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General Treatment of Reflection of Spherical Electromagnetic Waves from the Spherical, Uneven Antarctic Surface and its Implications for the Mystery Events detected by ANITA detector.

Sunday 13 October 2019 10:50 (20 minutes)

The NASA sponsored balloon-borne ANITA detector operating in Antarctica is designed to detect ultra high energy cosmic rays (UHECR) with energies exceeding 1 EeV (10^{18} eV) by collecting the radio pulse generated through the interaction of the primary particle with Earth's atmosphere. The radio pulse is detected after reflection from the Antarctic ice surface. For calibration and measurement of surface reflectivity, the balloon-borne HiCal radio-frequency (RF) transmitter is used. Here we are interested in determining the mean value of reflection coefficient over the range of frequencies which are of interest in HiCal observations.

In this talk, I will discuss a general formalism that we have developed to treat reflection of spherical electromagnetic waves from a spherical surface. Our main objective is interpretation of radio wave signals produced by cosmic ray interactions with Earth's atmosphere which are observed by the Antarctica based ANITA detector after reflection off the ice surface. The incident wave is decomposed into plane waves and each plane wave is reflected off the surface using the standard Fresnel formalism. For each plane wave the reflected wave is assumed to be locally a plane wave. This is a very reasonable assumption and there are no uncontrolled approximations in our treatment of the reflection phenomenon. The surface roughness effects are also included by using a simple model. We apply our formalism to the radiation produced by the balloon-borne HiCal radio-frequency (RF) transmitter. The final results for the reflected power are found to be in good agreement with data for all elevation angles. We also study the properties of reflected radio pulses in order to study their phase relationship with direct pulses. We find that for some roughness models the pulse shape can be some what distorted and may be misidentified as a direct pulse. The effect of various surface roughness models on the pulse shape will also be discussed. In this talk, I will also explain that our proposed roughness model, suitable for actual Antarctic surface topography is able to provide an explanation for the observed mystery events by ANITA.

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