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The complex nature of the abnormally weak absorption of cosmic ray hadrons in lead calorimeters at superhigh energies [Online]

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In the course of further processing of data from two similar cosmic ray experiments, carried out in the Tien Shan and Pamir mountains using calorimeters, represented by 2-tier X-ray emulsion chambers (XRECs) with large air gaps (2.12 and 2.5 m, respectively), were obtained distributions of numbers of blackening spots, created by electron-photon cascades (EPCs) on X-ray films, according to the hadron observation depth in the chamber.

These distributions, in principle, are in good agreement with each other, taking into account other smaller differences in the design of the two XRECs, different sensitivities of the films used, as well as different depths of the XREC location in the Earth's atmosphere (3340 m and 4370 m, respectively).

On the other hand, the obtained experimental distributions are also well reproduced by model calculations performed within the framework of the phenomenological model of strong interactions FANSIY 1.0, which takes into account the production of charmed hadrons and the rapid increase in their production cross section with the energy of colliding particles, observed in the LHC experiments. Computer modeling of experiments also include detailed simulations of the response of XREC of a particular design.

In particular, taking into account the production of charmed hadrons, which effectively decay in the air gap between two lead blocks of the calorimeter through electromagnetic channels with the emission of electrons and gammas, makes it possible to qualitatively and quantitatively describe the experimentally observed peak in the distribution curves at a depth of t_0 = 9.0 c.u. The amplitude of this peak, sensitive to the cross section for the production of charmed particles, makes it possible to conclude that the cross section σ_{pp→cc̄} ˜ 8 mb at <E$_{Lab}$ > ˜$75TeVandatx\_\{Lab\}$ 0.1.

An unexpected result of both experiments was an excess of blackening spots, apparently formed by some unconventional hadrons (possibly strangelets), at great depths of the lower lead blocks (in particular, at t_0 = 29.0 c.u. and t_0 = 120.0 c.u., respectively). This result needs more careful study and analysis.

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