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Observation of the Cosmic Ray Moon shadowing effect with ARGO-YBJ

The ARGO-YBJ Collaboration

(Submitted on 25 Jul 2011)

Cosmic rays are hampered by the Moon and a deficit in its direction is expected (the so-called \emph{Moon shadow}). The Moon shadow is an important tool to determine the performance of an air shower array. Indeed, the westward displacement of the shadow center, due to the bending effect of the geomagnetic field on the propagation of cosmic rays, allows the setting of the absolute rigidity scale of the primary particles inducing the showers recorded by the detector. In addition, the shape of the shadow permits to determine the detector point spread function, while the position of the deficit at high energies allows the evaluation of its absolute pointing accuracy.
In this paper we present the observation of the cosmic ray Moon shadowing effect carried out by the ARGO-YBJ experiment in the multi-TeV energy region with high statistical significance (55 standard deviations). By means of an accurate Monte Carlo simulation of the cosmic rays propagation in the Earth-Moon system, we have studied separately the effect of the geomagnetic field and of the detector point spread function on the observed shadow. The angular resolution as a function of the particle multiplicity and the pointing accuracy have been obtained. The primary energy of detected showers has been estimated by measuring the westward displacement as a function of the particle multiplicity, thus calibrating the relation between shower size and cosmic ray energy. The stability of the detector on a monthly basis has been checked by monitoring the position and the deficit of the Moon shadow.
Finally, we have studied with high statistical accuracy the shadowing effect in the "day"/"night" time looking for possible effect induced by the solar wind.

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