_{23} octant preference is very weak and depends on choice of parameterisation**

1D marginalised posteriors for T2K's latest analysis[2] (no RC), using different symmetry priors

[1] J.-F. Fortin, N. Giasson, and L. Marleau, "Probability density function for neutrino masses and mixings," Phys. Rev. D, vol. 94, no. 11, p. 115004, 2016

[2] K. Abe et al., "Measurements of neutrino oscillation parameters from the t2k experiment using 3.6×10^{21} protons on target," The European Physical Journal C, vol. 83, Sept. 2023

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T2K