

# On the coherent inelastic binary and multiparticle processes in ultrarelativistic hadron-nucleus, photon-nucleus and nucleus-nucleus collisions

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The coherent inelastic processes of the type  $a \rightarrow b$ , which may take place in the interaction of hadrons and  $\gamma$  quanta with nuclei at very high energies (the nucleus remains the same), are theoretically investigated. For taking into account the influence of matter inside the nucleus, the optical model based on the concept of refraction index is applied. Analytical formulas for the effective cross section  $\sigma_{\text{coh}}(a \rightarrow b)$  are obtained, taking into account that at ultrarelativistic energies the main contribution into  $\sigma_{\text{coh}}(a \rightarrow b)$  is provided by very small transferred momenta in the vicinity of the minimum longitudinal momentum transferred to the nucleus. It is shown that the cross section  $\sigma_{\text{coh}}(a \rightarrow b)$  may be expressed through the “forward” amplitudes of inelastic scattering  $f_{a+N \rightarrow b+N}(0)$  and elastic scattering  $f_{a+N \rightarrow a+N}(0)$ ,  $f_{b+N \rightarrow b+N}(0)$  on a separate nucleon, and it depends on the ratios  $L_a/R$ ,  $L_b/R$ , where  $L_a$  and  $L_b$  are the respective mean free paths in the nucleus matter for the particles  $a, b$  and  $R$  is the nuclear radius.

In doing so, several characteristic cases with different relations of the magnitudes  $L_a, L_b, R$  are considered in detail – in particular, the cases  $L_a/R \gg 1$ ,  $L_b/R \sim 1$  and  $L_a/R \gg 1$ ,  $L_b/R \ll 1$  ( which correspond, e.g., to the coherent production of vector mesons  $\rho^0, \omega, \phi$  at the interaction of very high energy photons with nuclei ), and some numerical estimates are made for the coherent process  $\gamma \rightarrow \rho^0$  on the  $Pb$  nucleus .

The above formalism is generalized also for coherent inelastic multiparticle processes on a nucleus of the type  $a \rightarrow \{b_1, b_2, b_3 \dots b_i\}$  and for the case of coherent processes in collisions of two ultrarelativistic nuclei.

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