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The Synergistic Role of JUNO in Global Neutrino Oscillation Measurements with NOvA and T2K

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We study the impact of combining the present NOvA and T2K data with simulated data from the JUNO experiment on the determination of the leptonic CP phase and the neutrino mass hierarchy. The current NOvA data exhibit a hierarchy- δ_{CP} degeneracy, admitting both normal hierarchy (NH) with $\delta_{\text{CP}} \in [0, 180^\circ]$, and inverted hierarchy (IH) with $\delta_{\text{CP}} \in [180^\circ, 360^\circ]$ solutions at comparable significance, while T2K prefers $\delta_{\text{CP}} \simeq 270^\circ$ for both hierarchies, leading to a 2σ tension between the two experiments for normal hierarchy. Using detailed GLOBES simulations, we show that future JUNO data with excellent hierarchy sensitivity can lift the hierarchy- δ_{CP} degeneracy in NOvA and strengthen the hierarchy reach of T2K despite having no δ_{CP} sensitivity. Allowing the hierarchy to be a free parameter in the fit, if the true ordering is IH, JUNO aligns the NOvA and T2K allowed regions and resolves their present tension; if NH is true, the tension continues to persist. We also show that JUNO's precise measurement of $|\Delta_{31}|$ leads to improved constraints on $\sin^2 \theta_{23}$ and δ_{CP} for normal mass hierarchy in NOvA even though JUNO itself is insensitive to these parameters. Finally, updated solar-parameter measurements from JUNO's first data release further enhance the combined precision. Our results demonstrate that JUNO plays a crucial synergistic role in the global neutrino-oscillation programme, enabling a more robust determination of the mass ordering and improving the sensitivity to the CP phase when combined with long-baseline data.

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