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Reconstruction of the parameters of cosmic ray induced extensive air showers using radio detection and simulation

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Cosmic rays have a wide energy spectrum and their flux decreases quickly with the energy. For the most energetic events (above 10^{17} eV), the mass composition is not well known, due to shower to shower fluctuations. The knowledge of the mass composition would allow us to constrain theoretical models which predict different types of source and acceleration mechanism according to the mass of the particle. The only way to study such rare events is to observe the extensive air shower (EAS), composed of the secondary particles produced in the atmosphere after the interaction between the primary cosmic ray and the atmosphere's constituents. The EAS is mainly composed of electrons, positrons and photons. Different ways of detection exist to determine the EAS parameters. The fluorescence detectors receive the light emitted by the atmosphere constituents after being excited by the EAS charged particles. Cerenkov tanks and plastic scintillators sample the particles on the ground. Radio antennas record the electric field emitted by the electrons and positrons of the shower. These detection methods are able to reconstruct some of the EAS parameters such as the energy of the primary particle, its arrival direction, the EAS core position on the ground and the atmospheric depth at which the number of particles is maximum (Xmax). The radio signal is now quite well understood and its description via the simulation is successful. In this context, the reconstruction method described in this contribution is based on a detailed comparison between the simulated radio footprint and the one sampled by an array of antennas. The method is sensitive to the Xmax value which is strongly correlated to the primary mass. We finally show how the radio detection is able to reconstruct all the EAS parameters on its own.

Collaboration

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