GENIE Systematic Uncertainties with the Multiverse Approach in CAFAna

1. Overview

The standard approach for drawing the NOvA systematic error band from GENIE cross section models is to vary the GENIE tunable physics parameters by N σ's, $N \in \{-2, -1, 1, 2\}$, input this number through the shift parameter of the CAFAna Spectrum class, and obtain shifted spectra as the boundaries of the error band. There are tens of tunable GENIE parameters, hereafter referred to as GENIE knobs, but only a few of them having the biggest effects are varied. This leaves somewhat arbitrary where to leave out the knobs.

A consistent way of treating the GENIE systematic uncertainties across all analyses, known as the multiverse approach, was proposed, which varies all the knobs at the same time.