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On the coherent inelastic binary and multiparticle processes in the ultrarelativistic hadron–nucleus, photon–nucleus and nucleus–nucleus interactions

The coherent inelastic processes of the type a –> b, which may take place in the interaction of hadrons and γ 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 conception of the refraction index, is used .
Analytical formulas for the effective cross section $\sigma_{coh}(a - - > b)$ are obtained,
taking into account that at ultrarelativistic energies the
main contribution into $\sigma_{coh}(a - - > b)$
is provided by very small transferred momenta in the vicinity of the minimal longitudinal momentum transferred to the nucleus. It is shown that the cross section $\sigma_{coh}(a - - > b)$ may be expressed through the "forward" amplitudes of inelastic scattering $f_{a+N - - > b+N}(0)$ and elastic scattering
$f_{a+N - - > a+N}(0)$, $f_{b+N - - > b+N}(0)$ on a separate nucleon, and it depends on the ratios L_a/R and L_b/R (L_a and L_b are the mean free paths in matter inside the nucleus for the particles a and b, respectively,
R is the nuclear radius). In particular, when
$L_a/R >> 1$, but $L_b/R << 1$ (or $L_a/R << 1$, but $L_b/R >> 1$), $\sigma_{coh}(a - - > b)$ is equal to
the ratio of the "forward" cross sections of inelastic scattering $a + N - - > b + N$ and elastic scattering of the particle b (or a) on a nucleon, multiplied by the cross section of scattering on the "black" nucleus πR^2.
When both the conditions $L_a/R >> 1$ and $L_b/R >> 1$ are satisfied, $\sigma_{coh}(a - - > b)$ is proportional to the factor R^4/k^2, where k is the initial energy of the particle a in the laboratory frame.
The above formalism is generalized also for the case of coherent inelastic multiparticle processes on a nucleus of the type a –> { b_1, b_2, b_3 ....b_i }, and for the case of coherent processes at collisions of two ultrarelativistic nuclei .

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