# Proton Spectra in p-p for full ranges of rapidity and X_F

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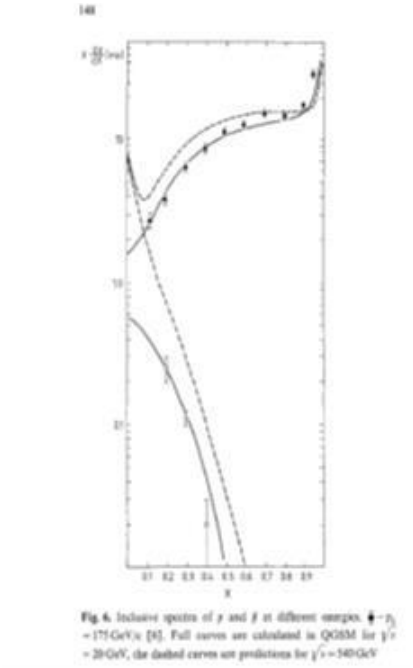
# About proton spectrum in c.m.s.

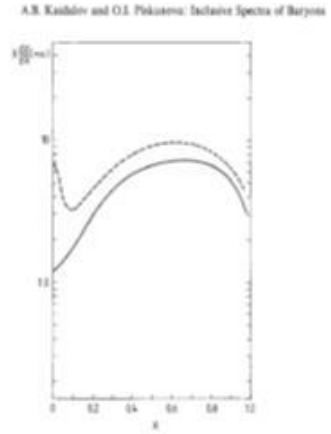
- Proton spectrum in p-p is very specific and differs from spectra of other hadrons
- In QGSM it consists of two independent parts: central rapidity “table” and fragmentation region at Y>2.
- In the central-rapidity area, protons and antiprotons appear from diquark-antidiquark pairs of quark sea
- The fragmentation part is a result of the diquark component migration from beam proton or due to the contribution of three-pomeron diagram
- Proton spectra are the basis for all processes of matter collisions in astrophysics as well as for the production of cosmic rays

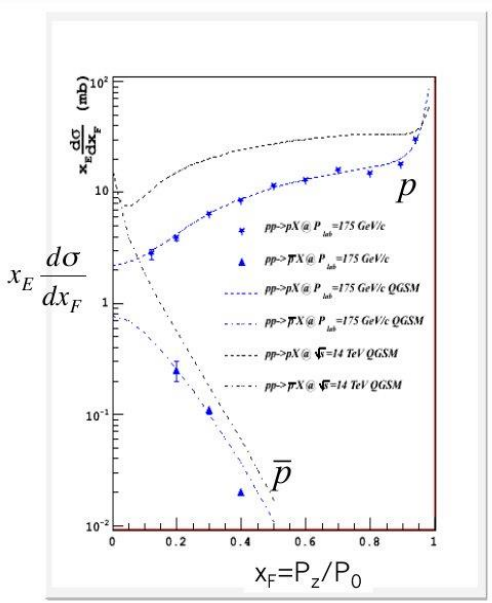
# The idea of proton spectra in entire kinematical range: 0 < Y < Ymax

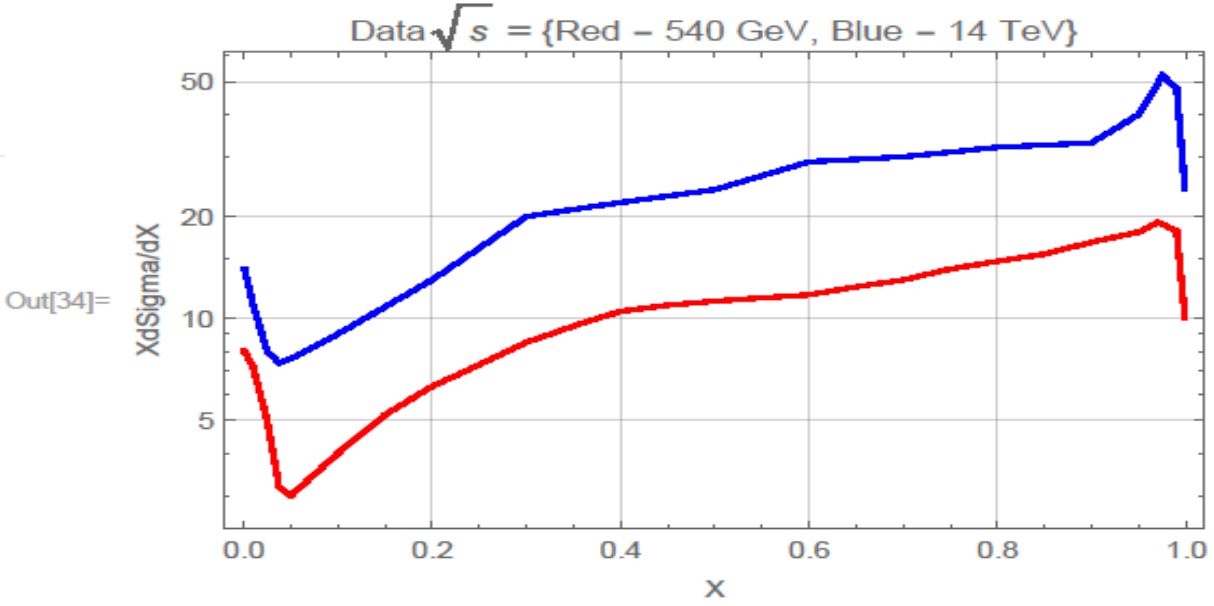
A.B. Kaidalov and O.I. Piskounova,

Inclusive specrta of baryons, Zeit.fur Phys. C30,1986

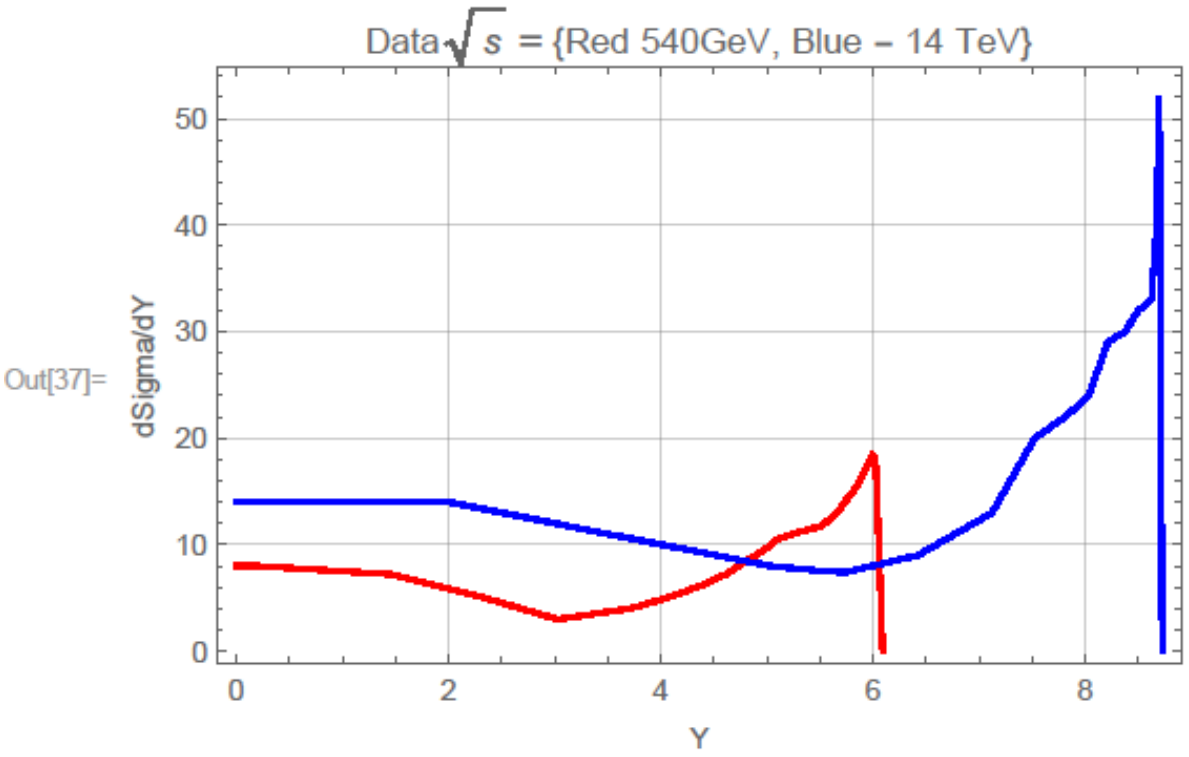






# Spectra in rapidity



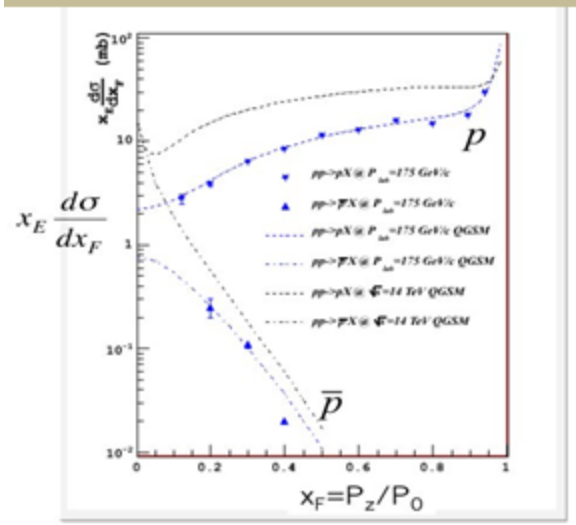

There are two independent regions in proton spectra:

1) central proton-antiproton pairs production at Y< 2 makes the “table”
2) fragmentation of beam proton at Y -> Ymax gives **single** proton due to three - pomeron diffractive dissociation

# What is the three-pomeron diagram and its contribution?

- The diffractive term in spectra of proton may be just three-pomeron junction giving us the proton with little smaller energy. The weight of this enhanced diagram is almost 10%. But this process gives the very specifics of proton spectra!

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

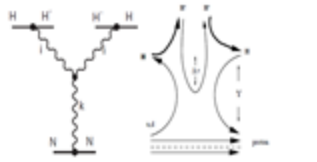


Figure 4: Left: triple-reggo diagram describing the process $H + N \to H' + X$. Right: representation of rapidity gaps between the quark systems in the three reggeon exchange diagram.

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

# How the fragmentation works

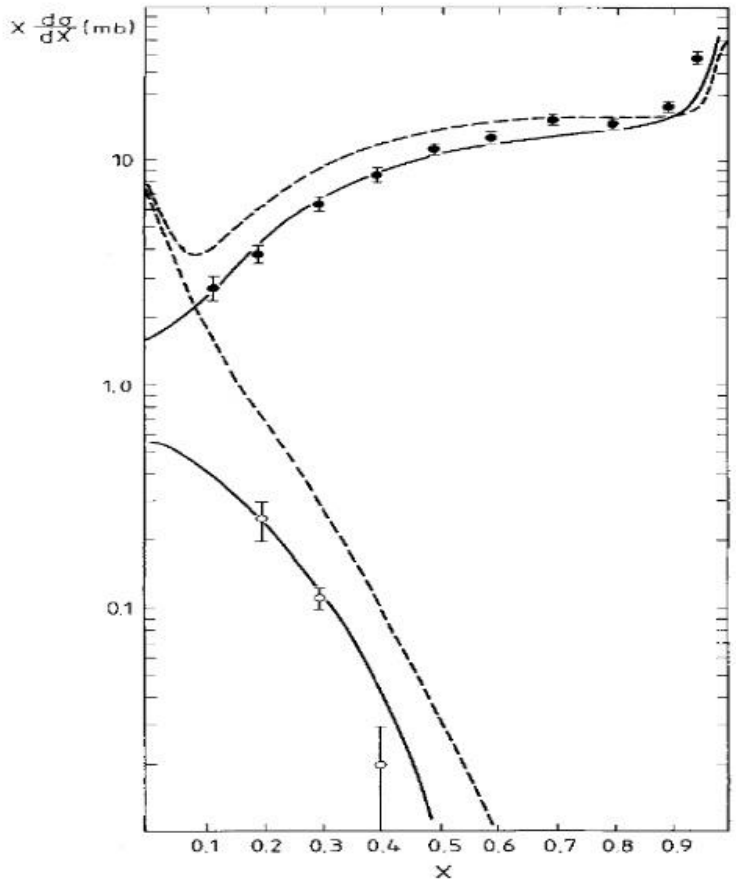



**Fig. 6.** Inclusive spectra of $p$ and $\bar{p}$ at different energies. $\bar{p}$ $-175$ GeV/c [6]. Full curves are calculated in QGSM for $= 20$ GeV, the dashed curves are predictions for $\sqrt{s} = 540$ GeV

X=0 -> multipomeron contributions

0.1< X < 0.9 - RRP contribution

0.95< X < 1 - PPP

# More about Quark-Gluon Strings Model

What should be stressed in the title of Model:

- It operates with **quarks** instead of partons, that's why the Model predicts the form of spectra for certain hadrons in dependence on quark content of colliding hadrons. It allows us to calculate as well the asymmetries between spectra of produced particle and antiparticle;
- The values of differential cross sections and total X sections are calculated with pomeron exchanges that means **gluon** exchanges;
- the **string** behaviors of strong interaction expose themselves in Regge type of spectra, where the fragmentation of pomeron strings with production of hadrons is proportional to

  (1-x_F)^\alpha(0)_{ro,N,phi,etc.},

  where each alpha(0)_h is the intercept of corresponding regge trajectory .

# Conclusions

- There is the contribution of three-pomeron (“enhanced”) diagram, which brings some specifics to proton spectrum in fragmentation area;
- this contribution has no similarity with proton production at central rapidity region;
- the precise measurements of spectrum at $1-X_F < 0.05$ will help us to fix parameters of three-pomeron peak and apply proton spectra for astrophysical purposes.