

# The Inelastic Cross Section versus the Centre-of-Mass Energy for Proton-Proton Collisions

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**Abstract:** Here, applying the Scale-Symmetric Theory (SST), we calculated the inelastic cross section versus the centre-of-mass energy for proton-proton collisions. For centre-of-mass energies lower than 34.2 TeV, the obtained theoretical results overlap with the Standard-Model predictions but for energies of proton higher than 17.1 TeV, contrary to the Standard-Model prediction, there appears the asymptote: cross-section = 82.5 mb = constant. It follows from the fact that due to the production of the 17.1 TeV Higgs-boson-like particles, the protons cannot be accelerated above energy 17.1 TeV. Just whole surplus proton energy is instantaneously emitted. It is associated with the internal structure of the core of baryons. Emphasize that calculated here the cross section for energy 13 TeV (73.1 mb) is the central value obtained in the ATLAS experiment.

## 1. Introduction and motivation

According to the Scale-Symmetric Theory (SST), [1], the asymptotic freedom for the strong interactions follows from the fact that the absolute rest mass of virtual pions decreases with increasing energy of nucleons [2]. It means that with increasing energy/temperature, effective radius of nucleons, so characteristic wave length as well, increases. In the luminal gravitating Einstein spacetime, [1A], the moving nucleons have the four degrees of freedom (the 3 spatial coordinates and time associated with kinetic motion) so temperature is directly proportional to four powers of the characteristic length. On the other hand, the cross section is directly proportional to two powers of the characteristic length. Applying the Stefan-Boltzmann law for total emitted energy of a black body,  $\bar{E}$ , we obtain (we can apply this law to relativistic objects)

$$E \sim T^4 \sim \lambda_{Charact.}^{16} \sim \sigma_{Cross-section}^8. \quad (1)$$

It leads to following relation

$$\sigma_{Cross-section} = F E^{1/8}. \quad (2)$$

Notice that the moving neutrinos are the non-relativistic objects, [1A], so we cannot apply to them the Stefan-Boltzmann law and they have only two degrees of freedom [3].

Calculate the factor  $F$  from the initial conditions. We know that the muon radius of proton is  $R_{proton(muon)} = 0.84074$  fm [4], i.e. the cross section is  $\sigma_{Cross-section} = \pi R_{proton(muon)}^2 =$

22.206 mb – this value is for the rest energy of proton i.e. for  $E = 0.93827$  GeV. Applying formula (2) we obtain

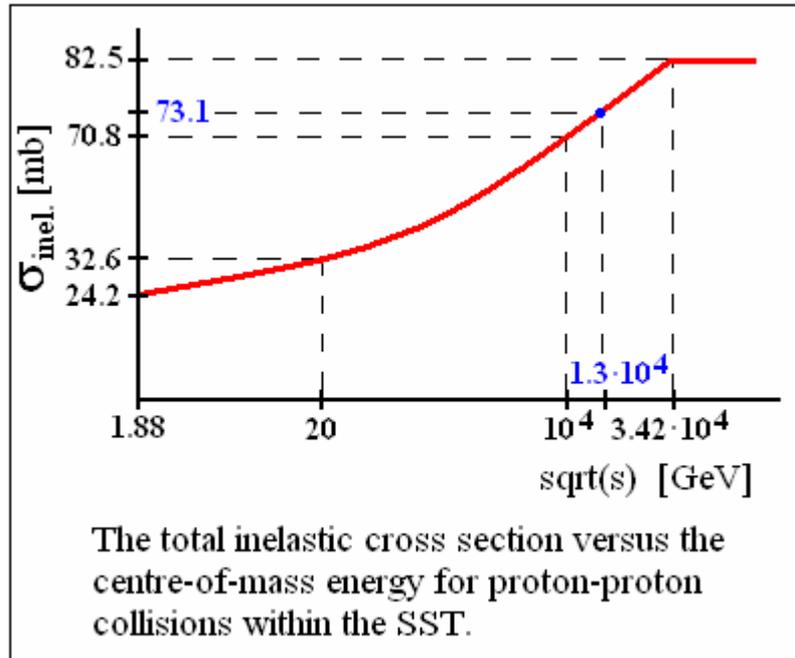
$$F = 22.384 \text{ mb/GeV}^{1/8}. \quad (3)$$

Calculate a few inelastic cross sections for different centre-of-mass energy for proton-proton collisions,  $E = \text{sqrt}(s)$

$$\sigma_{\text{Cross-section}} = F \text{sqrt}(s)^{1/8}. \quad (4)$$

For  $\text{sqrt}(s) = 2 M_{\text{Proton}}$  is  $\sigma_{\text{Cross-section}} = 24.2$  mb, for  $\text{sqrt}(s) = 20$  GeV is  $\sigma_{\text{Cross-section}} = 32.55$  mb, for  $\text{sqrt}(s) = 10^4$  GeV is  $\sigma_{\text{Cross-section}} = 70.78$  mb, for  $\text{sqrt}(s) = 13$  TeV is  $\sigma_{\text{Cross-section}} = 73.1$  mb (it is the central value obtained with the ATLAS Detector (!) [5]), for  $\text{sqrt}(s) = 2 \cdot 17.1 = 34.2$  TeV is  $\sigma_{\text{Cross-section}} = 82.5$  mb.

For centre-of-mass energies lower than 34.2 TeV, the obtained theoretical results overlap with the Standard-Model predictions, [6], but for energies of proton higher than 17.1 TeV, contrary to the Standard-Model prediction, there appears the asymptote:  $\sigma_{\text{Cross-section}} = 82.5$  mb = *constant*. It follows from the fact that due to the production of the 17.1 TeV Higgs-boson-like particles, the protons cannot be accelerated above energy 17.1 TeV [1A]. Just whole surplus proton energy is instantaneously emitted. It is associated with the internal structure of the core of baryons [1A].



## References

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