

Origin of the ankle in the ultra-high energy cosmic ray spectrum and extragalactic protons below it

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The sharp change in slope of the ultra-high energy cosmic ray (UHECR) spectrum around $10^{9.6}$ GeV (the ankle), combined with evidence of a light but extragalactic component near and below the ankle and intermediate composition above, has proved exceedingly challenging to understand theoretically. We propose a mechanism whereby photo-disintegration of ultra-high energy nuclei in the region surrounding a UHECR accelerator naturally accounts for the observed spectrum and inferred composition at Earth. We discuss the conditions required to reproduce the spectrum above $10^{8.5}$ GeV and the composition, which – in our model – consists below the ankle of extragalactic protons and the high energy tail of Galactic cosmic rays, and above the ankle of surviving nuclei from the extended source. Predictions for the spectrum and flavors of neutrinos resulting from this process will be presented, and also implications for candidate sources.

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