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The synergy between High-energy Physics in Atmosphere and Cosmic Ray Physics

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Last decade the research in high-energy physics in the atmosphere (HEAP) was mostly concentrated on measuring the particle fluxes from the electrified atmosphere (thunderstorm ground enhancements, TGEs, and Terrestrial gamma flashes, TGFs) and revealing their origin. Afterward, in 2021 started the research of the atmospheric electric fields using particle fluxes traversing thunderstorms and registering on the earth's surface with particle spectrometers. The new approach gives very interesting results, sometimes contradicting the common knowledge on the vertical profile of atmospheric electric field, however, supported by the exact methods of particle physics and well-established theories of the electromagnetic interactions.
First of all, it was confirming of a model of electron acceleration in the strong atmospheric electric fields [1]. Then using the largest TGEs obtained on Aragats and Lomnicky Stit we estimated the maximum achievable potential drop (voltage) on these summits to be consequently 300 and 500 MV [2,3]. Afterward, we use the modulation of the "muon beams" by strong atmospheric electric fields to investigate the disturbances of the atmospheric electric field [4]. Finally, profiting from the 24/7 operation of the Aragats Solar neutron spectrometer (ASNT), we develop a methodology for the remote monitoring of the vertical profile of electric field in thunderclouds [5]. Thus, the synergy of cosmic ray and atmospheric physics allows explaining all types of particle bursts within one framework, i.e., as consequences of extensive air showers.
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