Suborbital Detection of Nanosecond Radio Transients from Ultra-High Energy Particles with ANITA

Peter W. Gorham
Dept. of Physics & Astronomy, Univ. of Hawaii at Manoa, Honolulu, HI 96822

Ultra-high energy cosmic rays and neutrinos produce ultra-wideband radio transients in the terrestrial atmosphere and cryosphere of Earth. When an ultra-high energy particle interacts with the terrestrial medium it produces a shower of particles that radiate coherently in time scales of a nanosecond. Neutrino induced showers in ice accumulate a charge excess of particles traveling faster than the speed of light in the medium which produce coherent Cherenkov radiation, a process known as the Askaryan effect. Ultra-high energy cosmic ray induced extended air showers undergo separation of positive and negative charges by the geomagnetic field producing coherent radio transients.

The Antarctic Impulsive Transient Antenna (ANITA) is a long-duration balloon-borne antenna array that operates in the 200–1200 MHz range aimed at detecting these transients with the goal of engendering UHE particle astronomy. ANITA has successfully completed two flights around the Antarctic continent and is scheduled for a third flight in 2013 December. The first two flights of ANITA have produced the most stringent limits on ultra-high energy neutrino fluxes to date while detecting pulses from ultra-high energy cosmic rays reflected on the Antarctic ice-sheet. We report on the phenomenology of the radio emission from these events, the methodology for their detection and selection from among anthropogenic backgrounds, and results from the two ANITA flights.

Future efforts to exploit these methods include ANITA-3 and possible successors, as well as proposed orbital platforms. The latter will face challenges in dealing with ionospheric dispersion, but the payoff will be an enormous increase in sensitivity.