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Crystal Excitation Features in the Photon Emission Spectra of the Quantum Channeled Particle

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The mutual influence of the processes of radiation and generation of excitations in the quantum crystal with the channeled particle (electron or positron) is considered. The emergence of new peaks in the emission spectrum of such a channeled particle associated with the processes of simultaneous resonant hard gamma-quantum and plasmon excitation during its motion in the crystal is predicted. The distance between the particle transverse motion levels should be equal to the sum of the photon energy and quantum plasmon energy in the coordinate system associated with the moving particle. Plasmon energy in such a system increases with the Lorentz factor , comparing the characteristic energy depth of the crystal potential well . The energy-momentum conservation laws in the comoving coordinates system are feasible. After the transition to the laboratory coordinate system the plasmon energy $\hbar\omega_{pl}$ is reduced to the values of about 20 eV, while the energy of a photon $\hbar\omega$ emitted within a narrow cone of directions near the angle θ, coaxial with the motion direction of a channeled particle is determinated in accordance with the energy-momentum conservation laws in this process $\hbar\omega = \frac{\Delta E_{\perp} \pm \hbar\omega_{pl}}{1-(v/c)\cos\theta}$.

Essentially, this effect represents the record of the Doppler effect for the process of the simultaneous emission of a photon and a plasmon with the channeled particle. In this case, however, the resulting emission peaks have a large half-width due to the plasmon momentum carryover, in contrast to the conventional channeled particle radiation process without plasmon emission. Thus a cone of the emitted photons undergoes blurring. The probability of the discussed process with the transition of fast particles in the virtual state after the emission of the plasmon and with the subsequent emission of photons is calculated . It is found that the photon-plasmon radiation probability is of the same order order of magnitude with a known standard radiation process probability. The possibility of the experimental observation of the effect is estimated.

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