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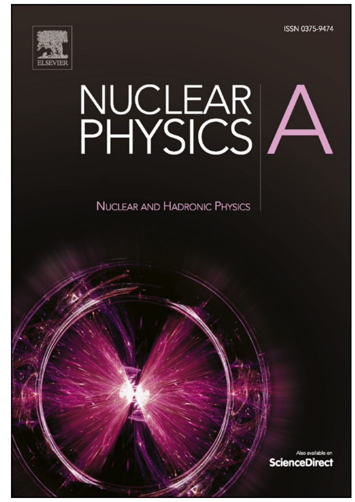

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Systematic study of α-decay half-lives using Royer and related Formula

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Abstract

The alpha decay half-lives of 356 isotopes were studied using the Royer and related Formula and are compared with experimental data. The study shows that the predicted half-lives match well with experimental data over a wide range for each (Z, N) parity of the parent nuclei. We have calculated the standard deviation of $\log_{10}T_{\alpha}(s)$, for each formula and our study indicate that, for alpha decay studies, generally, analytical ℓ-dependent formula proposed by Royer, with σ^{RB} = 0.4373, is the best model followed by the formula proposed by Denisov and Khudenko (DK), σ^{DK}= 0.4743 for all 356 nuclei. We hope the present study is a clear indicator of the predictive power of Royer and related formula.

Keywords: α-decay; half-life; iso-spin; semi-empirical formula.

PACS: 27.90. +b, 21.10.Tg, 23.60.+e, 23.50.+z, 23.70. +j

1. Introduction

The alpha decay (AD) mode basically occurs in heavy and super-heavy nuclei (SHN). Historically, alpha particles were used in the investigations of radioactivity by Rutherford in 1899 [1, 2]. The process of alpha decay via the quantum tunneling phenomenon was first explained by Gamow [3], in 1928. In 1966, Viola and Seaborg [4] predicted a simple formula which is based on Gamow model. In 1992, Brown [5] predicted a universal scaling law for alpha decay half-lives of even–even parents by using the Geiger-Nuttall law and the $Z_dQ^{-1/2}$ dependence with the best representation of data by the linear dependence of the logarithm of the half-lives on $Z_d^{0.6}Q_{\alpha}^{-1/2}$ quantity, where Z_d is the charge number of the daughter nucleus. In 1983, a semi empirical relationship on the grounds of the fission theory for alpha decay in each group of the nuclei (e-e, o-e, e-o and o-o), was proposed by Poenaru and Ivascu [6]. Wapstra et al. [7] proposed a simple relationship for estimation of the alpha decay half-lives of even-even nuclei with $Z \geq 85$. Denisov and Khudenko [8] considered the set of 344 nuclei, divided into four subsets according the number of protons and neutrons: even-even (e-e), even-odd (e-o), odd-even (o-e) and odd-odd (o-o) nuclei and studied alpha decay half-lives using the unified model for alpha decay and alpha capture (UMADAC). In 2005, Parkhomenko and Sobiczewski [9] discussed a simple version of the Viola-Seaborg formula for the description of alpha decay of heavy and superheavy nuclei. Denisov et.al [10] considered the ground-state-to-ground-state alpha-transition half-lives in 401 nuclei and the alpha capture cross sections of ^{40}Ca, ^{44}Ca, ^{59}Co, ^{208}Pb and ^{209}Bi in the framework of the unified model for alpha-decay and alpha-capture. The Coulomb and proximity potential model for deformed nuclei proposed by Santhosh et al., [11-15] is proved to be an effective tool for studying alpha decay of even-even, even-odd, odd-even and odd-odd nuclei. Also, many other