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The Pierre Auger Observatory: Studying atmospheric electricity with cosmic-ray detectors

The Pierre Auger Observatory, designed to detect extensive air showers (EAS) generated by ultra high energy cosmic rays, proved to be a unique instrument to study phenomena associated with atmospheric electricity as Terrestrial Gamma-ray Flashes (TGFs) and ELVES. TGFs are the most explosive events emitted by thunderstorms and have been usually observed by spacecraft, but the Auger surface detector have collected events with a morphology very different from that proper of EAS, that are likely downward TGFs. Ground observations are a crucial addition to detection in space, as detectors are closer to TGF sources, and a single event can be observed with several instruments which are complementary one to another. In this talk, I will discuss the comparison of the already collected data with simulations as well as the on-going work to adapt the data-taking system to detect TGFs. I will also discuss the status of the study of ELVES, upper atmospheric optical phenomena associated with thunderstorms, which we have detected since 2013 with the fluorescence detectors. We have recorded with unprecedented time and space resolution both single and double ELVES, the latter being classified using radial variation of the time gap and the photon flux ratio between flashes. The detection and classification algorithms were improved by detecting ELVES from closer lightning thanks to the three High Elevation Auger Telescopes, which observe the night sky with an enhanced time resolution at elevation angles between 30 and 60 degrees.

Primary authors: COLALILLO, Roberta; FOR THE PIERRE AUGER COLLABORATION

Presenter: COLALILLO, Roberta