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CROSS SECTIONS AT LARGE MOMENTUM TRANSFER

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The possibility of obtaining center-of-mass energies of the order of 200 BeV by the use of storage rings with the NAL accelerator raises the question of the cross sections to be expected for high momentum-transfer events at such large energies.

The most conservative view is to suppose that a local field theory is true; then at momentum transfers, q, such that δq is large compared to the threshold energies of most of the final channels, one would expect to see the scattering of the bare point particles of the theory.

Momentum transfers q come from scattering at impact parameters $R<\frac{\hbar}{q}$, so if we add that the interactions are strong, we would expect the cross section for momentum transfer greater than q to be

$$\sigma = \pi R^2 = \frac{\pi \hbar^2}{q^2} \tag{1}$$

or a differential cross section

$$d\sigma = \pi \frac{\hbar^2}{q^4} dq^2 \tag{2}$$

These are the cross sections for all inelastic events, irrespective of the final channel.

To illustrate these remarks, we may point out that the high-energy pair-production cross section for γ-rays is not proportional to Z^2 , but rather to $Z^2+ Z$, since each electron,

when its recoil energy is larger than its binding in the atom, contributes as if it were free. Thus if we adopted a quark model in its most naive form, we should expect to get nine times (1) in proton-proton collisions as soon as $q \gg mc$, with m the quark mass.

The cross sections given by (1) are not small. For $q \geqslant 20$ BeV|c, $\sigma \sim 10^{-30} cm^2$. With storage ring luminosities of $10^{32}/cm^2$ /sec one would obtain many events per second. These of course, are divided among many final channels, but it is our point of view that all such events are interesting.

It seems to us that other suppositions (for example that the cross sections fall off exponentially) might have the most radical implications for physics. The question would be raised as to the measurability of very small distances, and our concept of Euclidean (or Lorentzian) space could be challenged.

It is fortunate that a large cross section can be forecast on the most conservative of assumptions.

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