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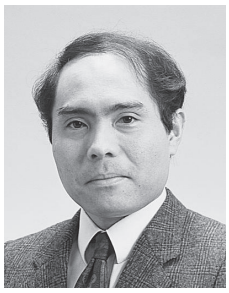

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Summary of Achievement

Refereed Journal Papers

[k-asai-01:2013] Kazuto Asai. The Group Generated by the Gamma Functions Γ (ax + 1), and its Subgroup of the Elements Converging to Constants. *Kyushu Journal of Mathematics*, pages accepted, to appear, 2014.

Let G be the multiplicative group generated by the gamma functions Γ (ax+1) (a=1,2,⋯), and H be the subgroup of all elements of G that converge to nonzero constants as x →∞ . The quotient group G/H is the group of equivalence classes of G, where f and g are equivalent fCg (x →∞) for some C ≠ 0. We show that G/HQ+. A similar consideration is possible for the case that the gamma functions Γ (ax+1) with a∈ R+ are concerned, and we show that G/HZ × R × R. Also, several concrete examples of the elements of H are constructed.

[m-honma-01:2013] H. Fujita A. Algora B. Blank M. Csatlós J. M. Deaven E. Estevez-Aguado E. Ganioğlu C. J. Guess J. Gulyás K. Hatanaka K. Hirota M. Honma D. Ishikawa A. Krasznahorkay H. Matsubara R. Meharchand F. Molina H. Okamura H. J. Ong T. Otsuka G. Perdikakis B. Rubio C. Scholl Y. Shimbara E. J. Stephenson G. Susoy T. Suzuki A. Tamii J. H. Thies R. G. T. Zegers Y. Fujita, T. Adachi and J. Zenihiro. High-resolution study of T_z=+2→+1 Gamow-Teller transitions in the ^{44}Ca(^{3}He,t)^{44}Sc reaction. *Phys. Rev. C*, 88:014308/1–18, 2013.

In order to study the Gamow-Teller (GT) transitions from the T_z=+2 nucleus ^{44}Ca to the T_z=+1 nucleus ^{44}Sc, where T_z is the z component of isospin T, we performed the (p,n)-type (^{3}He,t) charge-exchange (CE) reaction at 140 MeV/nucleon and the scattering angles 0° and 2.5°. An energy resolution of 28 keV, that was realized by applying matching techniques to the magnetic spectrometer system, allowed the study of fragmented states. The GT transition strengths, B(GT), were derived up to the excitation energy (E_x) of 13.7 MeV assuming the proportionality between cross sections and B(GT) values. The total sum of B(GT) values in discrete states was 3.7, which was 31using the GXPF1J interaction could reproduce the gross features of the experimental B(GT) distribution, but not the fragmentation of the strength.

[m-honma-02:2013] Y. Tsunoda T. Otsuka M. B. Bennett A. Chemey M. Honma N. Larson C. J. Prokop S. J. Quinn N. Shimizu A. Simon A. Spyrou V. Tripathi Y. Utsuno S. Suchyta, S. N. Liddick and J. M. VonMoss. Shape coexistence in ^{68}Ni. *Phys. Rev. C*, 89:021301(R)/1–5, 2014.

The internal-conversion and internal-pair-production decays of the first excited 0^+ state in ^{68}Ni are studied following the beta decay of ^{68}Co. A novel experimental technique, in which the ions of ^{68}Co were implanted into a planar germanium double-sided strip detector and which required digital pulse processing, is developed. New values for the energy of the first excited 0^+ state and the electric monopole transition strength from the first excited 0^+ state to the ground state in ^{68}Ni are determined to be 1605(3) keV and 7.6(4) x 10^{-3}, respectively. Comparisons of the experimental results to Monte Carlo Shell Model calculations suggest the coexistence between a spherical ground state and an oblate first excited 0^+ state in ^{68}Ni.

[m-honma-03:2013] T. Adachi C.L. Bai A. Algora G.P.A. Berg P. von Brentano G. Colò M. Csatlós J.M. Deaven E. Estevez-Aguado C. Fransen D. De Frenne K. Fujita E. Ganioğlu C.J. Guess J. Gulyás K. Hatanaka K. Hirota M. Honma D. Ishikawa E. Jacobs A. Krasznahorkay H. Matsubara K. Matsuyanagi R. Meharchand F. Molina K. Muto K. Nakanishi A. Negret H. Okamura H.J. Ong T. Otsuka N. Pietralla G. Perdikakis L. Popescu B. Rubio H. Sagawa P. Sarriguren C. Scholl Y. Shimbara Y. Shimizu G. Susoy T. Suzuki Y. Tameshige A. Tamii J.H. Thies M. Uchida T. Wakasa1 M. Yosoi R.G.T. Zegers K.O. Zell Y. Fujita, H. Fujita and J. Zenihiro. Observation of Low- and High-Energy Gamow-Teller Phonon Excitations in Nuclei. *Phys. Rev. Lett.*, 112:112502/1–5, 2014.

Gamow-Teller (GT) transitions in atomic nuclei are sensitive to both nuclear shell structure and effective residual interactions. The nuclear GT excitations were studied for the mass number A=42, 46, 50, and 54 "f-shell" nuclei in (^{3}He, t) charge-exchange reactions. In the ^{42}Ca$\rightarrow^{42}$Sc reaction, most of the GT strength is concentrated in the lowest excited state at 0.6 MeV, suggesting the existence of a low-energy GT phonon excitation. As A increases, a high-energy GT phonon excitation develops in the 6-11 MeV region. In the ^{54}Fe$\rightarrow^{54}$Co reaction, the high-energy GT phonon excitation mainly carries the GT strength. The existence of these two GT phonon excitations are attributed to the 2 fermionic degrees of freedom in nuclei

[m-honma-04:2013] Noritaka Shimizu Michio Honma Yusuke Tsunoda, Takaharu Otsuka and Yutaka Utsuno. Novel shape evolution in exotic Ni isotopes and configuration-dependent shell structure. *Phys. Rev.*, 89:031301(R)/1–5, 2014.

The shapes of neutron-rich exotic Ni isotopes are studied. Large-scale shell

model calculations are performed by the advanced Monte Carlo shell model (MCSM) for the pf-$g_{9/2}$-$d_{5/2}$ model space. Experimental energy levels are reproduced well by a single fixed Hamiltonian. Intrinsic shapes are analyzed for MCSM eigenstates. Intriguing interplays among spherical, oblate, prolate, and γ-unstable shapes are seen, including shape fluctuations, E(5)-like situations, the magicity of doubly magic ^{56,68,78}Ni, and the coexistence of spherical and strongly deformed shapes. Regarding the last point, strong deformation and change of shell structure can take place simultaneously, being driven by the combination of the tensor force and changes of major configurations within the same nucleus.

[m-honma-05:2013] N. Aoi P. Doornenbal M. Matsushita H. Wang H. Baba N. Fukuda S. Go M. Honma J. Lee K. Matsui S. Michimasa T. Motobayashi D. Nishimura T. Otsuka H. Sakurai Y. Shiga P.-A. Söderström T. Sumikama H. Suzuki R. Taniuchi Y. Utsuno J. J. Valiente-Dobón D. Steppenbeck, S. Takeuchi and K. Yoneda. Evidence for a new nuclear 'magic number' from the level structure of ^{54}Ca. *Nature*, 502:207–210, 2013.

Atomic nuclei are finite quantum systems composed of two distinct types of fermion—protons and neutrons. In a manner similar to that of electrons orbiting in an atom, protons and neutrons in a nucleus form shell structures. In the case of stable, naturally occurring nuclei, large energy gaps exist between shells that fill completely when the proton or neutron number is equal to 2, 8, 20, 28, 50, 82 or 126. Away from stability, however, these so-called 'magic numbers' are known to evolve in systems with a large imbalance of protons and neutrons. Although some of the standard shell closures can disappear, new ones are known to appear. Studies aiming to identify and understand such behaviour are of major importance in the field of experimental and theoretical nuclear physics. Here we report a spectroscopic study of the neutron-rich nucleus ^{54}Ca (a bound system composed of 20 protons and 34 neutrons) using proton knockout reactions involving fast radioactive projectiles. The results highlight the doubly magic nature of ^{54}Ca and provide direct experimental evidence for the onset of a sizable subshell closure at neutron number 34 in isotopes far from stability.

[t-maeda-01:2013] Takao Maeda and Takafumi Hayashi. Fourier Analysis of Sequences over a Composition Algebra of the Real Number Field. *IEICE Trans. Fun d*, E96-A(12):24522456, December 2013.

To analyze the structure of a set of perfect sequences over a composition

algebra of the real number field, transforms of a set of sequences similar to the discrete Fourier transform (DFT) are introduced. The discrete cosine transform, discrete sine transform, and generalized discrete Fourier transform (GDFT) of the sequences are defined and the fundamental properties of these transforms are proved. We show that GDFT is bijective and that there exists a relationship between these transforms and a convolution of sequences. Applying these properties to the set of perfect sequences, a parameterization theorem of such sequences is obtained.

[tsuchiya-01:2013] Hiroya Hashimoto and Takahiro Tsuchiya. Remarks on the rate of strong convergence of Euler-Maruyama approximation for SDEs driven by rotation invariant stable processes. *JSIAM Letters*, 5:13–16, 2013.

In this paper, we consider Euler-Maruyama approximations for 1-dimensional stochastic differential equations (SDEs) driven by rotation invariant (i.e. symmetric) α stable processes and discuss their rate of strong convergence by numerical simulations. We also study the relationship between the convergence rate and the index α of rotation invariant stable process and/or the exponent γ of the Hlder continuity of the diffusion coefficient.

[yamagami-01:2013] M. Yamagami, J. Margueron, H. Sagawa, and K. Hagino. Development of local energy density functional for description of pairing correlations in drip-line regiong. *RIKEN Accel. Prog. Rep. 46*, page 42, 2013.

We discuss the predictive power of our local energy density functional for pairing correlations in nuclei around the neutron drip line. An empirical relation among the parameters in the isoscalar part of pair-DF is extracted. The uncertainty of the isovector part is also examined by calculating the pairing gaps of neutron-rich and proton-rich nuclei in a wider region of of the nuclear chart.

[yamagami-02:2013] M. Yamagami and K. Matsuyanagi. Skyrme-RPA calculation for octupole vibrations on rotating superdeformed nuclei. *RIKEN Accel. Prog. Rep. 47*, page in press, 2014.

We developed a new computer code of a microscopic nuclear model (random phase approximation in rotating frame) for investigating rotational effects on vibrational excitations in radioactive atomic nuclei with large neutron excess. In the computer code, we used an up-to-date representation of the Skyrme-

type local energy density functional that enables us to describe/predict static and dynamical properties across the nuclear chart.

Unrefereed Papers

[tsuchiya-02:2013] Hiroya Hashimoto and Takahiro Tsuchiya. Convergence rate of stability problems of SDEs with (dis-)continuous coefficients. *arXiv*, (1401.4542 [math.PR]), 2013.

We consider the stability problems of one dimensional SDEs when the diffusion coefficients satisfy the so called Nakao-Le Gall condition. The explicit rate of convergence of the stability problems are given by the Yamada-Watanabe method without the drifts. We also discuss the convergence rate for the SDEs driven by the symmetric α stable process. These stability rate problems are extended to the case where the drift coefficients are bounded and in L1. It is shown that the convergence rate is invariant under the removal of drift method for the SDEs driven by the Wiener process.

Refereed Proceeding Papers

[t-maeda-02:2013] Takafumi Hayashi, Takao Maeda Shigeru Kanemoto, and Shinya Matsufuji. Low-Peak Factor Optimal Zero-Correlation Zone Sequence Set and Its Applications. In Pingzhi Fan et al., editor, *Proceedings of the Sixth International Workshop on Signal Design and Its Applications in Communications (IWSDA'13)*, pages 72–75. IEEE, IEEE press, October 2013.

The present paper introduces a novel method for the construction of sequences that have a zero-correlation zone. For the proposed sequence set, both the cross-correlation function and the side lobe of the auto-correlation function are zero for phase shifts within the zero-correlation zone. The proposed sequence set can be generated from an arbitrary Hadamard matrix of order n and a set of $2n$ trigonometric-like function sequences of length $4n$. The proposed construction can generate an optimal sequence set that satisfies, for a given zero-correlation zone and sequence period, the theoretical bound on the number of members. The peak factor of the proposed sequence set is equal to $\sqrt{2}$.

[tsuchiya-03:2013] Hiroya Hashimoto and Takahiro Tsuchiya. Euler and Maruyama scheme and the convergence rate of SDEs driven by rota-

tion invariant α-stable processes. In *RIMS Kokyuroku*, number 1855, pages 229–235, 2013.

The rate of convergence of the Euler-Maruyama schemes to the solution was drawn primarily from the paper Deelstra and Delbaen in 1998. Their results has been sharpened and considerably generalized by Gyongy and Rasonyi in 2011. In the real world, these heavy tail behaviors are observed in various fields. Then, we are interested in how much effect the mathematical framework depend of the fat-tail driven process Z. We consider the stability problems of one dimensional stochastic differential equations when the diffusion coefficients satisfy the so called Nakao-Le Gall condition. A bounded rate of strong convergence in the sense of L^1 is given via the Yamada-Watanabe method. Using the extended Tanaka-Meyer formula, the result is extended to the SDEs driven by rotation invariant and α-stable processes ($1 < \alpha < 2$) under the Belfadli-Ouknine's condition.

Academic Activities

[sigeru-w-01:2013] S. Watanabe, 2013-2014.

Reviewer: Mathematical Reviews published by the American Mathematical Society

[t-maeda-03:2013] Takao Maeda, October 2013.

He was the treasurer of IWSDA (the International Workshop on Signal Design and its Applications in Communications) supported by IEEE.

[t-maeda-04:2013] Takao Maeda, November 2013.

A member of the Steering Committee of ACM International Collegeate Programming Contest, Asia Regional Contest, 2013, Aizu.

[t-watanb-01:2013] Toshiro Watanabe, 2013.

Analysis prize 2013

Ph.D and Others Theses

[a-fujitu-01:2013] Taisuke Honda. Graduation Thesis: Simulation of Milk Crown using Molecular Dynamics, University of Aizu, 2013.

Thesis Advisor: A. Fujitstu

[a-fujitu-02:2013] Yuma Takahama. Graduation Thesis: The Bekenstein-Hawking Entropy of Anti-de Sitter Black Holes, University of Aizu, 2013.

Thesis Advisor: A. Fujitstu

[m-honma-06:2013] Yoshika Nomura. Graduation Thesis: Stability of Classical Electron Orbits in Helium Atom, University of Aizu, 2014.

Thesis Advisor: M. Honma

[m-honma-07:2013] Yu Saito. Graduation Thesis: Exotic Patterns Generated in Autocatalytic Chemical Reactions with Diffusion, University of Aizu, 2014.

Thesis Advisor: M. Honma

[m-honma-08:2013] Yuki Kawawada. Graduation Thesis: Period-Doubling Bifurcations in Transmitted Light from a Ring Cavity, University of Aizu, 2014.

Thesis Advisor: M. Honma

[sigeru-w-02:2013] Takahiro Oda. Graduation thesis, School of Computer Science and Engineering, March 2013.

Thesis Adviser: S. Watanabe

[sigeru-w-03:2013] Hiroshi Nemoto. Graduation thesis, School of Computer Science and Engineering, March 2013.

Thesis Adviser: S. Watanabe

[sigeru-w-04:2013] Misato Sampei. Graduation thesis, School of Computer Science and Engineering, March 2013.

Thesis Adviser: S. Watanabe

[sigeru-w-05:2013] Shin ichi Tsunoda. Graduation thesis, School of Computer Science and Engineering, March 2013.

Thesis Adviser: S. Watanabe

[sigeru-w-06:2013] Toshiki Yamazaki. Graduation thesis, School of Computer Science and Engineering, March 2013.

Thesis Adviser: S. Watanabe

[sigeru-w-07:2013] Motohito Yoshida. Graduation thesis, School of Computer Science and Engineering, March 2013.

Thesis Adviser: S. Watanabe

[sigeru-w-08:2013] Nobuyuki Dobashi. Master thesis, Graduate School of Computer Science and Engineering, March 2013.

Thesis Adviser: S. Watanabe

[yamagami-03:2013] Shunsuke Sasaki. Body accumulation of radioactive substances estimated by differential equation, School of Computer Science and Engineering, September 2013.

Thesis Advisor: M. Yamagami

[yamagami-04:2013] Haruki Inaho. Calculation of internal structure of a white dwarf, School of Computer Science and Engineering, March 2014.

Thesis Advisor: M. Yamagami

[yamagami-05:2013] Masato Harada. Stability of Orbit in Restricted Three-body Problem, School of Computer Science and Engineering, March 2014.

Thesis Advisor: M. Yamagami

Others

[k-asai-02:2013] Kazuto Asai. Handouts (Texts for classes) in Japanese: Discrete Systems (85 pages), Linear Algebra (84 pages), Complex Analysis (66 pages), Applied Algebra (48 pages) Handout (graduate school) in English: ALGEBRAIC SYSTEMS AND COMBINATORICS (43 pages). pdf-files, 2013 (revised edition).

http://web-ext.u-aizu.ac.jp/ k-asai/classes/class-texts.html

[t-maeda-05:2013] Takao Maeda. Construction Schemes of Zero Correlation Zone Sequence Sets, March 2013.

A dissertation submitted in partial fulfilment of the requirements for the degree of philosophy in computer science and engineering