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Muon neutrino-antineutrino separation potential of the IceCube Upgrade using inelasticity

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The IceCube Neutrino Observatory is a cubic-kilometre Cherenkov detector located at the South Pole. The IceCube Upgrade will improve the detection, reconstruction, and particle identification of atmospheric neutrinos in the GeV energy range using seven additional strings of new multi-PMT photosensors to increase the instrumentation density in the bottom centre of the detector. Neutrino telescopes are currently falling short at separating between neutrino and antineutrino events. Even a small partial separation between those two signals would be a major improvement. For example, this separation could be used to enhance the detector sensitivity to the neutrino mass ordering. The difference in the weak interactions between the neutrinos and antineutrinos caused by their opposed chiral states results in different inelasticity distributions. The muon neutrino or antineutrino interacting through charged current creates a muon who can be separated from the hadronic cascade. The modelling of the theoretical inelasticity distribution of the interactions in the GeV energy range coupled with the higher rate of detected events improves the potential of statistically separating the neutrino from the antineutrino signal. This is studied using simulations of the upgraded detector.

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