Shapes and Symmetries in Nuclei: from Experiment to Theory (SSNET'22 Conference)

Monday, 30 May 2022 - Friday, 3 June 2022

Report of Abstracts

ID de résumé : **30**

Charge radii in covariant density functional theory: general situation, odd-even staggering and connection to atomic physics

Contenu

A systematic global investigation of differential charge radii has been performed within the covariant density functional framework for the first time [1,2,3]. Theoretical results obtained with conventional covariant energy density functionals and separable pairing interaction are compared with experimental differential charge radii in the regions of the nuclear chart in which available experimental data crosses neutron shell closures at $N = 28, 50, 82$ and 126. The analysis of absolute differential radii of different isotopic chains and their relative properties indicate clearly that such properties are reasonably well described in model calculations in the cases when the mean-field approximation is justified. However, while the observed clusterization of differential charge radii of different isotopic chains is well described above the $N = 50$ and $N = 126$ shell closures, it is more difficult to reproduce it above the $N = 28$ and $N = 82$ shell closures because of possible deficiencies in underlying single-particle structure [1]. The impact of the latter has been evaluated for spherical shapes and it was shown that the relative energies of the single-particle states and the patterns of their occupation with increasing neutron number have an appreciable impact on the evolution of the $\delta \left\langle r^2 \right\rangle^{N,N'}$ values. These factors also limit the predictive power of model calculations in the regions of high densities of the single-particle states of different origin. It is usually assumed that pairing is a dominant contributor to odd-even staggering (OES) in charge radii. Our analysis paints a more complicated picture. It suggests a new mechanism in which the fragmentation of the single-particle content of the ground state in odd-mass nuclei due to particle-vibration coupling provides a significant contribution to OES in charge radii [1]. The connections between the physics of nuclear charge radii and atomic physics will also be discussed [4,5].

[1] U. C. Perera, A. V. Afanasjev and P. Ring, Phys. Rev. C. 104, 064313 (2021).
[2] T. Day Goodacre A. V. Afanasjev et al, Phys. Rev. Lett. 126, 032502 (2021).
[3] T. Day Goodacre A. V. Afanasjev et al, Phys. Rev. C 104, 054322 (2021).
[4] S.O. Allehabi et al, Phys. Rev. C 102,024326 (2020).
[5] S.O.Allehabi et al, Phys. Rev. A 103, L030801 (2021).

Auteur principal: AFANASJEV, Anatoli (Mississippi State University)

Orateur: AFANASJEV, Anatoli (Mississippi State University)

Déposé par **AFANASJEV, Anatoli** le **vendredi 1 avril 2022**

The 186Hg ground state deformation puzzle

A. Algora
for the IS539 experiment

Since the 70-s, the structure of neutron-deficient Hg isotopes has attracted considerable attention. Their mean square nuclear radii show a particular staggering, which was unique in the nuclear chart [1] until very recently [2]. This phenomenon was interpreted as a change in the ground state structure and consequently on the ground state shape around A=186 [3] and the existence of shape isomerism in the odd isotopes. Recent measurements at ISOLDE extended the study of the mean square radii in Hg nuclei down to 179Hg and confirmed earlier results for A < 185 [4].

We have recently studied the beta decay of 186Hg using the total absorption technique with the goal of inferring the shape of the ground state of 186Hg from the distribution of the beta strength in the daughter, a method that has been applied earlier for nuclei in the A=80 and A=190 regions (see for example [5,6]). The analysis of the beta decay data from the 186Hg case required the development of a new analysis technique because of the existence of highly converted gamma-ray transitions in the 186Au daughter nucleus [7]. The comparison of the results of our measurements with QRPA theoretical calculations shows a quite different picture than expected: 186Hg seems rather mixed in its ground state, with a dominantly prolate component [7]. In this presentation these results will be presented and future perspectives will be discussed.

[1] J. Bonn, et al., Z. Phys. A 276 (1976) 203; G. Huber, et al., Z. Phys. A 276 (1976) 187;
G. Ulm, et al., Z. Phys. A 325 (1986) 247; T. Kühl, et al., Phys. Rev. Lett. 39 (1977) 180.
[2] A. Barzakh, et al., Phys. Rev. Lett. 127 (2021) 192501.
[3] S. Frauendorf, V.V. Pashkevich, Phys. Lett. B 55 (1975) 365.
[4] B. A. Marsh, et al., Nat. Phys. 14 (2018) 1163.
[5] E. Nácher, et al., Phys. Rev. Lett. 92 (2004) 232501; E. Poirier, et al., Phys. Rev. C 69 (2004) 034307.
[6] M.E. Estévez Aguado, et al., Phys. Rev. C 92 (2015) 044321.
[7] A. Algora, E. Ganioglu, P. Sarriguren et al., Physics Letters B 819 (2021) 136438

Search for Triaxial Deformation using Coulomb Excitation and Beta Decay

J.M. Allmond[1]

[1] *Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831*

Collective shape degrees of freedom have been a major direction in the study of the nuclear finite many-body problem for over 50 years. There is widespread evidence for quadrupole deformations, primarily of large prolate spheroidal deformation with axially symmetric rotor degrees of freedom. This naturally leads to the question of whether or not axially asymmetric rotor degrees of freedom are exhibited by any nuclei, with the implication of triaxial shapes. With respect to best cases for observation of triaxial shapes near the ground state, two regions stand out. The first is the Os-Pt region and the second is the neutron-rich Mo-Ru region, where low-energy 2_2^+ states are consistent with such an interpretation. Furthermore, the neutron-rich Mo-Ru region is expected to undergo a relatively rare instance of prolate-to-oblate shape evolution. Recent results from Coulomb-excitation and beta-decay studies of neutron-rich Mo-Ru isotopes will be presented. These experiments were conducted at the CARIBU-ATLAS facility of ANL using GRETINA-CHICO2. A survey of the equipment, techniques, and results will be presented. In addition, a comparison of ^{106}Mo Coulomb-excitation data with the old ECR and new EBIS ion sources will be highlighted.

*This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics.

Contribution ID: **22** Type: **not specified**

Searching for Pygmy Quadrupole Resonance States in ^{118}Sn Using Neutron Capture at the Institut Laue-Langevin

The tin isotopic chain with its magic 50 proton closed shell is a benchmark for models of nuclear structure. While the neutron-rich tin nuclei around the magic 82 neutron shell play an important role in the rapid-capture nuclear process, the mid-shell region of the tin isotopes can display collective phenomena known as shape coexistence [1]; for example in $^{116}Sn_{66}$ deformed bands based on 2 particle − 2 hole excitations across the proton 50 shell gap exist [2]. Furthermore, at energies below the particle threshold, a new phenomenon called Pygmy Quadrupole Resonance (PQR) have been recently observed in ^{124}Sn below 5 MeV [3]. Coupled with theoretical calculations, the new excitation mode was interpreted as a quadrupole-type oscillation of the neutron skin. This study prompted investigations for corresponding states in the neighbouring ^{116,118,120}Sn nuclei populated using thermal neutron capture of ^{115,117,119}Sn(n,g) .

Thermal neutron capture of ^{115,117,119}Sn populates compound capture states at the neutron separation energy of about 9 MeV. The capture states in these experiments consist of 0+ and 1+ spins, ideal for populating subsequent 2+ states which could be attributed to the PQR predicted to exist in the 3-5 MeV range.

In the experiments performed at the Institut Laue-Langevin in Grenoble, France, a continuous high-flux of thermal neutrons of 108 s-1 cm-2 from the 57 MW research reactor was used for capture reactions on enriched odd-A Sn targets. Gamma ray transitions from excited states in nuclei of interest were detected by the Fission Product Prompt gamma-ray Spectrometer (FIPPS) [4] consisting of eight large n-type high purity germanium (HPGe) clover detectors and augmented with eight additional Compton-suppressed HPGe clovers from INFN Horia Hulubei, in Bucharest, Romania for enhanced gamma-ray efficiency and additional angular coverage used to produce angular correlations for spin assignments.

Preliminary results from the ^{117}Sn(n,g)^{118}Sn experiment will be presented highlighting the newly-observed levels within the 3-5 MeV energy range of interest for PQR.

[1] K. Heyde and J. L. Wood. Rev. Mod. Phys., 83, (2011).
[2] J.L. Pore et al., Eur. Phys. J A 53, 27, (2017).
[3] M. Spieker et al., Phys. Lett. B 752, 102 (2016).
[4]. C. Michelagnoli et al., EPJ A 193, 04009, (2018).

Primary authors: Prof. ANDREOIU, Corina (Simon Fraser University); Dr GARCIA, Fatima H. (Simon Fraser University); Ms ORTNER, Kevin; Dr SPAGNOLETTI, Pietro (Simon Fraser University)

Presenter: Prof. ANDREOIU, Corina (Simon Fraser University)

Contribution ID: **80** Type: **not specified**

Decay spectroscopy of isotopes above Fermium

Monday, 30 May 2022 15:05 (20 minutes)

The deformation of atomic nuclei is one of the important features significantly influencing the properties of the heaviest isotopes far above uranium. It is a decisive factor for their single-particle level structure, with an essential impact on the decay properties and, afterwards, the stability of heaviest nuclei with an odd number of protons or neutrons. Nuclear deformation is also crucial for the existence of phenomena like K isomers. Although there are available theoretical predictions for low-lying single-particle states of isotopes above fermium (see for example [1–3]), experimental data are scarce in this region. For many of these isotopes, even the ground-state or first excited states remain unassigned.

The use of sensitive α- and γ-decay studies combined with conversion-electron (CE) spectroscopy allowed detailed experimental studies of many isotopes in the region of heaviest nuclei (A > 250). This approach was applied in an extensive program aimed at nuclear structure studies of isotopes above fermium using α-CE, α-γ and CE-γ spectroscopy at the velocity filter SHIP of GSI Darmstadt.

This seminar will summarize some recent results obtained for the examples of recent studies – mainly isomeric states in ^{255}Rf [4,5] and ^{247}Md [6]. In addition, open problems for the single-particle level systematics of odd-Z isotopes will be discussed, as well.

[1] S. Ćwiok et al., Nucl. Phys. A 573, 356 (1994).
[2] A. Parkhomenko and A. Sobiczewski, Acta Phys. Pol. B35, 2447 (2004).
[3] A. Parkhomenko and A. Sobiczewski, Acta Phys. Pol. B36, 3115 (2005).
[4] S. Antalic et al., Eur. Phys. J. A 51, 41 (2015).
[5] P. Mošať et al., Phys. Rev. C 101, 034310 (2020).
[6] F.P. Heßberger et al., Eur. Phys. J A 58, 11 (2022)

Presenter: ANTALIC, Stanislav (Department of Nuclear Physics and Biophysics, Comenius University Bratislava, Slovakia)

Session Classification: Session 3: Spectroscopy of heavy and super-heavy nuclei

Microscopic description of triaxially deformed odd-odd proton emitters

P. Arumugam[1], P. Siwach[2], E. Maglione[3] and L.S. Ferreira[3]

[1] *Department of Physics, Indian Institute of Technology Roorkee, Roorkee 247667, India*
[2] *Department of Physics, University of Wisconsin, Madison, Wisconsin 53706, USA*
[3] *Centro de Física e Engenharia de Materiais Avançados CeFEMA, and Instituto Superior Técnico, Universidade de Lisboa, Avenida Rovisco Pais, P1049-001 Lisbon, Portugal*

Contact e-mail: arumugam@ph.iitr.ac.in

The nonadiabatic quasiparticle approach [1] to study the triaxially deformed odd-odd proton emitters is a powerful tool to unveil the structure of exotic nuclei near the proton drip line. The proton decay properties of nuclei in this region influence the path of the astrophysical *rp*-process [2, 3] significantly. We study these nuclei with the newly developed modified particle rotor model (MPRM) with two quasiparticles and a triaxial rotor. One of the major advantages of this approach is that the matrix elements of the coupled system explicitly carry the rotor's matrix element in the laboratory frame [4]. This provides the opportunity to utilize the rotor's experimental data, which in turn reduces the dependence on several adjustable parameters. The residual neutron-proton interaction is also considered within an appropriate formalism. The half-life of the proton emitter is calculated in a microscopic manner by coupling the parent and daughter wave functions. The information about the odd neutron is gathered from MPRM [4] which has been very successful in explaining the features of triaxially deformed odd-A proton emitters [5–6]. The configuration assignment of triaxially deformed odd-odd nuclei is done by looking into the rotational energies and the proton decay half-lives of the corresponding states, simultaneously. Important results in bringing out the necessity of a nonadiabatic approach while explaining the measured structure and decay data of 108I, including the fine structure in 140Ho and 144Tm, will be discussed.

1. G. Fiorin, E. Maglione, and L.S. Ferreira, Phys. Rev. C **67**, 054302 (2003).
2. H. Suzuki *et al.*, Phys. Rev. Lett. **119**, 192503 (2017).
3. K. Auranen *et al.*, Phys. Lett B **792**, 187 (2019).
4. P. Siwach, P. Arumugam, S. Modi, L.S. Ferreira and E. Maglione, J. Phys. G: Nucl. Part. Phys. **47**, 125105 (2020).
5. P. Siwach, P. Arumugam, S. Modi, L.S. Ferreira and E. Maglione, Phys. Rev. C **103**, L031303 (2021); Phys. Rev. C **105**, L031302 (2022).

Probing proton emitters using the MARA separator

K. Auranen,[1, a] A.D. Briscoe,[1] L.S. Ferreira,[2] T. Grahn,[1] P.T. Greenlees,[1] A.Herzáň,[3] A. Illana,[1] D.T. Joss,[4] H. Joukainen,[1] R. Julin,[1] H. Jutila,[1] M. Leino,[1] J. Louko,[1] M. Luoma,[1] E. Maglione,[2] J. Ojala,[1] R.D. Page,[4] J. Pakarinen,[1] P. Rahkila,[1] J. Romero,[1, 4] P. Ruotsalainen,[1] M. Sandzelius,[1] J. Sarén,[1] A. Tolosa-Delgado,[1] J. Uusitalo,[1] and G. Zimba[1]

[1] *Accelerator Laboratory, Department of Physics, University of Jyväskylä, FI-40014 Jyväskylä, Finland*
[2] *Centro de Física e Engenharia de Materiais Avançados CeFEMA, Instituto Superior Técnico, Universidade de Lisboa, Avenida Rovisco Pais, P1049-001 Lisbon, Portugal*
[3] *Institute of Physics, Slovak Academy of Sciences, SK-84511 Bratislava, Slovakia.*
[4] *Department of Physics, Oliver Lodge Laboratory, University of Liverpool, Liverpool L69 7ZE, United Kingdom*

Using the fusion-evaporation reaction ^{96}Ru(^{58}Ni,$p4n$)^{149}Lu and the MARA vacuum-mode recoil separator we have identified a new proton-emitting isotope ^{149}Lu. The measured decay Q-value of 1920(20) keV is the highest measured for a ground-state proton decay, and it naturally leads to the shortest *directly* measured half-life of 450^{+170}_{-100} ns for a ground-state proton emitter. The decay rate is consistent with $l_p = 5$ emission, suggesting a dominant $\pi h_{11/2}$ component for the wave function of the proton-emitting state. Through non-adiabatic quasiparticle calculations we were able to conclude that ^{149}Lu is the most oblate deformed proton emitter observed to date. In this talk I will discuss the experimental details and the already published results [1]. Additionally, we collected a good number of recoil-decay tagged γ rays feeding the proton decaying ^{147}Tm and ^{147m}Tm. The preliminary level schemes extracted from these data are also presented and discussed.

[1] K. Auranen *et al.*, PRL **128**, 112501 (2022)

[a] kalle.e.k.auranen@jyu.fi

Contribution ID: **19** Type: **not specified**

Shape coexistence in Sm nuclei around N=90

The nuclei near Z = 64 and N = 90, mainly the Sm and Gd isotopes, are classical examples of shape coexistence. The Sm (Z=62) isotopes are situated in the spherical to deformed shape transition path when valence neutrons are added. N=90 being the shape transition point [1], the coexistence of different quadrupole deformed shapes are expected in Sm nuclei around N=90. In addition, a variety of quadrupole shapes, both symmetric and asymmetric $\lambda = 3$ shapes are also expected in this region. The presence of deformation driving orbitals for the mid shell neutrons combined with the presence of ΔJ=3 orbitals for protons raises the possibility of octupole deformation to the nuclear surface in this region.

The shape coexisting characteristics of the 0^+ levels in ^{150}Sm and ^{152}Sm are suggested by two-nucleon transfer data from (p,t) reactions ~[2]. Distinct deformation is observed in conjunction with their near spherical and deformed ground states at the 0_3^+ levels of ^{150}Sm and ^{152}Sm, respectively. All of the 0^+ bands in ^{152}Sm are predicted to be quadrupole phonon multiplet structures [3] based on energy, B(E2), and the $\rho^2(E0)$ systematics. All low-lying 0^+ levels were considered by Gupta and Hamilton [4] to have identical rotational character, rejecting the shape coexistence and/or pairing isomer pictures for these levels. The 0_3^+ level was found to correspond to a deformed structure in coexistence with its near spherical ground state in the case of ^{150}Sm. Gupta, Kumar, and Hamilton [5] propose that the 0_3^+ level is the candidate for a K = 0 band with a quasirotational $\beta\beta$ phonon structure.

Knowledge of transition probabilities and transition matrix elements, especially for E0 transition between various close-lying 0^+ levels are of extreme importance for understanding such shapes, deformation, and their coexistence. Lifetimes measurements were performed for the low-lying levels in ^{150}Sm viz, 2_1^+ (334 keV), 0_2^+ (740 keV), and 0_3^+(1255) using $\gamma - \gamma$ fast timing spectroscopy with VECC array for nuclear fast timing and angular correlation studies(VENTURE array) [6] . The excited levels of ^{150}Sm were populated from the beta decay of ^{150}Pm, produced with ^{150}Nd(p,n) reaction using 8 MeV proton beam delivered from K-130 cyclotron facility at VECC, Kolkata. The lifetime of the 0_3^+ level in ^{150}Sm was measured for the first time in this work, and it was found to be 36(10) ps. The high E0 strength from 0_3^+ to 0_2^+ level confirms the presence of first-order quantum shape phase transition and shape mixing in N=88 Sm [7] .

A detailed band structure developed on the 0_3^+ level can also be used to compare the structure to the ground state band. In this context, the ^{152}Sm nucleus was studied to explore the structures of the bands develop on the excited 0^+ levels. Along with the 0^+ levels, the negative parity band structures were also investigated to look for different shapes that may coexist in ^{152}Sm. The excited states of ^{152}Sm were populated using the reaction ^{150}Nd(α,2n)^{152}Sm with 26 MeV α beam from K-130 cyclotron at VECC, Kolkata and the de-exciting gamma rays were detected using an array of 12 clover HPGe detectors. The details of the experiment and the observations in this work can be found in Ref. [8]. The experimental observations and shape coexistence feature in ^{150}Sm and ^{152}Sm will be presented.

[1] R. F. Casten et. al., Phys. Rev. C57, R1553 (1998).
[2] W. Mclatchie, W. Darcey, and J. E. Kitching, Nucl. Phys. A 159,615 (1970)
[3] M. Sakai, Nucl. Phys. A 104, 301 (1967)
[4] J. B. Gupta and J. H. Hamilton, Phys. Rev. C 96, 034321 (2017)
[5] J. B. Gupta, K. Kumar, and J. H. Hamilton, Int. J. Mod. Phys. E 19, 1491 (2010).
[6] S. S. Alam et al., Nucl. Instrum. Methods Phys. Res. A 874, 103 (2017)
[7] S. Basak, S. S. Alam , D. Kumar, A. Saha, and T. Bhattacharjee , Phys. Rev. C 104, 024320 (2021).
[8] S. Basak, et al., Proc. DAE-BRNS Symp. Nucl. Phys. 65 (2021) 140.

Primary author: BASAK, Shefali (Variable Energy Cyclotron Centre,Kolkata)

Co-authors: Mr KUMAR, D. (VECC,KOLKATA); Dr BHATTACHARJEE, T. (VECC,KOLKATA)

Presenter: BASAK, Shefali (Variable Energy Cyclotron Centre,Kolkata)

Contribution ID: **66** Type: **not specified**

A Giant Resonance tale: there and back again between experimental and theoretical results

Giant resonances are privileged modes of vibration. They enable one to understand aspects of atomic nuclei structure such as energy levels thanks to their decays and excitation energies, lying in the [10 : 30] MeV range. They can also be used to test the validity of a theoretical model and even count as constrains for phenomenological effective interactions. Among these modes, IsoScalar Giant Monopole Resonances (ISGMR) are particularly interesting since related by their centroids, located in the [10 : 20] MeV range, to the incompressibility of nuclear matter and therefore to its equation of state.
Although theoretical models reproduce fairly well global experimental spectra, some aspects of ISGMR are still subject to debate. Among those:
- whatever the phenomenological interaction used, not a single theoretical model manages to reproduce all experimental centroids at once, sometimes themself even incompatible with each other [1, 2]. As an example, models giving a good reproduction of Lead or Zirconium isotopes fail to reproduce the chains of Nickel, Cadmium and Tin, and vice versa [3, 4, 5, 6].
- Amplitudes at higher energies, in the [20 : 30] MeV region, are usually poorly to not reproduced at all by models, pointing out a lack of physics taken into account.
Within the theoretical framework of Quasi-particle Random Phase Approximation (QRPA) using the finite-range Gogny interaction, and systematically comparing our results to available experimental data, we aim at providing partial explanations to the first problem evoked as well as a plausible solution to the second one.
In a first part dedicated to the first problem, we will present our benchmark results obtained with the Gogny D1M parameter set in the isotopic chains aformentioned, and compare some of them with other parameter sets. We will also show the huge impact on ISGMR of different ground state deformations possibly obtained, especially in 12 C and 24 Mg nuclei, leading to recent results [8, 9] in comparison with previous ones [7].
Altogether, this will allow us to stress the importance of the interaction used when trying to replicate centroids as well as to show that a good reproduction of nuclear shapes is a necessary condition towards obtaining a global agreement between theory and experiment, the latter being strongly driven by the two-body center-of-mass correction.
In a second part dedicated to the second problem, we will discuss the expression of the transition operator from the ground state to the monopole one. We will show how a new expression of this operator, taking into account experimental kinematics data of inelastic scatterings used to probe the ISGMR, enables us to reproduce the high-energy component of monopolar spectra.
This high energy component, if also displayed in other giant resonances as dipole ones in particular, may prove useful for astrophysical applications.

References

[1] Krishichayan et al., Phys. Rev. C 92, 044323 (2015).
[2] Y.K. Gupta et al., Phys. Lett. B 760, 482-485 (2016).
[3] J. Piekarewicz Phys. Rev. C 76, 031301(R) (2007)
[4] M.N. Sharma, Nuclear Physics A 816 (2009) 65-88
[5] V. Tselyaev et al.,Phys. Rev. C 79, 034309 (2009)
[6] P. Veselý, et al., Phys. Rev. C 86, 024303 (2012)
[7] S. Péru and H. Goutte Phys. Rev. C 77, 044313 (2008)
[8] J. C. Zamora et al., Phys. Rev. C 101, 064609 (2020)
[9] J. C. Zamora et al., Phys. Rev. C 104, 014607 (2021)

Primary author: BATAIL, Lysandra (Institut d'Astronomie et d'Astrophysique - Université libre de Bruxelles)

Co-authors: PERU, Sophie (CEA); DAVESNE, Dany (Institut de Physique Nucléaire de Lyon); PASTORE, Alessandro (CEA Cadarache)

Presenter: BATAIL, Lysandra (Institut d'Astronomie et d'Astrophysique - Université libre de Bruxelles)

ID de résumé : **10**

High-precision study of excited states of ^{181,183}Au at ISOLDE

Contenu

Beta decay of ^{181,183}Hg isotopes was studied with simultaneous spectroscopy of conversion electrons and gamma rays. The experiments were performed at CERN-ISOLDE facility, employing the TATRA spectrometer. For detection of gamma rays, the Broad Energy germanium detector has been used in both singles and coincidence modes. Its excellent energy resolution together with nearly ideally Gaussian peak shape allowed to construct level schemes with application of the Rydberg-Ritz combination principe with 30 eV precision [1]. Level schemes of ^{181,183}Au will be presented. The new results include electric monopole transition in ^{183}Au and identification of first-excited state in ^{181}Au, which is only 1.79 keV above the ground state [2].
These results will be presented within a framework of known systematics of excited states in odd-Au isotopes.

[1] Venhart *et al.*, Nucl. Inst. and Met. Phys. Res. A **849**, 112 (2017).
[2] Sedlák *et. al.*, Eur. Phys. J. A **56**, 161 (2020).

Auteur principal: BÍROVÁ, Monika

Orateur: BÍROVÁ, Monika

Commentaires:

On behalf of the IS521 collaboration.

Déposé par **BÍROVÁ, Monika** le **mardi 1 mars 2022**

Contribution ID: **126** Type: **not specified**

Islands of shape coexistence in covariant density functional theory (remote)

Wednesday, 1 June 2022 17:55 (20 minutes)

Using covariant density functional theory with the DDME2 functional and labeling single particle energy orbitals by Nilsson quantum numbers [1], a search for particle-hole (p-h) excitations connected to the appearance of shape coexistence is performed for Z=38 to 84 nuclei. Islands of shape coexistence are found near the magic numbers Z=82 and Z=50, restricted in regions around the relevant neutron midshells N=104 and N=66 respectively, in accordance to the well accepted p-h interpretation of shape coexistence in these regions, which we call neutron induced shape coexistence, since the neutrons act as elevators creating holes in the proton orbitals. Similar but smaller islands of shape coexistence are found near N=90 and N=60, restricted in regions around the relevant proton midshells Z=66 and Z=39 respectively, related to p-h excitations across the 3-dimensional isotropic harmonic oscillator (3D-HO) magic numbers N=112 and N=70, which correspond to the beginning of the participation of the opposite parity orbitals $1i_{13/2}$ and $1h_{11/2}$ respectively to the onset of deformation.

We call this case proton induced shape coexistence, since the protons act as elevators creating holes in the neutron orbitals, thus offering a possible microscopic mechanism for the appearance of shape coexistence in these regions [2]. In the region around N=40, Z=40, an island is located on which both neutron p-h excitations and proton p-h excitations are present.

[1] K.E. Karakatsanis, G.A. Lalazissis, V. Prassa, and P. Ring, Phys. Rev. C 102 (2020) 034311.

[2] D. Bonatsos, K.E. Karakatsanis, A. Martinou, T.J. Mertzimekis, and N. Minkov, in preparation

Co-authors: KARAKATSANIS, K.E. (INPP, National Centre for Scientific Research "Demokritos"Department of Physics, Faculty of Science, University of Zagreb, and Physics Department, Aristotle University of Thessaloniki); MARTINOU, Andriana (INPP, National Centre for Scientific Research "Demokritos"); MERTZIMEKIS, T.J. (Department of Physics, National and Kapodistrian University of Athens); MINKOV, Nikolai (nstitute of Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences)

Presenter: BONATSOS, Dennis (Institute of Nuclear and Particle Physics,National Centre for Scientific Research "Demokritos')

Session Classification: Session12: Shapes and symmetries

Contribution ID: **114**　　　　Type: **not specified**

Two-quasiparticle states in some odd-odd heavy deformed nuclei within a microscopic approach

Wednesday, 1 June 2022 11:20 (20 minutes)

We study low-lying states of two-quasiparticle character in some well-deformed odd-odd nuclei around ^{178}Hf within the framework of the Skyrme energy-density functional (SEDF) approach, including BCS pairing correlations with selfconsistent blocking. We use the SIII SEDF parametrization with time-odd terms and seniority pairing residual interaction as in a previous study of two-quasiparticle K-isomeric states in actinide and heavier nuclei [to be published in Phys. Rev. C]. The strength of the seniority interaction is determined through an overall fit on the first 2^+ excitation energies [Phys. Rev. C \textbf{99}, 064306 (2019)]. Axial and parity symmetries are assumed throughout the Hartree–Fock–BCS calculations but time-reversal symmetry is broken.

After checking the relevance of the SIII single-particle spectrum by comparison with experimental bandhead states of low-lying one-quasiparticle states in odd-mass neighbors of ^{178}Hf, we calculate two-quasiparticle states in doubly-odd neighboring nuclei for the relevant neutron and proton configurations. A special attention is drawn on the Gallagher–Moskowski splitting and a comparison with experiment and results obtained by Robledo, Bernard and Bertsch [Phys. Rev. C **89**, 021303(R) (2014)] with the Gogny EDF.

Co-authors: KONTOWICZ, N. (Université de Bordeaux); KOH, Meng Hock (Department of Physics, Faculty of Science, Universiti Teknologi Malaysia); MINKOV, Nikolay (Institute of Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences,); BARTEL, J. (IPHC, UMR 7178, Université de Strasbourg, CNRS); MOLIQUE, H. (IPHC, UMR 7178, Université de Strasbourg, CNRS)

Presenter: LUDOVIC, Bonneau (University of Bordeaux, France)

Session Classification: Session 10: Shapes and shape coexistence

ID de résumé : **31**

Harmonic and anharmonic wobbling excitations from a semiclassical treatment of rigid quasiparticle alignments

Contenu

The dynamical features of particle-rotor systems are investigated by means of a semiclassical treatment applied to a triaxial rotor Hamiltonian with rigidly aligned high-j quasiparticles [1,2]. The effect on the rotation dynamics of an additional spin-spin interaction accounting for the rotational alignment mechanism is investigated in a classical mainframe [3]. The quantum realization of the excitations associated to the transverse wobbling regime in the presence of additional alignment is achieved in a harmonic approximation, whose quality is ascertained in a general theoretical context and particularly when applied to wobbling excitations in odd mass nuclei. In a further development, one constructed from the same semiclassical picture a quantum Hamiltonian with a consistent accounting for anharmonic effects [4]. The model is successfully applied for the description of wobbling excitations proposed in the two-quasiproton bands of even-even nuclei [4,5].

[1] R. Budaca, Phys. Rev. C 97, 024302 (2018).
[2] R. Budaca, Phys. Lett. B 797, 134853 (2019).
[3] R. Budaca, Phys. Rev. C 103, 044312 (2021).
[4] R. Budaca and C. M. Petrache, to be published.
[5] B. F. Lv et al., Phys. Rev. C 105, 034302 (2022).

Auteur principal: BUDACA, Radu ("Horia Hulubei" National Institute for R&D in Physics and Nuclear Engineering)

Orateur: BUDACA, Radu ("Horia Hulubei" National Institute for R&D in Physics and Nuclear Engineering)

Déposé par **BUDACA, Radu** le **samedi 2 avril 2022**

ID de résumé : **42**

Wobbling motion in the even-even nuclei

Contenu

The wobbling mode generally appears in the asymmetric top [1]. It is a clear evidence that the three moments of inertia are different. Transverse wobbling (TW) is a novel version thereof unique to triaxial nuclei [2]. It originates from the presence of large quasiparticle angular momentum. Most of TW bands are found in odd-mass nuclei. In this talk, I will introduce the TW in the even-even nucleus 130Ba [3], and compare it with those in the odd-mass nuclei.

References

[1] A. Bohr and B.R. Mottelson, Nuclear structure vol. II, Benjamin, New York, (1975).

[2] S. Frauendorf and F. Doenau, Phys. Rev. C 33, 014322 (2014).

[3] Q. B. Chen, S. Frauendorf, and C.M. Petrache, Phys. Rev. C 100, 061301(R) (2019).

Auteur principal: CHEN, Qibo (Peking University)

Orateur: CHEN, Qibo (Peking University)

Déposé par **CHEN, Qibo** le **vendredi 8 avril 2022**

Contribution ID: **132** Type: **not specified**

Different avenues for improving current Energy Density Functionals: The inverse Kohn-Sham problem

Thursday, 2 June 2022 11:00 (20 minutes)

Despite the steady and remarkable progress in *abinitio* approaches to nuclear structure, Density Functional Theory remains a tool of broader applicability. It makes sense to derive an Energy Density Functional (EDF) from an underlying ab initio method: this is the topic addressed by a few contributions to the conference. At the same time, it is worth attempting other routes for improving current EDFs. We have started to make the first steps in the so- called inverse Kohn-Sham problem, that is, in grasping information on the effective nuclear potential and the associated energy functional by starting from the knowledge of the nuclear densities. In particular, we have recently proposed a complete solution to the inverse Kohn-Sham (KS) problem. Our method consists of two steps. First, the effective KS potential is determined from the ground-state density of a given system. Then, the knowledge of the potentials along a path in the space of densities is exploited in a line integration formula to determine the KS energy of that system numerically. A possible choice for the density path is proposed. A benchmark in the case of a simplified yet realistic nuclear system is shown to be successful, so the method seems promising for future applications.

Presenter: COLÒ[1 2], Gianluca ([1] University of Milan, Italy, [2] INFN, Sezione di Milano)

Session Classification: Session 14: Nuclear structure with density functional and shell-model approaches

ID de résumé : **6**

A symmetry in-between the shapes, shells and clusters of nuclei

Contenu

The fundamental models of nuclear structure are based on different phys- ical pictures, e.g. liquid drop, shell, or molecule. Their intersection was found in 1958 for a single shell problem. In the present-day language we can say that their common overlap is provided by the U(3) ⊃ SU(3) ⊃ SO(3) dynamical symmetry.
For the multi-shell problem the intersection of these models turns out to be the multiconfigurational dynamical symmetry (MUSY) of
Us ⊗Ux ⊃U(3)⊃SU(3)⊃SO(3) (1)
algebraic structure [1]. This chain defines the set of basis states of the multi- shell excitations in the symplectic shell model in the contracted symplectic collective model as well as in the fully microscopic and semimicroscopic al- gebraic cluster models. MUSY is a composite symmetry in the sense that each configuration has the symmetry of chain (1) and in addition a further symmetry connects the different configurations to each other. The latter one is defined by the particle number classification scheme.
MUSY shows a dual breaking of symmetries [2], similarly to many other dynamical symmetries of algebraic structure models. In particular, the larger symmetries (U(3) and SU(3)) are dynamically broken by the interactions (expressed in terms of the invariant operators of their subalgebras), while the rotational symmetry is spontaneously broken in the eigenvalue problem of the intrinsic Hamiltonian [3].
Since MUSY connects different models, it is able to give a unified descrip- tion of spectra of different configurations in different energy and deformation regions. Typically low-lying shell-like or quartet spectra [4] are described together with high-lying alpha-cluster spectra, and exotic cluster configura- tions [1,5] including both super, and hyperdeformation. In some cases the high-lying cluster spectra could be predicted from the low-lying quartet states [6].

[1] J. Cseh, Phys. Rev. C 103, 064322 (2021).
[2] J. Cseh, Eur. Phys. J. A Spec. Top. 229, 2543 (2020).
[3] J. Cseh, Phys. Lett. B 793, 59 (2019).
[4] J. Cseh, Phys. Lett. B 743, 213 (2015).
[5] G. Riczu, J. Cseh, Int. J. Mod. Phys. E 30, 2150034 (2021).
[6] J. Cseh and G. Riczu, Phys. Lett. B 757, 312 (2016).

Auteur principal: Prof. CSEH, József (Institute for Nuclear Research)

Orateur: Prof. CSEH, József (Institute for Nuclear Research)

Déposé par **CSEH, József** le **samedi 12 février 2022**

Contribution ID: **106** Type: **not specified**

Jumps and bumps in charge radii around Z=82

Tuesday, 31 May 2022 17:55 (20 minutes)

The neutron-deficient lead region has myriad competing configurations of differing nuclear shapes. This competition is greatest when approaching the N=104 midshell, where deformation driving residual interactions become strong enough to challenge the stabilising effects of the nearby proton shell closure. Here, spherical, prolate, and oblate shapes can all be found as either ground or low-lying excited states in the isotopes that inhabit this region of the nuclear chart.

In recent years, a wide-ranging study has been made at the CERN-ISOLDE facility, using the in-source laser spectroscopy technique. In these experiments, isotope shift and hyperfine structure measurements of long chains of isotopes have been made, from which the change in mean-squared charge radii and magnetic dipole moments can be extracted. This talk will present highlights from the experimental campaigns, along with recent theoretical developments that have been made in an attempt to describe the region in a consistent manner, using Hartree-Fock-Bogoliubov calculations involving configuration mixing between states of different deformation.

Co-author: WINDMILL – RILIS – ISOLTRAP – IDS – BRUYÈRES-LE-CHÂTEL – BRUSSELS COLLABORATION

Presenter: CUBISS, James (Department of Physics, University of York)

Session Classification: Session 8: Nuclear charge radii, staggering and shell effects, neutron skin

Contribution ID: **12** Type: **not specified**

Band structures in ^{115,116}Sb

The structure of Sb (Z=51) isotopes in the vicinity of N=64 region has remained an interesting topic to study the coexistence of single particle, as well as, the collective structures within a single nucleus [1-7]. The low-lying, low-spin states in these nuclei are found to be dominated by single particle excitations, whereas, the higher spin states show coexistence of both single particle and collective excitations. In case of even-A isotopes, the single particle states have been found to emanate from the coupling of the quasi-proton $g_{7/2}$, $d_{5/2}$ and $h_{11/2}$, and the quasi-neutron $h_{11/2}$ orbitals. In case of odd-A isotopes, the low lying excitations are dominated by single valence proton, occupying the $d_{5/2}$, $g_{7/2}$ and $h_{11/2}$ orbitals. The $g_{9/2} - g_{7/2}$ excitation across the Z=50 shell gap plays an important role in developing the collectivity in these nuclei. In odd-A Sb isotopes, the intruder bands have been observed and are found to arise due to the coupling of the valence proton to the proton 2p-2h deformed states of the Sn core. The presence of neutron fermi level near the shape driving $h_{11/2}$ orbital enhances the collectivity in these nuclei. Because of the proximity of Z=50 spherical shell closure and N-64 subshell, the angular momentum generation by the phenomenon of magnetic rotation is also expected in the nuclei of this mass region.
In the present work, the excited states of the ^{115,116}Sb have been populated by using the fusion evaporation reaction ^{115}In(α, xnγ)^{115,116}Sb, at a beam energy of 52 and 40 MeV, obtained from the K-130 Cyclotron at Variable Energy Cyclotron Centre (VECC), Kolkata. The de-exciting γ-rays were detected with two different detector setups coupled to a digital data acquisition system [8]. The 115Sb nucleus was studied with a setup of gamma array consisting of 11 Compton suppressed clover HPGe and 1 LEPS detector, whereas, the ^{116}Sb was studied with a setup of Indian National Gamma Array (INGA) consisting of 7 Compton suppressed clover HPGe detectors.
The level structures of ^{115,116}Sb nuclei have been extended significantly as compared to their earlier studies [3, 6, 9-11]. Both the single particle and collective structures are extended to higher spins with the assignment of spin-parity to the energy states from DCO and PDCO measurements. In ^{116}Sb, the collective band structures have been extended beyond the band crossing and presence of a magnetic rotational band at higher spin has also been established [12]. In ^{115}Sb, the band structure built on $g_{7/2}$ orbital has been identified for the first time [13]. The details of the results will be discussed.

1. R. E. Shroy et al., Phys. Rev. C 19, 1324 (1979). 2 .R. Banik et. al., Phys. Rev. C 101, 014322 (2020).
2. R. S. Chakrawarthy et al., Phys. Rev. C 54, 2319 (1996).
3. G. J. Lane et al., Phys. Rev. C 58, 127 (1998).
4. E. S. Paul et al., Phys. Rev. C 50, 2297 (1994).
5. S. Y. Wang et al., Phys. Rev. C 86, 064302 (2012).
6. S. Y. Wang et al., Phys. Rev. C 82, 057303 (2010).
7. S. Das et al., Nucl. Instrum. Methods A 893, 138 (2008).
8. Yu. N. Lobach et al., Phys. Rev. C 57, 2880 (1998).
9. R. Duffait et al., Z. Phys. A 307, 259 (1982).
10. P. Van Nes et al., Nucl. Phys. A 379, 35 (1982).
11. Shabir Dar et al., Nucl. Phys. A 1019, 122382 (2022).
12. Shabir Dar et al., Proceedings of the DAE Symp. On Nucl. Phys. 65 52 (2021).

Primary author: Mr DAR, Shabir (Variable Energy Cyclotron Centre, Kolkata, India, HBNI, Anushaktinagar, Mumbai, India)

Co-authors: Dr RAJBANSHI, S. (Department of Physics, Presidency University, Kolkata India); Dr BANIK, R. (Institute of Engineering and Management, Saltlake Sector V, Kolkata, India); Dr BHATTACHARYYA, S. (Variable Energy Cyclotron Centre, Kolkata, India, HBNI, Anushaktinagar, Mumbai, India); Dr MUKHERJEE, G. (Variable Energy Cyclotron Centre, Kolkata, India, HBNI, Anushaktinagar, Mumbai, India); Mr BASU, S. (Variable Energy Cyclotron Centre, Kolkata, India, HBNI, Anushaktinagar, Mumbai, India); Dr BHATTACHARYA, Soumik (Variable Energy Cyclotron Centre, Kolkata, India, Department of Physics, Florida State University, Tallahassee, Florida, USA); Ms DAS, Sneha (Variable Energy Cyclotron Centre, Kolkata, India, HBNI, Anushaktinagar, Mumbai, India); Dr NANDI, S. (Physics Division, Argonne National Laboratory, Lemont, Illinois, USA); Dr CHAKRABORTY, S. (Variable Energy Cyclotron Centre, Kolkata, India); Mr NAYAK, S. S. (Variable Energy Cyclotron Centre, Kolkata, India); Dr DHAL, A. (IFIN-HH ELI-NP, Romania); Dr ALI, Sajad. (Government General Degree College, Pedong, Kalimpong, India); Ms BASAK, S. (Variable Energy Cyclotron Centre, Kolkata, India, HBNI, Anushaktinagar, Mumbai, India); Dr BHATTACHARJEE, T. (Variable Energy Cyclotron Centre, Kolkata, India, HBNI, Anushaktinagar, Mumbai, India); Dr BHATTACHARYA, C. (Variable Energy Cyclotron Centre, Kolkata, India, HBNI, Anushaktinagar, Mumbai, India); Mr CHATTERJEE, S. (UGC-DAE CSR, Kolkata Centre, Kolkata, India); Dr CHATTOPADHYAY, S. (Saha Institute of Nuclear Physics, Kolkata, India, HBNI, Anushaktinagar, Mumbai, India); Dr DAS, S. (UGC-DAE CSR, Kolkata Centre, Kolkata, India); Dr GHUGRE, S. S. (UGC-DAE CSR, Kolkata Centre, Kolkata, India); Dr GOSWAMI, A. (Saha Institute of Nuclear Physics, Kolkata, India); Ms KARMAKAR, A. (Saha Institute of Nuclear Physics, Kolkata, India); Mr KUMAR, D. (Variable Energy Cyclotron Centre, Kolkata, India, HBNI, Anushaktinagar, Mumbai, India); Dr MONDAL, D. (Variable Energy Cyclotron Centre, Kolkata, India); Dr MUKHOPADHYAY, S. (Variable Energy Cyclotron Centre, Kolkata, India, HBNI, Anushaktinagar, Mumbai, India); Dr PAI, H. (IFIN-HH ELI-NP, Romania); Dr PAL, S. (Variable Energy Cyclotron Centre, Kolkata, India, HBNI, Anushaktinagar, Mumbai, India); Dr PANDIT, D. (Variable Energy Cyclotron Centre, Kolkata, India); Dr RAUT, R. (UGC-DAE CSR, Kolkata Centre, Kolkata, India); Dr GUPTA, S. Das (Victoria Institution (College), Kolkata, India); Dr SAMANTA, S. (UGC-DAE CSR, Kolkata Centre, Kolkata, India); Dr RAY, P. (ABN Seal College, Coochbehar India)

Presenter: Mr DAR, Shabir (Variable Energy Cyclotron Centre, Kolkata, India, HBNI, Anushaktinagar, Mumbai, India)

ID de résumé : **67**

Triaxial nuclear shapes in odd-odd nuclei ^{126}I and ^{130}Cs

Contenu

Various nuclear shapes like prolate (or oblate) and triaxial - with underlying symmetries and associated conserved quantities - have drawn considerable interest during recent years. The reduced transition probabilities B(M1) and B(E2) are the crucial observables, derivable from the measured lifetimes. Doppler shift attenuation method (DSAM) is a modern and sophisticated technique to measure lifetimes in ps-fs range. We inferred nuclear shapes explaining both the signature splitting and inversion for a negative-parity band in ^{126}I [1]. While the axial deformation remained the same (β ~ 0.13) below and above the inversion, the triaxiality (γ) changed from -10° to +23° (Lund convention). Here we describe our study on ^{130}Cs with new results on DSAM.
The experiment was performed via the fusion-evaporation reaction ^{11}B(^{124}Sn, 5n)^{130}Cs using the Pelletron accelerator at the Tata Institute of Fundamental Research (Mumbai, India). The experimental set-up (INGA) consisted of 21 Compton suppressed HPGe clover detectors. The details of the experiment and data analysis can be found in our recent work on ^{129}Cs [2].
The negative-parity band in ^{130}Cs, labelled as 'C' by Kumar et al. [3], was originally identified with particle configuration $\pi g_{7/2}\nu h_{11/2}$ [4]. We observed DSAM lineshapes for some gamma-rays in this band, and fitted them using the computer code by J. C. Wells [5]. The new lifetime results up to 15 $\hbar$ have been found in the range of 1 ps - 2.5 ps with the corresponding B(E2) values within 0.1 – 0.5 e^2b^2. Interestingly, this band resembles very much with the yrast negative-parity band in ^{126}I [1]. The identical energies of their states above the matched bandhead is striking. Both show signature splitting, and backbending at almost the same frequency 0.45 $\hbar\omega$. The signature inversion occurs at the similar spin values (13 $\hbar$ in ^{126}I and 11 $\hbar$ in ^{130}Cs). However, the favoured signature above the inversion in ^{130}Cs corresponds to odd-spins, while it corresponds to even-spins in ^{126}I. The particle rotor model calculation is currently being performed to find the nuclear shape parameters; such that we can simultaneously reproduce the signature splitting and inversion, also our newly found experimental B(E2) values. Considering the similarity with ^{126}I [1], we expect the cause of inversion to be either change in the shape of triaxial nuclei, or change in the axis of rotation, or both.

[1] H. K. Singh et al., Phys. Rev. C 100 (2019) 064306.
[2] U. Lamani et al., Nucl. Phys. A 1014 (2021) 122220.
[3] R. Kumar et al., Eur. Phys. J. A 11 (2001) 5.
[4] P. R. Sala et al., Nucl. Phys. A 531 (1991) 383.
[5] J. C. Wells and N. R. Johnson, ORNL Report 6689 (1991) 44.

Auteur principal: DAS, Pragya (Indian Institute of Technology Bombay)

Orateur: DAS, Pragya (Indian Institute of Technology Bombay)

Déposé par **DAS, Pragya** le **jeudi 5 mai 2022**

ID de résumé : **37**

Experimental Identification Criteria of Exotic Shapes around Octupole Magic Number $N = 136$

Contenu

We present the results from Ref.[1] where the results of the realistic mean-field calculations performed using phenomenological mean-field Hamiltonian with the deformed Woods-Saxon potential and newly adjusted parameters containing no parametric correlations (cf. Ref.[2]) were discussed. Focusing at the four octupole deformations $\alpha_{3,\mu=0,1,2,3}$, we find very large neutron shell gaps at $N = 136$, which generate well-pronounced double potential-energy minima in the standard multipole (α_{20}, α_{22}, $\alpha_{3\mu}$, α_{40}) representation, often at $\alpha_{20} = 0$. These potential minima lead to the exotic symmetries C_{2v}, D_{2d}, T_d, and D_{3h} which we will discussed in detail.

In the recent Ref.[3] the basis for the spectroscopic identification of the T_d and O_h groups were stablished. Already there it was shown that the consequent band structures of exotic symmetries are very different from the {\it traditional ones}, namely those generated from ellipsoidal symmetry with $\Delta I = 2$ sequences. Following the same scheme and with the help of the representation theory of point groups we find the spin-parity sequences for each of the mentioned symmetries above, allowing us to formulate quantum mechanical criteria for experimental identification of such exotic symmetries. We will show that their spin-parity sequences mix even and odd spins, as well as positive and negative parities.

References

[1] J. Yang, J. Dudek, I. Dedes, A. Baran, D. Curien, A.Gaamouci, A.Gozdz, A. Pędrak, D. Rouvel, H.-L. Wang, and J. Burkat, Phys. Rev. C105, 034348 (2022)

[2] A. Gaamouci, I. Dedes, J. Dudek, A. Baran, N. Benhamouda, D.Curien, H.-L. Wang, and J. Yang, Phys. Rev. C103, 054311 (2021)

[3] J. Dudek, D. Curien, I. Dedes, K. Mazurek, S. Tagami, Y. R. Shimizu, and T. Bhattacharjee, Phys. Rev. C97, 021302(R) (2018)

Auteur principal: DEDES, Irene (IFJ PAN)

Orateur: DEDES, Irene (IFJ PAN)

Déposé par **DEDES, Irene** le **lundi 4 avril 2022**

ID de résumé : **54**

Shell-model calculations of the neutrinoless double-beta decay matrix elements

Contenu

Between the late 1990s and the early 2000s, the observation that solar and atmospheric neutrinos oscillate has indicated that these elusive particles have nonzero mass, and has supported investigations to search for physics beyond the standard model. This discovery has revived interest in the study of neutrinoless double-β decay (0νββ), a rare second-order electroweak process that, if occurring, would provide fundamental knowledge about the nature of the neutrino.
The standard mechanism that is considered in a 0νββ-decay is the exchange of a light Majorana neutrino, and in such a framework the half-life depends on the phase-space factor, that can be calculated with high accuracy, on the nuclear matrix element, that strongly depends on the nuclear model adopted, on the axial coupling constant and on the effective neutrino mass.
We approach the calculation of the nuclear matrix element of the 0νββ-decay process, considering the light-neutrino-exchange channel, by way of the realistic shell model. To this end, we start from a realistic nucleon-nucleon potential and then derive the effective shell-model Hamiltonian and 0νββ decay operator within the many-body perturbation theory. We focus on investigating the perturbative properties of the effective shell-model operator of such a decay process, aiming to establish the degree of reliability of our predictions. Our results for the different candidates, ^{48}Ca, ^{76}Ge, ^{82}Se, ^{130}Te ^{136}Xe [1] and, more recently, for ^{100}Mo [2], provide evidence that the effect of the renormalization of the 0νββ-decay operator on the values of the nuclear matrix elements is less relevant than what we obtain for the effective single-body Gamow-Teller transitions operating also in the two-neutrino double-β decay.

References

[1] L. Coraggio et al. Phys. Rev. C **101**, 044315 (2020)
[2] L. Coraggio et al. Phys. Rev. C **105**, 034312 (2022)

Auteurs principaux: Dr DE GREGORIO, Giovanni (Università della Campania "Luigi Vanvitelli" & INFN--Napoli); Dr GARGANO, Angela (INFN, Napoli); Prof. CORAGGIO, Luigi (Università della Campania "Luigi Vanvitelli" &INFN, Napoli); Prof. ITACO, Nunzio (Università della Campania "Luigi Vanvitelli" &INFN, Napoli)

Orateur: Dr DE GREGORIO, Giovanni (Università della Campania "Luigi Vanvitelli" & INFN-Napoli)

Déposé par **Dr DE GREGORIO, Giovanni** le **mardi 19 avril 2022**

Contribution ID: **133** Type: **not specified**

Electromagnetic moments in nuclei within nuclear DFT (remote)

Thursday, 2 June 2022 11:25 (20 minutes)

Ground-state electromagnetic moments are known in hundreds of odd and odd-odd nuclei. Very often, they have been measured by atomic spectroscopic methods up to very high precision. In nuclear DFT approaches, these essential observables have been rarely considered so far. At the same time, time-odd properties of nuclear density functionals, which crucially influence magnetic moments, are poorly known. In this talk, I will discuss recent DFT calculations of magnetic dipole and octupole, and electric quadrupole and Schiff moments.

Presenter: DOBACZEWSKI, Jacek (University of York, UK)

Session Classification: Session 14: Nuclear structure with density functional and shell-model approaches

Contribution ID: **71** Type: **not specified**

Solving the puzzles of the decay of the heaviest known proton-emitting nucleus ^{185}Bi

Monday, 30 May 2022 09:35 (20 minutes)

In two experiments at Argonne National Laboratory's ATLAS facility, utilising both the Fragment Mass Analyzer (FMA) and Argonne Gas-Filled Analyzer (AGFA) we have revisited two long-standing puzzles in the decay of ^{185}Bi, which is the heaviest known proton-emitting nucleus. Combining the results from the two complementary experiments has established the existence of an isomeric state in ^{185}Bi and shown that the proton- and alpha-decaying ground state is extremely short. These results, which will be discussed in this seminar, lead to a proton-decay spectroscopic factor which is close to unity and represents the only known example of a ground-state proton decay to a daughter nucleus (^{184}Pb) with a major shell closure. The implications for nuclear structure in this important region of the chart will be discussed as will implications for future work studying proton-emitting nuclei - which continue to yield surprising and fascinating results.

Presenter: DOHERTY, Dan (University of Surrey, UK)

Session Classification: Session 1: Recent achievements in the study of ptoron emitters

ID de résumé : **61**

Cross sections of neutron-rich isotopes near N=50 in knock-out reactions

Contenu

We present cross sections for neutron-rich copper (Z=29) to germanium (Z=32) isotopes in nucleon-removal reactions. The experiments were carried out at the Radioactive Isotope Beam Factory of the Riken laboratory during the Seastar campaign, where an incident beam of 238U at 345 MeV/u created a range of exotic nuclei in a beryllium target. These nuclei were sent through the Bigrips separator onto the Minos cryogenic hydrogen target, in which secondary reactions took place. The outcoming fragments were subsequently identified in the Zerodegree separator.
Our results are in agreement with our previous study [1] regarding the dependence of the proton knock-out cross section on the nucleon separation energy. For knock-out reactions of a single neutron, we find that the cross section reaches its highest value for projectiles with the magic neutron number N = 50, after which it drops sharply. This reflects the occupancy of the valence orbital and conforms to eikonal predictions [2], whilst departing from the flat trend that was noted in our earlier publication [1].

1. N. Paul et al., Physical Review Letters 122, 162503 (2019)
2. T. Aumann, C. Bertulani, and J. Ryckebusch, Physical Review C 88, 064610 (2013)

Auteur principal: FRANCHOO, Serge (IJC)

Co-auteurs: SEASTAR COLLABORATION; NGUYEN, Hong Ha (Université Paris-Saclay); OLIVIER, Louis (IJC)

Orateur: FRANCHOO, Serge (IJC)

Commentaires:

Seastar collaboration: L. Olivier, 1 H. Nguyen, 1 S. Franchoo, 1 M. Niikura, 2 P. Doornenbal, 3 A. Obertelli, 3, 4 G. Authelet, 4 H. Baba, 3 D. Calvet, 4 F. Château, 4 A. Corsi, 4 A. Delbart, 4 J.-M. Gheller, 4 A. Giganon, 4 A. Gillibert, 4 T. Isobe, 3 V. Lapoux, 4 M. Matsushita, 5 S. Momiyama, 2 T. Motobayashi, 3 H. Otsu, 3 C. Péron, 4 A. Peyaud, 4 E. Pollacco, 4 J.-Y. Roussé, 4 H. Sakurai, 2, 3 C. Santamaria, 3, 4 M. Sasano, 3 Y. Shiga, 3, 6 S. Takeuchi, 3 R. Taniuchi, 2, 3 T. Uesaka, 3 H. Wang, 3 K. Yoneda, 3 T. Ando, 2, 3 T. Arici, 7, 8 A. Blazhev, 9 F. Browne, 10 A. Bruce, 10 R. Carroll, 11 S. Chen, 3, 12 L. Chung, 13 M. Cortés, 3, 7, 14 M. Dewald, 9 B. Ding, 15 Z. Dombradi, 16 F. Flavigny, 1 F. Giacoppo, 17 M. Górska, 7 A. Gottardo, 1 K. Hadyńska-Klek, 17 A. Jungclaus, 18 Z. Korkulu, 16 S. Koyama, 2 Y. Kubota, 3, 5 J. Lee, 19 M. Lettmann, 14 B. Linh, 13 J. Liu, 19 Z. Liu, 15 C. Lizarazo, 7, 14 C. Louchart, 14 R. Lozeva, 1, 20 K. Matsui, 2, 3 T. Miyazaki, 2 K. Moschner, 9 S. Nagamine, 2, 3 N. Nakatsuka, 21 S. Nishimura, 3 C. Nita, 22 C. Nobs, 10 R. Orlandi, 23 S. Ota, 5 Z. Patel, 11 N. Paul, 3, 4 Z. Podolyák, 11 M. Rudigier, 11 E. Sahin, 17 T. Saito, 2, 3 C. Shand, 11 P.-A. Söderström, 3 D. Sohler, 16 I. Stefan, 1 D. Steppenbeck, 5 T. Sumikama, 24 D. Suzuki, 1 Z. Vajta, 16 V. Vaquero, 18 V. Werner, 14 K. Wimmer, 2 J. Wu, 3, 12 and Z. Xu 19 1 Laboratoire Irène Joliot-Curie, CNRS, 91405 Orsay, France 2 Department of Physics, University of Tokyo, Tokyo 113-0033, Japan 3 Riken Nishina Center, Saitama 351-0198, Japan 4 Institut de recherche sur les lois fondamentales de l'univers, CEA, 91191 Gif-sur-Yvette, France 5 Center for Nuclear Study, University of Tokyo at Riken, Saitama 351-0198, Japan 6 Department of Physics, Rikkyo University, Tokyo 172-8501, Japan 7 GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Germany 8 Justus-Liebig University, 35392 Giessen, Germany 9 Institut für Kernphysik, University of Cologne, 50937 Cologne, Germany 10 School of Computing Engineering and Mathematics, University of Brighton, Brighton BN2 4GJ, United Kingdom 11 Department of Physics, University of Surrey, Guildford GU2 7XH, United Kingdom 12 State Key Laboratory of Nuclear Physics and Technology, Peking University, Peking 100871, China 13 Institute for Nuclear Science & Technology, Vinatom, P.O. box 5T-160, Hanoi, Vietnam 14 Institut für Kernphysik, Technical University of Darmstadt, 64289 Darmstadt,

Germany 15 Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, China 16 Atomki, Hungarian Academy of Sciences, P.O. box 51, 4001 Debrecen, Hungary 17 Department of Physics, University of Oslo, 0316 Oslo, Norway 18 Instituto de Estructura de la Materia, CSIC, 28006 Madrid, Spain 19 Department of Physics, University of Hong Kong, Pokfulam, Hong Kong 20 Institut pluridisciplinaire Hubert Curien, CNRS, 67037 Strasbourg, France 21 Department of Physics, Kyoto University, Kyoto 606-8502, Japan 22 IFIN Horia Hulubei National Institute of Physics and Nuclear Engineering, 077125 Bucharest, Romania 23 Advanced Science Research Center, Japan Atomic Energy Agency at Tokai, Ibaraki 319-1195, Japan 24 Department of Physics, Tohoku University, Sendai 980-8578, Japan

Déposé par **FRANCHOO, serge** le **mardi 3 mai 2022**

ID de résumé : **28**

Topological classification of particle-triaxial-rotor systems

Contenu

The rotational response of nuclei provides decisive evidence for triaxial shapes, because collective rotation about all three principal axes is possible. This new mode is entangled with the rotational response of high-j valence quasiparticles. Quantal approaches as the multiquasiparticle-triaxial rotor model or the triaxial projected shell model describe the coupling in a realistic way. Projecting the complex wave functions onto the pertaining subspaces of spin coherent states generates orbital-like images for the total, quasiparticle and rotor angular momenta. The topology of these orbitals is used to classify the entangled quasiparticle-rotor modes. The classification of the modes as transverse wobbling, longitudinal wobbling, chiral vibration and chiral rotation, which were introduced under the simplifying assumption of a fixed quasiparticle alignment, is generalized in a natural way to the topology of the orbits, which takes the quasiparticle realignment into account. The transition from transverse to longitudinal wobbling with increasing spin via special transitional modes is discussed.

Auteur principal: FRAUENDORF, Stefan (University Notre Dame)

Orateur: FRAUENDORF, Stefan (University Notre Dame)

Déposé par **FRAUENDORF, Stefan** le **jeudi 31 mars 2022**

ID de résumé : **24**

83Kr isomers induced by femtosecond lasers

Contenu

Producing nuclear isomers at high rates is very important for many pioneering applications, like nuclear clocks and nuclear (or gamma-ray) lasers, etc. However, limited by the small cross sections and beam intensities, it is hard to achieve high rates of producing nuclear isomers with traditional accelerators or reactors. Here, we report a new experiment of pumping to nuclear isomeric states by a femtosecond high-intensity laser. A peak rate that pumps Kr83 from its ground state to its isomeric state (E=41.6keV, T1/2=1.83h) is observed. It can be explained by the Coulomb excitation of ions with the quivering electrons during the interaction between laser pulses and clusters at nearly solid densities. This high rate isomer-producing method can be widely used for pumping isotopes with excited state lifetimes down to picoseconds.

Auteur principal: FU, Changbo

Orateur: FU, Changbo

Déposé par **FU, Changbo** le **mercredi 30 mars 2022**

Contribution ID: **41** Type: **not specified**

Exotic Shapes and Shape Coexistence in Light Atomic Nuclei: From super-oblate to toroidal structures) (remote)

We present the results of a systematic analysis of exotic nuclear shapes and shape coexistence in light nuclei region. The study was carried out using mean field theory in its phenomenological realisation involving a deformed Woods-Saxon potential with the so-called universal parametrisation without parametric correlations. The parametric correlations have been removed with the help of the Inverse Problem Theory and the Monte-Carlo approach. The model was first examined by comparing the energy spectra of individual nucleons in spherical nuclei with experimental energies, the quality of reproduction of these energies by the model is satisfactory and approximately the same for all spherical nuclei. Another test of the predictive power of the model was performed by calculating the equilibrium deformations of the ground state of numerous nuclei in the studied region. Comparison of the theoretical predictions for equilibrium deformation with the experimental data showed a good correspondence for most of the nuclei.

After obtaining affirmative results of the quality of the predictive power of the used mean-field Hamiltonian, we have carried out a systematic analysis of the existence and coexistence of certain particular exotic configurations which inspired significant experimental and theoretical interest in the literature, namely, super-oblate and toroidal configurations. The results showed an explicit influence of strongly oblate configurations in the region of mass A = (30 to 50). In addition, we have found that the hexadecapole deformation α_{40} strengthens the underlying oblate shell effects by presenting well-pronounced energy minima and leading to various forms of exotic shapes such as super-oblate and hyper-oblate, and shape coexistence.

Primary author: GAAMOUCI, Abdelghafar (Laboratoire de Physique Théorique, Faculté de Physique, USTHB, BP 32, El Alia, 16111 Bab Ezzouar, Algiers, Algeria)

Presenter: GAAMOUCI, Abdelghafar (Laboratoire de Physique Théorique, Faculté de Physique, USTHB, BP 32, El Alia, 16111 Bab Ezzouar, Algiers, Algeria)

ID de résumé : **16**

Quantum Simulation of the Agassi Model in Trapped Ions

Contenu

A quantum simulation of the nuclear Agassi models proposed so as to be implemented within a trapped-ion quantum platform. Numerical simulations and analytical estimations illustrate the feasibility of this simple proposal with current technology, while our approach is fully scalable to a larger number of sites. The use of a quantum correlation function is studied as a signature of the quantum phase transition by quantum simulating the time dynamics, with no need of computing the ground state. The use of machine learning procedure to determine the quantum phase diagram of the model is also explored.

Auteur principal: GARCÍA-RAMOS, José Enrique (University of Huelva)

Co-auteurs: M. ÁLVARO, Saiz (University of Seville); Prof. PEDRO, Pérez-Fernández (University of Seville); Prof. JOSÉ M., Arias (University of Seville); Prof. LUCAS, Lamata (Universiy of Seville)

Orateur: GARCÍA-RAMOS, José Enrique (University of Huelva)

Déposé par **GARCÍA-RAMOS, José Enrique** le **mardi 15 mars 2022**

ID de résumé : **50**

Studies of E0 transition strengths at TRIUMF-ISAC

Contenu

The GRIFFIN and TIGRESS HPGe spectrometers are used for a variety of nuclear structure, nuclear astrophysics, and fundamental symmetries investigations at TRIUMF's Isotope Separator and Accelerator (ISAC) ISOL radioactive beam facility. The investigation of shape coexistence and electric monopole (E0) transition strengths is a strong theme of many experiments.

The GRIFFIN spectrometer provides unique opportunities in decay spectroscopy research with stopped radioactive beams. The HPGe array is complimented by a powerful suite of ancillary detector sub-systems that includes cryogenic Si(Li) detectors for conversion electron measurements and an array of eight LaBr3 scintillators for fast-timing measurements. The TIGRESS spectrometer is used for studies with accelerated radioactive beams and is operated in conjuction with a range of particle detector sub-systems. The SPICE detector for in-beam internal conversion electron spectroscopy employs a magnetic lens formed of pernament magnets.

An overview of the experimental capabilities will be given through detailed examples of recent results for E0 transitions in Ge isotopes and 188Hg using GRIFFIN as well as in 70,72Se using SPICE.

Auteur principal: GARNSWORTHY, Adam (TRIUMF)

Orateur: GARNSWORTHY, Adam (TRIUMF)

Déposé par **GARNSWORTHY, Adam** le **mardi 12 avril 2022**

Contribution ID: **83** Type: **not specified**

Superheavy Elements with FIONA (remote)

Monday, 30 May 2022 16:20 (10 minutes)

The search for new elements has netted us six additions to the periodic table this decade, bringing the total to 118 known elements. These elements must be formed one-atom-at-a-time in complete-fusion evaporation reaction. Once formed, the atoms typically exist for just seconds or less before they decay into other elements. While we have made great progress in making and studying these elements, there is much that is still unknown – including things as basic as the proton and neutron numbers of the recently discovered elements.

Recently, the Berkeley Gas-filled Separator (BGS) at the Lawrence Berkeley National Laboratory (LBNL) was coupled to a new mass analyzer, FIONA. The goal of BGS+FIONA is to provide a M/ΔM separation of ~300 and transport nuclear reaction products to a shielded detector station on the tens of milliseconds timescale. These upgrades will allow for direct A and Z identification of ii) new actinide and transactinide isotopes with ambiguous decay signatures such as electron capture or spontaneous fission decay and i) superheavy nuclei such as those produced in the ^{48}Ca + actinide reactions. Here we will present recent results from first FIONA scientific experiments.

Presenter: GATES, Jacklyn (awrence Berkeley National Laboratory)

Session Classification: Session 3: Spectroscopy of heavy and super-heavy nuclei

Contribution ID: **119** Type: **not specified**

Recent results and perspectives of DESPEC

Wednesday, 1 June 2022 14:40 (20 minutes)

Recently the DESPEC nuclear spectroscopy campaign started at the SIS/FRS facility at GSI as part of the FAIR/NUSTAR Phase-0 program. It aims at the investigation of exotic heavy nuclei produced in fragmentation reactions employing detectors and instrumentation developed for the FAIR facility. An important aspect of the program is the training of students and young researchers in the field. Despite the Covid-19 pandemic, a novel fast-timing spectroscopy set-up has been commissioned and first experiments have successfully been performed. Physics topics include the evolution of the shell structure around ^{100}Sn, basic decay information of n-rich isotopes at N=126 below ^{208}Pb and octupole correlations of n-rich actinide isotopes. Novel experimental techniques and first results will be presented.

Presenter: GERL, Jürgen (GSI/FAIR Darmstadt)

Session Classification: Session 11: Results from DESPEC, CARIBU and JYFL

Imaging ^{54m}Ni proton radioactivity with ACTAR TPC

J. Giovinazzo[1], D. Rudolph[2], B. Blank[1], T. Roger[3],
on behalf of the E690 collaboration
[1] *Centre d'Etudes Nucléaires de Bordeaux Gradignan, Université de Bordeaux, France*
[2] *Department of Physics, Lund University, Sweden*
[3] *Grand Accélérateur National d'Ions Lourds, Caen, France*

The proton radioactivity of the 10^+ isomer in ^{54}Ni could be observed [1] in an experiment performed at GANIL with the ACTAR TPC detector. Together with the previously measured gamma decay of this isomer [2], this work allowed to establish the complete decay pattern of this state, which is needed for detailed studies [3] of the isospin symmetry breaking in the region of doubly-magic ^{56}Ni.

This study illustrates challenging works on both the experimental and theoretical sides. The unusual high angular momenta, $\ell = 5$ and $\ell = 7$, for the proton emission branches, requires a dedicated theoretical treatment due to extremely low spectroscopic factors. Because of the short half-life of the isomer, about 150 *ns*, the experimental measurement of the proton emission requires a time projection chamber to separate the proton signal from the ion signal. This experiment, the first of its kind, allowed for a 4D imaging of the proton radioactivity, *i.e.*, a direct measurement of the particles tracks and emission time.

[1] J. Giovinazzo *et al*., *Nature Comm*. 12, 4085 (2021)
[2] D. Rudolph *et al*., *Phys. Rev.* C 78, 021301(R) (2008)
[3] D. Rudolph *et al*., *Phys. Lett.* B, in press

ID de résumé : **43**

Lifetime measurements of neutron-deficient odd-A W and Os nuclei

Contenu

We have carried out a series of lifetime measurements of excited states in the vicinity of ^{168}Os, where a peculiar feature of $B(E2; 4^+ \rightarrow ^2 +)/B(E2; 2^+ \rightarrow 0^+) < 1$ has been observed [1]. Subsequent measurements have been confirmed that this feature can be found in W, Os and Pt nucleus close to $N = 92$. To date, no sound explanation based on contemporary nuclear models have been found. The transition energies of the ground-state bands suggests that these bands would be collective, and perhaps triaxial. However, the transition probability systematics disagree with the predictions of available collective nuclear models.

In ^{172}Pt, the phase transition has been suggested to be responsible of this feature [2]. Our latest study of ^{163}W [3] has elaborated the role of the odd nucleon and geometric features in description of decrease of collectivity as a function of spin.

The presented Recoil Distance Doppler-Shift measurements have been carried out at University of Jyväskylä using the JUROGAM γ-ray spectrometer. The results of the experiments and their possible interpretations will be discussed.

[1] T. Grahn et al., Phys. Rev. C 94, 044327 (2016)
[2] B. Cederwall et al., Phys. Rev. Lett. 121, 022502 (2018)
[3] M. C. Lewis et al., Phys. Lett. B, 798, 134998 (2019)

Auteur principal: GRAHN, Tuomas (University of Jyväskylä)

Orateur: GRAHN, Tuomas (University of Jyväskylä)

Déposé par **GRAHN, Tuomas** le **vendredi 8 avril 2022**

ID de résumé : **64**

Brussels Skyrme mass models: from triaxial nuclei to neutron stars

Contenu

Our understanding of nuclear matter is systematically being challenged, whether by earth-based experiments probing the structure of atomic nuclei or by astrophysical observations: the abundance of elements in the universe, supernovae, and the merging neutron stars. Theoretical nuclear models are indispensable to interpret measurements on earth and act as a guide toward the study of extreme configuration of nuclei, whether in isospin, angular momentum, or temperature. Models are also deeply needed to provide the vast amount of data required for simulations of astrophysical phenomena.
We have recently proposed a new family of microscopic models: the Brussels-Skyrme-on-a-Grid or BSkG models are based on nuclear energy density functionals of the Skyrme type. Similar to the earlier BSk models, the fit protocol includes essentially all known nuclear binding energies and charge radii, ensuring an excellent global description of masses, as required for applications. The existing entries in this series (BSkG1 [1] and BSkG2 [2]) focus on exploiting the powerful concept of symmetry breaking: for the first time we incorporate the possibility of triaxial deformation, matching the available experimental data on this exotic deformation across the nuclear chart.
We will present the next improvement in the series, adding to the description of finite nuclei a fair proper description of neutron star properties. In particular, we focus on rendering the predicted equation of state stiffer along the lines of Ref.[3], ensuring the model can accommodate the existence of heavy pulsars such as J1614-2230 and J0740+662 [4]. We also replace the phenomenological pairing interaction of previous models by a form designed to match the pairing gaps in infinite nuclear matter deduced from advanced microscopic calculations [5]. Both improvements, combined with our state-of-the-art description of atomic nuclei, render our latest calculation BSkG3 a tool of choice for applications in nuclear structure and astrophysics.

[1] G. Scamps et al., Eur. Phys. J. A 57, 333 (2021).

[2] W. Ryssens et al., in preparation.

[3] N. Chamel, S. Goriely and J. M. Pearson, Phys. Rev. C 80, 065804 (2009).

[4] P. B. Demorest, et. al, Nature 467, 1081 (2010); .M.C. Miller et al., ApJL 918, L28 (2021); T.E. Riley et al., ApJL 918, L27 (2021)

[5] S. Goriely, N. Chamel and J. M. Pearson, Phys. Rev. C 93, 034337 (2016).

Auteurs principaux: GRAMS, Guilherme (Astronomy and Astrophysics Institute (I.A.A.) - ULB); RYSSENS, Wouter (Astronomy and Astrophysics Institute (I.A.A.) - ULB); SCAMPS, Guillaume (Department of Physics, University of Washington, Seattle, USA); GORIELY, Stephane (Astronomy and Astrophysics Institute (I.A.A.) - ULB); CHAMEL, Nicolas (Astronomy and Astrophysics Institute (I.A.A.) - ULB)

Orateur: GRAMS, Guilherme (Astronomy and Astrophysics Institute (I.A.A.) - ULB)

Déposé par **GRAMS, Guilherme** le **mercredi 4 mai 2022**

ID de résumé : **26**

Probing ^{93m}Mo isomer depletion with an isomer beam in HIRFL

Contenu

As the inverse process of internal conversion, Nuclear Excitation by Electron Capture (NEEC) was predicted to play an important role to trigger the isomer depletion [1], which is a potential path for releasing nuclei energy stored in isomer [2]. Traditionally, NEEC is expected to be observed in two scenarios, plasma and slowing down process of highly-charged ions. However, in both cases, NEEC might be sheltered by other mechanisms, such as Coulomb excitation.
The first experimental observation on NEEC was reported in the slowing down process of ^{93m}Mo [3]. The observed isomer depletion probability was too large to be reproduced by Coulomb excitation, and thus attributed to NEEC. However, a subsequent theoretical work unveiled a dramatic gap between the theoretical and experimental results [4]. Later, another theoretical work was devoted to resolve the disagreement by considering the momentum distribution for bound electron rather than free electron [5]. However, only the upper limit was slightly increased and the discrepancy remained. On the experimental side, a comment was addressed on the influence of complex γ background which may cause the overestimation of isomer depletion probability [6].
To avoid the complex γ background, we produce a ^{93m}Mo secondary beam using the RIBLL in HIRFL to separate the isomer depletion from the primary reactions. In such a low γ-ray background environment, the signature of isomer depletion is not observed, and an upper limit of 2×10^{-5} is estimated for the excitation probability. This is consistent with the theoretical expectation. This measurement was performed with lower recoiling energies than the previous experimental work. However, the discrepancy between the two experimental results also exceeds the theoretical expectation based on NEEC mechanism.
Further experimental investigations with low γ-ray background and high recoiling energies are necessary to verify if NEEC probability is large enough to be studied in the slowing down process. If not, one need considers to conduct measurements under resonance conditions.

[1] V. Goldanskii and V. Namiot, Phys. Lett. B 62 (1976) 393.
[2] P. Walker and G. Dracoulis, Nature 399 (1999) 35.
[3] C. J. Chiara et al., Nature 554 (2018) 216.
[4] Y. Wu et al., Phys. Rev. Lett. 122 (2019) 212501.
[5] J. Rzadkiewicz et al., Phys. Rev. Lett. 127 (2021) 042501.
[6] S. Guo et al, Nature 594 (2021) E1.

Auteur principal: GUO, Song (Institute of Modern Physics, Chinese Academy of Science, Lanzhou)

Orateur: GUO, Song (Institute of Modern Physics, Chinese Academy of Science, Lanzhou)

Déposé par **GUO, Song** le **jeudi 31 mars 2022**

ID de résumé : **27**

The experimental evidence questioning the validity of wobbling interpretation at low spin

Contenu

In 1958, nuclear precession was proposed by Davydov and Fillipov [1]. Later, it was approximated by Bohr and Mottelson as wobbling motion [2], namely the coupling of a rotation and a harmonic vibration. At the beginning of this century, the first experimental observation of wobbling band was reported at high spins of ^{163}Lu [3]. Subsequently, a series of similar wobbling bands were identified in neighboring highly deformed Lutetium and Tantalum nuclei. Recently, a bunch of low-spin wobbling bands were reported in ^{135}Pr�^{105}Pd�^{133}La�^{127}Xe�^{183,187}Au and ^{133}Ba [4,5].
However, the wobbling approximation cannot be fulfilled at low spin. Via a new experiment including both angular correlation and linear polarization measurements, we demonstrate that one reported low-spin wobbling band in ^{187}Au is actually generated by dominant single-particle excitation. Thus, we further assessed all the reported low-spin wobbling bands, and concluded that the corresponding experimental and theoretical evidence are generally insufficient [6].
After ruling out the wobbling motion at low spin, there are two questions to be answered. First, what is the lower limit of spin for the wobbling approximation? Second, how to identify and describe the true nuclear precession motion at low spin? Fortunately, important progress has been made for them recently.

[1] A. S. Davydov and G. F. Filippov, Nucl. Phys. 8 (1958) 237.
[2] A. Bohr and B. R. Mottelson, Nuclear Structure vol. II (1975).
[3] S. W. Ødegård et al., Phys. Rev. Lett. 86 (2001) 5866.
[4] J. T. Matta et al., Phys. Rev. Lett. 114 (2015) 082501.
[5] N. Sensharma et al., Phys. Rev. Lett. 124 (2020) 052501.
[6] S. Guo et al, Phys. Lett. B 828 (2022) 137010.

Auteur principal: GUO, Song (Institute of Modern Physics, Chinese Academy of Science, Lanzhou)

Orateur: GUO, Song (Institute of Modern Physics, Chinese Academy of Science, Lanzhou)

Déposé par **GUO, Song** le **jeudi 31 mars 2022**

ID de résumé : **23**

Shapes in the stable Xe isotopic chain

Contenu

Xenon isotopes make one of the longest stable isotopic chains found in the entire nuclide chart and its vicinity is recognised as a region of the so-called „γ-soft" nuclei (axially deformed shapes that are soft with respect to triaxial deformations). The Xe isotopes exhibit a slow transition from vibrational level structures close to the N=82 neutron shell closure (136Xe) to the relatively well-deformed γ-soft isotopes (124Xe and 126Xe). The quadrupole deformation can be studied via E2 transition strengths and the spectroscopic moments. Transition probabilities were measured in Coulomb excitation experiments in 124,126,128,130,132Xe, however, no information on the spectroscopic quadrupole moments of the excited states in the Xe isotopes has been published so far, except for 130Xe[[1]]. To date, the richest set of electromagnetic matrix elements has been extracted from the Coulomb excitation of 128Xe, partially published in [[2]]. The analysis of Coulomb excitation of 128Xe is now being finalised with the new spectroscopic information available for this isotope (i.e., lifetimes of the excited states), and will provide key information on the quadrupole shapes in both the ground and the excited states in this nucleus.

In this talk I will present the results of the Coulomb excitation of 128,130Xe isotopes together with the theoretical predictions of the shape evolution along the Xe isotopic chain.

[1] L. Morrison, K. Hadyńska-Klęk et al., Phys. Rev. C 102, 054304 (2020)
[2] J. Srebrny, P.J. Napiorkowski et al., Nuclear Physics A557 (1993) 663c-672

Auteur principal: Dr HADYNSKA-KLEK, Kasia (Heavy Ion Laboratory University of Warsaw)

Orateur: Dr HADYNSKA-KLEK, Kasia (Heavy Ion Laboratory University of Warsaw)

Déposé par **Dr HADYNSKA-KLEK, Kasia** le **mercredi 30 mars 2022**

ID de résumé : **44**

Structure study of light superheavy nuclei

Contenu

Inspired by the newly discovered experimental data, the nuclear structure of the light superheavy nuclei are studied. The single-particle structure, high-K isomers, rotational properties and α-decay energies of the transfermium nuclei are investigated within the framework of the cranked shell model (CSM) with pairing correlation treated by a particle-number-conserving (PNC) method. Particular emphasis will be place on the effect of the deformation. High-order deformation ε_6 plays an important role both in the single-particle orbitals and in the multi-particle states of the transfermium mass region. A reverse of the single-particle energy levels is resulted by including ε_6 deformation, based on which the microscopic mechanism of the identical bands between Lr isotopes is explained. The reflection asymmetric octupole deformation is used to explain the variation of the rotational bands versus the rotational frequency in U and Pu isotopes. Based on the microscopic calculation of the nuclear binding energies, the possible existence of the bound nuclei beyond neutron drip lines are demonstrated, which is driven mainly by the deformations. Pairing reduction of the multi-particle bands in transfermium nuclei is discussed in details.

Auteur principal: HE, Xiao-Tao (College of Material Science and Technology, Nanjing University of Aeronautics and Astronautics)

Orateur: HE, Xiao-Tao (College of Material Science and Technology, Nanjing University of Aeronautics and Astronautics)

Déposé par **HE, Xiao-Tao** le **samedi 9 avril 2022**

Contribution ID: **131** Type: **not specified**

Nuclear shapes and density profiles of exotic nuclei (remote)

Thursday, 2 June 2022 10:15 (20 minutes)

Exotic nuclei exhibit various nuclear shapes depending on their shell structure.
In this talk, I will present our recent systematic analyses of the nuclear shapes
on neutron-rich nuclei using the density distributions of microscopic mean-field models.
First, I will discuss how the density profile is changed by nuclear deformation [1]
and show some examples of characteristic density profiles in the island of inversion
near N=40 [2]. This property is well reflected in the density distributions
near the nuclear surface. I will show that high-energy nucleus-nucleus collision
can be a promising tool to investigate such density profiles.
References
[1] W. Horiuchi and T. Inakura, Prog. Theor. Exp. Phys. 2021, 103D02 (2021).
[2] W. Horiuchi, T. Inakura, and S. Michimasa, Phys. Rev. C 105, 014316 (2022).

Presenter: HORIUCHI, Wataru (Osaka Metropolitan University)

Session Classification: Session 13: Ab initio methods

Electric monopole transition from the superdeformed band in ^{40}Ca

E. Ideguchi,[1] T. Kibédi,[2] J. T. H. Dowie,[2] T. H. Hoang,[1] M. Kumar Raju,[1, 3] N. Aoi,[1] A. J. Mitchell,[2] A. E. Stuchbery,[2] N. Shimizu,[4] Y. Utsuno,[5, 4] A. Akber,[2] L. J. Bignell,[2] B. J. Coombes,[2] T. K. Eriksen,[2] T. J. Gray,[2] G. J. Lane,[2] and B. P. McCormick[2]

[1] RCNP, Osaka University, Japan
[2] Australian National University, Australia
[3] GITAM Institute of Science, GITAM University, India
[4] CNS, University of Tokyo, Japan
[5] ASRC, Japan Atomic Energy Agency, Japan

The spherical doubly magic nucleus, ^{40}Ca, is a good example exhibiting shape coexistence [1]. A unique feature of this nucleus is an appearance of low-lying 0^+ states. First exited state is 0^+ at 3.3 MeV and the second excited 0^+ state closely locates at 5.2 MeV. These states are understood as band heads of the normal deformed and the superdeformed bands, respectively [2,3], which corresponds to the multiple shape coexistence in ^{40}Ca.

Existence of the superdeformed band starting from the 0^+ band head is another unique feature of ^{40}Ca. Although the existence of superdeformed nuclei are reported in many nuclei of various mass regions, A=60, 80, 130, 150, 190 [4], the superdeformed band head 0^+ states are only observed in mass 40 region [5,6], and in the fission isomer region [4]. Such situation makes it difficult to understand the property of superdeformed state, such as the mixing of the states with different configurations. Therefore, ^{40}Ca is a quite unique nucleus where one can study the electric monopole (E0) transition strength between the band head of superdeformed state and the spherical ground state, which directly reflects the shape mixing [7].

In order to study the property of superdeformed state of ^{40}Ca, we have performed an experiment to measure the E0 transition from the excited 0^+ states. Experiment was carried out using a ^{40}Ca(p,p') reaction at the 14UD tandem accelerator facility in Australian National University. The Super-e pair spectrometer [8,9,10], a superconducting magnetic-lens spectrometer, is employed to measure conversion electrons and electron-positron pairs with excellent background suppression. A single germanium detector was also used to measure gamma transitions from the excited states simultaneously.

In the presentation, the experimental results on E0 transition strength from the normal deformed and superdeformed band in ^{40}Ca and the theoretical studies based on the large-scale shell model calculation will be discussed.

This work is partially supported by the International Joint Research Promotion Program of Osaka University and JSPS KAKENHI Grant Number JP 17H02893, the Australian Research Council grant numbers DP140102896 and DP170101673. KAKENHI grants (20K03981, 17K05433), “Priority Issue on post-K computer” (hp190160, hp180179, hp170230) and “Program for Promoting Researches on the Supercomputer Fugaku” (hp200130, hp210165), MEXT, Japan, and the support from the RCNP Collaboration Research Network, the Australian Government Research Training Program are acknowledged.

[1] K. Heyde and J.L. Wood, Rev. of Mod. Phys. **83**, 1467 (2011)
[2] E. Ideguchi *et al.*, Phys. Rev. Lett. **87**, 222501 (2001)
[3] C.J. Chiara, et al., Phys. Rev. C 67, 041303(R) (2003).
[4] B. Singh, R. Zywina, R.B. Firestone, Nucl. Data Sheets **97**, 241 (2002)
[5] C.E. Svensson *et al.*, Phys. Rev. Lett. **85**, 2693 (2000)
[6] E. Ideguchi *et al.*, Phys. Lett. B **686**, 18 (2010)
[7] J.L. Wood *et al.*, Nucl. Phys. A **651**, 323 (1999)
[8] T. Kibédi *et al.*, Nucl. Instrum. Meth. A **294**, 523 (1990).
[9] T. K. Eriksen, T. Kibédi, et al., Phys. Rev. C **102**, 024320 (2020).
[10] J. T. H. Dowie, et al., Phys. Lett. B **811**, 135855 (2020).

ID de résumé : **49**

The 0+ Isomers and Shape Coexistence

Contenu

We compare the data on the lowest 0+ isomers in the half-life range greater than 10 ns and those in less than 1 ns [1-3]. In comparing the two group of isomers from even-even nuclei, we come across many similarities. This suggests that the 0+ states having half-life less than 1 ns have similar structure. The relationship of these states to shape coexistence will also be highlighted. We also consider couple of examples, which point to specific symmetries [4].

References:

1. A.K. Jain, B. Maheshwari, A. Goel, Nuclear Isomers-A Primer, Springer Nature, 2021.
2. K. Heyde and J.L. Wood, Rev. Mod. Phys. 83, 1655 (2011).
3. Swati, B. Maheshwari, Balraj Singh, Y. Sun, A. Goel, and A. K. Jain, Atlas of Isomers -2022, to be published.
4. Aagrah Agnihotri and A.K. Jain, B.Tech. Dissertation, 2022.

Auteur principal: JAIN, Ashok Kumar (Indian Institute of Technology Roorkee)

Orateur: JAIN, Ashok Kumar (Indian Institute of Technology Roorkee)

Déposé par **JAIN, Ashok Kumar** le **mardi 12 avril 2022**

Contribution ID: **1** Type: **not specified**

Study of collectivity and shape coexistence in A~120 region near to proton drip-line

The phenomenon of shape-coexistence is established in several regions of the nuclear chart. It corresponds to the existence of more than two distinct geometrical shapes at similar excitation energies. Experimentally, one of the ways to study this phenomenon is through the gamma-spectroscopy, by identifying bands built on coexisting minima with different shapes. This method becomes challenging particularly when studying the neutron deficient isotopes due to the low cross-sections for the formation of these isotopes with the available stable beams. Also, even if these isotopes are formed, they can have very short half-lives. Thus, this requires an in-beam spectroscopy or the use of very fast separation techniques.
In the present work, our focus is on studying the shape-coexistence in the neutron deficient isotopes of Cs, Ba, and La by in-beam gamma-spectroscopy and recoil decay tagging techniques.

In an experiment performed with JUROGAM3+MARA at JYFL, Finland, using the ^{64}Zn beam on a thin ^{58}Ni target, we were able to identify new bands in ^{116,117}Cs, ^{118}Ba and ^{120}La, and extract the lifetimes of several new isomers in the same nuclei. We also extracted the β-delayed proton spectra from the data collected at the MARA focal plane, which will be compared with theoretical calculations to determine the spin of the parent nuclei.

Presenter: JODIDAR, Praveen M (Université Paris-Saclay, CNRS/IN2P3 IJC Lab)

Contribution ID: **59** Type: **not specified**

A large number of observations indicate broken axial symmetry as essential feature for the ground states of heavy nuclei.

The observation of nuclear quadrupole moments by atomic hyperfine structure induced the habit to consider axial symmetry to be chracteristic for most nuclear ground states. For decades this assumption became common practice, albeit it was often falsified in some nuclei. Our reanalysis of various observations made for very many heavy nuclei allows a consistent modelling of these experimental data only if it is based on broken axial symmetry:
1_Based on it a good description of the apparent shapes of isovector giant resonances in very many nuclei is reached without local parameter fitting and with one global parameter for the observed apparent widths.
2_The interpretation of ground state bands in well deformed nuclei without a variable moment of inertia and a triaxiality as observed from the lowest 2+ and 4+ energies fits the yrast level measurements up to the band crossing region. The popular I(I+1)-rule is not applied here, as it was shown long ago to be strictly connected to axial symmetry only.
3_The widely observed R42 values (ratios of low state excitation energies) very surprisingly correlate to gamma-triaxialities predicted in HFB-calculations.
4_And these values together with the backshift between ground state masses and Thomas-Fermi calculations allow surprisingly good predictions of level densities to capture resonance spacings in nearly all heavy nuclei.
5_The average widths of such resonances are also well predicted when the dipole strengths from our strongly improved description of IVGDR data are combined to these level density values and these were predicted allowing broken axial symmetry.
6_The disagreement of measured quadrupole moments to those extracted from B(E2) values to the lowest 2+-state is shown to disappear in a non-axial scheme.
7_Our reexamination of experimental data with respect to broken axial symmetry found further theoretical support from recent calculations in the Monte-Carlo shell model scheme – and the triaxialities predicted there agree to the less sophisticated HFB-calculations modified by a generator coordinate approximation.

Primary authors: Dr JUNGHANS, Arnd (HZ Rossendorf Dresden); GROSSE, Eckart (TU Dresden)

Presenter: Dr JUNGHANS, Arnd (HZ Rossendorf Dresden)

Contribution ID: **62** Type: **not specified**

In beam gamma ray spectroscopy of the exotic 79Cu with germanium detectors

An experiment aiming at in-beam γ-ray spectroscopy of 79Cu after one-proton knock-out from 80Zn was carried out at the Radioactive Isotope Beam Factory of the Riken laboratory during the 2021 HiCARI campaign. An incident beam of 238U at 345 AMeV created a wide range of exotic nuclei including 80Zn, after fragmentation on a primary beryllium target. These nuclei were sent through the BigRIPS separator onto a secondary beryllium target, in which the knock-out reactions took place. The outcoming fragments including 79Cu were subsequently identified in the ZeroDegree separator. The emitted gamma rays were detected by the HiCARI germanium detector array placed around the target.
The particle identification of the nuclei of interest for our 80Zn(p,2p)79Cu reaction channel has been achieved in the ongoing analysis after optical corrections and background removal. We present here the preliminary gamma spectra, which we compare with the results from our previous campaign with a scintillator array [1].

1. L. OLivier et al. , Persistence of the Z = 28 shell gap around 78 Ni : first spectroscopy of 79 Cu, Phys. Rev. Lett. 119, 192501 (2017).

Primary authors: HICARI COLLABORATION; KACI, MASSYL (Laboratoire Irène Joliot-Curie, CNRS,)

Presenter: KACI, MASSYL (Laboratoire Irène Joliot-Curie, CNRS,)

Electric monopole transitions in nuclei

T. Kibédi[1], A.B. Garnsworthy[2], J.L. Wood[3]

1) Department of Nuclear Physics and Accelerator Applications, Research School of Physics, The Australian National University, Canberra, ACT 2601, Australia
2) TRIUMF, 4004 Wesbrook Mall, Vancouver, BC, V6T 2A3, Canada
3) School of Physics, Georgia Institute of Technology, Atlanta, GA 30332, USA

Electric monopole, E0 transitions are unique to nuclei; they are not observed in any other manifestations of matter. The reason for this ‘‘isolated’’ manifestation is because photons have spin one, and nuclei are well isolated from their environment by atomic electrons. Thus, electromagnetic decay by single-photon emission is forbidden for a transition between two states with spin zero. However, decay is possible through the interaction between the nucleus and its atomic electrons: the so-called internal conversion process. While the formation region of higher multipole order transitions (E1, M1, E2, etc.) is dominantly outside the nucleus, the formation region of E0 transitions, involving a different set of nuclear matrix elements, takes place inside the nuclear volume. Decay is also possible through the creation of electron–positron pairs (if the decay energy exceeds the mass of the pair, i.e., $\Delta E > 1.022$ MeV): the so-called internal pair formation (IPF).

States with spin zero in nuclei are of particular interest. They are often considered as a sensitive indicator of nuclear structure. In particular, at low energy, excited 0^+ states are associated with either changes in pair-correlated structure or changes in deformation (shape) relative to the ground state of the nucleus. The largest E0 transition strengths are consistent with changes in deformation: thus, we consider them a compelling spectroscopic fingerprint of shape coexistence in nuclei. The issue of shape coexistence in nuclei has progressively become an ever more fundamental one over the past fifty years: it may be said, along with the domination of nuclear structure by deformed shapes, to have become a leading indicator of the fundamental defining characteristics of atomic nuclei.

In this talk selected examples from the recent review [1] of E0 transitions will be presented including ^{12}C [2] and ^{24}Mg [3].

This work was supported in part by the Australian Research Council Grant Nos. DP140102896, No. DP170101673.

[1] T. Kibédi, A.B. Garnsworthy, J.L. Wood, Prog. Part. And Nucl. Phys. **123** (2022) 103930
[2] T. Kibédi, et al., Phys. Rev. Lett. **125** (2020) 182701, T.K. Eriksen et al., Phys. Rev. **C 102** (2020) 024320
[3] J.T.H. Dowie, et al., Phys. Lett. **B 811** (2020) 135855

Decay Spectroscopy of Neutron-Rich Nuclei at CARIBU*

F.G. Kondev
Physics Division, Argonne National Laboratory, Lemont, Illinois 60439, USA

The properties of neutron-rich nuclei are of significant interest for elucidating the structure of nuclei away from the line of stability. They are an essential ingredient in the interpretation of the r-process nucleosynthesis and are needed in fission-like applications since theoretical models depend sensitively on the nuclear structure input.

Predicated on these ideas, we have initiated a dedicated decay spectroscopy experimental program at Argonne National Laboratory, by combining the CARIBU radioactive beam facility with the Canadian Penning Trap and the X-Array spectrometers. The initial focus was on several deformed odd-odd nuclei, where β^- decays of both the ground state and an excited isomer were investigated. Because of the spin difference, a variety of structures in the daughter nuclei were selectively populated and characterized, which in turn provided information about the structure of the parent isomers.

Results from these measurements will be presented, together with predictions based on deformed shell model that includes effects of pairing and spin-depended, nucleon-nucleon interactions. The newly commissioned, beta-decay station at Gammasphere will also be discussed and results from recent experimental campaigns will be presented.

* Work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357 and the National Nuclear Security Administration, Office of Defense Nuclear Nonproliferation R & D (NA-22).

Contribution ID: **108** Type: **not specified**

Exploring the sensitivity of nuclear charge radii to structural changes in the Ca region (remote)

Tuesday, 31 May 2022 18:45 (10 minutes)

Laser spectroscopy experiments provide a precise measurement of the changes in the nuclear mean-square charge radii and the electromagnetic moments of isotopes. State-of-the-art techniques can routinely measure these properties of the ground state and long-lived isomers which are produced in minute samples at radioactive ion beam facilities. The region of the nuclear chart between the magic Ca (Z=20) and Ni (Z=28) isotopes is rich in nuclear structure changes and is perfectly placed to investigate the evolution of the nuclear shape and size in both neutron- and proton-rich isotopes, as well as the isospin symmetry in self-conjugate isotopes.

In this talk the nuclear charge radii in the Ca to Ni region will be presented, including the newly measured of $^{48-54}$Cr isotopes from the IGISOL laboratory. Recent developments for the laser spectroscopy of proton-rich Co and Fe will also be discussed.

Presenter: KOSZORUS, Agota (CERN, Suisse)

Session Classification: Session 8: Nuclear charge radii, staggering and shell effects, neutron skin

Contribution ID: **81** Type: **not specified**

Candidates for long-lived high-K ground states and isomers in superheavy nuclei

Monday, 30 May 2022 15:30 (20 minutes)

By selecting the lowest lying of more than 2000 excitations we found the candidates for high-K ground states / K-isomers in Md - Rg nuclei.
Energies of nuclear configurations are calculated within the microscopic-macroscopic model with the Woods-Saxon potential in two scenarios: via blocking or/and using quasi-particle BCS method. Optimal deformations for a fixed configuration as well as for ground states are found by the four-dimensional energy minimization over deformations. Obtained excitation energies are discussed and compared with available experimental data.

Co-authors: SKALSKI , Janusz (Centre for Nuclear Research); JACHIMOWICZ, P. (Institute of Physics, University of Zielona Góra)

Presenter: KOWAL, Michal (NCBJ Warsaw, Poland)

Session Classification: Session 3: Spectroscopy of heavy and super-heavy nuclei

ID de résumé : **53**

Nature of the excited bands in odd-mass triaxial nuclei within the quasiparticle-plus-triaxial rotor model

Contenu

Nuclei are quantum mechanical systems with discrete states with quite complicated nature. The understanding of these states has been gradually reaching new depths while at the same time it has been expanding toward different frontiers, for instance toward high spins, toward heavy nuclei, toward nuclei near the proton-drip lines and for neutron-rich nuclei, as well as toward non-yrast structures. Revealing the nature of yrare nuclear states is in general quite challenging. While the yrast states are usually well understood and described by the presently available nuclear models, the yrare states are often more complex and difficult.

In general the rotational bands in deformed odd-mass nuclei with triaxial shape can be described with the quasiparticle-plus-triaxial rotor (QTR) model. The model couples the three-dimensional rotation of the triaxial core (that looks like a precession similar to the precession a rotating top) with the single-particle degree of freedom of the odd nucleon. The calculated rotational bands represent combinations of these two mechanism, and look like tilted precession, TiP bands, [1]. The collective rotation comprises a dominant rotational component around the axis with largest moment of inertia (called here favoured rotation) and a rotational component orthogonal to this axis (unfavoured rotation). In the case where the single-particle configuration is frozen and where the unfavoured rotational angular momentum is small, the tilted precession can be approximated with wobbling, that is it can be described as a coupling of favoured rotation with excitations of wobbling phonons [2]. Therefore the calculated excited rotational bands are associated with 1-, 2-, etc. wobbling phonons. However the harmonic frozen approximation (HFA) [2] is typically valid for one-quasiparticle bands in odd-mass nuclei only for longitudinal coupling of the angular momenta of the valence nucleon and the core and only at high spins. Therefore the nature of the proposed low-spin wobbling bands in a number of nuclei [3-9] seems open to question and needs further investigations. Serious questions on the nature of the excited bands in two of these nuclei, (^{135}Pr and ^{187}Au), were also raised by very recent experimental data [10,11], where the measurements are in conflict with the previously proposed wobbling.

In this presentation the nature of the excited bands in odd-mass triaxial nuclei are studied with the QTR model. In particular the HFA condition and the difference between TiP and wobbling phonon bands will be discussed. In addition a study of the nature of the QTR model solutions for the $\pi h_{11/2}$ bands in ^{135}Pr will be presented. The calculations highlight the important impact of the single-particle degree of freedom on the nature of the bands. They show that for these bands the angular momentum of the valence nucleon rapidly aligns from the short toward the intermediate axis as the spin increases, which is in contrast with the fixed alignment along the short axis imposed within the HFA.

References:

[1] E. A. Lawrie, O. Shirinda, and C. M. Petrache, Phys. Rev. C 101, 034306 (2020).
[2] S. Frauendorf and F. Dönau, Phys. Rev. C 89, 014322 (2014)
[3] J. T. Matta et al., Phys. Rev. Lett. 114, 082501 (2015).
[4] N. Sensharma et al., Phys. Lett. B 792, 170 (2019).
[5] J. Timár et al., Phys. Rev. Lett. 122, 062501 (2019).
[6] S. Nandi et al., Phys. Rev. Lett. 125, 132501 (2020).
[7] S. Biswas et al., Eur. Phys. J. A 55, 159 (2019).
[8] N. Sensharma et al., Phys. Rev. Lett. 124, 052501 (2020).
[9] S. Chakraborty, et al., Phys. Lett. B, 811, 135854 (2020).
[10] B. F. Lv et al, Phys. Lett. B, 824, 136840 (2022).
[11] S. Guo et al., Phys. Lett. B 828, 137010 (2022).

Auteur principal: Dr LAWRIE, Elena (iThemba LABS)

Orateur: Dr LAWRIE, Elena (iThemba LABS)

Déposé par **LAWRIE, Elena** le **samedi 16 avril 2022**

Contribution ID: **110** Type: **not specified**

β-decay spectroscopy activities at ALTO

Wednesday, 1 June 2022 09:25 (20 minutes)

A little more than ten years ago, the very first electron beam was produced with the ALTO electron LINAC. 50 MeV and 10 μA later, the induced photofission process allow the production of exotic neutron rich isotopes. Based on the ISOL technique, ALTO has shown its capability to produce radioactive ion beams in the ^{78}Ni mass region. Since then, the Orsay team working with the facility developed a set of instruments dedicated to the study of neutron rich nuclei β -decay such as BEDO or the neutron counter named TETRA [1]. The availability of these setups allowed the investigation of possible existence of low-lying structures in the β -strength function above the neutron separation energy (Sn). This endeavor was further encouraged by two remarkable serendipities. The first one concerns the unexpected observation of "ultra"-high-energy γ-rays (8-9 MeV) [2] in the β-delayed emission products of ^{83}Ga (Z=31 ; N=52 ; T1/2=312 ms ; Qb=11.7 MeV) sources collected at the BEDO station [3]. The second one concerns β-delayed neutron-emission probability (Pn) measurements of the ^{82,83,84}Ga (N=51,52,53) precursors [4] using the neutron counter TETRA: quite unexpectedly, after a steep increase of the Pn values from N=51 to 52, the Pn falls down again at N=53 by a factor ~2. More recently, manifestation of Pygmy Dipole Resonances (PDR) was observed in ^{80}Ge [5]. These results will be presented and discussed. It will be shown that they clearly point towards the existence of structures in the threshold region of the daughter-nucleus excitation spectrum, governing the decay properties in the ^{78}Ni region. Perspectives for further investigation of these questions at ALTO using the PARIS, TETRA and MONSTER (γ and neutron) spectrometers will be presented.
Others β-decay activities of the Orsay research group will also be presented.

[1] D. Testov, D. Verney, B. Roussière et al., NIM A815, 96 (2016)
[2] A. Gottardo, D. Verney, I. Deloncle et al. PLB 772, 359 (2017)
[3] A. Etilé, D. Verney, N. N. Arsenyev et al. PRC 91, 064317 (2015)
[4] D. Verney, D. Testov, F. Ibrahim et al., PRC 95, 054320 (2017)
[5] R. Li, Ph. D. Thesis, Université Paris-Saclay (2022)

Co-author: ON THE BEHALF OF THE ORSAY $BETA$-DECAY SPECTROSCOPY GROUP.

Presenter: LEBOIS, Mathieu (University Paris-Saclay and IJCLab, France)

Session Classification: Session 9: Selected methods for the study of exotic phenomena in nuclei

ID de résumé : **69**

Warm nuclei at high spin: the pioneering multi-dimensional vision of Bent Herskind

Contenu

The physics of warm rotation at high spin in the many-body atomic nucleus will be briefly reviewed with the attempt of providing a historical perspective. This fascinating research topic, investigated in past decades by various research groups in Europe and the US, was greatly inspired by the seminal work carried out at the NBI, with Bent Herskind being the central figure. Bent had unique vision for experimental techniques and analysis methods. He contributed to the birth of Compton-suppressed Ge arrays, and his pioneering multi-dimensional γ-coincidence approaches and statistical data treatment were instrumental in investigating the properties of rotational motion at high excitation energy and chaotic phenomena, also associated with nuclear superdeformation. Perspectives in nuclear structure investigations inspired by Bent legacy will be also briefly discussed.

Auteur principal: LEONI, Silvia (University of Milano and INFFN Milano)

Orateur: LEONI, Silvia (University of Milano and INFFN Milano)

Déposé par **LEONI, Silvia** le **samedi 7 mai 2022**

ID de résumé : **154**

From energy density functionals to partial dynamical symmetries in nuclei

Contenu

Dynamical symmetries (DSs) provide useful benchmarks for interpreting the structure of nuclei. Notable examples are the U(5), SU(3) and SO(6) DSs of the interacting boson model (IBM), which encode the dynamics of spherical, axially-deformed and γ-unstable shapes, respectively. In the majority of nuclei, however, an exact DS rarely occurs. More often some states obey the patterns required by the symmetry, but others do not. This necessitates a certain degree of symmetry-breaking, a prominent case of which is partial dynamical symmetry (PDS) [1]. Its basic idea is to relax the stringent conditions imposed by an exact DS so that solvability and/or good quantum numbers are retained by only a subset of states. Detailed studies, in the IBM framework, have shown that PDSs account quite well for a wealth of spectroscopic data in various types of nuclei. In all these phenomenological studies, an Hamiltonian with a prescribed PDS is introduced, its parameters are determined from a fit to the spectra, and the PDS predictions (which are often parameter-free) are compared with the available empirical energies and transition rates. In the present contribution, we show that the PDS notion is robust and founded on microscopic grounds [2]. For that, we use self-consistent mean-field methods in combination with the IBM, to establish a linkage between universal energy density functionals (EDFs) and PDSs. An application to ^{168}Er shows that IBM Hamiltonians derived microscopically from known non-relativistic and relativistic EDFs in this region, conform with SU(3)-PDS.

[1] A. Leviatan, Prog. Part. Nucl. Phys. **66**, 93 (2011).
[2] K. Nomura, N. Gavrielov, and A. Leviatan, Phys. Rev. C **104**, 044317 (2021).

Auteurs principaux: Prof. LEVIATAN, Amiram (Racah Institute of Physics, The Hebrew University); Dr GAVRIELOV, Noam (Hebrew University of Jerusalem); Dr NOMURA, Kosuke (University of Zagreb, Croatia)

Orateur: Prof. LEVIATAN, Amiram (Racah Institute of Physics, The Hebrew University)

Déposé par **LEVIATAN, Amiram** le **jeudi 12 mai 2022**

Contribution ID: **117** Type: **not specified**

Study of nuclear low-lying spectrum and shape phase transition within microscopic triaxial-and-pairing collective Hamiltonian (remote)

Wednesday, 1 June 2022 12:30 (20 minutes)

The triaxial deformation and coupling with pairing vibration play important roles on the nuclear low-lying spectra and shape transitions. Here we have constructed a triaxial-and-pairing collective Hamiltonian that describes the triaxial shape vibrations, rotations, and coupling with pairing vibration, based on the covariant density functional theory (CDFT). The dynamics of the collective Hamiltonian is fully determined by the constrained CDFT calculations in the space of intrinsic shape and pairing deformations. The effect of coupling between shape and pairing degrees of freedom is analyzed in a study of low-energy spectra and transition rates of ^{156}Gd, by comparing with the calculations from quadrupole collective Hamiltonian. Finally, the shape phase transitions and triaxial deformations in Xe isotopes have been studied in detail.

Co-authors: XIANG, J. (School of Physics and Electronic, Qiannan Normal University for Nationalities); NIKŠIĆ, T. (Physics Department, Faculty of Science, University of Zagreb); VRETENAR, D. (Physics Department, Faculty of Science, University of Zagreb)

Presenter: LI, Zhipan (Southwest University, Chongqing, China)

Session Classification: Session 10: Shapes and shape coexistence

ID de résumé : **38**

Reconciling superfluidity and deformation in the relativistic nuclear field theory

Contenu

The recent theoretical effort in reconciling superfluidity and deformation will be presented for the domain of the single-quasiparticle motion. Starting from a general many-body Hamiltonian confined by the two-body instantaneous bare interaction, the equation of motion for the fermionic propagator is obtained in the Dyson form. Before making any approximation, the interaction kernel is found to be decomposed into the static and dynamical (time-dependent) contributions, while the latter translates to the energy-dependent and the former maps to the energy-independent terms in the energy domain. The three-fermion correlation function being the heart of the dynamical part of the kernel is factorized into the two-fermion and one-fermion ones. With the relaxed particle number constraint, the normal propagator is coupled to the abnormal one via both the static and dynamical kernels, that is formalized by introducing the generalized quasiparticle propagator of the Gor'kov type. The dynamical kernel in the factorized form is associated with the quasiparticle-vibration coupling (QVC) with the vibrations unifying both the normal and pairing phonons. The QVC vertices are related to the variations of the Hamiltonian of the Bogoliubov quasiparticles, which can be obtained by the finite amplitude method. Calculations of single-particle characteristics for axially deformed nuclei will be presented and discussed.

Auteurs principaux: BJELČIĆ , Antonio (University of Zagreb); LITVINOVA, Elena (Western Michigan University); Prof. NIKŠIĆ, Tamara (University of Zagreb); Prof. RING, Peter (Technische Universität München); SCHUCK, Peter (Université Grenoble Alpes); Dr ZHANG, Yinu (Western Michigan University)

Orateur: LITVINOVA, Elena (Western Michigan University)

Déposé par **LITVINOVA, Elena** le **lundi 4 avril 2022**

Contribution ID: **113** Type: **not specified**

Underlying mechanism responsible for even-parity ground state and one-neutron halo of ^{11}Be (remote)

Wednesday, 1 June 2022 10:40 (10 minutes)

Using the axially deformed relativistic Hartree-Fock-Bogoliubov (D-RHFB) model, we explore the mechanism that triggers the novelties in ^{11}Be, i.e., the parity inversion and one-neutron halo which are well reproduced by the RHF Lagrangian PKA1. Following the evolution from spherical to large prolate shapes, it is illustrated that the evidently enhanced π-pseudo-vector (π-PV) and ρ-tensor (ρ-T) couplings in PKA1 are crucial for correctly describing even-parity ground state (GS) of ^{11}Be. By fragmentizing the even-parity orbit $1/2^+_2$, it is shown that the main fragment $1d_{5/2}$ strengthens the couplings with nuclear core to promise the even-parity GS, in which the ρ-T and π-PV couplings play an important role, and the other major one $2s_{1/2}$ remains weakly bound to form the halo in ^{11}Be. Furthermore, it is found that the attractive inherent correlations between the $2s_{1/2}$ and $1d_{5/2}$ fragments are essential not only in determining the parity inversion but also in stabilizing the one-neutron halo of ^{11}Be. Thus, an apparent picture of the deformed halo is achieved, which paves an efficient way to clarify the underlying mechanism responsible for the halos and other novelties in deformed unstable nuclei.

Presenter: LONG, Wen Hui (Lanzhou University, China)

Session Classification: Session 9: Selected methods for the study of exotic phenomena in nuclei

Contribution ID: **103** Type: **not specified**

Re-investigation of the low-lying structure of ^{135}Pr (remote)

Tuesday, 31 May 2022 16:20 (20 minutes)

The low-lying negative-parity bands of ^{135}Pr were previously interpreted as the first case of zero-, one- and two-phonon transverse wobbling bands. In the present work, we re-investigated its structure via a high statistics JUROGAM experiment. It is shown that the mixing ratios of all analyzed connecting transitions between low-lying bands in^{135}Pr have absolute values smaller than one. This indicates predominant M1 magnetic character, which is incompatible with the proposed wobbling nature. All experimental observables are instead in good agreement with quasiparticle-plus-triaxial-rotor model calculations, which describe the bands as resulting from a rapid re-alignment of the total angular momentum from the short to the intermediate nuclear axis.

Presenter: LV, Binfeng (IMP Lanzhou)

Session Classification: Session 7: Wobbling and chirality in nuclei

ID de résumé : **13**

Generalized seniority for isomers and low-lying excitations in nuclei

Contenu

Abstract

Isomers are the long-lived excited states of nuclei and are of particular interest due to their capacities to provide insights into the nuclear structure [1]. The reason behind their occurrence depends mostly upon the structural surroundings and can vary from region to region. Symmetries of pairing Hamiltonian for the shell model in terms of seniority and generalized seniority are known to play a crucial role in explaining the semi-magic spherical/ near-spherical isomers, particularly for the Sn isotopes [2, 3]. Our recent works provide more credence to the generalized seniority approach to decipher the decay probabilities as well as moments of isomers and other low-lying excited states [4–7]. In this conference, I will focus on the solution for the puzzle of finding consistent nuclear configurations to understand both the decay probabilities and moments of the 9/2−, 8+, and 21/2− isomers in and around N = 126 closed shell in terms of generalized seniority [8]. Though h9/2 is the dominant orbital for these isomers, the role of configuration mixing from the surrounding f7/2 and i13/2 orbitals is found to be very important for the consistent explanation of all the isomeric properties such as the B(E2) rates, Q−moments, and g−factors. Further, recent efforts to understand the B(E3) rates in both odd-A and even-A N = 80, 82, 84 isotones using the generalized seniority will also be discussed [9].

Acknowledgments

BM acknowledges the financial support from the Croatian Science Foundation and the´Ecole Poly-technique F´ed´erale de Lausanne, under the project TTP-2018-07-3554 "Exotic Nuclear Structure and Dynamics", with funds of the Croatian-Swiss Research Programme.

References

[1] A. K. Jain, B. Maheshwari, A. Goel, Nuclear Isomers - A Primer, Springer Nature, Switzerland (2021).
[2] B. Maheshwari and A. K. Jain, Phys. Lett. B 753, 122 (2016).
[3] B. Maheshwari, A. K. Jain and B. Singh, Nucl. Phys. A 952, 62 (2016).
[4] B. Maheshwari and A. K. Jain, Nucl. Phys. A 986, 232 (2019).
[5] B. Maheshwari, H. A. Kassim, N. Yusof and A. K. Jain, Nuclear Physics A 992, 121619 (2019).
[6] B. Maheshwari, European Physical Journal Special Topics 229, 2485 (2020).
[7] B. Maheshwari, D. Choudhury and A. K. Jain, Nucl. Phys. A 1014, 122277 (2021).
[8] B. Maheshwari, D. Choudhury and A. K. Jain, Phys. Rev. C 105, 024315 (2022).
[9] B. Maheshwari, et al., communicated.

Auteur principal: MAHESHWARI, Bhoomika (Department of Physics, Faculty of Science, University of Zagreb, HR-10000 Zagreb, Croatia)

Orateur: MAHESHWARI, Bhoomika (Department of Physics, Faculty of Science, University of Zagreb, HR-10000 Zagreb, Croatia)

Déposé par **MAHESHWARI, Bhoomika** le **lundi 14 mars 2022**

Contribution ID: **75** Type: **not specified**

A quest for nuclear Jacobi shapes: the impact of Bent Herskind on theory and instrumentation developments

Monday, 30 May 2022 11:25 (30 minutes)

The possibility of existence in atomic nuclei of the so called "Jacobi shape transitions", the rapid shape changes at certain narrow angular momentum range from an oblate to a very elongated prolate shape (analogous to those predicted by Jacobi for rotating stellar objects), was postulated by theorists already in the early 1960's [1,2]. In the 90's, the Seattle group, and soon after the NBI Copenhagen group, studying the GDR gamma decay from hot rotating 45Sc [3] and 46Ti [4], nuclei observed signals interpreted as the first manifestations of the nuclear Jacobi shape transition.
However, the direct evidence for the existence of the Jacobi shape transition in 46Ti nucleus came from the experiment performed in Strasbourg [5], where two arrays of gamma-ray detectors, scintillator array HECTOR and the germanium array EUROBALL, were coupled. Moreover, the interpretation of the results has become possible only because of the development of a theoretical approach referred to as Lublin-Strasbourg Drop (LSD) [6], which appeared simple to use by experimentalists.
Bent Herskind was pivotal to this achievement not only by taking part in the experiment and discussing the results, by also by his strong contribution to the development of the two detector arrays used, and also to the development of the links with the LSD model.
In the talk I will present the history of the quest for nuclear Jacobi shape transitions and the impact of Bent. In addition, I will present the currents status of understanding of the phenomenon of nuclear Jacobi shape transitions, the status of the instrumentation (especially, construction of the new scintillator array PARIS [7]) and some outlook of the coming perspectives such as the search for the Poincare shape transitions [8].

References:
[1] R. Beringer, W.K. Knox, Phys. Rev. 121 (1961) 1195
[2] S. Cohen, F. Plasil, W.J. Swiatecki, Ann. Phys. (N.Y.) 82 (1974) 557
[3] M. Kicińska-Habior et al., Phys.Lett. B308 (1993) 225
[4] A. Maj et al., Nucl.Phys. A687, 192c (2001)
[5] A. Maj et al., Eur.Phys.J. A 20, 165 (2004)
[6] K. Pomorski, J. Dudek, Phys. Rev. C67 (2003) 044316
[7] F. Camera, A. Maj, PARIS White Book, http://rifj.ifj.edu.pl/handle/item/333
[8] A. Maj et al., Int.J.Mod.Phys. E19, 532 (2010)

Presenter: MAJ, Adam (IFJ PAN Krakow, Poland)

Session Classification: Sesion 2: The science and impact of Bent Herskind (1931 - 2021)

ID de résumé : **45**

Properties of giant dipole resonances within an extended spd-IBM model

Contenu

The IBM, as proposed by Arima and Iachello [1], includes two types of bosons with angular momentum L = 0 (s bosons) and L = 2 (d bosons). Building forward from this, and following the work of Maino et al. [2], in this lecture we consider the spectrum of giant dipole resonances with an spd-IBM. Specifically, the scope of the present lecture is to describe dipole spectra by coupling a p boson to the IBA sd-boson system for a theory with three pairing control parameters (cs, cd, and cp) and study the quantum phase transition. To investigate the properties of giant dipole resonances, similar to that of the two-level system in the spd-boson system, a three-level system in the s, p, and d boson model is considered here. To analyze the Quantum Phase Transition between the spherical and rotational shapes, similar to Refs. [3-5], the SU(1,1) pairing algebra is introduced.

[1] A. Arima and F. Iachello, Phys. Rev. Lett. 35, 1069 (1975).

[2] G. Maino, A. Ventura, L. Zuffi, and I. Iachello, Phys. Rev. C 30, 2101 (1984).

[3] F. Pan and J. Draayer, Nucl. Phys. A 636, 156 (1998)

[4] A. J. Majarshin, Y.-A. Luo, F. Pan, H. T. Fortune, and J. P. Draayer, Phys. Rev. C 103, 024317 (2021).

[5] A. J. Majarshin, Y.-A. Luo, F. Pan, and H. T. Fortune, Phys. Rev. C 104, 014321 (2021).

Auteurs principaux: JALILI MAJARSHIN, Amir (Nankai University); Prof. LUO, Yan An (Nankai University); Prof. PAN, Feng (louisiana state university)

Orateur: JALILI MAJARSHIN, Amir (Nankai University)

Déposé par **JALILI MAJARSHIN, Amir** le **lundi 11 avril 2022**

ID de résumé : **29**

Energy functionals grounded in ab initio calculations: a systematic ladder of approximations

Contenu

Ab initio methods [1] hold the promise of allowing to determine all the structural properties of nuclei and infinite nucleonic matter, starting from the individual interactions between protons and neutrons. Despite recent remarkable progress, full-scale studies of heavy nuclei are still out of reach.

By contrast, Density Functional Theory (DFT) [2] can be readily applied to ground-state and excited-state properties across the whole nuclear chart. However, the Energy Density Functionals (EDFs), the key quantities in DFT, are phenomenological and biased towards stable nuclei close to magicity. Shortcomings of the empirical EDFs manifest themselves far from the stability valley, e.g. in neutron-rich nuclei or pure neutron matter (PNM). To accompany the growing experimental research efforts devoted to unstable nuclei at the limits of the nuclear chart, there is a strong need for improving the theoretical tools at our disposal.

In this contribution, we wish to discuss our approach, inspired by the "Jacob's ladder" of condensed matter DFT [3], that aims at constructing ab initio-constrained EDFs. We shall first present the first rung [4], called local density approximation (LDA), that exploits the equation of state of nucleonic matter as sole input. Then, we describe our current work, in which the static response [5] of both PNM and symmetric nuclear matter to an external potential is studied by means of ab initio techniques, namely the Quantum Monte Carlo and the Self-consistent Green's functions approach, and exploited to constrain the gradient terms of the nuclear EDF.

[1] H. Hergert, Front. Phys. 8, 00379 (2020)
[2] G. Colò, Advances in Physics: X 5, 1740061 (2020)
[3] J. P. Perdew and K. Schmidt, AIP Conf. Proc. 577, 1 (2001)
[4] F. Marino et al., Phys. Rev. C 104, 024315 (2021).
[5] M. Buraczynski et al., Physics Letters B 818, 136347 (2021)

Auteur principal: MARINO, Francesco (University of Milan and INFN)

Co-auteurs: Prof. BARBIERI, Carlo (University of Milan and INFN); Dr CARBONE, Arianna (INFN−CNAF); Prof. COLÒ, Gianluca (University of Milano and INFN); Dr LOVATO, Alessandro (Argonne National Laboratory and INFN-TIFPA); Prof. PEDERIVA, Francesco (University of Trento and INFN-TIFPA); Prof. ROCA-MAZA, Xavier (University of Milano and INFN); Dr VIGEZZI, Enrico (INFN Milano)

Orateur: MARINO, Francesco (University of Milan and INFN)

Déposé par **MARINO, Francesco** le **jeudi 31 mars 2022**

ID de résumé : **21**

The islands of shape coexistence within the Shell Model SU(3) symmetry

Contenu

Shape Coexistence in nuclei appears in all mass regions, in certain nuclei and manifests by the presence of two low-lying nuclear bands, which correspond to drastically different nuclear shapes. The state-of-the-art theoretical mechanism is the well established particle-hole excitation, which attributes the one of the two coexisting bands to proton or neutron excitations. This mechanism is realized within the traditional Shell Model and predicts that particle-hole excitations- and so shape coexistence- can occur in every nucleus. Our group proposed in 2021 a dual-shell mechanism, which aligns with the particle-hole mechanism, is realized within the Shell Model SU(3) symmetry of Elliott and predicts that shape coexistence can occur in certain islands of nuclei on the nuclear chart, namely the islands of shape coexistence. The new mechanism shall be presented and comparison with the experimental occurrences of shape coexistence shall be discussed.

Auteur principal: MARTINOU, Andriana (INPP Demokritos)

Orateur: MARTINOU, Andriana (INPP Demokritos)

Commentaires:

I will participate in the conference on-line.

Déposé par **MARTINOU, Andriana** le **mardi 29 mars 2022**

ID de résumé : **7**

SHAPE COEXISTENCE IN STRONTIUM ISOTOPES

Contenu

The shape of nuclei is determined by a fine balance between the stabilizing effect of closed shells and the pairing and quadrupole force that tends to make them deformed. As other well known cases, located in the A = 100 mass region, as Yb, Zr or Nb for example, Sr isotopes are good candidates to study the existence of this nuclear deformation. In particular in this case, particle-hole excitations are favored because of the presence of the proton subshell closure Z = 40, resulting in low-lying intruder bands.

The aim of this contribution is the study of the nuclear structure of 92-102 Sr even-even isotopes using the Interacting Boson Model with configuration mixing to reproduce excitation energies, B(E2) transition rates, nuclear radii and two-neutron separation energies.

For the whole chain of isotopes analyzed, good agreement between theoretical and experimental values of excitation energies, transition rates, separation energies, radii and isotope shift has been found. Furthermore, the wave functions, together with the mean field energy surfaces and the value of nuclear deformation have been analyzed.

This study will clarify the presence of low-lying intruder states in even-even Sr isotopes and the way it connects with the onset of deformations. Lightest Sr isotopes considered present a spherical structure while heaviest one are clearly deformed. The onset of deformation at N = 60 is induced by the crossing of the regular and intruder configuration, furthermore, both families of states present an increase of deformation with the neutron number.

Auteurs principaux: MAYA BARBECHO, Esperanza (Universidad de Huelva); GARCÍA-RAMOS, José Enrique (University of Huelva)

Orateur: MAYA BARBECHO, Esperanza (Universidad de Huelva)

Déposé par **MAYA BARBECHO, Esperanza** le **mardi 15 février 2022**

Contribution ID: **149** Type: **not specified**

Novel shapes for exotic nuclei (remote)

Friday, 3 June 2022 16:10 (20 minutes)

The study of exotic nuclei far from the β-stability line has been at the forefront of nuclear physics research since 1980s. The relativistic density functional theory has achieved great success in the study of nuclear structure in recent years.
In order to explore the effects of triaxial deformation in exotic nuclei and the existence of triaxially deformed halo nuclei, a self-consistent triaxial relativistic Hartree-Bogoliubov theory in continuum (TRHBc) is developed. Possible triaxially deformed halo nuclei are explored by taking aluminum isotopes as examples. The binding energies, nucleon separation energies, and charge radii are well reproduced. It is predicted that the experimentally observed nucleus, ^{42}Al, is a triaxially deformed halo nucleus, and there is a triaxial shape decoupling between its core and halo. Potential energy surfaces are constructed by the constrained calculations to verify the ground states obtained from unconstrained calculations.

Presenter: MENG, Jie (Peking University)

Session Classification: Session 18: Shapes, cranking models and best posters presentations

Neutron Skins of ^{48}Ca and ^{208}Pb from Parity-Violating Scattering at JLab

Robert Michaels
Thomas Jefferson National Accelerator Facility, Newport News, VA, USA

New experimental results from CREX and PREX on the weak form factors and neutron skins will be presented. The Calcium(Lead) Radius Experiment CREX(PREX) ran in 2019-2020 in Hall A at the Thomas Jefferson National Accelerator Facility (JLab). The experiments measured the parity-violating asymmetry in the elastic scattering of longitudinally polarized electrons from ^{48}Ca and ^{208}Pb at low Q^2 and forward angles. The Z boson that mediates the weak neutral interaction couples mainly to neutrons and provides a clean, model-independent measurement of the RMS radius R_n of the neutron distribution in the nucleus. The measurements are a fundamental test of nuclear structure theory and will be compared to ab-initio theoretical calculations and nuclear models.

ID de Contribution: **56** Type: **Non spécifié**

Study of particle emissions following after β-decays and muon captures

Nuclei can be at an excited state by beta decays and muon captures. If the excitation energy is above particle threshold energies, the nuclei emit particles competing with the gamma deexcitation. The typical examples are neutron emissions after beta decays and muon captures. In addition, it is known that proton and alpha particle emissions occur for highly excited neutron deficient nuclei. The information is important not only for estimating delayed neutrons that play an important role for a stable operation of reactors, but also for evaluating radioactivities, soft errors of semiconductors, and nucleosynthesis in stars. Although experimental data of the particle emissions following beta decays and muon captures have been reproduced with some phenomenological models, the detailed mechanism with respect to the nuclear structure is still unclear. In particular, experimentally measured neutron spectra after muon capture cannot be reproduced well with a nuclear structure model. In this work, we go into the investigation on this issue with a microscopic approach of proton neutron random phase approximation and particle evaporation models considering pre-equilibrium and compound process.

[1] M. Ciccarelli, F. Minato, T. Naito, "Theoretical study of Nb isotope productions by muon capture reaction on 100Mo," Phys. Rev. C 102, 034306 (2020).
[2] F. Minato, T. Marketin, N. Paar, "β-delayed neutron emission and fission calculations within relativistic quasiparticle random phase approximation and a statistical model," Phys. Rev. C 104, 044321 (2021).

Auteur principal: MINATO, Futoshi (JAEA)

Orateur: MINATO, Futoshi (JAEA)

Contribution ID: **118**

Type: **not specified**

Effects of the shape on the formation and decay properties of the ^{229m}Th isomer (remote)

Wednesday, 1 June 2022 12:55 (15 minutes)

It will be shown within a relatively simple nuclear structure model framework [1] that the formation of the 8 eV "clock" isomer ^{229m}Th may be the effect of single-neutron levels quasi-degeneracy stemming from a specific quadrupole octupole shape of the nucleus. The very fine interaction between collective and single-particle modes within narrow limits in the deformation space rather unambiguously determines the isomer formation conditions with the attendant B(M1), B(E2) decay rates and magnetic dipole moment in the isomeric state. Estimates based on a comprehensive model analysis of these isomer characteristics will be discussed.
It will be shown that the approach used provides a clear protocol for the search, prediction and identification of low-energy excitations in other nuclei opening a way to study similar effects and phenomena on the border between nuclear and atomic physics.

References

[1] N. Minkov and A. Palffy, Phys. Rev. Lett. **118**, 212501 (2017);
Phys. Rev. Lett.**122**, 162502 (2019); Phys. Rev. C **103**, 014313 (2021).

Presenter: Prof. MINKOV, Nikolay (Institute of Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences)

Session Classification: Session 10: Shapes and shape coexistence

ID de résumé : **36**

Ab initio calculations of heavy-mass nuclei

Contenu

The recent developments mainly in nuclear interaction and many-body techniques allow us to compute the properties of finite nuclei. The applicability of the ab initio calculations is expanding to the mass number ~ 100 [1]. However, it becomes difficult to find a reliable result for further heavy nuclei, primarily due to the memory expensive three-nucleon interaction. To overcome the limitation and make the computation of the heavier nuclei feasible, we proposed a new storage scheme of the 3N matrix elements [2], exploiting the feature of widely used normal-ordered two-body approximation. This new scheme enables us to compute the heavier nuclei well beyond the previous limitation. In this talk, I will present some applications for heavy nuclei.

References
[1] S. R. Stroberg, J. D. Holt, A. Schwenk, and J. Simonis, Phys. Rev. Lett. 126, 022501 (2021).
[2] T. Miyagi, S. R. Stroberg, P. Navrátil, K. Hebeler, and J. D. Holt, Phys. Rev. C 105, 014302 (2022).

Auteur principal: MIYAGI, Takayuki (TU Darmstadt)

Orateur: MIYAGI, Takayuki (TU Darmstadt)

Déposé par **Dr MIYAGI, Takayuki** le **lundi 4 avril 2022**

ID de résumé : **4**

The Atomic Nucleus is a Protein-folding Problem

Contenu

Nucleons in the atomic nucleus are strongly correlated which causes the breakdown of mean-field theory. Small A nuclei are the key to the atomic nucleus. I show that 3He is an equilateral triangle, using elastic electron scattering data. Previous work has already shown that the alpha-particle is a three-base pyramid. Point-group symmetry comes from quark-exchange between overlapping nucleon wavefunctions. This causes 2-body, 3-body and 4-body quark exchange forces, which have scalar, spin-orbit, spin-spin and tensor interactions. The strong correlations cause multiple spin correlations/alignments which give the impression of a 'nuclear shell'; no actual nuclear shells exist.

The structure of the atomic nucleus reduces to a very complicated protein-folding problem, which balances spin-spin forces, Coulomb repulsion and nucleon wavefunction overlap percentages.

Auteur principal: MORLEY, Peter (Blue Ridge Scientific LLC)

Orateur: MORLEY, Peter (Blue Ridge Scientific LLC)

Déposé par **Dr MORLEY, Peter** le **mardi 8 février 2022**

ID de résumé : **48**

Search for wobbling bands in 193Au

Contenu

Triaxially deformed nuclei have unique characteristics, for instance they can form wobbling and chiral rotational bands. The wobbling bands are produced by excitations of wobbling phonons. This phenomenon has been proposed for several odd-mass nuclei in the mass regions of A~ 100, 130, 160 and 190. The nature of the proposed wobbling bands is of great interest for the science community as there are other phenomena in triaxial nuclei that can be present instead of wobbling. For instance, tilted precession which is generated by adding non-favored rotation (orthogonal to the axis of largest moment of inertia) or by changes in the single-particle configuration can also produce excited bands in triaxial nuclei. Another mechanism that generates such excited bands is the gamma vibration of the nuclear shape. The Au isotopes are good candidates for studying such phenomena as the nuclei in this mass region are strongly affected by the triaxial degree of freedom. Recently transverse wobbling was proposed to occur in 183Au, while longitudinal wobbling was suggested for 187Au. However, we have shown that the observed excited band in 187Au is not associated with wobbling, but with tilted precession. In the present work excited states of 193Au are studied using the tape station experimental set-up at iThemba LABS. These states were populated in the beta-decay reaction that follows the 197Au(p,5n)193Hg reaction at Ep=50 MeV. The emitted gamma rays were detected with three Compton-suppressed clover detectors and one Compton-suppressed segmented clover. In addition a Si(Li) detector was used for the emitted internal conversion elections. Preliminary experimental results on the low-to-medium spin states in 193Au, including results from internal conversion measurements, will be presented and discussed.

Auteur principal: MTHEMBU, Sinegugu (University of the western cape & iThemba LABS)

Orateur: MTHEMBU, Sinegugu (University of the western cape & iThemba LABS)

Déposé par **MTHEMBU, Sinegugu** le **mardi 12 avril 2022**

Contribution ID: **135** Type: **not specified**

Can we improve energy density functionals? A perturbative method (remote)

Thursday, 2 June 2022 12:15 (20 minutes)

The accuracy of an energy density functional determines the accuracy of the density functional calculation. Thus, it is highly motivated to improve the accuracy of an EDF.
Then, a question arises: Can we improve an EDF if we know the "exact" density?
To answer this question, recently, we proposed a method named "IKS-DFPT" to improve the known EDF using a combination of the inverse Kohn-Sham method and the density functional perturbation theory [1]. In Ref. [1], this method was benchmarked in atomic systems, while it was extended to the covariant density funcitonal theory for nuclear systems [2].
In this talk, I will introduce this method and its benchmark results.

References:
[1] T. Naito, D. Ohashi, and H. Liang. J. Phys. B 52, 245003 (2019).
[2] G. Accorto, T. Naito, H. Liang, T. Nikšić, and D. Vretenar. Phys. Rev. C 103, 044304 (2021).

Presenter: NAITO, Tomoya (RIKEN, Tokyo, Japan)

Session Classification: Session 14: Nuclear structure with density functional and shell-model approaches

Contribution ID: **144** Type: **not specified**

Alpha-particle distribution in nuclei (remote)

Friday, 3 June 2022 12:10 (20 minutes)

Alpha clustering is a well-known correlation in nuclei. We use the mean-field theory to investigate where in the nucleus and how probable the alpha particles are formed. In addition, the calculation approximately provides information how much the daughter nucleus is excited, when the alpha particle is knocked out.
We will discuss effect of the pairing and deformation of the parent nucleus.

Presenter: NAKATSUKASA, Takashi (Tsukuba University)

Session Classification: Session 16: Alpha clustering, magnetic moments, structure of superheavy nuclei

ID de résumé : **20**

Ab initio investigations of A=8 nuclei: Alpha-clustering, deformation in 8He, p+7Li radiative capture and the X17 boson

Contenu

A realistic description of atomic nuclei, in particular light nuclei characterized by clustering and low-lying breakup thresholds, requires a proper treatment of continuum effects. We have developed an approach, the No-Core Shell Model with Continuum (NCSMC) [1,2], capable of describing both bound and unbound states in light nuclei in a unified way. With chiral two- and three-nucleon interactions as the only input, we can predict structure and dynamics of light nuclei and, by comparing to available experimental data, test the quality of chiral nuclear forces. Recently, the capability to describe α-clustering has been implemented [3].

We will discuss applications of NCSMC to the α-α scattering and the structure of 8Be, the p+7Li radiative capture and the production of the hypothetical X17 boson claimed in ATOMKI experiments [4]. Finally, we will highlight our investigation of the neutron rich exotic 8He that has been recently studied experimentally at TRIUMF with an unexpected deformation reported [5].
Supported by the NSERC Grants No. SAPIN-2016-00033 and by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, under Work Proposals No. SCW1158 and No. SCW0498. TRIUMF receives federal funding via a contribution agreement with the National Research Council of Canada. This work was prepared in part by LLNL under Contract No. DE-AC52-07NA27344. Computing support came from an INCITE Award on the Summit supercomputer of the Oak Ridge Leadership Computing Facility (OLCF) at ORNL, from Westgrid and Compute Canada, and from the LLNL institutional Computing Grand Challenge Program.

[1] S. Baroni, P. Navratil, and S. Quaglioni, Phys. Rev. Lett. 110, 022505 (2013); Phys. Rev. C 87, 034326 (2013).
[2] P. Navratil, S. Quaglioni, G. Hupin, C. Romero-Redondo, A. Calci, Physica Scripta 91, 053002 (2016).
[3] K. Kravvaris, S. Quaglioni, G. Hupin, and P. Navratil, arXiv: 2012.00228.
[4] A. J. Krasznahorkay et al., Phys. Rev. Lett. 116, 042501 (2016).
[5] M. Holl et al., Phys. Lett. B 822, 136710 (2021).

Auteurs principaux: GYSBERS, Peter (TRIUMF); HUPIN, Guillaume (CNRS - IJClab); Dr KRAVVARIS, Kostas (LLNL); Dr NAVRATIL, Petr (TRIUMF); Dr QUAGLIONI, Sofia (LLNL)

Orateur: Dr NAVRATIL, Petr (TRIUMF)

Déposé par **PETR, Navratil** le **samedi 26 mars 2022**

Shape isomers in Pt, Hg and Pb isotopes with N<126 [1]

Bożena Nerlo-Pomorska

Institute of Physics, Maria Curie-Skłodowska University, Lublin, Poland

Abstract:

Deformation-energy surfaces of 54 even-even isotopes of Pt, Hg and Pb nuclei with neutron numbers up to 126 are investigated [1]) within a macroscopic-microscopic model based on the Lublin-Strasbourg-Drop macroscopic energy [2]) and shell plus pairing-energy corrections obtained from a Yukawa-folded mean-field potential at the desired deformation. A new, rapidly converging Fourier shape parametrization [3,4]) is used to describe nuclear shapes. The stability of shape isomeric states with respect to non-axial and higher-order deformations is investigated.

References:

1) K. Pomorski, B. Nerlo-Pomorska, A. Dobrowolski, J. Bartel, C.M. Petrache, Eur. Phys. J. A **56**, 107 (2020).
2) K. Pomorski and J. Dudek, Phys. Rev. C **67**, 044316 (2003).
3) K. Pomorski, B. Nerlo-Pomorska, J. Bartel, C. Schmitt, Acta Phys. Pol. B Supl. **8,** 667 (2015).
4) C. Schmitt, K. Pomorski, B. Nerlo-Pomorska, J. Bartel, Phys. Rev. C **95**, 034612 (2017).

Contribution ID: **97** Type: **not specified**

Mean-field derivation of the interacting boson model for transitional nuclei (remote)

Tuesday, 31 May 2022 12:35 (20 minutes)

method of determining the interacting boson model Hamiltonian based on the nuclear density functional theory is presented, with a focus on the recent applications to γ-soft transitional nuclei. The constrained self-consistent mean-field calculations using a universal energy density functional and pairing interaction provide microscopic inputs to determine strength parameters for the IBM Hamiltonian in general cases. The mapped Hamiltonian then yields relevant spectroscopic properties of a given nucleus, that is, excitation spectra and electromagnetic transition rates. The topics to be discussed include the descriptions of the quantum shape phase transitions, shape coexistence, and triaxial deformations in the neutron-rich N~60 γ-soft nuclei in the mass A~100 region, and the simultaneous inclusion of pairing and quadrupole triaxial shape vibrations in the calculation of the low-lying excited 0^+ states of triaxially-deformed transitional nuclei in the mass A~190 and 130 regions.

Presenter: NOMURA, Kosuke (University of Zagreb, Croatia)

Session Classification: Session 6: Coupling of quasiparticles with collective triaxial degrees of freedom

ID de résumé : **11**

Universality of abundances in r-process nucleosynthesis

Contenu

The abundance of about half of the stable nuclei heavier than iron via the rapid neutron capture process or r-process is intimately related to the competition between neutron capture and β-decay rates, which ultimately depends on the binding energy of neutron-rich nuclei. The well-known Bethe-Weizsäcker semi-empirical mass formula describes the binding energy of ground states – i.e. nuclei with temperatures of T≈0 MeV – with the symmetry energy parameter converging between 23–27 MeV for heavy nuclei. In this work, we find an unexpected enhancement of the symmetry energy at higher temperatures, T≈0.7–1.0 MeV, from the available data of giant dipole resonances built on excited states. Although these are likely the temperatures where seed elements are created – during the cooling down of the ejecta following neutron-star mergers or collapsars– the fact that the symmetry energy remains constant between T≈0.7–1.0 MeV, suggests a similar trend down to T≈0.5 MeV, where neutron-capture may start occurring. Calculations using this relatively larger symmetry energy yield a reduction of the binding energy per nucleon for heavy neutron-rich nuclei and inhibits radiative neutron-capture rates. This results in a substantial close in of the neutron dripline – where nuclei become unbound – which elucidates the long sought universality of heavy-element abundances through the r-process; as inferred from the similar abundances found in extremely metal-poor stars and the Sun [1].

[1] José Nicolás Orce, Balaram Dey, Cebo Ngwetsheni, Srijit Bhattacharya, Deepak Pandit, Brenden Lesch, and Andile Zulu, submitted to Phys. Lett. B (2022) https://arxiv.org/abs/2110.00713

Auteur principal: ORCE, Nico (University of the Western Cape)

Orateur: ORCE, Nico (University of the Western Cape)

Déposé par **ORCE, Nico** le **vendredi 4 mars 2022**

ID de résumé : **68**

Prevailing triaxiality of heavy deformed nuclei

Contenu

It has been widely believed that most of heavy deformed nuclei have axially-symmetric prolate ground states and gamma-vibrational excitations for the second 2+ states. This prolate-shape dominance is stated in many textbooks. Aage Bohr seemed to have found this structure from observed data. The pairing + quadrupole-quadrupole (P+QQ) model of Baranger and Kumar supported this hypothesis. But, observed double-gamma-phonon states show challenges. Recently, Monte Carlo Shell Model with more realistic interaction [1] showed that in many nuclei, this hypothesis is not the case, and that the low-lying states are triaxially deformed. This new picture is a consequence of the monopole-quadrupole interplay, which leads to the self-organization towards most favorable shapes [1,2]. Once the traiaxial shapes arise, the Davydov model can be used for the modeling of levels and transitions [3]. Although the rigid triaxiality is not a very precise picture, the Davydov model is useful. I would like to recall that Davydov is an Ukrainian physicist, who now contributes a lot to the deep understanding of nuclear structure.

[1] T. Otsuka et al., Phys. Rev. Lett. 123, 222502(2019), https://doi.org/10.1103/PhysRevLett.123.222502

[2] T. Otsuka, Physics 4, 258 (2022), https://doi.org/10.3390/physics4010018

[3] Y. Tsunoda and T. Otsuka, Phys. Rev. C 103, L021303 (2021);
https://doi.org/10.1103/PhysRevC.103.L021303

Auteur principal: OTSUKA, Takaharu (Department of Physics, University of Tokyo)

Orateur: OTSUKA, Takaharu (Department of Physics, University of Tokyo)

Déposé par **OTSUKA, Takaharu** le **vendredi 6 mai 2022**

ID de résumé : **58**

Simultaneous in-beam gamma-ray and electron spectroscopy at JYFL

Contenu

One of the goals of modern nuclear physics research is to understand the origin of coexisting nuclear shapes and exotic excitations and their relation to the fundamental interactions between nuclear constituents. Despite of huge amount of both theoretical and experimental efforts, many open questions remain [1 and references therein]. In order to verify and understand these subjects in more detail, complementary approaches are needed.

This talk will give an insight into shape coexistence studies around neutron-deficient Pb nuclei. In particular, it will focus on series of simultaneous in-beam electron and gamma-ray spectroscopy experiments employing the SAGE spectrometer [2] at JYFL, Finland. Their relation to Coulomb excitation studies at Miniball [3] at HIE-ISOLDE, CERN [4] will also be discussed.

References
[1] K. Heyde and J.L. Wood, Rev. Mod. Phys. 83 1467 (2011).
[2] J. Pakarinen et al., Eur. Phys. J. A 50: 53 (2014).
[3] N. Warr et al., Eur. Phys. J. A 49, 40 (2013).
[4] P. Van Duppen, K. Riisager, J. Phys. G: Nucl. Part. Phys. 38, 024005 (2011).

Auteur principal: PAKARINEN, Janne (University of Jyväskylä)

Orateur: PAKARINEN, Janne (University of Jyväskylä)

Commentaires:

On behalf of the JYFL Nuclear Spectroscopy Group

Déposé par **PAKARINEN, Janne** le **mardi 26 avril 2022**

Description of magnetic moments within Gogny HFB

S.Péru [1,2], S. Hilaire [1,2], S. Goriely [3]

[1] CEA, DAM, DIF, F-91297 Arpajon, France

[2] Université Paris-Saclay, CEA, Laboratoire Matière sous Conditions Extrêmes, 91680 Bruyères-Le-Châtel, France

[2] Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, CP-226, 1050 Brussels, Belgium

While the ground state configuration is classically determined by the variational principle minimizing the binding energy of the system, some deviation are obtained for spin and parity assignment between Hartree-Fock-Bogolyubov (HFB) ground states and experimental measurements. Such difference can be attributed to the shortcomings of the actual interaction as well as to those of the method. In this context, we propose a procedure to identify the configuration of the ground state in odd-A and odd-odd nuclei. This procedure is based on the HFB framework with a self-consistent blocking of the unpaired nucleon and identifies the ground state as the blocked quasi-particle configuration compatible with the observed spin and parity and, most importantly, the measured magnetic moment.

First, we present the protocol focusing on magnetic moments for all odd Hg isotopes for which experimental data is available. To validate the method, a systematic comparison between the predicted and measured electric quadrupole moments and isotopic shifts is performed [1]. Second this protocol is applied to all odd and odd-odd nuclei for which magnetic momenta are given in Stone table [2]. Once the best candidate to reproduce the data has been selected, effective factors for the orbital and spin parts of the magnetic operator are adjusted in order to increase the identification procedure in forthcoming measurements. The values of this effective coefficient and their impact will be discussed. Third, the impact of ground state selection through the magnetic moment constrain will be illustrated in the context of the isotopic shift analysis for the bismuth isotopic chain [3].

To finish, some perspectives will be given for beyond-mean-field approaches and new generation of effective interaction.

[1] S. Péru, S. Hilaire, S.Goriely and M. Martini, Phys.Rev. C 104, 024328 (2021)

[2] N.J. Stone, Atomic Data and Nuclear Data Tables 90,75-176 (2005)

[3] A. Barzakh *et al.*, Phys. Rev. Lett. 127, 192501 (2011)

ID de résumé : **5**

Triple shape coexistence and beta decay of 96Y to 96Zr

Contenu

The effects of shape coexistence in ^{96}Y and ^{96}Zr on the β^- first-forbidden decay of the 0^- ground state and Gamow-Teller decay of the 8^+ isomer of ^{96}Y to ^{96}Zr were studied within the beyond-mean-field {\it complex} Excited Vampir model. The structure of the parent and daughter states and the β-decay properties have been investigated using an effective interaction derived from a G-matrix based on the charge-dependent Bonn CD potential and a large model space. The influence of shape coexistence and mixing on the properties of the states involved in the investigated allowed and first-forbidden β^- decays will be discussed and comparison to the available data will be presented. The comprehensive treatment of different identified characteristics includes the description of the significant E0 transitions between the lowest four 0^+ daughter states in ^{96}Zr, fingerprint of the predicted triple shape coexistence underlying their structure.

Auteur principal: PETROVICI, Alexandrina (IFIN-HH)

Orateur: PETROVICI, Alexandrina (IFIN-HH)

Déposé par **PETROVICI, Alexandrina** le **mardi 8 février 2022**

ID de résumé : **34**

Isomeric states around 208Pb

Contenu

208Pb is the heaviest known doubly-magic nucleus. Its neighbourhood is characterised by the presence of seniority isomers based on the high j orbitals νg9/2 (N>126) πh9/2 (Z>82) and πh11/2 (Z<80).
Deep-inelastic reactions provide large statistics data sets for nuclei close to 208Pb (.e.g. [1,2]). In contrast, the most neutron-rich nuclei studied so far in the region were populated in fragmentation reactions (see e.g. [3,4,5,6]). This latter method relies on the existence of isomeric states in order to separate the nuclei of interest. The status of our understanding of the nuclear structure, focused on the neutron-rich region and on isomeric states, will be presented.
[1] R. Broda et al., Phys. Rev. C 98, 024324 (2018).
[2] R. Broda et al., Phys. Rev. C 95, 064308 (2017).
[3] A. Gottardo et al., Phys. Rev. Lett. 109, 162502 (2012).
[4] J-J. Valiente-Dobon et al., Phys. Lett. B 816, 136183 (2021).
[5] S.J. Steer et al., Phys. Rev. C 84, 044313 (2011).
[6] A.I. Morales et al., Phys. Rev. Lett. 113, 022702 (2014).

Auteur principal: PODOLYAK, Zsolt (University of Surrey)

Orateur: PODOLYAK, Zsolt (University of Surrey)

Commentaires:

invited talk in the isomer session

Déposé par **PODOLYAK, Zsolt** le **lundi 4 avril 2022**

ID de résumé : **65**

Search for octupole deformation in A~225 Po-Fr nuclei

Contenu

In the landscape of nuclear shapes the occurrence of asymmetric pear-like nuclei has long been searched for. Evidence of static octupole deformation has been found only in selected regions of the nuclear chart (A$\sim$146 and A$\sim$222), where orbitals which differ by $\Delta j, \Delta l = 3$ approach the Fermi level for both protons and neutrons [1].
A$\sim$225 Rn-Th nuclei are expected to show the largest static octupole deformations, as highlighted both by recent experimental measurements and by theoretical calculations [2,3]. This region is characterised by a dearth of experimental information and very few direct measurements of E3 transitions were performed in recent years in ^{220}Rn, ^{224}Ra [4] and ^{228}Th [5], highlighting also a typical de-excitation pattern. Atoms where nuclei display static octupole deformation are an ideal playground for measurements of electric dipole moments (EDM) [6].
We performed an experiment at GSI-FAIR (Darmstadt, Germany) in April 2021 within the HISPEC-DESPEC collaboration experimental campaign, with the aim to search for evidence of octupole deformation in 220<A<230 Po-Fr nuclei via beta decay measurements. The primary ions were produced in in-flight fragmentation reactions, selected and identified using the FRagment Separator (FRS) [7] and implanted in the DEcay SPECtroscopy (DESPEC) station [8]. The DESPEC station is composed of a stack of Double Sided Silicon-Strip Detectors (DSSD) sandwiched between two plastic scintillator detectors and a hybrid γ-detection array consisting of HPGe and $LaBr_3$(Ce) detectors. The ions are let decay in the DSSDs and the internal structure of the daughter nuclei is studied with ion-beta-gamma correlations and fast timing techniques.
Recent results of the data analysis will be reported on.

[1] P. A. Butler, Phys. G: Nucl. Part. Phys., 43 (2016) 073002;
[2] L. M. Robledo and P. A. Butler, Phys. Rev. C, 88 (2013) 051302(R);
[3] S. Y. Xia et al., Phys. Rev. C, 96 (2017) 054303;
[4] L. P. Gaffney et al., Nature, 497 (2013) 199-204;
[5] M. M. R. Chishti et al., Nature Physics, 16 (2020) 853–856;
[6] T. E. Chupp, Rev. Mod. Phys., 91 (2019) 015001;
[7] H. Geissel et al., Nucl. Instrum. Methods Phys. Res. B, 70 (1992) 286;
[8] A. K. Mistry et al., Nucl. Instrum. Methods Phys. Res. A 1033 (2022) 166662;

Auteur principal: POLETTINI, Marta (University of Milano & INFN Milano)

Co-auteurs: BENZONI , G. (Istituto Nazionale di Fisica Nucleare, Sezione di Milano, Milano, Italy); PELLUMAJ, J. (Dipartimento di Fisica e Scienze della Terra, Università di Ferrara, Italy); VALIENTE-DOBÓN, J. J. (INFN, Laboratori Nazionali di Legnaro, Italy); ZHANG, G. (Dipartimento di Fisica e Astronomia, Università di Padova and INFN Padova, Italy); MENGONI, D. (Dipartimento di Fisica e Astronomia, Università di Padova and INFN Padova, Ital); PEREZ VIDAL, R. M. (INFN, Laboratori Nazionali di Legnaro, Italy); HUANG, Z. (Dipartimento di Fisica e Astronomia, Università di Padova and INFN Padova, Italy); HUBBARD, N. (Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany); ALBERS, H. M. (GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany); BRACCO, A. (Dipartimento di Fisica dell'Università degli Studi di Milano, Milano, Italy & Istituto Nazionale di Fisica Nucleare, Sezione di Milano, Milano, Italy)

Orateur: POLETTINI, Marta (University of Milano & INFN Milano)

Commentaires:

on behalf of the HISPEC-DESPEC collaboration for S460 experiment

Déposé par **POLETTINI, Marta** le **mercredi 4 mai 2022**

On the Stability of Superheavy Nuclei [1]

Krzysztof Pomorski,

Institute of Physics, Maria Curie-Skłodowska University, Lublin, Poland

Abstract:

Potential energy surfaces of even-even superheavy nuclei are evaluated within the macroscopic-microscopic approximation. A very rapidly converging analytical Fourier-type shape parametrization [2]) is used to describe nuclear shapes throughout the periodic table, including those of fissioning nuclei. The Lublin Strasbourg Drop [3]) and another effective liquid-drop type mass formula [4]) are used to determine the macroscopic part of nuclear energy. The Yukawa-folded single-particle potential, the Strutinsky shell-correction method, and the BCS approximation for including pairing correlations are used to obtain microscopic energy corrections. The evaluated nuclear binding energies, fission-barrier heights, and Q_α energies show a relatively good agreement with the experimental data. A simple one-dimensional WKB model à la Świątecki [5,6]) is used to estimate spontaneous fission lifetimes, while alpha- decay probabilities are obtained within a Gamow-type model [7,8]).

References:

1) 1. K. Pomorski, A. Dobrowolski, B. Nerlo-Pomorska, M. Warda, J. Bartel, Z.G. Xiao, Y.J. Chen, L.L. Liu, J.-L.Tian, and X.Y Diao, to be published in Eur. Phys. Journ. A.
2) K. Pomorski, B. Nerlo-Pomorska, J. Bartel, and C. Schmitt, Phys. Rev. C **97**, 034319 (2018).
3) K. Pomorski and J. Dudek, Phys. Rev. C **67**, 044316 (2003).
4) L. G. Moretto, P. T. Lake, L. Phair, and J. B. Elliott, Phys. Rev. C **86**, 021303(R) (2012).
5) W. J. Świątecki, Phys. Rev. **100,** 937 (1955).
6) K. Pomorski, A. Zdeb, M. Warda, Phys. Scr. C **90**, 114013 (2015).
7) G. Gamow, Z. Phys. **51**, 204 (1928).
8) A. Zdeb, M. Warda, and K. Pomorski, Phys. Rev. C **87**, 024308 (2013).

ID de résumé : **18**

Commissioning the Fast TIMing Array (FATIMA) at FAIR-0: Lifetimes of Excited states in the N=50 isotones 96Pd and 94Ru

Contenu

This abstract reports results of the first experiment of the DESPEC Phase-0 campaign at GSI, which focused on the study of neutron-deficient nuclei approaching 100Sn. These data provide the first extended commissioning experiment for the DESPEC collaboration within NuSTAR. We present results on electromagnetic transition rates associated with the decays from excited states populated following the formation of I⊠=8+ proton 'seniority-isomer' states in the N=50 isotones 94Ru and 96Pd. Direct half-life measurements via gamma-gamma coincidences using the FATIMA detector array consisting of 36 LaBr3(Ce) scintillators have determined the reduced matrix elements associated with decays between low-lying states in these semi-magic nuclei. The extracted half-lives for yrast spin/parity 6+ and 4+ states in 96Pd and the 6+ state in 94Ru are consistent with the published, highest-precision values for these nuclei.

Auteur principal: Prof. REGAN, PATRICK (University of Surrey & NPL, UK)

Co-auteurs: CEDERWALL, Bo (KTH Royal Institute of Technology); GORSKA, Magdalena (GSI Darmstadt); GERL, Jürgen (GSI); PODOLYAK, Zsolt (University of Surrey); BENZONI, giovanna (INFN); WERNER, Volker (TU Darmstadt)

Orateur: Prof. REGAN, PATRICK (University of Surrey & NPL, UK)

Commentaires:

For the DESPEC collaboration.

Déposé par **Prof. REGAN, PATRICK** le **lundi 21 mars 2022**

Contribution ID: **107** Type: **not specified**

Charge radii in nuclear DFT: developments and predictions (remote)

Tuesday, 31 May 2022 18:20 (20 minutes)

Precision measurements in exotic beam facilities deliver great amounts of new information on isotopic shifts of nuclear charge radii. The radii as such are usually well described by modern nuclear density functional theory (DFT) within their typical extrapolation uncertainty of 0.02 fm. However, trends of radii which are quantified by radius differences, as istopic shifts, or three point differences, as oddd-even staggerings, are much more sensitive observables and they reveal great differences in the performance of the various DFT functionals. Radius differences thus provide invaluable information for scrutinizing and further developing of nuclear DFT.
The talk addresses recent studies within the non-realtivistic Skyrme and Fayans functionals aiming at a better description of trends of charge radii. The tools are least-squares fits to ground state data extended by information on recently measured radius differences with subsequent statistical analysis to explore the sensitivity of the new data to the various aspects of a functional. The data call clearly for an improved description of pairing which is achieved by the Fayans pairing functional. The analysis also points to the need for further extensions of the functionals.

Co-author: NAZAREWICZ, , W. (Michigan State University,)

Presenter: REINHARD, Paul-Gerhard (Friedrich-Alexander-University,)

Session Classification: Session 8: Nuclear charge radii, staggering and shell effects, neutron skin

ID de résumé : **57**

Decay spectroscopy of 225Pa : Toward laser spectroscopy of neutron-deficient actinides

Contenu

The study of the structure of neutron-deficient actinides is of particular interest since several theoretical calculations predicts strong octupole deformation in this region of the nuclear chart [1, 2, 3]. In addition, this region includes ^{229}Th whose study of the low-lying isomeric state is of great interest [4]. However experimental data are scarce due to very low production rates.

There is an ongoing program at IGISOL, University of Jyväskylä, to study actinides isotopes, including a study of the production and decay spectroscopy of neutron-deficient actinides through proton-induced fusion-evaporation reactions on a ^{232}Th target. A successful experiment was performed in July 2020 where short-lived actinide isotopes were produced, mass separated and guided to a decay spectroscopy station. Using an experimental setup composed of Ge, Si and Si(Li) detectors, α, γ and conversion electrons decay spectroscopy of the selected nuclei can be performed to extract the decay schemes that are missing or incomplete in this region of the nuclear chart. First results of the analysis are promising and, in this presentation, I will show preliminary results focusing on the mass A=225 and in particular ^{225}Pa, for which very little decay information is available, as well as a preliminary level scheme for the daughter nucleus ^{221}Ac. A second goal of this experiment is to measure production yields in order to consider a laser spectroscopy program in the future. Indeed laser ionisation spectroscopy is well established as a powerful tool in nuclear structure studies [5]. It allows the measurement of spins, magnetic dipole moments, electric quadrupole moments and changes in the mean-square charge radii independently of nuclear models.

In the near future, the possibility to perform laser ionisation spectroscopy at S3-LEB of neutrondeficient actinides produced and selected by S3 will allow to continue this program towards nuclei further from stability. In particular the SEASON (Spectroscopy Electron Alpha in Silicon bOx couNter) detector will enable the coupling of two approaches : laser ionisation spectroscopy and decay spectroscopy. I will conclude my talk discussing perspectives offered by SEASON at S3-LEB.

References

[1] S.E. Agbemava, A.V. Afanasjev, Phys. Rev. C 96, 024301 (2017).

[2] S.E. Agbemava, A.V. Afanasjev and P. Ring, Phys. Rev. C 93, 044304 (2016).

[3] L.M. Robledo and R.R. Rodr´ıguez-Guzm´an, J. Phys. G: Nucl. Part. Phys. 39, 105103 (2012).

[4] L. von der Wense, B. Seiferle and P.G. Thirolf, Meas. Tech. 60, 1178-1192 (2019).

[5] P. Campbell, I.D. Moore and M.R. Pearson, Prog. Part. Nucl. Phys. 86, 127-180 (2016).

Auteur principal: M. REY-HERME, Emmanuel (CEA Saclay DPhN)

Co-auteurs: Prof. MOORE, Iain (Accelerator Laboratory, Department of Physics, University of Jyväskylä, Finland); VANDEBROUCK, Marine (CEA Saclay DPhN); Dr POHJALAINEN, Ilkka (Accelerator Laboratory, Department of Physics, University of Jyväskylä, Finland); M. RAGGIO, Andrea (Accelerator Laboratory, Department of Physics, University of Jyväskylä, Finland)

Orateur: M. REY-HERME, Emmanuel (CEA Saclay DPhN)

Déposé par **REY-HERME, Emmanuel** le **lundi 25 avril 2022**

Chirality and wobbling in ^{135}Pr

N. Sensharma,[1,2,3] U. Garg,[3] Q. B. Chen,[4] S. Frauendorf,[3] J. Arroyo,[3] A. D. Ayangeakaa,[1,2] D. P. Burdette,[3] M. P. Carpenter,[5] P. Copp,[5] J. L. Cozzi,[3] S. S. Ghugre,[6] D. J. Hartley,[7] K. B. Howard,[3] R. V. F. Janssens,[1,2] F. G. Kondev,[5] T. Lauritsen,[5] J. Li,[5] R. Palit,[8] R. Rathod,[3] D. Seweryniak,[5] S. Weyhmiller,[3] and J. Wu[5]

[1]*Department of Physics and Astronomy, University of North Carolina Chapel Hill, NC 27599, USA*
[2]*Triangle Universities Nuclear Laboratory, Duke University, Durham, NC 27708, USA*
[3]*Physics Department, University of Notre Dame, Notre Dame, IN 46556, USA*
[4]*Department of Physics, East China Normal University, Shanghai 200241, China*
[5]*Physics Division, Argonne National Laboratory, Argonne, IL 60439, USA*
[6]*UGC-DAE Consortium for Scientific Research, Kolkata 700 064, India*
[7]*Department of Physics, United States Naval Academy, Annapolis, MD 21402, USA*
[8]*Department of Nuclear and Atomic Physics, Tata Institute of Fundamental Research, Mumbai 400 005, India*

Chirality and wobbling are the two unique signatures that characterize the rare triaxial shapes in nuclei. While both these modes have been separately established in a few regions of the nuclear chart, the coexistence of chirality and wobbling in a nucleus has never been observed so far. Using a high statistics Gammasphere experiment with the ^{123}Sb(^{16}O,4n)^{135}Pr reaction, the very first observation of co-existing chiral and wobbling modes in ^{135}Pr has been made. In addition to the previously established n_ω = 1 and n_ω = 2 wobbling bands, two chiral-partner bands with the configuration $\pi(1h_{11/2})^1 \otimes \nu(1h_{11/2})^{-2}$ have been observed in this nucleus. Angular distribution analyses of the ΔI = 1 connecting transitions between the two chiral partners have revealed strong quadrupole mixing. Particle Rotor Model calculations have been found to be in good agreement with the experiment.

This work has been supported by the U.S. National Science Foundation [Grant No. PHY-1713857].

ID de résumé : **47**

Spectroscopy of Deformed Trans-fermium Nuclei using the Argonne Gas-Filled Analyzer

Contenu

Nuclei near the closed Z=100, N=152 deformed shells are prolate deformed but higher order shapes play important role for their structure, e.g. β_6 is critical for creating the N=152 energy gap. In-beam, K-isomer, α-decay and spontaneous fission spectroscopy of trans-fermium nuclei provide a stringent test of nuclear models which are used to describe the heaviest known nuclei. To extend these studies to heavier, more proton-rich, odd-A, odd-odd nuclei, the Argonne Gas-filled Fragment Analyzer (AGFA) was constructed. During the talk, recent decay and isomer spectroscopy experiments with AGFA in stand-alone mode and in-beam spectroscopy experiments with AGFA coupled to Gammasphere will be reviewed. Among others, the high statistics prompt and delayed γ-ray spectroscopy of the benchmark nucleus ^{254}No, the observation of the ground-state rotational band in the fissile nucleus ^{254}Rf, and the discovery of the new isotope ^{251}Lr will be presented. The impact of these results on shape evolution in this region will be discussed. Plans for experimental program with AGFA will be also presented.

This material is based upon work supported by the U.S Department of Energy, Office of Science, Office of Nuclear Physics, under contract number DE-AC02-06CH11357. This research used resources of ANL's ATLAS facility, which is a DOE Office of Science User Facility.

Auteur principal: SEWERYNIAK, Dariusz (Argonne National Laboratory)

Orateur: SEWERYNIAK, Dariusz (Argonne National Laboratory)

Déposé par **SEWERYNIAK, Dariusz** le **lundi 11 avril 2022**

Triaxial Deformation in Atomic Nuclei

Javid A. Sheikh
Department of Physics, University of Kashmir, India

Abstract

It is shown using the triaxial projected shell (TPSM) approach that γ bands observed in atomic nuclei contain important clues on the nature of the triaxial deformation in atomic nuclei. This will be demonstrated using both energy and electromagnetic properties of the γ bands. Further, it is noted that inclusion of the quasiparticle excitations in the TPSM approach inverts the staggering phase for all the 23 nuclei studied, except for the four nuclei of ^{76}Ge, ^{112}Ru, ^{170}Er and ^{232}Th.

Contribution ID: **156** Type: **not specified**

Beta-decay spectroscopy of exotic nuclei around ^{132}Sn

Nuclei around ^{132}Sn play a significant role in nuclear structure and nuclear astrophysics, their nuclear structure properties, like mass, half life, Pn & P2n values, are essential to reproduce the r-process abundances and to understand the origin of the elements in the universe [1-2]. The three valence protons and two neutrons of ^{137}I could polarize the ^{132}Sn core and lead to collective motion. The three valence protons in the Iodines is also regarded as a cluster to explain some features of these nuclei [3]. It is different from both the semi-magic character of the Sn isotopes and the well-developed quadrupole and octupole deformations appearing in the Xe and Ba isotopes [4-5]. Little information is known previously. In this work we investigated the exotic neutron-rich ^{137}I by the beta-decay of ^{137}Te. The study is performed at the ILL by the ^{235}U(n,f) reaction. The experimental information is largely expanded and the Pn channel is also investigated. The new data results are compared to the predictions of Large Scale Shell Model calculations, providing a set of forbidden transitions appearing at the immediate proximity of the doubly-magic ^{132}Sn.

[1] J. Wu et al., Phys. Rev. C 101, 042801(R) (2020)

[2] M. Mumpower et al., J. Phys. G: Nucl. Part. Phys. 42, 034027 (2015)

[3] JG,V,Berghe et al., Z.Phys.266.139(1974)

[4] G. S. Simpson et al., Phys. Rev. Lett. 113, 132502 (2014)

[5] http://www.nndc.bnl.gov.

Presenter: SI , Min (IJC lab, Université Paris-Saclay)

ID de résumé : **9**

A new α-decay branch in ^{179}Hg

Contenu

Alpha decay is long known to be a powerful probe to study exotic nuclei far from β-stability line. Moreover, the α-decay fine structure, discovered by Rosenblum in 1929 [1], allows to study properties of low-lying excited states in these nuclei, that are difficult to populate due to low reaction cross-sections.
The results of our experiment performed at JYFL Finland will be discussed. Particularly, the α-decay fine structure of ^{179}Hg has been investigated. A new α-decay branch populating the (9/2$^-$) excited state at an energy of 131 keV in ^{175}Pt has been identified. This state is a member of the negative-parity band built on top of the (7/2$^-$) ground state of ^{175}Pt. The conversion coefficient for the 131 keV transition has been measured experimentally for the first time, confirming the assumptions made in [2]. Considering the newly observed α-decay branch in ^{179}Hg, its characterization by means of δ^2 and HF, and comparison to neighbouring isotones will be given.

[1] S. Rosenblum, C. R. Acad. Sci. Paris **188**, 1401 (1929).

[2] P. Peura *et al.*, Phys. rev. C **89**, 024316 (2014).

Auteur principal: ŠPAČEK, Andrej (Institute of Physics, Slovak Academy of Sciences)

Orateur: ŠPAČEK, Andrej (Institute of Physics, Slovak Academy of Sciences)

Commentaires:

On behalf of the S17 collaboration.

Déposé par **ŠPAČEK, Andrej** le **mardi 1 mars 2022**

Contribution ID: **79** Type: **not specified**

Spectroscopy of the deformed ^{249,251}Md

Monday, 30 May 2022 14:40 (20 minutes)

Despite significant and steady advances in the synthesis of the heaviest elements, reaching the predicted superheavy island of stability is still a distant objective, because of the ever-decreasing cross sections. Nevertheless, nuclear spectroscopy, mass measurements, and laser spectroscopy of the heaviest nuclei have shown their effectiveness by providing information on the quantum nature of extreme mass nuclei. In this context, deformed midshell nuclei near N=152, Z=100, are of great relevance: a large diversity of orbitals are accessible, some of which being involved in the structure of heavier spherical nuclei, i.e., placed just above and below the predicted superheavy spherical shell gaps.

In a series of experiments performed at the University of Jyväskylä, we have studied different facets of the odd-Z ^{249}Md and ^{251}Md isotopes. ^{251}Md was studied using combined gamma ray and conversion-electron in-beam spectroscopy [1]. Besides the previously known K=1/2$^-$ rotational band [2], a new band has been observed. Using the gamma and electron intensities that depend on the gyromagnetic factor, the ground-state configuration could be inferred. We will also present a new method that allows to derive the gyromagnetic factor using the gamma-ray intensity profile. A comparison of ^{251}Md with the ^{255}Lr nucleus [3] revealed unexpected similarities between transition energies. Skyrme-Hartree-Fock-Bogoliubov calculations were performed to investigate the origin of these similarities.

If time permits, we will discuss new isomers observed in ^{249,251}Md using decay spectroscopy, interpreted as high-K 3qp configurations [4]. These data were compared to new theoretical calculations using two scenarios: via blocking nuclear states located in proximity to the Fermi surface or/and using the quasiparticle Bardeen–Cooper–Schrieffer method.

[1] R. Briselet, Ch. Theisen , B. Sulignano et al., Phys. Rev. C 102 (2020) 014307.
[2] A. Chatillon, C. Theisen et al., Phys. Rev. Lett. 98 (2007) 132503.
[3] S. Ketelhut, P. T. Greenlees et al., Phys. Rev. Lett. 102 (2009) 212501.
[4] T. Goigoux, Ch. Theisen, B. Sulignano et al., Eur. Phys. J. A 57 (2021) 57.

Presenter: THEISEN, Christoph (CEA Saclay, France)

Session Classification: Session 3: Spectroscopy of heavy and super-heavy nuclei

ID de résumé : **35**

Recent advances in the in-medium similarity renormalization group

Contenu

The *ab initio* description of nuclear systems has undergone a major renewal due to the use of low-resolution interaction derived from chiral effective field theory in conjunction with many-body techniques admitting for mild computational scaling [1]. Nowadays many-body practitioners are able to target systems with up to one hundred interacting particles from first principles in a systematically controllable way [2]. In this talk I will cover recent developments in the non-perturbative in-medium similarity renormalization group (IMSRG) approach that eventually pave the way for scalable yet accurate predictions of many-body observables in atomic nuclei.

[1] H. Hergert, Front. Phys. 8, 379 (2020).
[2] T. Morris *et al.*, Phys. Rev. Lett. 120, 152503 (2018)

Auteur principal: Dr TICHAI, Alexander (TU Darmstadt)

Orateur: Dr TICHAI, Alexander (TU Darmstadt)

Déposé par **Dr TICHAI, Alexander** le **lundi 4 avril 2022**

Contribution ID: **32** Type: **not specified**

Beta- decay of very exotic P, S and Cl isotopes near N=28 with T_z from 5.5 to 7

Phosphorus, Sulphur and Chlorine isotopes with neutron number around 28 belong to a region of deformation and sudden changes in shape, mainly because of the quenching of the $N = 28$ shell gap. The reduced spacing of the $f_{7/2}$ and $p_{3/2}$ orbitals also affects the beta decay properties, like half life, beta-delayed neutron emission and Gamow Teller (GT) strength distributions.
To investigate the structure evolution in these very neutron rich nuclei, beta decay of $^{42-44}$P, $^{43-46}$S and $^{45-47}$Cl was studied following the fragmentation of ^{48}Ca (140MeV/u) at the National Superconducting Cyclotron Laboratory using the Si DSSD implant detector coupled to a clover array for detecting implants, decay events and beta-delayed gamma rays. Half-life and new level schemes have been obtained for the daughter nuclei in all cases.
A systematic analysis also reveals sudden jumps in the beta delayed neutron emission probability (P_n), for example, the P_n for ^{42}P is less than 50% but for ^{43}P we find it to be 100% but not so for ^{44}P ($T_z = 7$). These changes are not just because of the lowering of the neutron separation energy (S_n) in the more exotic isotopes but also due to moving of the GT strength distribution to higher energies. Details of the analysis and new results will be discussed in the context of state of art shell model calculations.

This work is supported by the U.S. National Science Foundation under Grant No. PHY-2012522 (FSU).

Primary author: TRIPATHI, Vandana (Florida State University)

Co-authors: BHATTACHARYA, S. (Department of Physics, Florida State University, Tallahassee, 32306 Florida USA); CHOUDHARY, D. (Department of Physics, Florida State University, Tallahasse, 32306 Florida USA); SONG, W. (Department of Physics, Florida State University, Tallahassee, 32306 Florida USA); RUBINO, E. (Department of Physics, Florida State University, Tallahassee, 32306 Florida USA); BENETTI, C. (Department of Physics, Florida State University, Tallahassee, 32306 Florida USA); PERELLO, J. (Department of Physics, Florida State University, Tallahassee, 32306 Florida USA); TABOR, S.L. (Department of Physics, Florida State University, Tallahasse, 32306 Florida USA); UTSUNO, Yutaka (Advanced Science Research Center, Japan Atomic Energy Agency, Tokai, Ibaraki 319-1195, Japan); SHIMIZU, N. (Center for Nuclear Study, University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan); ZHU, Yiyi (Department of Physics and Applied Physics, University of Massachusetts Lowell, Lowell 01854 Massachusetts USA); BENDER, P.C. (Department of Physics and Applied Physics, University of Massachusetts Lowell, Lowell 01854 Massachusetts USA); SAHA, S. (Department of Physics and Applied Physics, University of Massachusetts Lowell, Lowell 01854 Massachusetts USA); LIDDICK, S.N. (Department of Chemistry, Michigan State University , East Lansing 48824 Michigan USA & National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing 48824 Michigan USA); RICHARD, A. (Department of Chemistry, Michigan State University , East Lansing 48824 Michigan USA & National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing 48824 Michigan USA); CHESTOR, A. (Department of Chemistry, Michigan State University , East Lansing 48824 Michigan USA & National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing 48824 Michigan USA); CHILDER, K. (Department of Chemistry, Michigan State University , East Lansing 48824 Michigan USA & National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing 48824 Michigan USA); CRIDER, B.P. (Department of Physics & Astronomy, Mississippi State University, Starkville 39762 Mississippi USA); OGUNBEKU, T. H. (Department of Physics & Astronomy, Mississippi State University, Starkville 39762 Mississippi USA); CARROLL, J.J. (DEVCOM/Army Research Laboratory, Adelphi 20783 Maryland USA); CHIARA, C. (DEVCOM/Army Research Laboratory, Adelphi 20783 Maryland USA); HARKE, J. T. (Lawrence Livermore National Laboratory, Livermore 94550 California USA)

Presenter: TRIPATHI, Vandana (Florida State University)

Recent isomer studies using MARA recoil separator at JYFL-ACCLAB

Juha Uusitalo and Andrew Briscoe
Nuclear Spectroscopy Group
University of Jyväskylä

The Nuclear Spectroscopy Group (NSG) at JYFL-ACCLAB is employing two complementary in-flight separators in their spectroscopic studies. Recoil Ion Transport Unit (RITU) [1] is a gas-filled recoil separator and has been in operation for almost 30 years. Mass Analyzing Recoil Apparatus (MARA) [2], is a vacuum-mode double focusing mass separator, has been in use for about five years. As said separators are complementary and allow us to perform spectroscopic studies at and beyond the proton-drip line and in the Very Heavy Element (VHE) region starting from mass A = 40 onward. Separators can be occupied with detector setups at the target position and at the focal plane. At the target position particle array JYtube as well as a Ge-array, JUROGAM, are used. Focal planes consist of gas counters, silicon detectors, and Ge detectors. This allows simultaneous prompt and delayed spectroscopy to be performed. Recoil separators combined with various auxiliary detector arrays has allowed new spectroscopic information to be dug out. In this presentation recent new isomer studies using MARA recoil separator will be presented.

[1] J. Sarén, J. Uusitalo, M. Leino, and J. Sorri, Nucl. Instr. Meth. Phys. Res. A 654, 508 (2011).

[2] J. Uusitalo, J. Sarén, J. Partanen, and J. Hilton, Acta Physica Polonica B 50, 319 (2019).

ID de résumé : **63**

Nuclear structure investigations of even-even Hf isotopes

Contenu

The medium–to-heavy mass Hafnium ($_{72}$Hf) isotopes, located in the rare–earth mass region of the nuclear chart, are known to be well deformed nuclei, which can be populated to very high values of spin. Spectroscopic information becomes significantly scarcer with increasing neutron number, impeding our understanding of the nuclear structure in this mass region, where interesting phenomena, such as shape coexistence, have been predicted. In this work we study the energy levels, β_2 deformation parameters, $B(E2; 0_1^+ \rightarrow 2_1^+)$ reduced transition matrix elements, intrinsic and transition electric quadrupole moments Q_0 and Q, respectively, for the even–even $^{162-184}$Hf isotopes. Seven different models are employed for the calculations: 1) the Phenomenological model, 2) the Finite Range Droplet Model (FRDM), 3) the Hartree–Fock BCS model with MSk7 force, 4) the Hartree–Fock–Bogoliubov model with the Gogny D1S interaction, 5) the Universal Nuclear Energy Density Functional–1 (UNEDF–1), and 6) the Covariant Energy Density Functional NL3*. This newly acquired information can serve as a guide for current and future experimental endeavors in the exploration of the neutron–rich Hf isotopic chain of the rare–earth mass region. Among such endeavors is the recent experiment focused in the study of nuclear structure of ^{180}Hf, through lifetime measurements employing the plunger technique, carried out at IFIN–HH, Romania. Along these lines the results for the $^{162-180}$Hf are compared with the existing experimental data. An overall good agreement is found between the available adopted data and the theoretical predictions.

Auteur principal: M. VASILEIOU, Polytimos (National and Kapodistrian University of Athens)

Co-auteurs: Prof. MERTZIMEKIS, Theo J. (National and Kapodistrian University of Athens); Mlle ZYRILIOU, Aikaterini (National and Kapodistrian University of Athens); Prof. MAVROMMATIS, Eirini (National and Kapodistrian University of Athens); M. PELONIS, Stefanos (National and Kapodistrian University of Athens); Prof. BONATSOS, Dennis (INPP, NCSR "Demokritos"); Dr KARAKATSANIS, Konstantinos E. (INPP, NCSR "Demokritos"); Dr MARTINOU, Andriana (INPP, NCSR "Demokritos"); M. PEROULIS, Spyros K. (INPP, NCSR "Demokritos"); Dr CHALIL, Achment (IRFU, CEA, Université Paris-Saclay); Dr MARGINEAN, Nicolae (Horia Hulubei National Institute of Physics and Nuclear Engineering – IFIN–HH); Dr MIHAI, Constantin (Horia Hulubei National Institute of Physics and Nuclear Engineering – IFIN–HH); Dr FLOREA, Nikoleta (Horia Hulubei National Institute of Physics and Nuclear Engineering – IFIN–HH); Dr NITA, Christina (Horia Hulubei National Institute of Physics and Nuclear Engineering – IFIN–HH); Dr TURTURICA, Andrei (Horia Hulubei National Institute of Physics and Nuclear Engineering – IFIN–HH)

Orateur: M. VASILEIOU, Polytimos (National and Kapodistrian University of Athens)

Commentaires:

This research work was supported by the Hellenic Foundation for Research and Innovation (HFRI) under the HFRI PhD Fellowship grant (Fellowship Number: 101742/2019) for AZ. All the authors are grateful to the ROSPHERE and SORCERER collaboration for providing the equipment used for the measurements presented in this work.

Déposé par **VASILEIOU, Polytimos** le **mercredi 4 mai 2022**

Contribution ID: **92** Type: **not specified**

Nuclear Structure and Possible E0 transitions in ^{179}Au

Tuesday, 31 May 2022 10:15 (20 minutes)

Very neutron-deficient isotopes were studied by means of in-beam gamma-ray spectroscopy, beta-decay spectroscopy, alpha-decay spectroscopy and isomeric-decay spectroscopy. The experiments were performed at ISOLDE and at cyclotron laboratory of the University of Jyväskylä. Unprecented rotational bands, based on $1h_{11/2}$ proton-hole configurations, coupled with intruder 0^+ states in even-even Hg cores, were identified in ^{177,179}Au. Their band-heads de-excite with transitions that might have significant E0 components, although they were not unambiguously identified. In addition to that, in ^{179}Au, two coexisting 9/2 states connected with transition with possible E0 component were identified. They are based on coupling of $1h_{9/2}$ proton-intruder configurations with two 0^+ states in the ^{180}Hg core.

Presenter: VENHART, Martin (Institute of Physics, Bratislava, Slovakia)

Session Classification: Session 5: The status of E0 transitions

ID de résumé : **46**

Tilted Precession Bands in 133Ce and 131Ba

Contenu

Most nuclei that exist in nature have deformed nuclear shapes. In the A = 130 mass region, nuclei are predicted to show triaxial nuclear shapes at low spins and therefore provide a rich testing ground for nuclear structure theories. Triaxial nuclei have unequal nuclear matter distribution along the three principle nuclear axes. Unlike axially symmetric nuclei, triaxial nuclei can rotate around all three nuclear axes simultaneously which gives rise to 3D Tilted Precession (TiP) bands [1, 2].

Here results from two experiments are presented. The first experiment was carried out in 2019 using the AFRODITE array at iThemba LABS. A new excited rotational band based on the neutron orbital in 133Ce was discovered. Quasiparticle-plus-Triaxial Rot (QTR)or model calculations suggest that the new band has the same intrinsic configuration as the yrast band, but different rotational angular momentum. In general, the bands correspond to a gradual re-alignment of the angular momentum of the valence neutron towards the intermediate axis as the spin increases. Experimental observables including the signature splitting, the excitation energies, the mixing ratios, and the transitional probability ratios of the new band in 133Ce are compared the QTR model and an interpretation of the band as a TiP band is proposed.

The data set from the iThemba LABS experiment also revealed a new positive-parity rotational band based on the neutron orbital in 133Ce. The second experiment, aiming at study of 131Ba , was carried out at the XTU Tandem accelerator of Laborotori Nazionali di Legnaro, Italy. This experiment revealed a new positive-parity rotational band based on the neutron orbital. The Nilsson configuration was assigned to both bands in 133Ce and 131Ba. A comparison of the experimentally observed signature splitting and excitation energies with theoretical calculations using the QTR model revealed that an interplay between the effects of triaxiality and the Coriolis associated with single particle s1/2 contributions. This interplay determines the features of the observed bands in 133Ce and 131Ba [3, 4].

1. E. A. Lawrie, O. Shirinda, and C. M. Petrache, Tilted Precession and Wobbling in Triaxial Nuclei," Phys. Rev. C, vol. 101, p. 034306, Mar 2020. [Online]. Available: https://link.aps.org/doi/10.1103/PhysRevC.101.034306
2. B. F. Lv, C. M. Petrache, E. A. Lawrie, et al. , "Tilted Precession Bands in 135Nd," Phys. Rev. C, vol. 103, p. 044308, Apr 2021. [Online]. Available: https://link.aps.org/doi/10.1103/PhysRevC.103.044308
3. B. Ding, C. M. Petrache, S. Guo, E. A. Lawrie, I. Wakudyanaye, et al., Phys. Rev. C, vol. 104, p. 064304, Dec 2021. https://link.aps.org/doi/10.1103/PhysRevC.104.064304
4. I. Wakudyanaye, "Triaxiality and Rotational Bands in 133Ce", MSc. Thesis, University of the Western Cape, 2021. https://etd.uwc.ac.za/handle/11394/8922

Auteur principal: WAKUDYANAYE, Ignasio (University of the Western Cape, iThemba LABS)

Orateur: WAKUDYANAYE, Ignasio (University of the Western Cape, iThemba LABS)

Déposé par **WAKUDYANAYE, Ignasio** le **lundi 11 avril 2022**

Contribution ID: **77**

Type: **not specified**

Exploring the extremes of nuclear deformation in Denmark and elsewhere

Monday, 30 May 2022 12:30 (30 minutes)

Two of the most admirable traits of Bent Herskind were his intense curiosity and his lively imagination which were particularly evident when applied to the search for new physics and the development of new analysis techniques. In this presentation I will give an overview on the research carried out at the Niels Bohr Institute into extreme nuclear deformations (superdeformation, hyperdeformation, Jacobi shapes, etc.) and present some of the important discoveries made by Bent and his collaborators. Finally, I will present some of my own personal thoughts on what promising directions could be explored in the future to continue this important work.

Presenter: WILSON, Jon (IJClab Orsay, France)

Session Classification: Sesion 2: The science and impact of Bent Herskind (1931 - 2021)

ID de résumé : **39**

Shape coexistence and E0 transitions in neutron-deficient Hg isotopes studied through Coulomb excitation

Contenu

The neutron-deficient mercury isotopes around mid-shell point for neutrons (N=104) represent one of the most prominent examples of shape coexistence known so far [1]. This region has been extensively studied using various experimental techniques, such as laser spectroscopy [2,3], decay spectroscopy studies [4,5], lifetime measurements [10-12] and Coulomb excitations [6,7]. These studies point to the coexistence of two classes of states with strong mixing between the low-lying members at Hg-182,184 [1,5-7,12]. Especially, the presence of strong E0 components in the I→I(I≠0) transitions is interpreted as a fingerprint for mixing [1].

In order to probe the properties of yrast and non-yrast states of the exotic even-even $^{182-188}$Hg isotopes Coulomb excitation experiments were performed at REX-ISOLDE facility at CERN. Reduced E2 matrix elements coupling lowest-lying states in the mercury isotopes were extracted for the first time, including their relative signs. These are a sensitive probe of shape coexistence and may be used to validate various nuclear models. Moreover, the analysis of the intense K X-ray peaks measured for ^{182,184}Hg revealed that the $2^+_2 \rightarrow 2^+_1$ transitions are strongly converted yielding prominent E0 transitions. This observation was supported by the large relevant conversion coefficients inferred from the β^+/EC decay of ^{182,184}Tl [5,9].

In the presentation the experimental results will be shown and discussed in terms of mixing of two different configurations along with the comparison with various theoretical model predictions: the Beyond Mean Field model, the Interacting Boson Model with configuration mixing and the General Bohr Hamiltonian [7].

A detailed studies on shape coexistence in the neutron deficient Hg isotopes will be continued using higher beam energies at HIE-ISOLDE. In view of the most recent experimental and theoretical achievements obtained in the scope of the Hg charge radii measurements [2,3] the Coulomb excitation studies will be for the first time performed for the odd-mass ^{185}Hg. These measurements will benefit from: (i) the use of the electron spectrometer SPEDE [8] which will provide direct information on intensities of conversion electrons; (ii) recently performed measurements of the β^+/EC decay of $^{182;184;186}$Tl with the ISOLDE Decay Station (IDS) which yielding precise, complementary spectroscopic data in the Hg isotopes [9]. An overview of the future Coulomb excitation campaign in the neutron deficient Hg-Pb region at HIE-ISOLDE will be given.

[1] K. Heyde, J.L. Wood, Rev. Mod. Phys83, 1467 (2011).
[2] B.A. Marsh et al., Nature Physics 14, 1163 (2018).
[3] S. Sels et al., Phys. Rev. C 99, 044306 (2019).
[4] J. Wauterset al., Phys. Rev. C 50, 2768 (1994).
[5] E. Rapisarda et al., J. Phys. G 44, 074001 (2017).
[6] N. Bree et al., Phys. Rev. Lett112, 162701 (2014).
[7] K. Wrzosek-Lipskaet al.,Eur. Phys. J. A 55, 130 (2019).
[8] P. Papadakis et al., Eur. Phys. J. A 54, 42 (2018).
[9] M. Stryjczyk, PhD thesis KU Leuven '' Shape coexistence in the nickel (Z=28) and mercury (Z=80) regions probed through decay studies''
[10] T. Grahn, et al., Phys. Rev. C 80, 014324 (2009).
[11] M. Scheck, et al., Phys. Rev. C 81, 014310 (2010).
[12] L. P. Gaffney, et al., Phys. Rev. C 89, 024307 (2014).

Auteur principal: WRZOSEK-LIPSKA, Katarzyna

Orateur: WRZOSEK-LIPSKA, Katarzyna

Commentaires:

on behalf of the IS452 and IS563 collaborations

Déposé par **WRZOSEK-LIPSKA, Katarzyna** le **lundi 4 avril 2022**

Contribution ID: **150** Type: **not specified**

Rotational excitations in rare- earth nuclei: a comparative study within different cranking models (remote)

Friday, 3 June 2022 16:35 (20 minutes)

High-spin rotational bands in rare-earth Er, Tm and Yb isotopes are investigated by (1) the cranked relativistic Hartree Bogoliubov approach with Lipkin-Nogami method, (2) the cranking covariant density functional theory with pairing correlations treated by a shell-model-like approach or the so called particle-number conserving (PNC) method, and (3) cranked shell model (CSM) with pairing correlations treated by the PNC method. A detailed comparison between these three models in the description of the ground state bands of even-even Er and Yb isotopes is performed. The similarities and differences between these models in the description of the moments of inertia, the band crossings, equilibrium deformations and pairing energies of even-even nuclei under study are discussed. On average, a comparable accuracy of the description of available experimental data is achieved in these models.
However, the differences between model predictions become larger above the first band crossings. Because of time consuming nature of the two CDFT-based models, systematic study of the rotational properties of both ground state and excited state bands in odd-mass Tm nuclei is carried out only by the PNC-SCM. With few exceptions, the rotational properties of experimental 1-quasiparticle and 3-quasiparticle bands in ^{165,167,169,171}Tm are reproduced reasonably well.

Presenter: ZHANG, Zhenhua (North China Electric Power University, China)

Session Classification: Session 18: Shapes, cranking models and best posters presentations

Contribution ID: **100** Type: **not specified**

How do triaxial nuclei rotate chirally? (remote)

Tuesday, 31 May 2022 15:05 (20 minutes)

Chirality is a well-known phenomenon in many fields, such as chemistry, biology, molecular physics, and particle physics. The study of nuclear chirality has attracted a lot of attention since it was originally suggested for triaxial nuclei in 1997 [1]. The experimental evidence of nuclear chirality is the so-called chiral doublet bands, which have been observed in many nuclei. Theoretically, there have been many approaches employed to study the chiral nuclei including the phenomenological approaches and the microscopic ones [2].
In a series of our recent works [3,4,5,6], we have developed the three-dimensional cranking relativistic density functional theory to study the chirality in triaxial nuclei. In particular, by overcoming the variational collapse and the fermion doubling problem, relativistic density functional theory has been solved in three-dimensional lattice space, and the corresponding time-dependent relativistic density functional theory has been established. It allows a unified description of the static and dynamic properties of nuclei without assuming any spatial symmetry restrictions. In this talk, I will review recent progress in the development of time-dependent relativistic density functional theory in space lattice and its application for the chiral structure and dynamics in triaxial nuclei.

[1] S. Frauendorf and J. Meng, Nucl. Phys. A 617, 131 (1997).
[2] S. Frauendorf, Rev. Mod. Phys. 73, 463 (2001).
[3] P. W. Zhao, Phys. Lett. B 773, 1 (2017).
[4] P. W. Zhao, Y. K. Wang, and Q. B. Chen, Phys. Rev. C 99, 054319 (2019).
[5] Z. X. Ren, P. W. Zhao, J. Meng, Phys. Lett. B 801, 135194 (2020).
[6] Z. X. Ren, P. W. Zhao, J. Meng, Phys. Rev. C 105, L011301 (2022).

Presenter: ZHAO, Pengwei (Peking University,)

Session Classification: Session 7: Wobbling and chirality in nuclei

Contribution ID: **51** Type: **not specified**

Evidence of oblate-prolate shape coexistence in the strongly-deformed nucleus 119Cs

Three new bands and several low-lying levels have been identified in ^{119}Cs from an experiment performed with JUROGAM 3 + MARA setup. One of the four reported bands, built on a $11/2^-$ state at 670 keV, consists of nearly degenerate signature partners, and has properties which unequivocally indicate the strongly-coupled $\pi h_{11/2}[505]11/2^-$ configuration associated with oblate shape. Together with the decoupled $\pi h_{11/2}[541]3/2^-$ band built on the $11/2^-$ prolate state at 110 keV, for which a half-life of $T_{1/2}$ = 55(5) μs has been measured, the new bands bring evidence of shape coexistence at low spin in the proton-rich strongly deformed A $\sim$ 120 nuclei, a phenomenon predicted since long time, but not yet observed. Calculations using the particle-number conserving cranked shell model and two dimensional tilted axis cranking covariant density functional theory support and well reproduce the observed oblate and prolate coexisting low-energy states in ^{119}Cs. Prolate-oblate shape coexistence close to the ground state in the strongly-deformed proton-rich A $\sim$ 120 nuclei is reported for the first time.

Primary authors: Prof. PETRACHE, Costel (University Paris-Saclay); Ms ZHENG, Kuankuan (Institute of Madern Physics, Chinese Academy of Sciences)

Presenter: Ms ZHENG, Kuankuan (Institute of Madern Physics, Chinese Academy of Sciences)

Contribution ID: **52** Type: **not specified**

Candidate revolving chiral doublet bands in 119Cs

Two rotational bands are identified in ^{119}Cs from an experiment performed with JUROGAM 3 + MARA setup, one of which having very similar pattern to that of the strongly-coupled $\pi g_{9/2}$[404]9/2$^+$ band. The properties of the bands with similar patterns extracted from the experimental data are in agreement with a chiral interpretation. Tilted axis cranking covariant density functional theory with pairing correlations and particle number conserving cranked shell model calculations are employed to determine the deformation and to investigate the band configurations, respectively. It results that the backbending is induced by the rotational alignment of two $h_{11/2}$ protons, whose angular momenta reorient from the short to the intermediate axis, in a plane orthogonal to the angular momentum of the strongly coupled $g_{9/2}$ proton which keeps aligned along the long axis. The total spin points in 3D, inducing the breaking of the chiral symmetry. The bands are observed in the transient backbending regime, showing that the chirality in nuclei is a general phenomenon, being robust and present not only in nuclei with nearly maximal triaxiality and pure configurations, but also in nuclei with moderate triaxiality and mixed configurations which gradually evolve from one to three-quasiparticle configurations, like in the backbending region. This is the first observation of candidate chiral bands built on a configuration with three protons in the backbending regime, one in the strongly coupled [404]9/2$^+$ orbital which does not change orientation with increasing rotational frequency, and two in the $h_{11/2}$ orbital which reorients to the rotation axis. We call this new type of chiral bands Revolving Chiral Doublet (RχD) bands.

Primary authors: Prof. PETRACHE, Costel (University Paris-Saclay); Ms ZHENG, Kuankuan (Institute of Madern Physics, Chinese Academy of Sciences)

Presenter: Ms ZHENG, Kuankuan (Institute of Madern Physics, Chinese Academy of Sciences)

ID de résumé : **55**

Low-spin structures in T_z = 0, ^{70}Br and T_z=-1 ^{70}Kr

Contenu

The study of nuclei close to the N=Z line provides information about the nuclear force's charge symmetry and independence: Charge symmetry ($V_{pp} \approx V_{nn}$) can be studied through the investigation of mirror energy differences (MED) between the isobaric analogue states in mirror nuclei, which have interchanged proton and neutron numbers. Information on charge independence ($(V_{pp} + V_{nn})/2 = V_{pn}$) can be obtained from the investigation of triplet energy differences (TED) in isobaric triplets. These investigations have proven to be difficult since experimental data on the T=1 states for the N=Z nuclei in the A=60-80 mass region are scarce. The same is also true for the N=Z-2 members of the isobaric triplets. An experiment was recently performed at the Accelerator Laboratory of the University of Jyväskylä, aiming to study the low-spin structures of of N=Z, T_z=0, ^{70}Br and N=Z-2, T_z=-1 ^{70}Kr. The fusion-evaporation reaction ^{40}Ca(^{32}S, pn/2n)^{70}Br/^{70}Kr was employed at beam energies of 103, 96, and 92 MeV. The experiment was carried out using by the Jurogam 3 γ-ray spectrometer in conjunction with the Mass Analysing Recoil Apparatus (MARA) and other auxiliary detector systems. The Fermi super-allowed beta emitters ^{70}Br and ^{70}Kr, with characteristic high beta-decay endpoint energies and short half-lives of 80 ms and 40 ms, respectively, allowed for applying the recoil-β-β tagging methods to identify γ rays originating from these nuclei. Previously, ^{70}Br and ^{70}Kr were studied in four different experiments [1,2,3,4]; however, there are discrepancies in the reported low-spin structures. Thus, this study was aimed to rigorously investigate the low-spin structures built on the T=1, J^{π}=0^+ ground states in ^{70}Br and ^{70}Kr. These results will provide essential experimental data to test the MED and TED predictions obtained from the shell-model calculations. In addition, this experiment aimed to extend the T=1 band in ^{70}Kr, which is currently known only up to the J=4^+ state. This presentation will discuss the experimental methods developed at JYFL-ACCLAB to perform in-beam gamma-ray spectroscopy measurements in the challenging N=Z region, highlighting the A=70 isobaric triplet.

[1] A. Author, B. Author, C Author, Phys. Lett. B. 793, 403 (2020).
[2] A. Author, et al., Phys. Rev. D. 116, 540033 (2020).
[3] D. M. Debenham and at al., Phys. Rev. C 94, 054311 (2016).
[4] K. Wimmer and et al., Physics Letters B 785, 441 (2018).

Auteur principal: ZIMBA, George (Accelerator Laboratory, Department of Physics, University of Jyväskylä)

Co-auteurs: RUOTSALAINEN, Panu (Accelerator Laboratory, Department of Physics, University of Jyväskylä); BRISCOE, Andrew (Accelerator Laboratory, Department of Physics, University of Jyväskylä); AURANEN, Kalle (Accelerator Laboratory, Department of Physics, University of Jyväskylä); GRAHN, Tuomas (Accelerator Laboratory, Department of Physics, University of Jyväskylä); GREENLEES, Paul (Accelerator Laboratory, Department of Physics, University of Jyväskylä); ILLANA SISÓN, Andrés (Accelerator Laboratory, Department of Physics, University of Jyväskylä); JULIN, Rauno (Accelerator Laboratory, Department of Physics, University of Jyväskylä); JUTILA, Henri (Accelerator Laboratory, Department of Physics, University of Jyväskylä); LOUKO, Jussi (Accelerator Laboratory, Department of Physics, University of Jyväskylä); LUOMA, Minna (Accelerator Laboratory, Department of Physics, University of Jyväskylä); OJALA, Joonas (Accelerator Laboratory, Department of Physics, University of Jyväskylä); PAKARINEN, Janne (Accelerator Laboratory, Department of Physics, University of Jyväskylä); RAHKILA, Panu (Accelerator Laboratory, Department of Physics, University of Jyväskylä); ALVARO, Tolosa Delgado (Accelerator Laboratory, Department of Physics, University of Jyväskylä); SARÉN, Jan (Accelerator Laboratory, Department of Physics, University of Jyväskylä); UUSITALO, Juha (Accelerator Laboratory, Department of Physics, University of Jyväskylä); JENKINS, David (University of York); LENZI, Silvia (University of Padua and INFN); NARA SINGH, Bondili (Nuclear Physics Research Group University of the West of Scotland); WADSWORTH, Robert (University of York)

Orateur: ZIMBA, George (Accelerator Laboratory, Department of Physics, University of Jyväskylä)

Déposé par **ZIMBA, George** le **vendredi 22 avril 2022**