Identification of neutrino flavor in the ANITA experiment

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introduction

If a charged lepton experiences a hard energy loss in a dense transparent medium such as ice, the particle shower resulting from the energy transfer produces a coherent radio Cherenkov pulse. For shower energies greater than $\sim 10^{19}$ eV, the radio pulse can be detected by ANITA. Because the cross sections of bremsstrahlung, pair production, and photonuclear interactions depend on the flavor and energy of a charged lepton, the distribution of the showers can indicate the flavor and energy of the neutrino. A Monte Carlo simulation has been developed with a focus on multiple bang events, which are neutrinos that produce more than one detectable radio pulse.

example of shower distributions for the 1st km in ice

<table>
<thead>
<tr>
<th>Flavor</th>
<th>Energy (eV)</th>
<th>Pulses</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\nu_e$</td>
<td>$10^{19}$</td>
<td>3</td>
</tr>
<tr>
<td>$\nu_x$</td>
<td>$10^{20}$</td>
<td>2</td>
</tr>
<tr>
<td>$\mu^\pm$</td>
<td>$10^{20}$</td>
<td>1</td>
</tr>
<tr>
<td>$\tau^\pm$</td>
<td>$10^{20}$</td>
<td>1</td>
</tr>
</tbody>
</table>

simulated wave forms for a triple bang event

- 3 radio pulses
- detector triggered twice
- wave forms shown for the 6 antennas that are hit most directly by the pulses

average time between pulses

- ice shelves used as the target
- $10^{20}$ eV
- time between pulses can be > 3000 ns
- similar distribution at other energies
- large number of events required to determine the flavor ratio

pulses per event

- ice shelves used as the target
- 1:1:1 flavor ratio
- on average, more pulses per event at higher neutrino energy
- large number of events required to determine the spectrum based only on the number of pulses per event