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ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ
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ON THE STRUCTURE OF THE PHOTON

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Abstract

Making use of experimental data on electromagnetic form - factors, an upper limit is obtained for the slope of the Regge trajectory of photon. We found: $\frac{d a_\gamma(t)}{dt} < 10^{-3}$ for $-20 < t < 0$.

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О СТРУКТУРЕ ФОТОНА

Аннотация

На основании экспериментальных данных по электромагнитным форм-факторам получена верхняя оценка для наклона реджеевской траектории фотона. Найдено

$\frac{d a_\gamma(t)}{dt} < 10^{-3}$ при $-20 < t < 0$.

Работа издаётся только на английском языке.

Recently Blankenbecler et al[1] looked into the possibility that the photon also is to be considered as composite, that is, to be described by a moving pole in the angular momentum plane.

In the present note we try to get an upper estimate for the slope of the photon trajectory experimental data for electric formfactors of the nucleon.

These data were used in paper[2] to get the Regge trajectory through the ρ-meson. The trajectory obtained was almost a straight line, see also paper[3]. It was assumed there that only strongly interacting particles show a Regge behaviour. If one can obtain an expression for the trajectory with the quantum numbers of the ρ-meson without the assumption that the photon spin is constant and equal to one, then one has in principle a possibility to get an estimate for the photon trajectory. For an other possibility see the paper[4].

For the ρ-trajectory one can obtain an expression with the help of the dispersion relation for Regge trajectories[5,6]. It turns out that, in contrast to the calculation of the vacuum - trajectory in[6], the behaviour just above threshold $t=4$ is markedly modified by the additional condition $L_1(t_\rho)=1$, where $t_\rho \approx 29$.

We get an expression for $L_1(t)$ which holds for $t<0$ and positive t up to t_ρ by the following ansatz*.

Write

$$L_1(\nu) = \lambda - a(\lambda)(-\nu)^{\lambda+\frac{1}{2}} \cdot \frac{1}{\nu^2 + c^2} \qquad (1)$$

where $\nu = \frac{1}{4}(t-4)$.

Then from $L_1(-1) = \frac{1}{2}$ (see e.g.[7]) , $L_1(\nu_\rho) = 1$ and $L_1(0) = \lambda$ with $\frac{1}{2} < \lambda < 1$ one gets

$$L_1(\nu) = \lambda - (\lambda - \tfrac{1}{2})(-\nu)^{\lambda+\frac{1}{2}} \cdot \left(\frac{1 + c^2}{\nu^2 + c^2} \right). \qquad (2)$$

Here $\lambda = 0.57$, $c^2 \approx 300$. In Fig. 1 one sees the linear interpolation from[2] and $L_1(t)$ given by formula (2). In the same approximation for the formfactor as in paper[2] we here have

$$F_N(t) = \frac{1}{2} \, \frac{\alpha_\gamma(0) - L_1(0)}{\alpha_\gamma(t) - L_1(t)} \qquad (3)$$

with $\alpha_\gamma(t)$ the photon trajectory.

Using then the experimental data for the nucleon formfactors and the curve for $L_1(t)$ from (2), we find that from $t=0$ down to $t \approx -20$ the trajectory is practically constant; in the mean it lies 3.10^{-2} lower than $\alpha_\gamma(t)=1$ in that region of energy.

If one assumes that all deviations from $\alpha_\gamma(t)=1$ come from the non-elementarity of the photon, then we have

$$\frac{d\alpha_\gamma(t)}{dt} \lesssim 10^{-3}.$$

We should like to point out that this is an upper limit; the real slope for a non-elementary photon should certainly be smaller.

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* Formula (1) can be used for $t<0$ at most up to the point where it has a minimum . Actually we wanted to have but a simple interpolation formula for a limited region of momentum transfers.

R e f e r e n c e s

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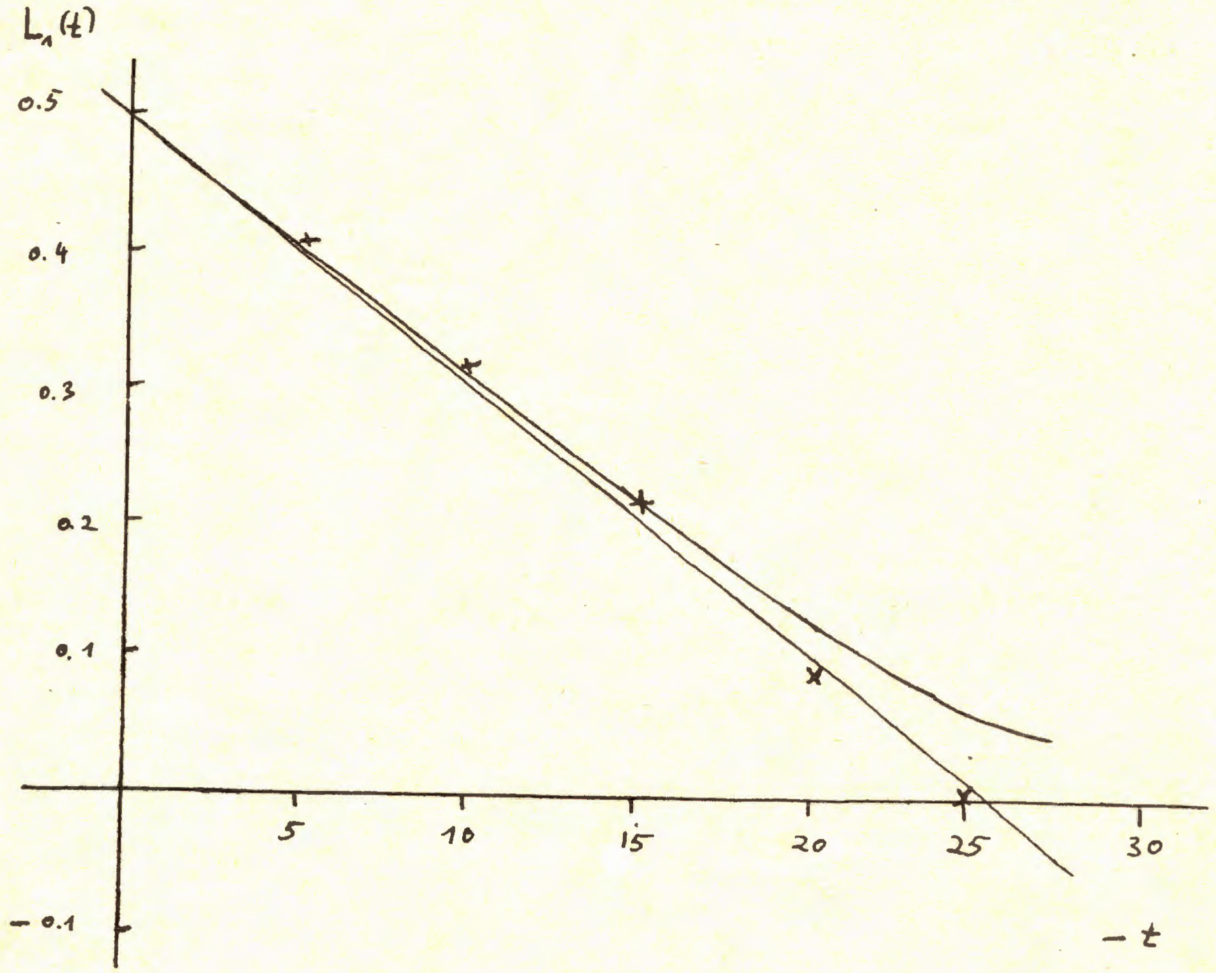

Fig. 1.