OPTIMIZING THE DETERMINATION OF THE θ_{23} OCTANT IN FUTURE LONG BASELINE NEUTRINO EXPERIMENTS

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Year 2015 saw the Nobel Prize [1] in physics awarded to Arthur B. McDonald and Takaaki Kajita "*for the discovery of neutrino oscillations, which shows that neutrinos have mass*". Neutrinos are among the most abundant particles in the universe and they interact only via weak interaction. This makes neutrinos very difficult to detect. The most remarkable property of neutrinos is their ability to change flavour in flight. This phenomena is known as neutrino oscillations and they have been subject to active study since 1960s.

There are various neutrino experiments which are actively involved in the attempt to determine the different neutrino oscillation parameters [2]. This field is severely complicated by parameter degeneracies where different values can lead to confusingly similar oscillation probabilities. One of the most promising methods to tackle degeneracy problems is to use long baseline experiments which are designed to study neutrino oscillations by sending neutrinos through long distances underground, where the matter presence affects the oscillation probabilities. Many of these experiments are currently in their planning stage, and it is important to find the best experiment conditions to study the degeneracies.

In this work we focus on one of the important parameter degeneracies in the three-neutrino paradigm. The atmospheric neutrino mixing angle θ_{23} is known to be near 45°, but it is not clear which octant it lies in, that is, whether $\theta_{23} > 45°$ or $\theta_{23} < 45°$, respectively. This is known as the octant degeneracy problem. We simulate a typical next generation long baseline experiment and evaluate its sensitivity to the θ_{23} octant in various conditions. We seek the best experimental setup by comparing experiments with different baseline lengths, neutrino beam options and detection capabilities. The work is done by using the GLoBES software and LBNO as benchmark. We employ the numerical methods that we introduced in our previous work [3].

[1] The Nobel foundation, www.nobelprize.org/nobel_prizes/physics/laureates/2015/.
[2] S. K. Agarwalla, Adv.High Energy Phys. 2014 (2014) 457803
[3] C. R. Das, J. Maalampi, J. Pulido and S. Vihonen, JHEP 1502 (2015) 048.