



Probing Atmospheric Electric Fields through Radio Emission from Cosmic-Ray-Induced Air Showers

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Energetic cosmic rays impinging on the atmosphere create a particle avalanche called an extensive air shower. In the leading plasma of this shower electric currents are induced that generate coherent radio wave emission that has been detected with LOFAR, a large and dense array of simple radio antennas primarily developed for radio-astronomy observations. Our measurements are performed in the 30-80 MHz frequency band.

For fair weather conditions the observations are in excellent agreement with model calculations. However, for air showers measured under thunderstorm conditions we observe large differences in the intensity and polarization patterns from the predictions of fair weather models. We will show that the linear as well as the circular polarization of the radio waves carry clear information on the magnitude and orientation of the electric fields at different heights in the thunderstorm clouds. We will show that from the measured data at LOFAR the thunderstorm electric fields can be reconstructed.

We thus have established the measurement of radio emission from extensive air showers induced by cosmic rays as a new tool to probe the atmospheric electric fields present in thunderclouds in a non-intrusive way.

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