Cosmic Ray Elemental Spectra and Atmospheric Neutrino Fluxes: Executive Summary

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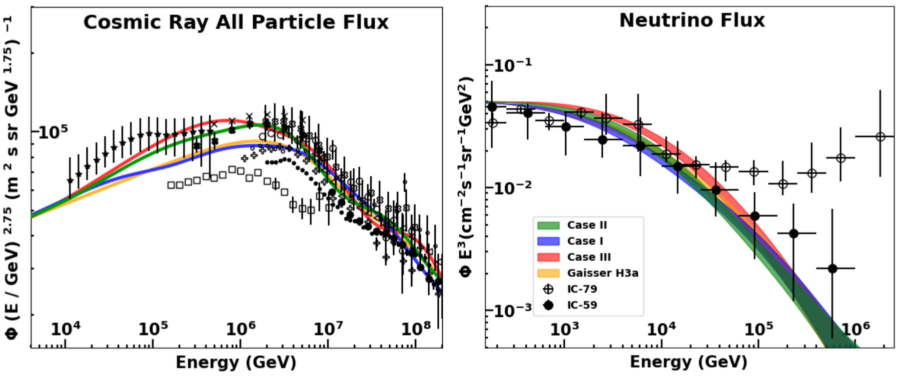
- Atmospheric neutrinos dominate the measured neutrino spectra up until ~100 TeV, and in order to better characterize the transition at 100 TeV from atmospheric to astrophysical neutrinos, the cosmic rays that produce the atmospheric flux, specifically around knee energies, are investigated in this analysis.
- We model the all-particle knee by fitting direct and indirect measurement data to various models and calculate expected atmospheric neutrino fluxes using these fits.
- The elemental spectra of the 8 most abundant charged cosmic rays presents spectral hardening starting at ~200 GV, motivating this analysis to model the all-particle knee energy regime with a 4 acceleration population model with rigidity dependent upper limits.
  - Three different knee models were investigated by altering the Population 1 rigidity cutoffs within our 4 population model.
- The fitting procedure was simplified by assuming elemental groupings as first reported by the AMS-02 collaboration; a Proton Group (p), Helium Group (He, C, O, Fe), and Neon Group (Ne, Mg, Si).
  - The elements in these groups have similar rigidity dependencies, so this analysis assumed the same groupings and applied identical spectral index values to each of the elements within a group.
- The Matrix Cascade Equations (MCEq) toolkit was then used to calculated the resulting atmospheric muon neutrino flux from the elemental fits.
- The all-particle spectra and calculated atmospheric neutrino fluxes for all three explored cases are shown in the figure below.



- The neutrino flux was found to be especially sensitive to the underlying light element spectra, specifically p and He.
- Some minor tension between the all-particle flux and atmospheric neutrino spectra was identified: below 10^5 GeV in cosmic rays, our calculated curves are below the cosmic ray all particle data, however, at the corresponding neutrino energies of 10^3 GeV and below, our calculated curves are above the neutrino data.
- Future work involves tuning our fits as more data becomes available and exploring more rigidity cutoffs for Pop. 1.