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Dynamical Chaos and Level Splitting under the Channeling of the High Energy Positrons in [100] Direction of the Silicon Crystal

The positively charged particles can perform the axial channeling in the small potential well formed between four neighboring [100] strings of the Silicon crystal. The transverse motion of the particle in this well can be both regular and chaotic, and the relative volume in the phase space filled by the regular trajectories decreases while rising from the bottom of the potential well to its edges [1].

The transverse motion of the particle in the well is quantized in the quantum mechanical limit. The energy levels in the completely regular case do not interact each other hence the level spacings obey exponential distribution that is characteristic for Poisson flow. The interaction of the levels under dynamical chaos conditions manifests itself in their repulsion and hence changes the statistical properties of the level spacing distribution [2]. The mechanism of the levels interaction consists in the quantum mechanical tunneling between the states which semiclassical wave functions are localized in the dynamically isolated domains in the phase space [3]. The tunneling rate can be strongly enhanced when such domains are separated from each other by the region of chaotic motion (chaos-assisted tunneling, CAT) [3-6].

Here we have found numerically all energy levels of the transverse motion for 30 GeV channeling positrons and extracted the values of the matrix elements for the tunnel transitions. These results confirm the chaos assistance for the tunneling and the level splitting. These values will be used in the further researches of the quantum chaos manifestations in the channeling phenomenon.

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Author: SYSHCHENKO, Vladislav

Co-authors: Dr ISUPOV, Alexander (Laboratory of High Energy Physics (LHEP), Joint Institute for Nuclear Research (JINR)); TARNOVSKY, Arthur (Belgorod National Research University); DRONIK, Vitaliy (Belgorod National Research University)

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