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TANDEM FREE ELECTRON X-RAY LASER ON CHANNELING RELATIVISTIC PARTICLES

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One of the optimal ways of generation of coherent hard radiation is connected with Free Electron Laser on relativistic particles. Unfortunately, the effectiveness of "usual"FEL is very low ($dN/dn < 0.001$ quanta/particle). The possibilities of optimization of FEL and creation of tandem short wave laser with extremely high efficiency ($dN/dn >> 1$ quanta/particle) are discussed. The main role in such system plays the full Doppler effect in extreme area of Cherenkov parameters $\beta n(\omega)cos(\theta) \approx 1$ that was investigated for the first time in 2006 [1].

For such laser the very effective process of consecutive generation of two types of photons with different frequencies $\omega_{1,2}$ on the same radiating transition is possible and this double photon generation leads to the restoration of the initial state of quantum system. This effect allows predicting the possibility of multiple repeat of radiation cycle on the same pair of energy levels $\varepsilon_{n,m}$

$\varepsilon_n \to \varepsilon_m + \hbar\omega_1 \to \varepsilon_n + \hbar\omega_1 + \hbar\omega_2 \to \varepsilon_m + 2\hbar\omega_1 + \hbar\omega_2 \to \varepsilon_n + 2\hbar\omega_1 + 2\hbar\omega_2 \to \ldots$

This closed loop can be repeated many times, leading to the possibility of multiphoton generation at two-level transition of the same particle [2]. The pumping source for such laser is the kinetic energy of moving particles. In tandem FEL there is no need for inversion.

[1] M. V. Vysotskyy and V. I. Vysotskii, "The Doppler effect in a medium for radiation sources in motion at extreme conditions,"Nucl. Instr. Meth. Phys. Res. B, vol. 252, pp. 75-80, 2006.
[2] V. I. Vysotskii and M. V. Vysotskyy, "Peculiarities of induced radiation and controlled dechanneling of relativistic particles in crystals under the Cherenkov—Vavilov extreme condition,"J. Surf. Invest. X-ray, Synchrotron Neutron Techn., vol. 4, pp. 162-169, 2010.

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