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

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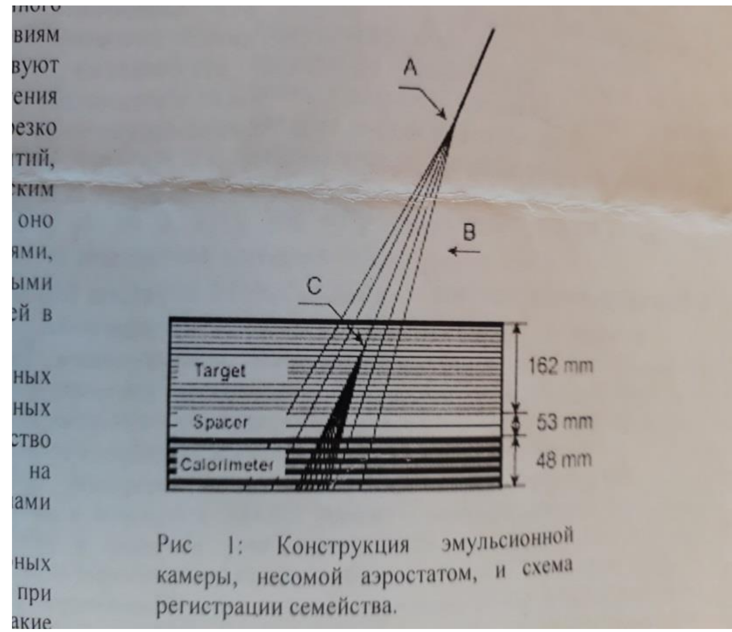
Outline

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

HE event in balloon flight 1975

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_{spot} for 106 particles.

Introduction

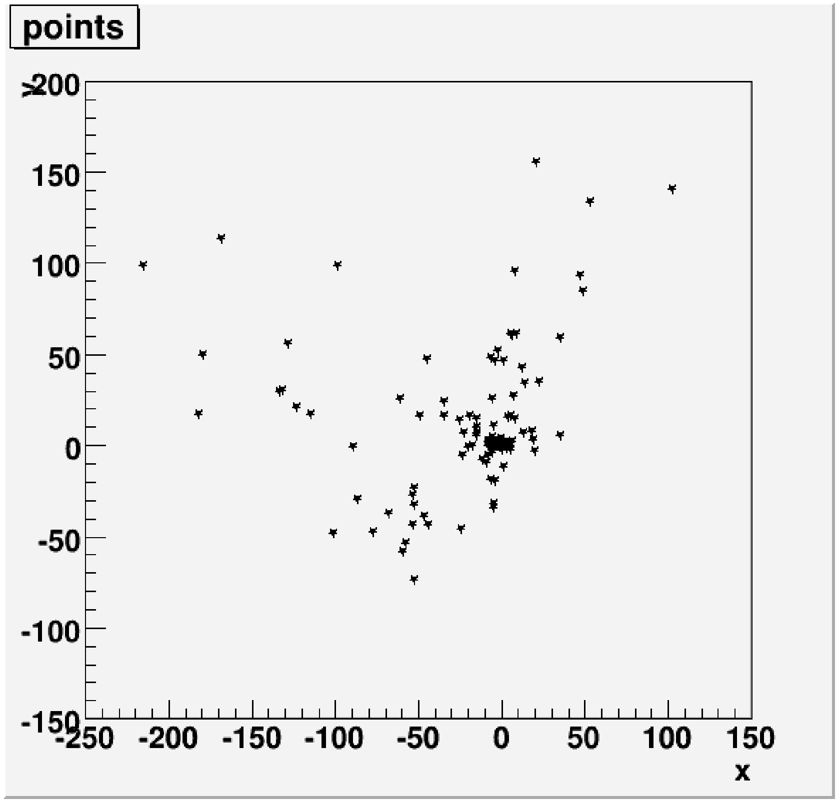
I. At least three particles were discovered unpredictably in cosmic rays: positron - 1929 (Dmitri Skobeltsyn), muon - 1932 (Carl Amerson and Seth Neadermeyer) and kaon – 1947.

II. Impressing event of the energy E_lab > 100TeV 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.

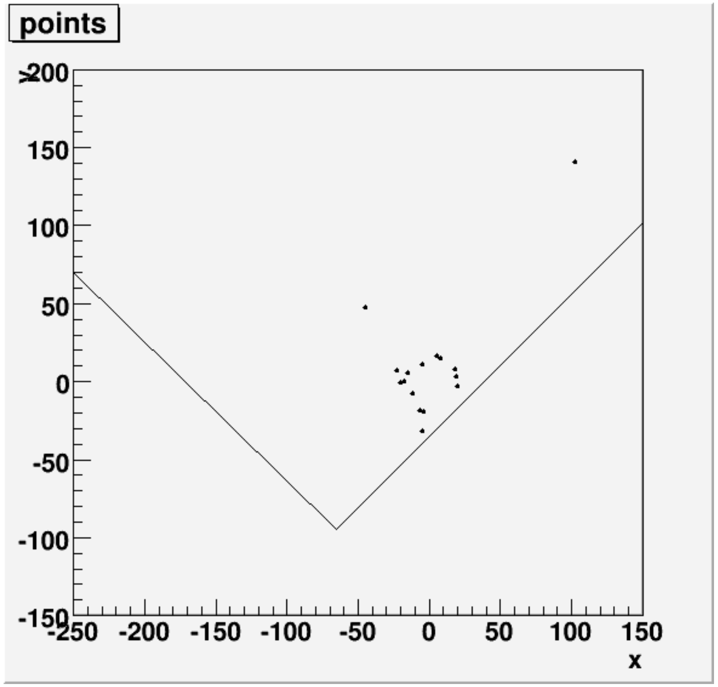
I. Two possibilities are examined. Event is similar to nucleus-nucleus collision at LHC (we know only about central kinematical region) or it is unknown astroparticle interaction in atmosphere (we afford some suggestions).

Target diagram and lost particles

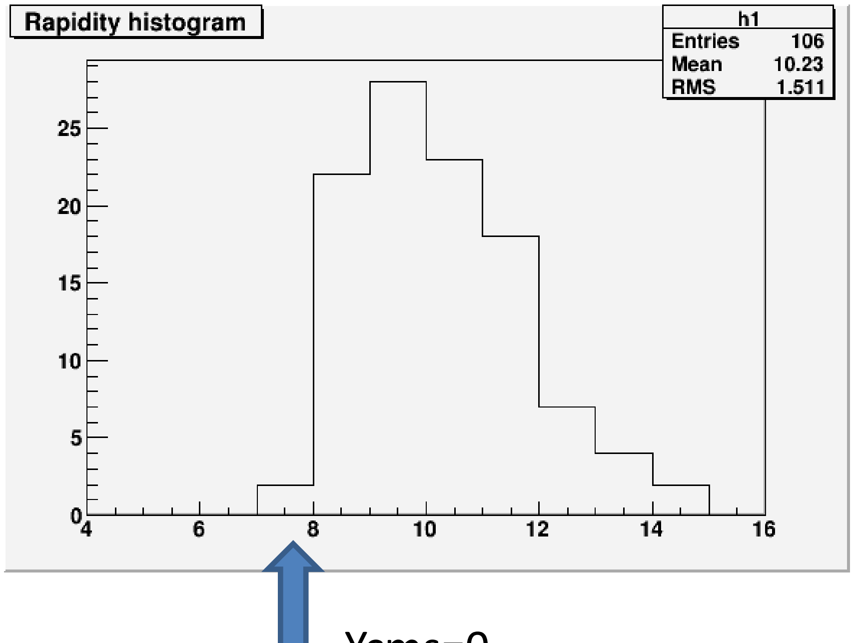


Total number of visible tracks is 106

Forward particles are also influenced with the detector edge



Rapidity distribution



Ycms=0

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

c) Ymax corresponds to the energy of one proton-proton collision ~400-600 GeV => average multiplicity = 5.

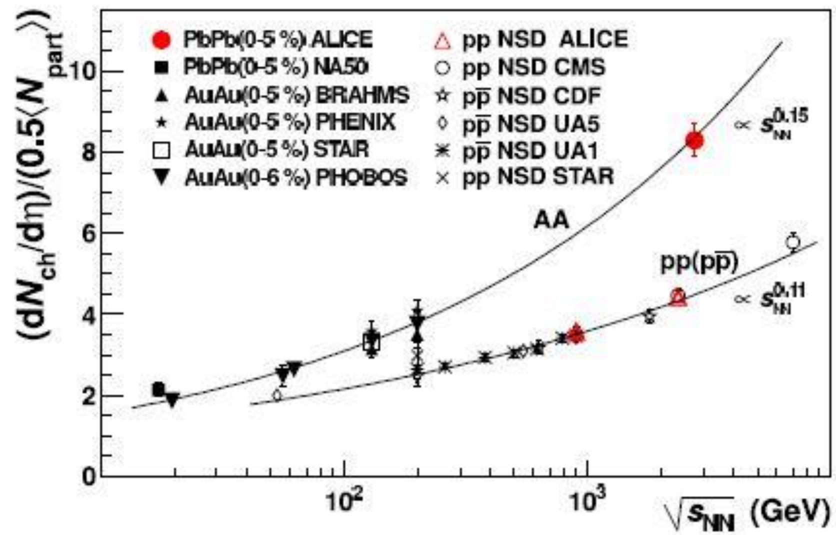
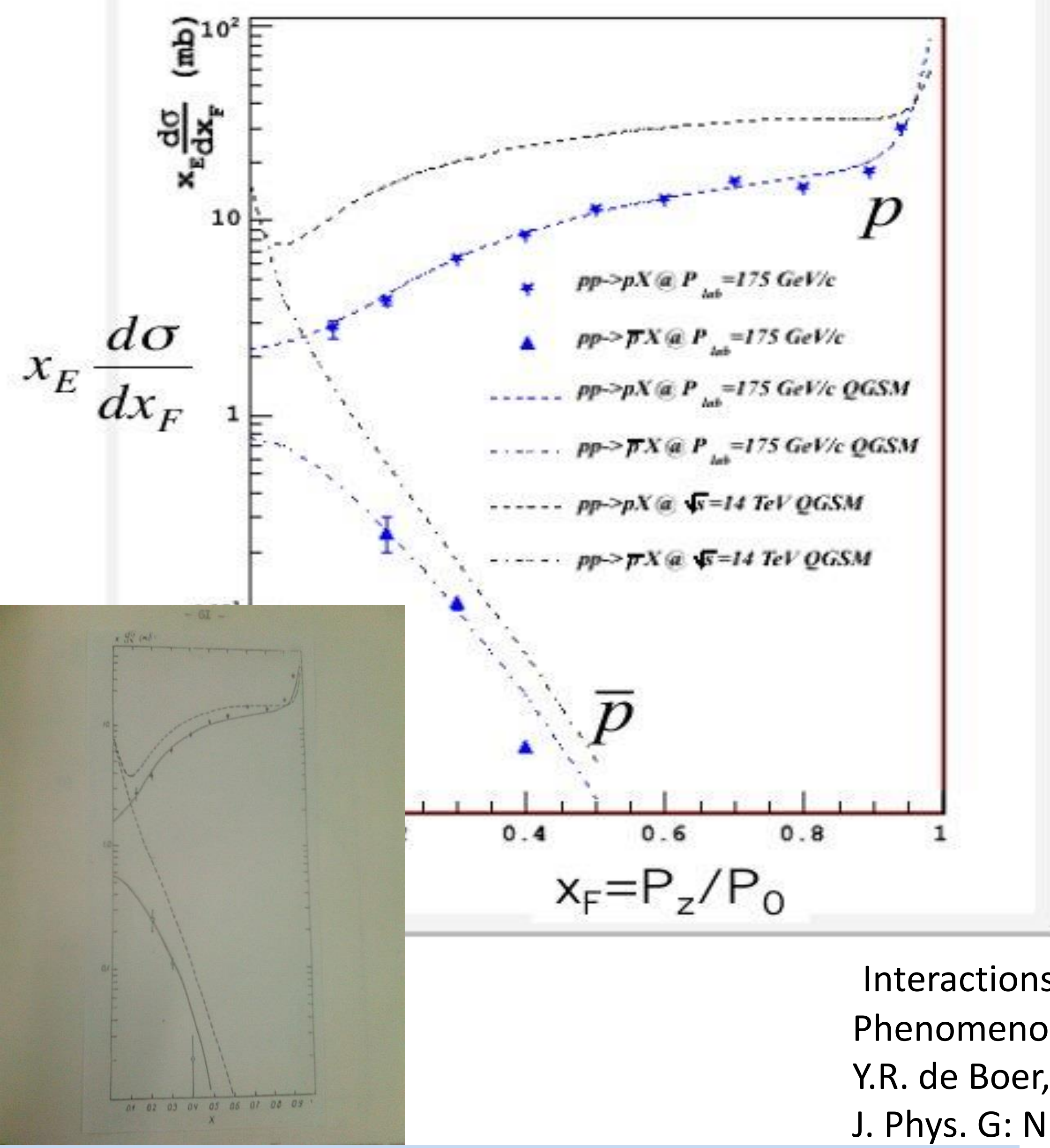


FIG. 3. Charged particle pseudo-rapidity density per participant pair for central nucleus–nucleus [17–25] and non-single diffractive pp ($p\bar{p}$) collisions [26–32], as a function of $\sqrt{s_{NN}}$. The solid lines $\propto s_{NN}^{0.15}$ and $\propto s_{NN}^{0.11}$ are superimposed on the heavy-ion and pp ($p\bar{p}$) data, respectively.

$$Ylab = -\frac{1}{2}\ln\left(\frac{Mt^2}{(E+Pz)^2}\right) = -\ln(Mt/2Elab)$$

28/5 = 5.5 proton pairs that means the projectile nucleus was C (12 nucleons), or more !

Baryon spectra in p-p



A.B. Kaidalov and O.I. Piskunova,
Inclusive Spectra Of Baryons In The Quark- Gluon Strings Model,
Z.Phys. C30 (1986) 145.

Three Pomeron peak

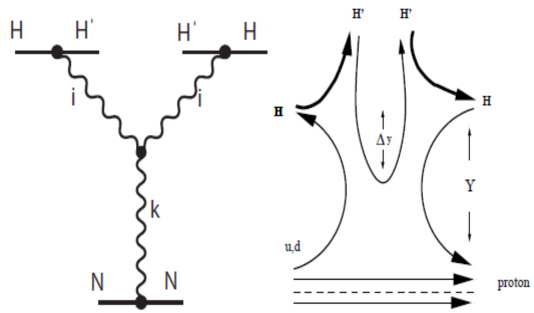


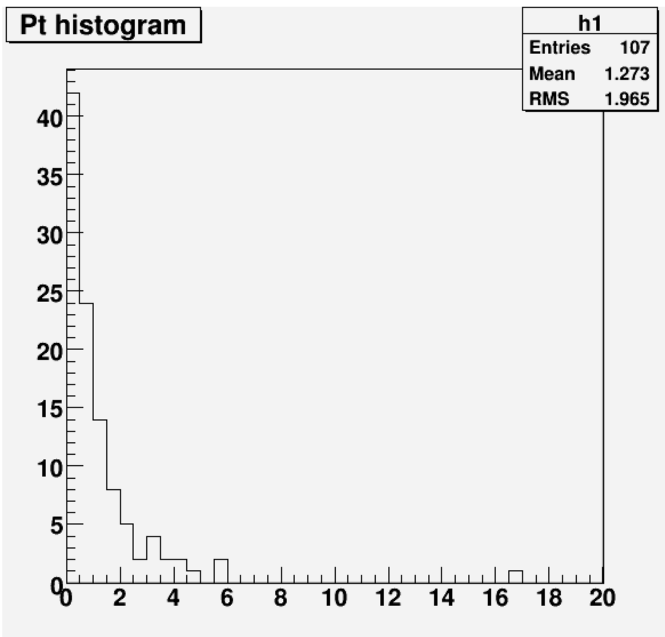
Figure 4: Left: triple-regge diagram describing the process $H + N \to H' + X$. Right: representation of rapidity gaps between the quark systems in the three reggeon exchange diagram.

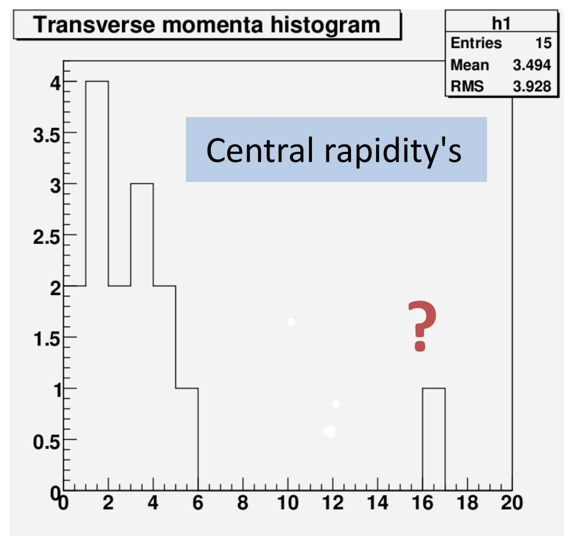
Interactions of Heavy Hadrons using Regge Phenomenology and the Quark Gluon String Model
Y.R. de Boer, A.B. Kaidalov, D.A. Milstead, O.I. Piskounova
J. Phys. G: Nucl. Part. Phys. 35 (2008) 075009

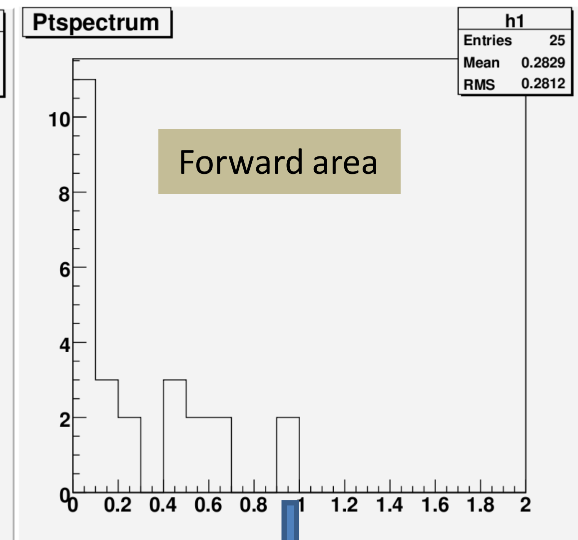
Transverse mass distributions

We can not distinguish between Pt and mass of hadrons

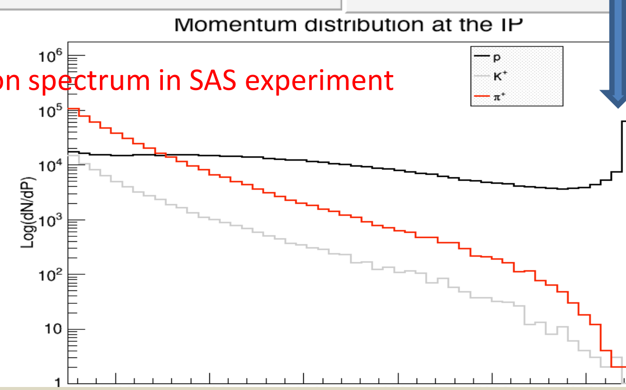
$$Mt=\sqrt{(Pt^2 + M_0{}^2)}$$







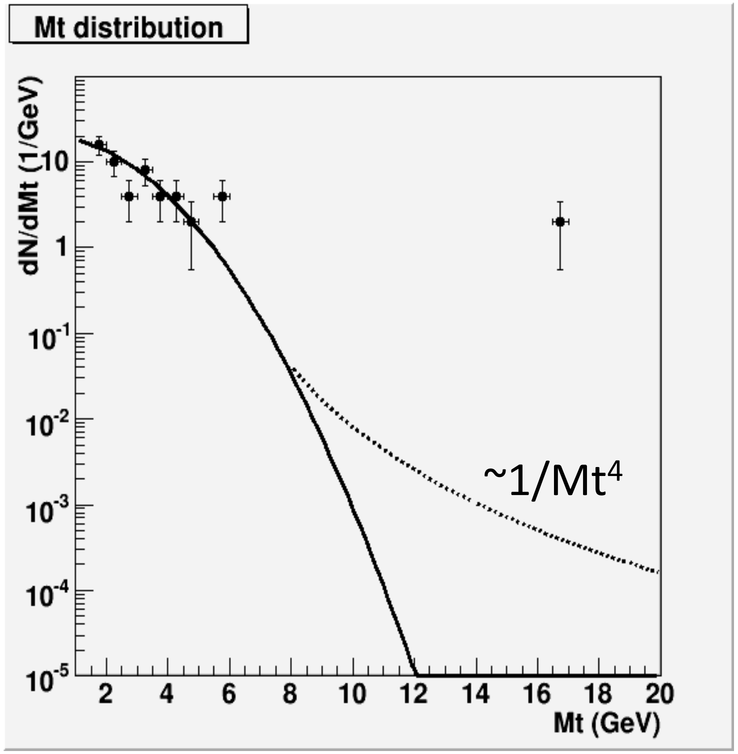
hadrons

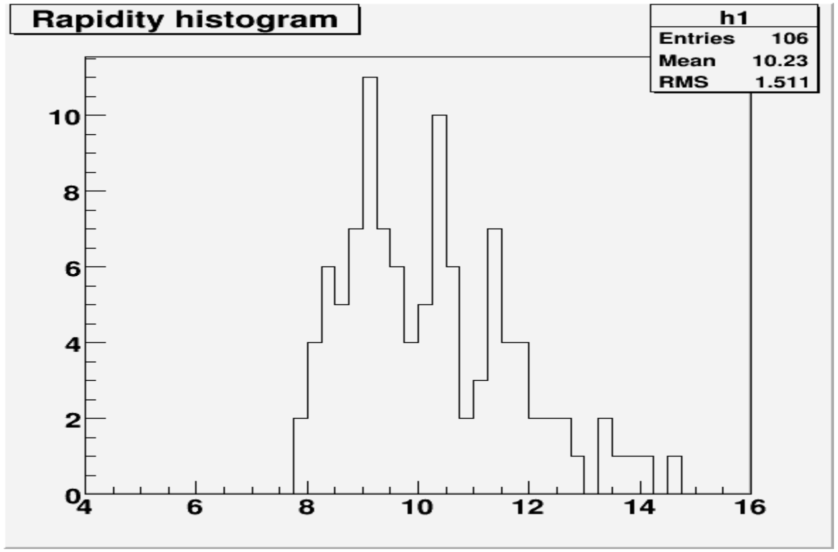


2 protons in **three pomeron** peak -> helium nucleus collision

Where is new physics?

One track with Mt = 16 GeV





Suggestion: heavy astroparticle decays in 3 parts. Two parts went to similar heavy particles of ~ 14 GeV mass and last one interacts like a helium+lithium nuclei.
In this case second peak should bring 4 protons.

State of art with the forward spectra at LHCf

EPJ Web of Conferences **208**, 05004 (2019)
ISVHECRI 2018
https://doi.org/10.1051/epjconf/20192080500

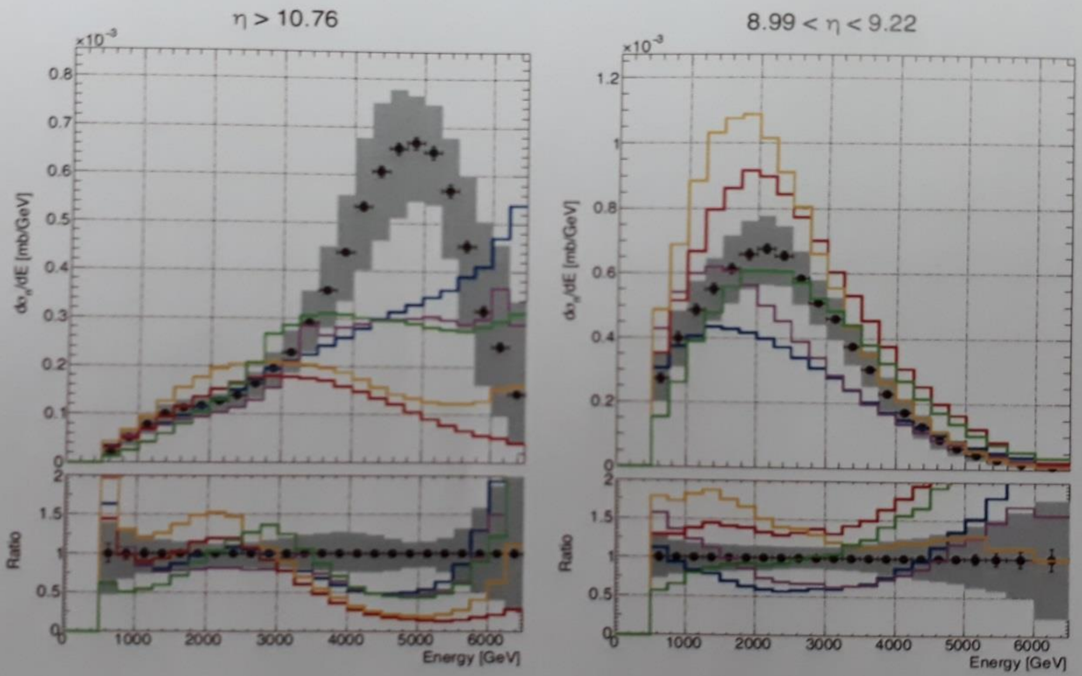
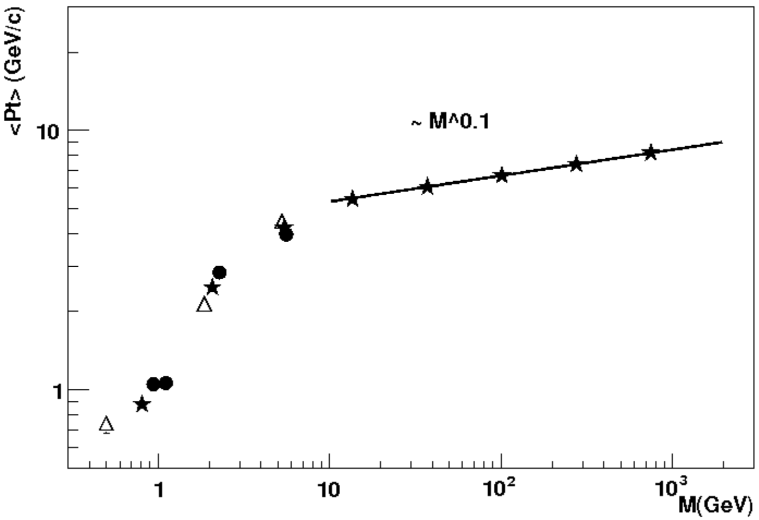


Figure 5. Differential neutron production cross sections at η >10.76 (left) and 9.22> η >8.99 (right) in 13 TeV p-p collisions measured by the LHCf Arm2 detector [19]. Colored histograms are predictions by QGSJET II-04 (blue), EPOS-LHC (magenta), DPMJET 3.06 (red), PYTHIA 8.212 (orange) and SIBYLL 2.3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

Suggestions about massive hadrons



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

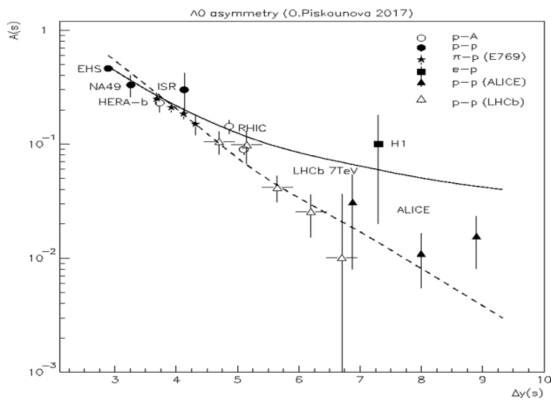
$$M_n = 0.258 * e^{(n-1)}$$

(arXiv.org:1908.10759)

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

Mt =√((9)^2 + (13.7)^2) =16.37 GeV !

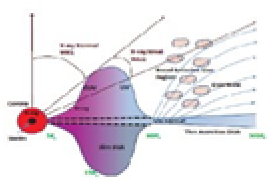
Toroidal baryonium states (arXiv:1702.02769)



String Junction brings baryon charge up to Ymax

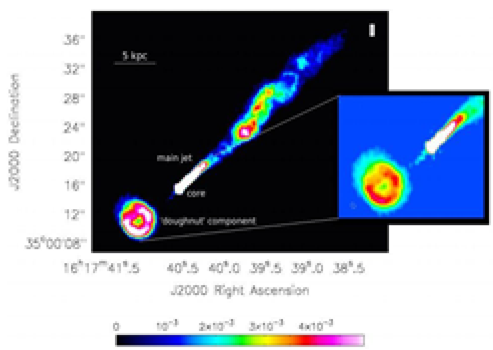
Toroidal structures at space observations near SMBH

Torus configuration of QCD matter, what has been revealed by Chandra (arxiv:1503.02085) at the event horizon of SMBH, must be such dense "doughnut" that roentgen radiation is screened on 40%)



Baryon matter falling under BH horizon should be symmetric, or in other words, has no charge information.

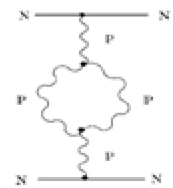
Toroidal structure of jet from radio galaxy NGC6109 (arXiv: 1808.019670) is recent observation of baryon matter in the extremal conditions.

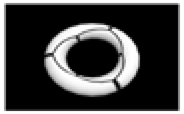


Super Massive Black holes are throwing out 1/3 of their mass with the jets.

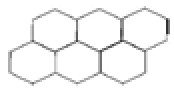
Baryon/antibaryon junction hexagon and hexagon net on the torus

Pomeron torus is covered with gluon exchange net





3D view of pomeron loop covered with the gluon net

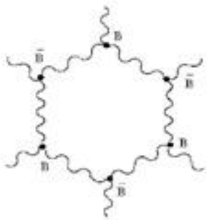


6 - minimal set of hexagon gluon cells to cover the pomeron torus (6 ,16, 30 ...)

Why hexagons?

Baryon/antibaryon junction hexagon

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



String junction brings the baryon/antibaryon charge

String junction is responsible for baryon/antybaryon asymmetry in spectra at LHC

It seems that string junction can not annihilate or disappear (??)

At fixed energy we can cover the pomeron torus with discrete numbers of hexagons

The gap in the pomeron exchange with loop may be of discrete values

We can insert quark-antiquark loops on every side or leg of SJ hexagon

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 $\sqrt{s}$ = 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: baryonic DM from space.

IV. The improved experiment on high level in atmosphere is desirable, as well as the LHC FP measurements for carbon-carbon collisions.

Thank you for the attention!