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Cosmic Rays in Thunderstorms

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Cosmic rays are protons and heavier nuclei that constantly bombard the Earth's atmosphere with energies spanning a vast range from 10^9 to 10^{21} eV. At typical altitudes up to 10-20 km they initiate large particle cascades, called extensive air showers, that contain millions to billions of secondary particles depending on their initial energy. These particles include electrons, positrons, hadrons and muons, and are concentrated in a compact particle front that propagates at relativistic speed. In addition, the shower leaves behind a trail of lower energy electrons from ionization of air molecules.

Under thunderstorm conditions these electrons contribute to the electrical and ionization processes in the cloud. When the local electric field is strong enough the secondary electrons can create relativistic electron run-away avalanches [1] or even non-relativistic avalanches. Cosmic rays could even trigger lightning inception. Conversely, strong electric fields also influence the development of the air shower [2].

Extensive air showers emit a short (tens of nanoseconds) radio pulse due to deflection of the shower particles in the Earth's magnetic field [3]. Antenna arrays, such as AERA, LOFAR and LOPES detect these pulses in a frequency window of roughly 10-100 MHz. These systems are also sensitive to the radiation from discharges associated to thunderstorms, and provide a means to study the interaction of cosmic ray air showers and the electrical processes in thunderstorms [4].

In this presentation we discuss the involved radiation mechanisms and present analyses of thunderstorm data from air shower arrays

[1] A. Gurevich et al., Phys. Lett. A 165, 463 (1992)
[2] S. Buitink et al., Astropart. Phys. 33, 1 (2010)
[3] H. Falcke et al., Nature 435, 313 (2005)
[4] S. Buitink et al., Astron. & Astrophys. 467, 385 (2007)