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UNRUH RADIATION OF QUARKS AND THE SOFT PHOTON PUZZLE IN HADRONIC INTERACTIONS

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ՔՎԱՐԿՆԵՐԻ ՈՒՆՐՈՒՅԻ ՃԱՌԱԳԱՅԹՈՒՄԸ և ՀԱԴՐՈՆԱՅԻՆ ՓՈԽԱԶԴԵՑՈՒԹՅՈՒՆՆԵՐՈՒՄ ՓԱՓՈՒԿ ՖՈՏՈՆՆԵՐԻ ՊՐՈԲԼԵՄԸ

Հաշվված է հադրոն-հադրոնային ընդհարումներում մեծ արագացումների ենթարկվող քվարկների կողմից փափուկ ֆոտոնների առաջացման հավանականությունը, ինչպես նաև գնահատված է համապատասխան ներդրումը $P = 70$ ԳէՎ-ի ժամանակ K^+p-փոխազդեցություններում դիտվող P_+-ի փոքր արժեքներով անոմալ ֆոտոնների թվի մեջ:

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In the transverse momentum P_t- distributions of the photon production differential cross sections measured in K^+p -interactions at 70 GeV/c [1] an excess of anomalous soft photons at $P_t \leq$ 40 MeV/c ($\sim$ 0.5 photon per interaction) remains after the extraction of the contribution from the decays of π^0 and other hadrons as well as from bremsstrahlung of particles. Such an excess is observed also in μp [2], pBe and pAl[3] interactions. The production of these photons seems to be unexplainable since it contradicts to the Low theorem and Landau-Pomeranchuk effect (see for instance [4]). Nevertheless, some success is achieved recently in the interpretation of this phenomenon in the frames of the dense pion gas model [5] and especially in the cold quark-gluon plasma (CQGP) globs model [6].

In this work we calculate the soft photon production probability by the mechanism of the Unruh radiation of quarks and estimate the corresponding contribution into the observed number of anomalous photons [1]. Let us remember that according to the Unruh effect any body moving with acceleration α in its rest frame finds itself in a bath of thermal radiation with a temperature $T=\alpha/2\pi K$ (K is the Boltzman constant, $\hbar=c=1$), which after Compton scattering on the charged body, say electron, becomes real Unruh radiation (see [7-9]). According to this conception this Unruh radiation becomes dominant at very large accelerations corresponding to $KT \gtrsim 10$ MeV in the case of electrons. On the other hand the quarks produced in hadron-hadron interactions get accelerations corresponding to $KT \sim 100$ MeV (see, for instance, [10]). Therefore the Unruh radiation of quarks is an additional source for soft photons.

With the help of the formulae of the work [8] we have calculated the dependence of the Unruh radiation intensity produced by a single quark on p_t and Feynman variable x (Fig.1 a and b, respectively) for KT=100 and 800 MeV taking into account the experimental conditions [1]. It is assumed that the quark mass M_q = 1 MeV and the acceleration takes place on a distance ~1f. The calculation results are normalized at certain points to the experimental data [1] given with their errors. It is seen that the experimental and theoretical data have the same relative behaviour weakly depending on T. However as it is seen from Fig.2 the integral number of the photons N_γ emitted by a single quark according to the calculations depends strongly on T. On the right side of Fig.2 the ordinate axis shows the number of the quarks N_q with charge 2/3 which for the given T can provide a mean number ~0.5 anomalous photons emitted per interaction act [1].

From Figs 1 and 2 one can conclude that in order to interpret the observed anomalous soft photons as result of Unruh radiation it is necessary the production of a dozen of quarks with KT=600-800 MeV or from 600 to 150 quarks with KT=100-200 MeV. The above considered radiation may be produced as in the initial phase of QCD parton shower as well as in the final phase when quark -gluon plasma is developed. The observed (see [4]) quadratic dependence of N_γ upon the number N_{ch} of the produced charged hadrons in the case of quark-gluon plasma, in particular in the CQGP model, is obtained since $N_\gamma \sim N_{coll} \sim N_p^2 \sim N_{ch}^2$ where N_{coll} is the number of collisions and N_p is the number of partons in plasma. In the initial phase one expects a dependence stronger than the linear one due to the increase of temperature with the growth of N_{ch}[11]. In order to make more certain conclusions it is necessary to obtain new experimental data especially on N_{ch} -dependence as well as experimental and theoretical results on low mass e^+e^--pairs since in this case too there is an observed excess of soft e^+e^--pairs.

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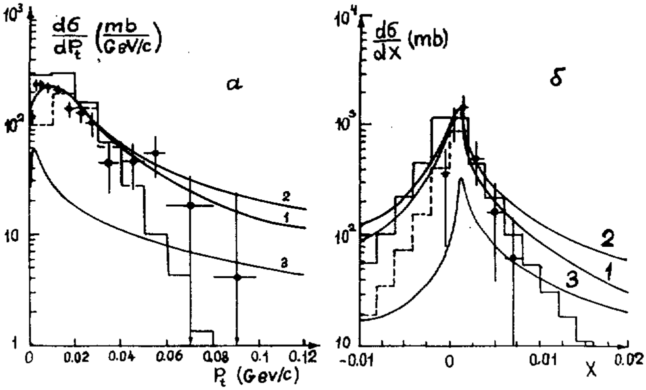
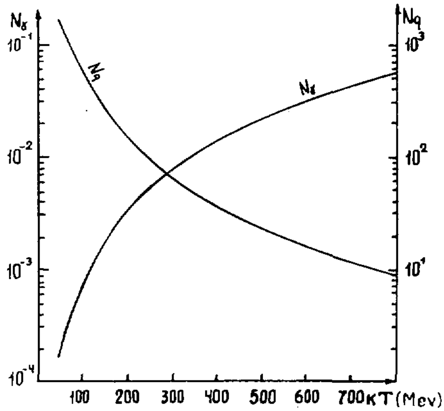


$\frac{d\sigma}{dP_t}$ $\left(\frac{mb}{GeV/c}\right)$
α
P_t (Gev/c)
$\frac{d\sigma}{dX}$ (mb)
δ
X

Fig.1



N_γ
N_q
KT (Mev)

Fig.2

FIGURE CAPTIONS

Fig.1. The spectral dependence of the soft photon number (a) upon P_t and (b) upon x. The points are for the experimental data [1]. The solid and dashed histograms are for the results of the CQGP model [6]. The curves 1 and 2 are for results of the present work at KT=100 and 800 MeV. The curves 3 are for the results of the bremsstrahlung calculations [1].

Fig.2. The dependence of N_γ and N_q upon KT.

REFERENCES

1. Chliapnikov P.U. et al. Phys.Lett., 1984, vol.141B, p.276-280.
2. Aubert J.J. et al., Phys.Lett., 1989, vol.218, p.248-256.
3. HELIOS Collaboration, Nucl. Phys., 1989, vol.A498, p.79-92.
4. Balek U., Pisutova N., Pisut J., Acta Phys. Polonica, 1990, vol.B21, p.149-167.
5. Shuryak E.V., Phys.Lett., 1989, vol.B231, p.175-177.
6. Lichard P., Van Hove L., Phys.Lett., 1990, vol.B245, p.605-608.
7. McDonald K.T., Preprint DO/ER/3072-38, Princeton University, 1986.
8. Darbinian S.M., Ispirian K.A., Margarian A.T., Preprint YERPHI-1188(65)-89, Yerevan Physics Institute, 1989.
9. Дарбинян С.М. и др., Письма в ЖЭТФ, 1990 т.51, с.97-99.
10. Barshay S., Troost W., Phys.Lett., 1978, vol.B73, p.437-439
11. Barshay S.,Phys.Lett., 1983, vol.B127, p.129-131.

С.М.ДАРБИНЯН, К.А.ИСПИРЯН, А.Т.МАРГАРЯН

ИЗЛУЧЕНИЕ УНРУ КВАРКОВ И ПРОБЛЕМА МЯГКИХ ФОТОНОВ В АДРОННЫХ ВЗАИМОДЕЙСТВИЯХ

(на английском языке, перевод авторов)

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