Space-Time Evolution of Wave Function for Cluster Decay of Nuclei

A. Ya. Dzyublik[1]

[1] Institute for Nuclear Research, Kiev, Ukraine

dzyublik@ukr.net

The cluster decay of spherical nuclei is analyzed in the framework of strict decay theory of Goldberger and Watson [1]. It is regarded as a transition, caused by a residual interaction, between the initial bound state of the parent nucleus and the scattering states of clusters in the continuous spectrum. In contrast to standard approach to the problem(e.g., [2]), dealing with complex energies and unnormalized wave function for the relative motion of clusters, our wave function is normalized to unity. It is calculated in the WKB approximation. In addition, general formulas for the decay constant are derived, which are converted then into famous quasiclassical expression. Using the Moshinsky function we analyzed the distortions of the wave front of the emitted clusters. Moreover, the conventional demand, that the decaying level should satisfy the Bohr-Sommerfeld quantization rule for bound states, is shown to be incorrect. The calculated partial lifetimes of α-decay of even-even isotopes of uranium into the ground rotational bands of thorium well agree with the experimental data. The obtained scattering wave functions can be used in the calculations of cluster decay of the deformed nuclei [3].

1. Goldberger M. L., Watson K. M. Collision Theory. – New York: J. Wiley, 1964, 919 p.
2. Delion D. S. Theory of Particle and Cluster Emission. Lecture Notes in Phys. v.819.–Heidelberg: Springer, 306 p.
3. Dzyublik A. Ya. Alpha decay of deformed even-even nuclei. Acta Phys. Polonica.–2017, B 10, 69-80.