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On the determination of the leptonic CP phase

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The combination of data from long-baseline and reactor oscillation experiments leads to a preference of the leptonic CP phase $\delta_{\rm CP}$ in the range between π and 2π. We study the statistical significance of this hint by performing a Monte Carlo simulation of the relevant data. We find that the distribution of the standard test statistic used to derive confidence intervals for $\delta_{\rm CP}$ is highly non-Gaussian and depends on the unknown true values of θ_{23} and the neutrino mass ordering. Values of $\delta_{\rm CP}$ around $\pi/2$ are disfavored at between 2σ and 3σ, depending on the unknown true values of θ_{23} and the mass ordering. Typically the standard χ^2 approximation leads to over-coverage of the confidence intervals for $\delta_{\rm CP}$. For the 2-dimensional confidence region in the $(\delta_{\rm CP}, \theta_{23})$ plane the usual χ^2 approximation is better justified. The 2-dimensional region does not include the value $\delta_{\rm CP} = \pi/2$ up to the 86.3 % (89.2 %) CL assuming a true normal (inverted) mass ordering. Furthermore, we study the sensitivity to $\delta_{\rm CP}$ and θ_{23} of an increased exposure of the T2K experiment, roughly a factor 12 larger than the current exposure and including also anti-neutrino data. Also in this case deviations from Gaussianity may be significant, especially if the mass ordering is unknown.

Authors: Ms ELEVANT, Jessica (OKC, Stockholm University); Prof. SCHWETZ-MANGOLD, Thomas (KIT)

Presenter: Ms ELEVANT, Jessica (OKC, Stockholm University)

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