Contribution ID: **27** Type: **oral**

Physics of Atmospheric Neutrino Oscillations with a Huge Underground Detector

Thursday, November 14, 2013 5:10 PM (25 minutes)

A general theoretical framework, in which the contributions of the neutrino mass hierarchy, octant of the atmospheric angle and the lepton number conserving CP phase are disentangled analytically, is established to study the potential of using atmospheric neutrino oscillations, detectable by huge underground detectors, to determine the three unknowns. To benchmark the detectability we take the implementation of PINGU as an example and compute muon-like and electron-like event rates with event cuts on neutrino energy and zenith angle. We find that the experiment has the potential of resolving the mass hierarchy and the octant degeneracies, while the measurement of the CP phase is significantly more challenging. Our observation merits a serious study of the detector capability of estimating the neutrino momentum for both muon-like and electron-like events and the background.

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Session Classification: Neutrinos II

Track Classification: Neutrinos