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# Complementarity between long-baseline and atmospheric neutrino experiments

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Recent measurements have shown that the value of $\theta_{13}$ in nature is moderately large. This allows the possibility of measuring the neutrino mass hierarchy, octant of $\theta_{23}$ and CP-violating phase $\delta_{CP}$ at the next generation of neutrino oscillation experiments. Long-baseline experiments have very good energy resolution, and hence are well suited to measure the mass-square differences, mixing angles and CP phase to a high degree of precision. Atmospheric neutrino experiments can access neutrinos over a wide range of baselines and energies and can resolve the problems of determining the mass hierarchy and octant of $\theta_{23}$, due to resonant matter effects.

The sensitivity of long-baseline experiments to the unknown neutrino
oscillation parameters depends on the value of $\delta_{CP}$ in nature. In fact, for unfavourable combinations of these parameters, the capabilities of long-baseline experiments are severely limited. On the other hand, the capabilities of atmospheric neutrino experiments have been shown to be independent of $\delta_{CP}$. We explore the reasons for the $\delta_{CP}$-independence of atmospheric neutrino results. We then study the synergy between atmospheric and long-baseline experiments. We find that there is a marked improvement in the sensitivity of long-baseline experiments for unfavourable values of parameters, when data from atmospheric experiments are also taken into account. We present our results in the context of planned upcoming oscillation experiments.

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