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Fluctuations in the development of EAS: problems and possible solution.

This paper proposes an approach that improves the accuracy of reconstructing the primary energy at ground-based cosmic-ray stations. The problems of determining the primary energy caused by large fluctuations in the development of an extensive air shower are considered in detail.
The information obtained during the study of EAS is of a very indirect nature, since the first interaction of a cosmic particle occurs in the upper layers of the atmosphere. As a result, experimenters usually operate not with single events, but with an ensemble of showers divided into groups by the number of electrons at the observation level, which is proportional on average to the energy of the primary particle. During the analysis, the average characteristics of a group of showers are compared with model calculations, which are usually based on the parameters of an elementary act from accelerator data.
However, the number of secondary particles recorded at the observation level depends on a sufficiently large number of parameters characterizing the development of EAS in the Earth's atmosphere. The most significant are: the primary energy, which determines the amplitude of the shower maximum; the mass of the primary particle, which determines the position of the shower maximum in the depth of the Earth's atmosphere; the zenith angle, which determines the thickness of the atmosphere that the EAS overcomes to the observation level; fluctuations in the development of EAS in the atmosphere.
Thus, determining the primary energy only by the number of electrons at the observation level leads to significant errors.
To solve this problem, the paper proposes a technique that allows suppressing the influence of fluctuations in the development of EAS on the assessment of the energy of primary particles. The proposed approach is based on the use of certain invariant curves, the behavior of which does not depend on the zenith angle, fluctuations in the development of EAS and weakly depends on the mass of the primary particles. This allows, firstly, to significantly reduce errors in determining the primary energy and, secondly, to analyze individual showers.
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