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HE Stratosphere Event of 1975 Revisited: the Difference between the Patterns of Astroparticle Interaction and LHC Nucleus-Nucleus Collision

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The event of astroparticle collision at high energy was detected in 1975 during the balloon flight in the stratosphere. In this paper the data have been re-analyzed in the style of LHC experiments: rapidity distributions of charged particles and transverse mass spectra of multi-particle production have been built. The comparison of multiple histograms with the expectations of the Quark-Gluon String Model (QGSM) gives us, at the first sight, the conclusion that it is the carbon-nucleus collision with the matter of atmosphere at the c.m.s. equivalent energy $\sqrt{s} \geq 5$ TeV. Nevertheless, the data indicate some features that cannot be associated with nucleus-nucleus collision: a small nucleon population has been seen in the region of projectile fragmentation that is impossible for carbon interaction. In addition, one particle with transverse mass 16 GeV was detected, which just cannot be any known hadron. Both facts make us convinced that there may be baryonium DM decay [9]. Baryonium DM particles are to be formed at the huge gravitation pressure around giant massive objects like Black Holes. The important difference between this form of matter and the ordinary nucleus lies in the structure function of nucleons in the colliding projectile: nuclei are just nucleon conglomerates, while a baryonium DM is the object, where protons and antiprotons are strongly connected, like quarks in the proton. Baryonium DM can also split into the pair of similar DM particle with lower mass of 14 GeV plus a number of baryons that collide with atmosphere in the ordinary way.

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1. Introduction

Nowadays, the collider experiments are based on the concrete predictions of contemporary theories. In this case, any research seems unable to meet an observation of unpredicted new particles or phenomena. An impressive event of HE interaction was detected long ago at the balloon flight in stratosphere [1]. This event was re-analyzed recently with the methods of data presentation of the LHC collider experiments. We hardly distinguish the type of produced particles as well as the signs of their charge. But the Model of Quark-Gluon Strings (QGSM) [2–4] gives us the idea about how the rapidity spectra of hadroproduction looks like in the full rapidity interval of projectile fragmentation. The QGSM was developed in the early 80'th for the purpose of complementary studies of HE fixed target hadron collisions in cosmic ray physics as well as of p-p and A-A interactions at colliders. Rapidity spectrum has to show protons at the energy area of triple-pomeron peak, as it was predicted in [5]. The analysis of transverse coordinates of detected particles represents the transverse mass distribution of hadrons, which are produced in the different intervals of rapidity.

2. Short description of detector and registration of particle tracks

The balloon flight took place on the attitudes around 30 kilometers for 160 hours. The size of detector was 400mmX500mm and 260mm high. Detector consisted of three cameras: upper target block, spacer, and calorimeter. The electron-photon cascades from secondary hadrons have been developed in the lead layers of the calorimeter and detected as the dark spots in the x-ray films. The spot with certain darkness gives us the energy of the particle produced in the interaction. A more detailed description can be found in the preprint [10]. The positions of 106 observed dark spots are recorded.

3. Rapidity distribution: the particle production at the central rapidity and in the forward fragmentation area

The primary data that we can extract from the table of coordinates and energies of visible tracks are transverse masses and rapidities, $Y = -0.5 * \ln((E - Pl)/(E + Pl)) = -\ln M_t/(2E)$, where $M_t = \sqrt{Pt^2 + M_0^2}$, E, Pl and Pt are energy and momenta of particle and M_0 - its mass. Transverse masses, M_t, have been calculated from energy, coordinates of particle track and the distance from the collision point.

As it was compared with collider distribution, the point near Y_{lab}=7.5 corresponds to the center of rapidity. Two regions of this distribution are interesting from the point of view of contemporary hadroproduction physics: central part of histogram gives us the density of produced hadrons, dN^h/dY at $Y_{cms} = 0$, and the area of forward hadroproduction helps to estimate the maximal rapidity of secondary protons Y^p_{max}, which depends on the energy of collision per one proton. The density of particles near $Y_{cms} = 0$ shows how many protons are collided that gives us the atomic number of a projectile nucleus. We can conclude that $dN^h/dY_{cms}(0) \geq 28$. In addition, we estimate the energy, $\sqrt{s}$, for proton-proton collision that can be calculated from $Y^p_{max} = ln(2\sqrt{s}/M_p) = 7$. The energy per one proton equals to 500 GeV approximately. In such a way, we should have the hadron multiplicity per a pair of interacting protons of the order 5.0, as it is compared with the LHC plot [6] for A-A collisions. It means that the projectile nucleus, A=2*(28/5.), was carbon (12 nucleons).

4. Transverse mass distributions

Actually, in this experiment, we cannot distinguish a type and a charge of particle, but their transverse masses, M_t, can be calculated. The partial histograms show the transverse mass distribution split between a) central rapidity region figure 1left and b) forward fragmentation area, right. Two forward tracks have masses near 1 GeV, which is the signature of proton from triple-pomeron

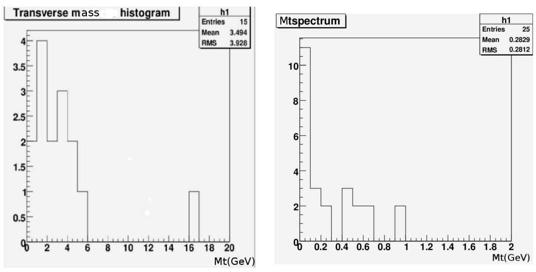

Figure 1: Transverse masse distribution in central rapidity area, $Y_{cms} \leq 2$, left, and in the region of forward fragmentation region, $Y_{cms} \geq Y_{max} - 3$, right.

peak that naturally exists at the end of inclusive spectra of protons [3]. The central rapidity spectrum of transverse masses in figure 1 shows M_t's in the range from 0 to 6 GeV that corresponds to typical masses of hadrons, excepting one track with the transverse mass 16 GeV. In this study, we have registered three phenomena that are not predicted. 1) The density of multiplicity, which is given by a projectile in the forward and the central rapidity regions, disagree: the central density of produced particles reports about carbon-nucleus interaction, while the presence of only two protons in the three-pomeron peak tells us that the projectile was helium. 2) The particle was detected with M_t=16 GeV that is more than any known hadron masses and cannot be explained by gluon-gluon fusion. It is natural to expect also a second particle with a similar high transverse mass, which was obviously lost beyond the scope of detector. 3) The rapidity distribution with smaller binning, see [10], shows few rapidity peaks of triple-Pomeron type in the spectrum. Such feature belongs to strongly connected nucleon system decayed for few hadrons with different masses. All these signatures may declare on the interaction of new heavy QCD particle, such as baryonium Dark Matter [9].

5. Conclusions

The analysis of hadroproduction event in the stratosphere has been carried out in the framework of QGS Model. The rapidity and transverse mass distributions have been compared with the spectra that are measured at LHC. The conclusions are as following: 1) The value of central multiplicity corresponds to carbon nucleus (12 nucleons) collision with the CNO nucleus of the atmosphere.

The maximal rapidity corresponds to the energy per nucleon of the order of 500 GeV in the center-of-mass system. 2) Two particles have transverse mass near 1 GeV and are interpreted as protons that contribute into the visible peak at the end of rapidity spectrum. Two protons in this peak hardly correspond to carbon collision. 3) One track with M_t=16 GeV shows the outstanding value of transverse mass that is far from the mass range of all other well known hadrons. This makes us concluded that a new state of hadron matter can exist at masses near 14 GeV. These heavy neutral hadronic states are good candidates for Dark Matter. The high-altitude cosmic ray experiments should be continued, on one hand, as a good supplement to the LHC measurements. On the other hand, they can observe first collision of baryonium DM particle in the entire kinematical region that is not available for colliders.

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