ISSN 1062-8738, Bulletin of the Russian Academy of Sciences: Physics, 2018, Vol. 82, No. 6, pp. 691–696. © Allerton Press, Inc., 2018.
Original Russian Text © M.L. Markova, T.M. Shneidman, N.V. Antonenko, T.Yu. Tretyakova, 2018, published in Izvestiya Rossiiskoi Akademii Nauk, Seriya Fizicheskaya, 2018, Vol. 82, No. 6.

Effect of Coriolis Interaction on the Decay of Isotones with $N = 149$ and $N = 153$

M. L. Markova[a], T. M. Shneidman[a, d, *], N. V. Antonenko[b], and T. Yu. Tretyakova[c]

[a]*Moscow State University, Moscow, 119991 Russia*
[b]*Joint Institute for Nuclear Research, Dubna, 141980 Russia*
[c]*Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow, 119991 Russia*
[d]*Kazan Federal University, Kazan, 420008 Russia*
**e-mail: shneyd@theor.jinr.ru*

Abstract—The quasi-neutron structure of nuclei in two chains of odd isotones with N = 149 and N = 153: ^{243,247}Pu, ^{245,249}Cm, ^{247,251}Cf, ^{249,253}Fm, ^{251,255}No, and ^{253,257}Rf is considered. Single-particle energy spectra are calculated using the two center shell model (TCSM). Minimizing the potential energy with respect to the collective coordinates gives the ground state of the studied nucleos, which is subsequently used to describe low-lying quasi-neutron states. The K-mixing of the basis TCSM wave functions is considered by including the Coriolis correction in the total Hamiltonian of the system. The effect of level blocking is also considered in the calculations. The probabilities of the $E2$ transitions to the ground states and the corresponding lifetimes of the quasi-neutron levels are estimated.

DOI: 10.3103/S1062873818060187

INTRODUCTION

Spectroscopic studies of odd isotopes of actinides and trans-actinides continue to be of great interest. Such efforts are complicated by the difficulty of identifying new isotopes of heavy and super-heavy nuclei [1]. The constant accumulation of experimental information and the improving accuracy of the obtained data stimulate the development of new theoretical approaches to describing the structure of heavy nuclei. Comparing theoretical calculations and experimental data on the quasi-particle states in odd isotopes of heavy nuclei allows us to specify the model parameters and make assumptions about the quantum numbers of the experimental levels. In describing low-lying excited levels of atomic nuclei with an odd values of mass number A, it is convenient to use a formal division of the nucleus into a valence particle and an even–even inert core. This simplifies the form of the system's total Hamiltonian and allows us to ignore particle–hole excitations. Studies of the quasi-neutron spectra of heavy and superheavy deformed nuclei focus on chains of isotones, particularly ones with N = 149 and N = 153. These include nuclei ^{243,247}Pu, ^{245,249}Cm, ^{247,251}Cf, ^{249,253}Fm, ^{251,255}No, and ^{253,257}Rf [2].

One of the most interesting features of the energy spectra of these nuclei is their isomeric states, which play a special role in the approach to islands of stability and allow the use of highly sensitive spectroscopy techniques to study the transitions from these states to the ground and excited states of lighter nuclei by means of α-decay. The comparatively long lifetime of the isomeric state with respect to the α-transition to the ground state is usually due to this transition being strongly forbidden and/or having a low energy. Rotation-induced mixing of the wave functions of the ground and excited states according to quantum number K (the projection of full nucleus moment J onto the axis of symmetry) plays an imortant role in identifying the isomeric states in heavy deformed nuclei [3]. This mixing is due to the so-called Coriolis correction in the total Hamiltonian of the system and can greatly affect the lifetimes of isomeric states. Proper consideration of Coriolis interaction in describing the quasi-particle (and especially quasi-neutron) spectra of heavy and super-heavy nuclei is therefore important when interpreting experimental data.

Experimental data on excited states are now available for most of the above isotones. Spectroscopic data for ^{245}Cm were obtained by studying the α-decay of ^{249}Cf, along with the β-decay of ^{245}Am and ^{245}Bk, and of ^{246}Cm (d,t) and ^{244}Cm (d,p) in the reactions of single-nucleon transfer [4, 5]. Experimental spectra for ^{247}Cf and ^{249}Fm were obtained in reactions of the α-decay of ^{251}Fm [6] and ^{253}No [7, 8], respectively. In addition to data on the α-decay of ^{255}Rf [9], important results for ^{251}No were obtained on the decay of excited states formed in the reaction ^{208}Pb(^{48}Ca, $3n$)^{251}No [10].