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Measuring and parameterizing the two-dimensional pattern of radio emission in air showers with LOFAR

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The detection of radio emission of air showers has rapidly advanced in the past years. New experiments have shed light on the details of the emission and air shower simulations provide rather accurate models of the measured emission. To exploit radio emission in large-scale experiments, a simple and analytic parametrization of the distribution of the radio signal at ground level is needed. Such a parametrization can allow for fast calculations of the expected signals and can be used to reconstruct the geometry of the measured air showers. Data taken with the Low- Frequency Array (LOFAR) show a complex two-dimensional pattern of pulse powers, which is sampled with hundreds of antennas per event. Earlier parametrizations of the lateral signal distribution have proven insufficient to describe these highly detailed data.

We present a two-dimensional model with five free parameters derived from air-shower simulations. All parameters show strong correlations with air shower properties, such as the energy of the shower, the arrival direction, and the height of the shower maximum. This parametrization represents the data taken with LOFAR very accurately. We present the application of this method to LOFAR data and discuss implications for the reconstruction of the shower geometry.

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