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Electron Neutrino Tagging in IceCube Using Graph Neural Networks

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The IceCube Neutrino Observatory detects Cherenkov light from neutrino interactions in the Antarctic ice. Despite more than a decade of operation, distinguishing electromagnetic and hadronic showers remains a persistent challenge. Accurately identifying electromagnetic showers provides a charged-current electron-neutrino-rich sample, which plays a pivotal role in Neutrino Mass Ordering studies. To address this challenge, we use the upcoming IceCube Upgrade (2025/26) and Graph Neural Networks (GNNs). The Upgrade, featuring advanced sensors and seven additional strings in the densely instrumented central region, enhances GeV-scale neutrino detection. GNNs, which effectively handle the irregular detector geometry, enable improved shower classification. Several parameters for identifying electromagnetic showers are explored in the Upgrade simulation dataset. Our recent studies demonstrate, for the first time, a clear separation between electromagnetic and hadronic showers.

Keyword-1

Neutrino Physics

Keyword-2

Electron Neutrinos

Keyword-3

IceCube

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