HE stratosphere event of 1975 revisited: new physics vs. LHC nucleus-nucleus collision

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Outline

I. High energy event in balloon experiment 1975
II. Introduction into the event analysis
III. Target diagram and lost tracks
IV. Rapidity distribution => interacting nucleus, energy of collision, multiplicity at $Y=0$
V. Transverse mass distributions => hadron multiplicity at central rapidity and particles in the forward region
VI. Where is new physics?
VII. Heavy neutral hadron states and toroidal baryonium
VIII. Conclusion

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The high energy interaction event was detected at 30km in stratosphere. The size of detector was 400mmX500mm and 260mm high. Detector consisted of three cameras: upper target block, spacer and calorimeter. The total thickness of calorimeter corresponds to 0.26 of free pass without hadron interaction that means the efficiency of particle track detecting is of order 40%.

The electron-photon cascades from secondary hadrons have been developed in the lead layers of calorimeter and detected in the x-ray films as the dark spots. The spots with the certain darkness give us the energy of secondary particles. The data are: x,y coordinates and \( E_{\text{spot}} \) for 106 particles.

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I. At least three particles were discovered unpredictably in cosmic rays: positron - 1929 (Dmitri Skobeltsyn), muon - 1932 (Carl Amerson and Seth Neadermeyer) and kaon – 1947.

II. Impressing event of the energy $E_{\text{lab}} > 100\text{TeV}$ was detected in 1975 at the balloon flight in stratosphere. It was re-analyzed with the methods of LHC collider experiments and knowledge obtained with QGSM.

I. Two possibilities are examined. Event is similar to nucleus-nucleus collision at LHC (we know only about central kinematical region) or it is unknown astroparticle interaction in atmosphere (we afford some suggestions).

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Target diagram and lost particles

Forward particles are also influenced with the detector edge

Total number of visible tracks is 106

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Rapidity distribution

a) Central multiplicity > 28
b) Maximal rapidity ~ 7-8 from center

Y_{max} corresponds to the energy of one proton-proton collision \( \sim 400-600 \text{ GeV} \) => average multiplicity = 5.

\[ \frac{28}{5} = 5.5 \] proton pairs that means the projectile nucleus was C (12 nucleons), or more!

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Transverse mass distributions

We can not distinguish between Pt and mass of hadrons

\[ M_t = \sqrt{(P_t^2 + M_0^2)} \]

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Where is new physics?

One track with $M_t = 16$ GeV

3 peaks in the rapidity distribution can be just the interaction of 3 parts from initial nucleus, but in this case there should be at least 3 protons in diffraction peak near $Y_{max}$

Suggestion: the baryonium particle decays in 3 parts. Two parts went into light particles of $\sim 14$ GeV mass and last one interacts like a helium+liithium nuclei. In this case second peak should bring 4 protons.

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State of art with the forward spectra at LHCf

Figure 5. Differential neutron production cross sections at $\eta > 10.76$ (left) and $9.22 > \eta > 8.99$ (right) in 13 TeV p-p collisions measured by the LHCf Arm2 detector [19]. Colored histograms are predictions by QGSJET II-04 (blue), EPOS-LHC (magenta), DPMJET 3.06 (red), PYTHIA 8.212 (orange) and SIBYLL 2.3 (green) generators.
Suggestions about mass

The extension of the mass sequence provides the hadron states with the following masses: 13.7, 37.3, 101.5, 276, 750 GeV etc.

The mass points between meson and baryon states in each flavor generation go with the following sequence:

\[ M_n = 0.258 \times e^{(n-1)} \]

(arXiv.org:1908.10759)

\[ M_t = \sqrt{((9)^2 + (13.7)^2)} = 16.37 \text{ GeV} \]

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Toroidal baryonium states (arXiv:1702.02769)

String Junction brings baryon charge up to Ymax

Toroidal structures at space observations near SMBH

Baryon/antibaryon junction hexagon

The only way to cover the torus with the SJ (string junctions) net is hexagon (honey comb).

Hexagon net is similar to graphene (graphene tubes etc.), thanks to M. Polikarpov and colleagues.
Conclusions

I. The hadroproduction event (Elab>100TeV) in stratosphere has been analyzed in the framework of up-to-date conventions about HE p-p and A-A interactions at colliders, see arXiv/1907.00176.

II. The inclusive distributions have been compared with the spectra at LHC:
   a) rapidity distribution show high density of secondary particles in central region that corresponds at least to carbon - air collision. The target nucleus fragmentation is not seen due to small detector, maximal rapidity corresponds to Vs = 400-600 GeV per proton;
   b) transverse mass distribution for forward particles shows 2 protons that corresponds to three pomeron peak. The distribution in the central region gives typical hadron masses and one particle with Mt=16 GeV.

III. Few disagreements with theoretical expectations give a room for the suggestions on new physics.

IV. The improved experiment on high level in atmosphere is desirable, as well as the LHC FP experiment with carbon-carbon collision of high energy.

P.S. Even one event of this sort seems rather informative for HE physics.

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Thank you for the attention!