

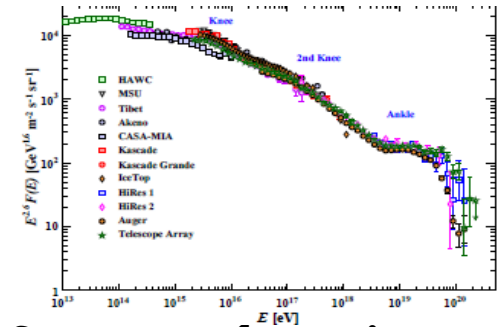
The form of proton spectra after HE p-p collision in laboratory system

O.I. Piskounova, P.N. Lebedev Physics Institute of RAN

Intro

In previous paper (O.P.,IJMPA, 2020), it was concluded that CR baryon spectrum is not influenced by a change in HE collision with the atmosphere. This time, we are studying, what form will it have in first collision of protons that are injected from UHECR source (relativ.jets from SMBH etc.)

CR spectrum (PartData19)



Spectrum at $\sqrt{s} = 540$ GeV

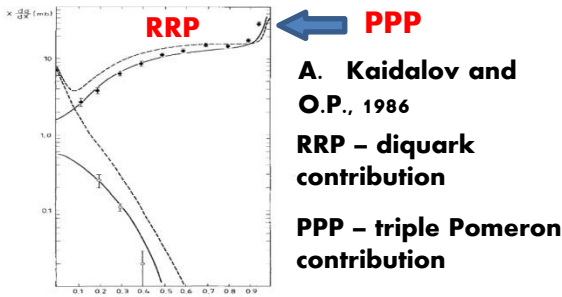


Fig. 6. Inclusive spectra of p and \bar{p} at different energies. $\sqrt{s} = 175$ GeV/c [6]. Full curves are calculated in QGSM for $\sqrt{s} = 20$ GeV, the dashed curves are predictions for $\sqrt{s} = 540$ GeV.

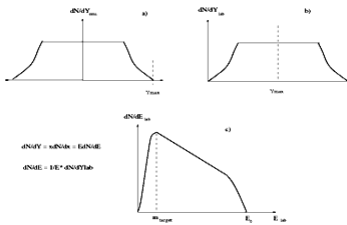
← PPP

A. Kaidalov and O.P., 1986

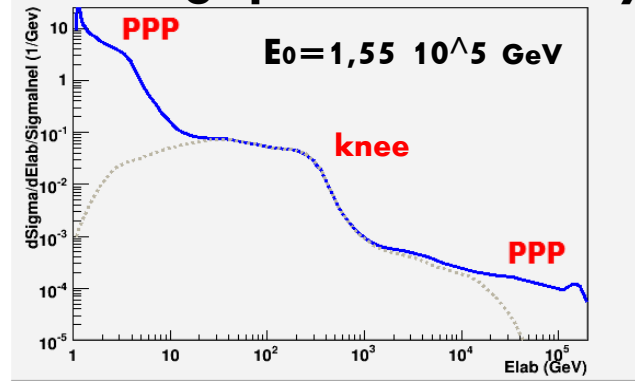
RRP – diquark contribution

PPP – triple Pomeron contribution

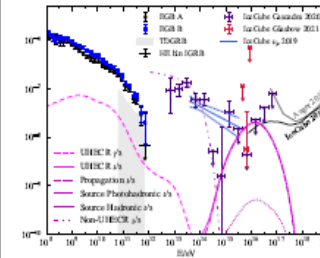
Formulas for spectrum transfer to lab. system



Resulting spectrum in lab. sys.



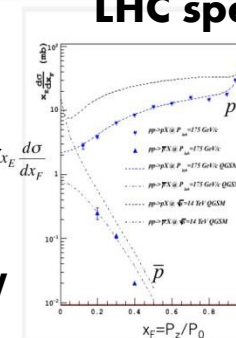
Spectrum of neutrinos at PeV energies



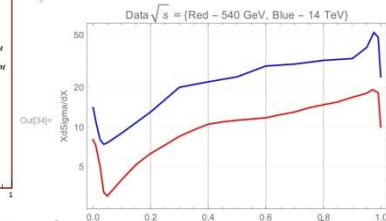
Bumping in neutrino spectrum at UHE

G.Farrar et al., 2021

Misleading and fake on LHC spectra at $\sqrt{s} = 14$ TeV



$X d\sigma/dX/\sigma_{inel}$



Spectrum 14TeV was just shifted graph of 540GeV!

Conclusions

- i. The form of CR proton spectrum is built in first HE collision.
- ii. Each additional interaction brings factor E^{-1} to the spectrum.
- iii. The knee in the spectrum of CR corresponds to fall from the central rapidity "table" in c.m.s.
- iv. PPP term leads to bump in neutrino spectrum.

References

- Inclusive Spectra of Baryons in the Quark-Gluon Strings Model, A.Kaidalov and O.Piskounova, Z. Phys. C 30, 145 (1986)
- Baryon production at LHC experiments: average p_t of hyperons versus energy, O.Piskounova, Int.Jou.of Mod.Phys.A 35, 13 (2020) 2050067, arXiv:1706.07648
- Ultrahigh energy cosmic rays and high energy astrophysical neutrinos. M. S. Muzio, G. R. Farrar, and M. Unger, arXiv:2108.05512v2

Gamma spectrum from π^0 decays

The form of gamma spectrum reproduces the shape of pion distribution in VHE cosmic proton collision.

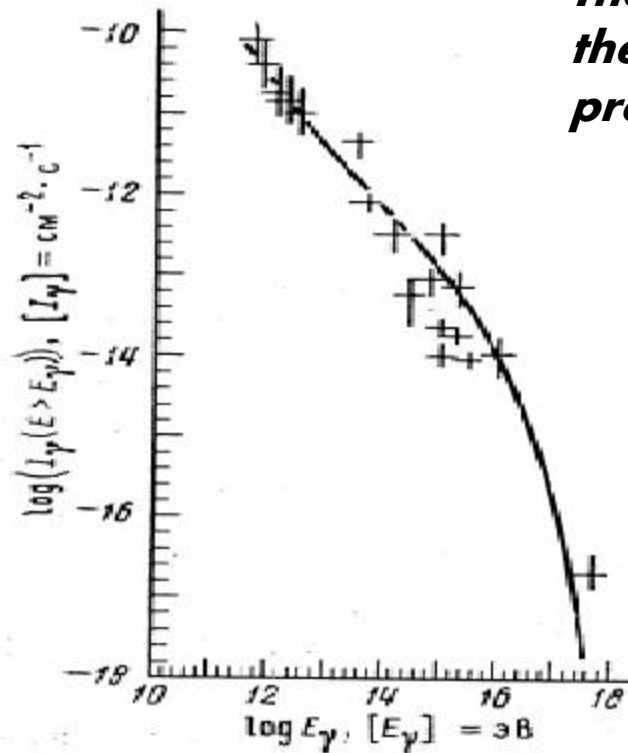


Рис. 2. Интегральное распределение потока фотонов, регистрируемых от источника Cygnus-X3.

Reference

Piskunova O.I. Shape of γ spectra from cosmic sources of high energy protons. *Sov. Journal of Nucl. Phys.* 51 (1990)1332