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ON A POSSIBILITY OF DETECTION OF THE VIOLATION OF COLOUR SYMMETRY IN THE TWO-PHOTON PLUTO EXPERIMENTS AT PETRA

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A study of deep inelastic processes in the framework of QCD and in the electrostrong interaction model (ES)[1,2,3] leads to understanding of the fact, that a unique source of reliable information about the properties of colour symmetry and consequently about electric charges of the quarks may be measurements of deep inelastic reaction involving real γ quanta. Only in such processes the dynamic averaging of the quark charge over the colour is absent. This is caused by suppression of the interference term with the neutral gluon which interacts with leptons. At present hard processes with real photons are extensively studied experimentally. So, the measurement of the proton-proton reaction with a real final photon in the c.m. frame 31 GeV $<\sqrt{S}<$63 GeV with transverse momentum of the photon to 9 GeV/c was made at CERN. In ref.[4] there are given graphs of the $P_\perp^2$ dependence for ratio γ/π°. The calculation in QCD[5] gives $\gamma/\pi^\circ \sim 0.05\div0.15$. $PP\to\gamma X$ reaction in the framework of the ES-model is not calculated in detail and an estimation gives $\gamma/\pi^\circ \sim 0.2\div0.5$. The applicability of the parton model for the description of experiment[4] is quite reliable, but the theoretical calculation is complicated by phenomenology (fit of the parton distribution and fragmentation function). An extra uncertainty comes from the argument $Q^2 \sim P_\perp^2$ of the constant $\alpha_S(Q^2)$. Deep inelastic photoproduction of the photon was studied in work[2]. SLAC measurements[6] are in better agreement with the ES-model as compared to QCD, but the applicability of the parton model is doubtful due to kinematic parameters of the experiment. The study of two-photon annihilation into hadron jets is the most convenient from the theoretical point of view. This is due to the absence of phenomenological parameters in the calculation of such processes. Moreover, one can be convinced in the applicability of the parton model experimentally. The corresponding measurements are performed by the groups PLUTO, CELLO and TASSO at DESY. Two-photon jet events with $P_\perp^2 \sim 6$ GeV^2 were detected. Obviously, the contribution of the long distance interaction is suppressed in such processes, though corrections may be considerable but not more than 20-30%. Another test of the parton-model applicability is the measurement of the hadronic structure function of the photon and comparison with leptonic structure function of the photon. Only in the region of small values of $x \sim 0{,}1 \div 0{,}2$ vector-dominance model is valid. So, we may expect that two-photon jet events will give information about the charge of quarks we are interested in. The probability density of the two-jet creation in the ES-model takes the form

$$\frac{d\omega(P_\perp^2, t)}{dP_\perp^2} = -\frac{4\pi\alpha^2 s}{P_\perp^2 t^2}\{A_Q(y+\frac{1}{y}) + B_Q[(y+\frac{1}{y})^2 - 2(y+\frac{1}{y}) + 5/2]\}, \qquad (1)$$

where $A_Q = \frac{1}{3}\sum_a (\sum_i Q_i)_a^4$; $B_Q = \frac{2}{3}\sum_{i\neq j}^{3}(Q_i - Q_j)^4$; $y = \frac{4P_\perp^2}{t}[1-\sqrt{1-4P_\perp^2/t}]^{-2}$, Q is the quark charge. For the integer charge $A_Q = 2$, $B_Q = 4/3$. The reaction $e^+e^- \to e^+e^- + 2\gamma \to e^+e^- + 2\,jets$ was studied experimentally. One electron and charged hadrons were detected. The $P_\perp^2$ distribution of charged particles with 3 GeV$<\sqrt{t}<$9 GeV was obtained. The integral of the quark part (1) equals

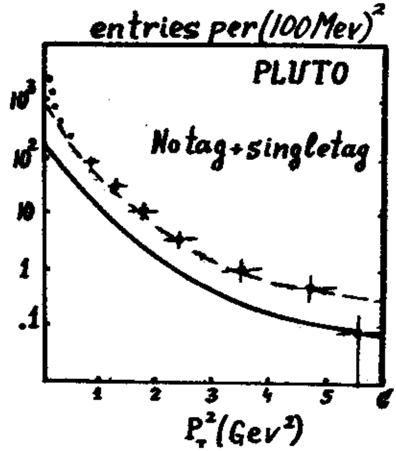
$$\int_a^b \frac{d\omega_q(t, P_\perp^2)}{dP_\perp^2}dt = \frac{8\pi\alpha^2}{P^2}[\ln x + \frac{2}{x} - 4(1+\frac{1}{x})\sqrt{1-x} - 4\ln|\frac{1-\sqrt{1-x}}{1+\sqrt{1-x}}|]\Big|_a^b, \qquad (2)$$

where $x = 4P_\perp^2/t$, we must take $a = 4P_\perp^2$ if $4P_\perp^2 > 9$ GeV^2. The gluon contribution takes the form:

$$\int_a^b \frac{d\omega_Q(t, P_\perp^2)}{dP_\perp^2}dt = \frac{8\pi\alpha^2}{3P_\perp^2}[-\frac{21}{2}\ln x + (21 + \frac{28}{x} - \frac{8}{x^2})\sqrt{1-x} + \frac{8}{x^2} - \frac{20}{x} + \frac{41}{2}\ln|\frac{1-\sqrt{1-x}}{1+\sqrt{1-x}}|]\Big|_a^b. \qquad (3)$$

Gluon subprocesses lead to the creation of neutral particles because observed hadrons are colour singlets. Comparison with experimental data is given in the figure. The solid line is the QCD predictions and the dashed line is the results of calculation in the ES-model. The important fact is that the neutral-meson creation in the ES model exceeds the QCD prediction by an order. In this connection, the measurement of the total invariant mass of the initial two-photon state at the MD-1 detector at Novosibirsk becomes at present an urgent problem.

An experiment, of this type allows one to determine electric charges of gluons. The equal contribution of U , d , S and C-quarks was proposed in the calculation, though the role of C-quark may be not so essential.



Figure

One can hope that higher twist corrections change the result considerably and the experiment with $P_{\perp}^{2} > 10 (GeV/c)^{2}$ will be in good agreement with the fractional charge model. But nowaday we have that in $\gamma N \to \gamma X$ reaction the difference between the QCD prediction and experiment is of an order, in $PP \to \gamma X$ process 3÷4 times, in the two photon jet events 4÷5 times, while the ES-model is in satisfactorily agreement with these data.

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