A. Bohr's hypothesis for angular distributions of fragments of low-energy nuclear fission and wriggling vibrations of the fissile nuclei

Titova L.V.

Voronezh State University, 394006, Russia, Voronezh, University square, 1

The A. Bohr's hypothesis [1], widely used in the describing of the fragments angular distributions (FAD) for low-energy fission of atomic nuclei, is based on the concept about the fission fragments emission along or against the symmetry axis of an axially symmetric fissile nucleus. This hypothesis does not take into account the quantum-mechanical uncertainty relation between the operator of the orbital moment of the particle L and the angle of its' escape θ' in the internal coordinate system (i.c.s.), from which it follows that the exact value of the angle θ' leads to the appearance of uncertainty of fission fragments relative orbital momenta $\Delta L \to \infty$. For the approximate validity of A. Bohr's hypothesis, it is necessary that orbital momenta L have large but finite values. The appearance of a such large L values in the framework of the quantum fission theory [2] can be connected with the influence of the transverse wriggling vibrations of the fissile nucleus near its scission point. For binary fission FAD $P(\theta')$ in the i.c.s. can be represented as $P(\theta') = \left|\sum_L \psi_L Y_{L0}(\theta')\right|^2$ (1), where ψ_L [3] is the wave function of the wriggling vibrations normalized to unity: $\psi_L = \sqrt{L/C_w}\exp\left(-L^2/4C_w\right)$ (2), characterized by the parameter C_w, which is defined in terms of the stiffness K_w and the mass M_w parameters as $C_w = M_w \hbar \omega_w$, where $\omega_w = \sqrt{K_w/M_w}$ [4].

The analysis of the experimental deviations of FAD from the A. Bohr's hypothesis [1] are investigated for the case of P-odd asymmetries in the FAD of low energy fission of ^{233}U and ^{235}U nuclei by thermal polarized neutrons [5], as well as the for the anisotropy coefficients in the FAD of aligned ^{233}U and ^{235}U nuclei fission induced by resonance neutrons [6]. For these cases A. Bohr's hypothesis are in good agreement with experiment, and the deviations can be observed in P-odd asymmetries coefficients only when $C_w \le 15$ for ^{233}U and $C_w \le 30$ for ^{235}U, and for FAD anisotropy coefficients of aligned nuclei when $C_w \le 60$ and $C_w \le 80$ for ^{233}U and ^{235}U. These results can be explained by the low experimental accuracy of measured coefficients in mentioned above experiments. But the comparison of the theoretical FAD coefficients, constructed with taking into account wriggling vibrations, and experimental FAD coefficients for the binary photofission of even-even uranium nuclei provided an estimation of the parameter $C_W = 130 \pm 20$ for ^{234,236,238}U nuclei, which is consistent with the values of this parameter in [4]. For this case the A. Bohr hypothesis, corresponding to $C_W \to \infty$, doesn't describe the experimental FAD.

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