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Production mechanisms of multiple primaries for Cosmic Rays Showers

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We investigate the physical mechanism of the GZ-effect that could explain the production of multiple primaries from an event initiated outside the Earth's atmosphere. In this case, there would correspondingly be multiple extensive air showers in temporal coincidence at ground, even for detectors separated by many kilometers, and also showers initiated by primaries of different energies could consequently have a common source. We analyse the perspectives and limits of some models and discuss the experimental counterparts.

1. Introduction

The history of a Cosmic ray from the production point and through the acceleration sites undergoes many changes in velocity and eventually in chemical structure. The nature of such a primary, either a heavy nucleus or proton or gamma-ray or whatever, influences strongly the byproduct of its interaction with the medium: interstellar matter, Cosmic Microwave Background photons (CMB) or local interstellar/intergalactic/galactic magnetic fields [**?**, **?**, **?**, **?**, **?**]. A great interest is therefore devoted to understanding the abundances of protons and relative chemical composition of the CR's flux, in terms of other elements or ions.
Among the various kinds of projectiles hitting the Earth's atmosphere, we will consider the fragments deriving from the photo disintegration of heavy nuclei (for example Fe) when interacting with the solar magnetic field [**?**]: the crucial aspect of this fragmentation relies in the possibility of detecting on Earth two (or eventually more) of them. In fact, the influence of the solar field permeates the space surrounding the Sun up to distances limited to 3 or 4 AU. This relatively small volume allows the fragments to arrive on Earth almost simultaneously and spaced ranging some up to few thousands Km. Thus, the Extensive Air Showers (EAS) generated by the two projectiles when hitting the atmosphere would be temporally as well spatially correlated and detectable when having many detectors placed at different distances, some closely and some widely spaced.
The arrival rate computed in the present paper heavily depends on the energy of the incoming particles and for this reason we include in our estimate small variations (some units) providing important differences in the expectation values.
What is strongly encouraging in the experimental search for this peculiar phenomena is the possibility of being detected by the new experiment "Extreme Energy Events" (EEE) which is starting in Italy [**?**]. In fact, the disposition of the particle detectors is planned inside numerous High Schools over all the Italian territory (about 300.000 Km^2), more densely inside the cities, from south to north.

2. Heavy primaries and correlation

2.1 Spatial and temporal correlation

The study and the detection of (ultra-)high energy CRs in temporal coincidence is based on the energy of the primaries, the time difference between the two (or more) events, the reconstructed arrival directions, the possible source or set of sources. Each of these patterns is strongly related to the others, and the accuracy in reconstructing a specific air shower puts forward experimental results paired with theoretical shortcomings.