ID de la contribución : **186** Tipo : **Talk**

Observation of In-ice Askaryan Radiation from High-Energy Cosmic Rays

jueves, 6 de noviembre de 2025 17:45 (15)

We present the first experimental evidence for in-ice radiofrequency emission from cosmic-ray-induced high-energy particle cascades developing in the Antarctic ice sheet. In 208 days of data recorded with the phased-array trigger of the Askaryan Radio Array, we detect 13 events with impulsive radiofrequency pulses originating from below the ice surface. Considering only the arrival angles and timing properties, this rate is inconsistent with the a-posteriori expectation of the combined background from thermal noise events and impulsive on-surface events at the level of 3.5 , rising to 5.1 when additionally considering impulsivity. The observed event geometry, event rate, signal shape, spectral content, and electric field polarization are consistent with Askaryan radiation from cosmic ray air shower cores impacting the ice sheet. For the brightest events, the angular radiation pattern independently favors an extended cascade-like emitter over a pointlike source.

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Clasificación de la sesión : Cosmic Rays

Clasificación de temáticas : Cosmic Rays