AY 250

HW 2 Problem 0

Problem 0. The figure below is from the 1998 paper "Evidence for oscillation of atmospheric neutrinos" of the Super-Kamiokande Collaboration. The plot is trying to convey a deficit in upward-going (U) muon-neutrinos relative to downward-going (D) muon neutrinos. The U neutrinos have traveled some distance through the Earth before reaching the detector, as opposed to the D neutrinos that (nearly) only traverse the atmosphere before detection. This strongly supports the theory of neutrino oscillations, as the muon-neutrinos can oscillate to a tau-neutrino and go undetected (there's a greater chance of oscillation for U neutrinos). The figure clearly shows deviation from simulation (shaded boxes near 0) and shows a measurement through the fitted, dashed line. My only complaint with the figure is the inclusion of partially-contained (PC) events. Fully-contained (FC) events come from an entire particle track within the detector, while PC events have exiting tracks that are incomplete. There's likely not a problem with any of the PC events, but it clutters up the figure a bit. However, the PC events complement the story so the subplot could still be added elsewhere.

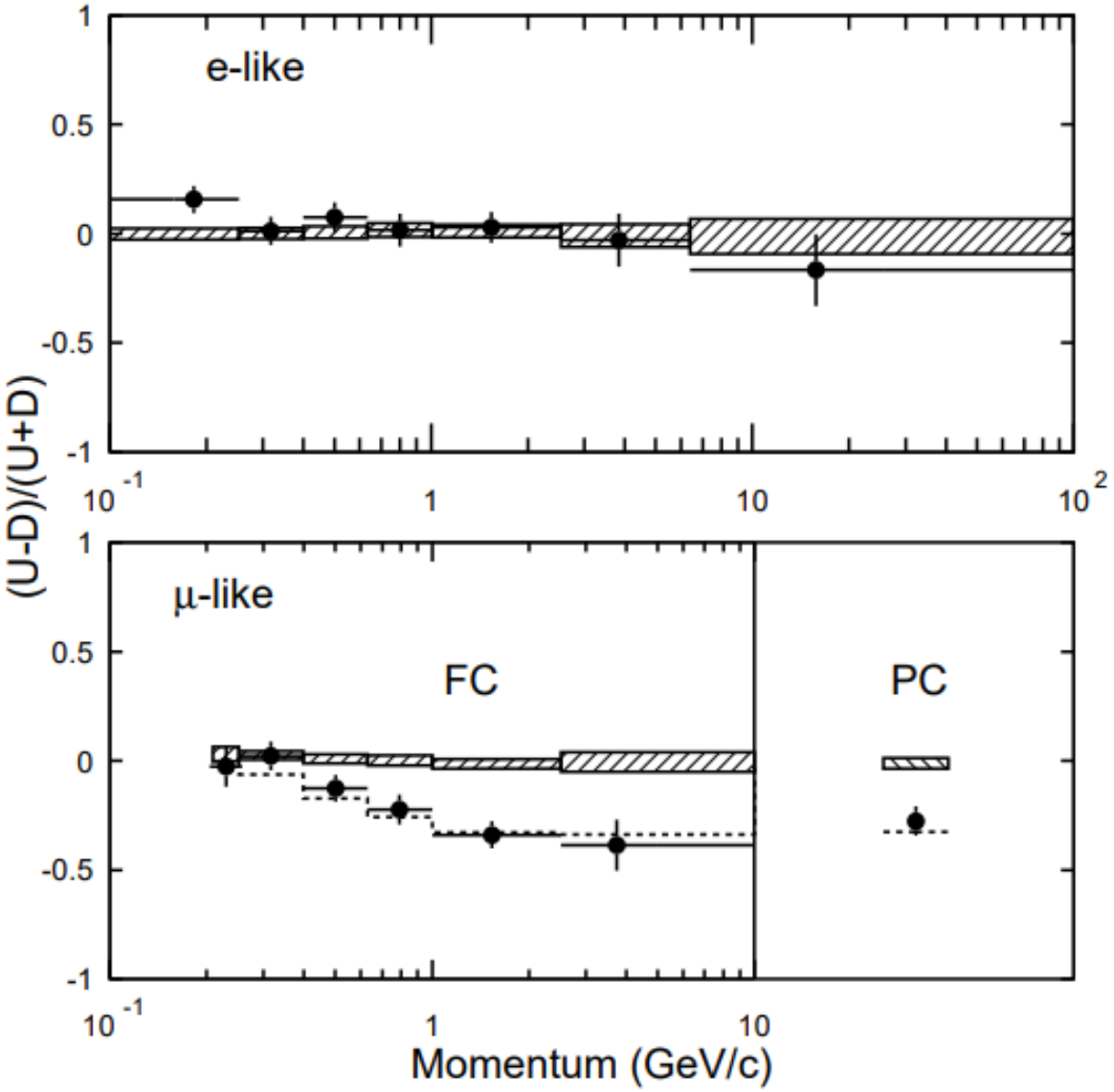

FIG. 1. The $(U - D)/(U + D)$ asymmetry as a function of momentum for FC e-like and μ-like events and PC events. While it is not possible to assign a momentum to a PC event, the PC sample is estimated to have a mean neutrino energy of 15 GeV. The Monte Carlo expectation without neutrino oscillations is shown in the hatched region with statistical and systematic errors added in quadrature. The dashed line for μ-like is the expectation for $\nu_\mu \leftrightarrow \nu_\tau$ oscillations with $(\sin^2 2\theta = 1.0, \Delta m^2 = 2.2 \times 10^{-3}\ \mathrm{eV}^2)$.