



Contribution ID: 113

Type: Oral

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Friday, 21 July 2023 14:05 (15 minutes)

Configuration mixing and quantum phase transitions in odd-mass nuclei around ^{100}Zr

J.-M. Régis¹, A. Pfeil¹, J. Jolie¹, A. Esmaylzadeh¹, L. Knafla¹, M. Ley¹, U. Köster², Y. H. Kim², N. Gavrielov³ and K. Nomura⁴

1: IKP, Universität zu Köln, Zùlpicher Str. 77, 50937 Köln, Germany

2: ILL, 71 avenue des Martyrs CS 20156, 38042 Grenoble Cedex 9, France

3: Center for Theoretical Physics, Sloane Physics Laboratory, Yale University, New Haven, Connecticut 06520-8120, USA

4: Department of Physics, Faculty of Science, University of Zagreb, 10000 Zagreb, Croatia

Abstract

Several $N = 60$ isotones around ^{100}Zr show rotational structures based on a deformed ground state. The shape transition from spherical single-particle structures of the $N = 50$ closed-shell isotones to quadrupole deformation at $N = 60$ can be described in terms of Quantum Phase Transitions (QPT). Recently, calculations using the Interacting Boson Model with configuration mixing (IBM-CM) of the ground and the $2p$ - $2h$ intruder states could very well describe the experimentally observed sudden (sharp) shape transition in the even-Zr isotopes going from $N = 58$ to $N = 60$ as an abrupt configuration crossing (type II QPT) [1]. The calculation revealed that the type II QPT is accompanied by a type I QPT of the intruder state as gradual spherical-to-deformed shape transition of this configuration [1]. The calculations have been extended to the odd-Nb isotopes with $N = 52$ - 64 using the IBFM-CM by coupling the $\pi(1g_{9/2})$ orbit to the Zr boson core [2]. Similarly to the even-Zr isotopic chain, the odd-Nb disclose a Type II QPT at $N = 60$ accompanied by a type I QPT of the intruder configuration and which is the feature of an intertwined QPT [1,2].

We are reporting on further investigation on QPTs by presenting results of γ - γ lifetime measurements of the lowest excited states in the odd ^{99}Zr and ^{99}Nb nuclei. Highly effective and precise γ - γ fast-timing experiments have been performed at the LOHENGRIN fission-fragment separator of the Institut Laue-Langevin [3]. The deduced transition rates are compared with newest calculations on ^{99}Nb within the IBFM-CM framework. Experimental results of transition rates in ^{99}Zr [3] have been used to investigate QPTs by comparing with the IBFM constructed with deformation constrained self-consistent mean-field calculations based on the relativistic Hartree-Bogoliubov model with a choice of a universal energy density functional and pairing interaction [4].

[1] N. Gavrielov, A. Leviatan and F. Iachello, Phys. Rev. C 105 (2022) 014305

[2] N. Gavrielov, A. Leviatan and F. Iachello, Phys. Rev. C 106 (2022) L051304

[3] A. Pfeil, Master Thesis, Universität zu Köln 2022

[4] K. Nomura, T. Niksic and D. Vretenar, Phys. Rev. C 102 (2020) 034315

Primary author: Dr RÉGIS, Jean-Marc (Institut für Kernphysik der Universität zu Köln)

Co-authors: Mr PFEIL, Aaron (Institut für Kernphysik der Universität zu Köln); Prof. JOLIE, Jan (Institut für Kernphysik der Universität zu Köln); Dr ESMAYLZADEH, Arwin (Institut für Kernphysik der Universität zu Köln); Mr KNAFLA, Lukas (Institut für Kernphysik der Universität zu Köln); Dr KÖSTER, Ulli (Institut Laue-Langevin); Mr LEY, Mario (Institut für Kernphysik der Universität zu Köln); Dr KIM, Yung Hee (Institut Laue-Langevin); Dr GAVRIELOV, Noam (Center for Theoretical Physics, Sloane Physics Laboratory, Yale University); Prof. NOMURA, Kosuke (Department of Physics, Faculty of Science, University of Zagreb)

Presenter: Dr RÉGIS, Jean-Marc (Institut für Kernphysik der Universität zu Köln)

Session Classification: Session 16

Track Classification: Experimental Nuclear Structure