PROTON AND HEAVIER CHARGED PARTICLES EMISSION HALF-LIVES WITHIN A GAMOW-LIKE MODEL

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The proton emission from the ground state of mother nuclei with mass ranging $110 \leq A \leq 150$ was measured in the early 1980s [1]. This decay mode is observed for the odd-Z emitters beyond the proton drip line. The associated half-lives ranges from nano to seconds. Another decay mode - cluster radioactivity - was theoretically predicted in 1980 [2] and discovered four years later [3]. This is a very rare process and corresponds to the emission of a nucleus heavier than He-4, but lighter than a mass of a lighter fragment of a binary fission. The observed atomic masses of clusters are in the range $14 \leq A \leq 34$, while the mass of a daughter nucleus is close ($\pm$ 4 nucleons) to the doubly-magic Pb-208 isotope.
One of the most important decay modes of heavy nuclei is α radioactivity. The first explanation of this process was given by Gamow in 1928 [4]. It was assumed that emission is due to the quantum mechanical tunneling of a charged α-particle through the nuclear Coulomb barrier.

We made an attempt to reproduce the half-lives for the mentioned above, three types of decay within the same simple formalism, based on Gamow theory [5]. The simple formula for the half-lives is derived using the WKB theory for the penetration of the Coulomb barrier with a square well for the nuclear part. We show that using only one adjustable parameter - the radius constant - it is possible to reproduce with a good accuracy the half-lives for even-even α and cluster emitters. This simple phenomenological formalism is also extended by including the centrifugal term to describe proton emission. The adjustable parameter – the effective nuclear radius constant has the same value (1.21 fm) for all discussed decay modes. A good agreement with the experimental data is achieved.

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