Sixth Article

Alpha decay around shell closures and correlation of half-life times with the neutron energy levels of the emitting nuclei

M. Ismail, S. G. Abd-Elnasser, **H. M. Elsharkawy** and I. A. M. Abdul-Magead
Nuclear Physics A **1029**, 122547 (**2023**)

Abstract

The α-decay half-lives ($T_{1/2}$) for 16 isotopic chains of even-even and even-odd nuclei, from ^{52}Te to ^{82}Pb were investigated by employing the density dependent cluster model. The α-nucleus potential was calculated by the double-folding model (DFM) using the M3Y-Reid NN interaction with the zero-range ex-change part assuming spherical and deformed density distributions of the daughter nuclei. In the framework of the WKB approximation, the half-lives of the α-emitters were calculated and compared using six analytic formulas (UDL, Horoi, BKAG, UNIV, NRDX and TM formulas). We found a clear similarity in the be-havior of $\log_{10}T_{1/2}$ versus the neutron daughter number (N_d) when the calculations performed using both DFM and these mentioned analytical formulas for each isotopic chain. In addition, the theoretical results of $\log_{10}T_{1/2}$ obtained with the UDL and UNIV formulas slightly better agree with the DFM calculations than those calculated from the other analytical methods. Moreover, the present work pointed out some magic or semi-magic neutron numbers of the daughter nuclei corresponding to dips in the behavior of $\log_{10}T_{1/2}$ with variation in N_d. The interplay of these magic (semi-magic) numbers is inspected as the total number of neutrons filling the upper neutron level in the parent nucleus. We test the predicted results of the above-mentioned models by comparing them with the available experimental α-decay half-lives. Starting from the number of neutrons needed for level closure and the small available values of the confirmed spin of parent and daughter nuclei, we predicted the level schemes around the known magicities N=50, 82 and 126. We found changes in the neutron levels for isotopes of the same element which become too large for heavy nuclei. Example for these changes is the repetition of the spin value $1/2^-$ for the three isotopes $^{195-199}$Hg and their daughters, we need five different neutron level arrangements with $3p_{1/2}$ level at the top.