Radio-Cherenkov Detection of Ultra–High-Energy Cosmogenic Neutrinos Using the South Pole IceCap

Robert Morse for the IceCube & IceRay Collaborations
University of Wisconsin-Madison & University of Hawaii-Manoa
<morse@phys.hawaii.edu>

Ultra–high-energy charged-current neutrino scattering events lead to detectable secondary muons, which may propagate 20 to 30 km before they are detected in an optical Cherenkov array like IceCube. These events are tantalizing in that one knows almost nothing about the parent neutrino other than its direction. The kinematics of such events are that the lepton carries away about 70 to 80% of the energy, while the remaining energy is deposited as a local hadronic cascade which produces strong coherent Cherenkov radio emissions (Askaryan-1960). This radiation is detectable at great distances in a radio-transparent medium such as Antarctic ice. Thus a suitably stationed array of antennas in a configuration surrounding a detector such as IceCube on the scale of several kms to several tens of kms will observe the Cherenkov emissions from the primary vertex of the same events that may produce lepton events in IceCube. One might ask why such a methodology was not adopted earlier, and the answer is that the energy of these radio events—in the 1~10-EeV region—is well above the initial design scale for optical Cherenkov detectors. Of late, however, there has been much renewed interest in using both radio and acoustical detection schemes to investigate models which produce these “guaranteed” EeV or GZK neutrinos, which arise when the highest-energy cosmic rays interact with the cosmic microwave background radiation. A modest radio detection scheme designed to measure the nature of the GZK effect will be presented. Such a detector could provide a measure of the neutrino cross-sections in the 1~10-EeV region.