# THE PAPER "The quark hypothesis and relations between cross sections at high energies", E.M. Levin and L.L. Frankfurt (1965)

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February 11, 2015

In the paper [1] derived formula of impulse approximation for the collisions of ultra relativistic composite systems by exploring non relativistic quark model of hadrons suggested by Zweig (1965,unpublished ) . Application of this formula to the collisions of ultra relativistic hadrons as the systems consisting of few constituent quarks allowed to derive relations between cross sections of hadron-hadron collisions. These relations agreed with numerous data. Agreement with data of the prediction: $\frac{[\sigma_{tot}(pp)+\sigma(\bar{p}+p)]/2}{\sigma_{tot}(\pi p)} = 3/2$ i.e. to the ratio of the number of constituents in the wave functions of proton(anti proton) and pion becomes one of fundamental confirmations of quark hypothesis .

Some concepts introduced in the paper were incorporated into current theoretical approaches . The assumption that the radius of a quark is significantly smaller than radius of a hadron found explanation in terms of asymptotic freedom in quantum chromodynamics. The assumed in the paper dominance of hadron-hadron collisions at central impact parameters and neglect by scattering off meson field of a nucleon contradicted to the basic ideas of $S$ matrix of that time but they are in line with current data and theoretical approaches . The Lorentz transformation of the rest frame wave function of a hadron into frame where this hadron is energetic uses light cone variables like fraction of energetic hadron momentum carried by interacting quark. This was incorporated later into Feynman parton model.

# References

[1] E.M. Levin and L.L. Frankfurt Pis'ma Zh.Eksp. Teor. Fiz. 2, 65 (1965)