

Report Title: JUSTIPEN: Japan US Theory Institute for Physics with Exotic Nuclei

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Abstract: The grant “JUSTIPEN: Japan US Theory Institute for Physics with Exotic Nuclei ” (DOE DE-FG02-06ER41407) ran from 02/01/2006 thru 12/31/2013. JUSTIPEN is a venue for international collaboration between U.S.-based and Japanese scientists who share an interest in theory of rare isotopes. Since its inception JUSTIPEN has supported many visitors, fostered collaborations between physicists in the U.S. and Japan, and enabled them to deepen our understanding of exotic nuclei and their role in cosmos.

Final Report

Summary

JUSTIPEN – the Japan U.S Theory Institute for Physics with Exotic Nuclei – was established in 2006. This institute is located at the Radioactive Ion Beam Facility RIBF at the RIKEN research center in Wako-shi, close to Tokyo. The JUSTIPEN grant of the U.S. Department of Energy supports the travel to JUSTIPEN of U.S. scientists with an interest in the theory of exotic nuclei. The Japanese side provides the U.S.-based visitors with office space and subsidized housing at RIKEN and also supports Japanese scientists to travel to JUSTIPEN for collaboration with the U.S.-based visitors. In addition, U.S.-based scientists are also supported for travel to Japanese scientists outside JUSTIPEN. For details, see <http://www.phys.utk.edu/JUSTIPEN/>. Since its inception, JUSTIPEN has fostered collaborations between U.S.-based and Japanese scientists with a keen interest in the theory of exotic nuclei. During the course of this grant, 118 visitors traveled to JUSTIPEN, and a total of 40 publications acknowledged support by the JUSTIPEN grant. Several jointly organized collaboration meetings in Japan and the U.S. furthered the scientific exchange and the collaborative spirit.

Summary of visitors and publications

Year	Number of visitors	Number of Publications
2006	5	1
2007	12	2
2008	27	2
2009	17	11
2010	25	5
2011	11	7
2012	8	7
2013	13	4
2014	—	1
2006 – 2014	118	40

Published articles in peer-reviewed journals

1. “Chiral three-nucleon forces and bound excited states in neutron-rich oxygen isotopes,” J.D. Holt, J. Menendez, and A. Schwenk, *Eur. Phys. J. A* **49**, 39 (2013).
2. “The character and prevalence of third minima in actinide fission barriers,” Takatoshi Ichikawa, Peter Moller, and Arnold J Sierk, *Phys. Rev. C* **87**, 054326 (2013).
3. “Benchmarks of the full configuration interaction, Monte Carlo shell model, and no-core full configuration methods,” T. Abe, P. Maris, T. Otsuka, N. Shimizu, Y. Utsuno, and J.P. Vary, *Phys. Rev. C* **86**, 054301 (2012).
4. “Calculated fission yields of neutron-deficient mercury isotopes,” Peter Möller, Jørgen Randrup, and Arnold J. Sierk, *Phys. Rev. C* **85**, 024306 (2012).

5. "Contrasting fission potential-energy structure of actinides and mercury isotopes," Takatoshi Ichikawa, Akira Iwamoto, Peter Möller, and Arnold J. Sierk, *Phys. Rev. C* **86**, 024610 (2012).
6. "Fission barriers in covariant density functional theory: Extrapolation to superheavy nuclei," H. Abusara, A. V. Afanasjev, and P. Ring, *Phys. Rev. C* **85**, 024314 (2012).
7. "New finite-range droplet mass model and equation-of-state parameters," Peter Möller, William D. Myers, Hiroyuki Sagawa, and Satoshi Yoshida, *Phys. Rev. Lett.* **108**, 052501 (2012).
8. "Nuclear Shape Isomers," P. Möller, A. J. Sierk, R. Bengtsson, H. Sagawa, T. Ichikawa, *Atomic Data and Nuclear Data Tables* **98**, 149 (2012).
9. "Three-body forces and shell structure in calcium isotopes," Jason D. Holt, Takaharu Otsuka, Achim Schwenk, and Toshio Suzuki, *J. Phys. G* **39**, 085111 (2012).
10. "Cluster formations in deformed states for ^{28}Si and ^{32}S ," Takatoshi Ichikawa, Yoshiko Kanada-En'yo, and Peter Möller, *Phys. Rev. C* **83**, 054319 (2011).
11. "Fission-fragment mass distributions from strongly damped shape evolution," J. Randrup, P. Moller, and A.J. Sierk, *Phys. Rev. C* **84**, 034613 (2011).
12. "Microscopic self-energy calculations and dispersive optical-model potentials," S. J. Waldecker, C. Barbieri, and W. H. Dickhoff, *Phys. Rev. C* **84**, 034616 (2011).
13. "Multipole strength function of deformed superfluid nuclei made easy," M. Stoitsov, M. Kortelainen, T. Nakatsukasa, C. Losa, and W. Nazarewicz, *Phys. Rev. C* **84**, 041305 (2011).
14. "Invariants of Collective Neutrino Oscillations," Y. Pehlivan, A.B. Balantekin, Toshitaka Kajino, and Takashi Yoshida, *Phys. Rev. D* **84**, 065008 (2011).
15. "Quantum Statistical Corrections to Astrophysical Photodisintegration Rates," G. J. Mathews, Yamac Pehlivan, Toshitaka Kajino, A. B. Balantekin, and Motohiko Kusakabe, *ApJ* **727**, 10 (2011).
16. "Dynamical Relativistic Effects in Breakup Processes of Halo Nuclei," Kazuyuki Ogata and Carlos A. Bertulani, *Prog. Theor. Phys.* **123**, 701 (2010).
17. "High-spin intruder band in ^{107}In ," E. Ideguchi, B. Cederwall, E. Ganioglu, B. Hadinia, K. Lagergren, T. Back, A. Johnson, R. Wyss, S. Eeckhauudt, T. Grahn, P. Greenlees, R. Julin, S. Juutinen, H. Kettunen, M. Leino, A.-P. Leppanen, P. Nieminen, M. Nyman, J. Pakarinen, P. Rahkila, C. Scholey, J. Uusitalo, D. T. Joss, E. S. Paul, D. R. Wiseman, R. Wadsworth, A. V. Afanasjev, and I. Ragnarsson, *Phys. Rev. C* **81**, 034303 (2010).
18. "Mirror asymmetry investigated by beta decay of proton-rich ^{24}Si ," Yuichi Ichikawa, *Mod. Phys. Lett. A* **25**, 1895 (2010).
19. "New Type of Asymmetric Fission in Proton-Rich Nuclei," A. N. Andreyev, J. Elseviers, M. Huyse, P. Van Duppen, S. Antalic, A. Barzakh, N. Bree, T. E. Cocolios, V. F. Comas, J. Diriken, D. Fedorov, V. Fedosseev, S. Franchoo, J. A. Heredia, O. Ivanov, U. Koster, B. A. Marsh, K. Nishio, R. D. Page, N. Patronis, M. Seliverstov, I. Tsekhanovich, P. Van den Bergh, J. Van De Walle, M. Venhart, S. Vermote, M. Veselsky, C. Wagemans, T. Ichikawa, A. Iwamoto, P. Moller, and A. J. Sierk, *Phys. Rev. Lett.* **105**, 252502 (2010).

20. "A New Approach to the 3D Faddeev Equation for Three-Body Scattering," Ch. Elster, W. Gloeckle, H. Witała, *Few Body Syst.* **45**, 1 (2009).
21. "Beta decay of the proton-rich nucleus ^{24}Si and its mirror asymmetry," Y. Ichikawa, T. K. Onishi, D. Suzuki, H. Iwasaki, T. Kubo, V. Naik, A. Chakrabarti, N. Aoi, B. A. Brown, N. Fukuda, S. Kubono, T. Motobayashi, T. Nakabayashi, T. Nakamura, T. Nakao, T. Okumura, H. J. Ong, H. Suzuki, M. K. Suzuki, T. Teranishi, K. N. Yamada, H. Yamaguchi, and H. Sakurai, *Phys. Rev. C* **80**, 044302 (2009).
22. "Dissociation of relativistic projectiles with the continuum discretized coupled-channels method," K. Ogata and C. A. Bertulani, *Prog. Theor. Phys.* **121**, 1399 (2009).
23. "Evidence for a doubly magic ^{24}O ," C.R. Hoffman, T. Baumann, D. Bazin, J. Brown, G. Christian, D.H. Denby, P.A. DeYoung, J.E. Finck, N. Frank, J. Hinfefeld, S. Mosby, W.A. Peters, W.F. Rogers, A. Schiller, A. Spyrou, M.J. Scott, S.L. Tabor, M. Thoennessen, and P. Voss, *Phys. Lett. B* **672**, 17 (2009).
24. "Global Calculation of Nuclear Shape Isomers," P. Möller, A. J. Sierk, R. Bengtsson, H. Sagawa, and T. Ichikawa, *Phys. Rev. Lett.* **103**, 212501 (2009).
25. "Heavy-element Fission Barriers," Peter Möller, Arnold J. Sierk, Takatoshi Ichikawa, Akira Iwamoto, Ragnar Bengtsson, Henrik Uhrenholt, and Sven Åberg, *Phys. Rev. C* **79**, 064304 (2009).
26. "Odd-even mass difference and isospin dependent pairing interaction," C.A. Bertulani, Hongfeng Lu, H. Sagawa, *Phys. Rev. C* **80**, 027303 (2009).
27. "Origin of the narrow, single peak in the fission-fragment mass distribution for ^{258}Fm ," T. Ichikawa, A. Iwamoto, and P. Möller, *Phys. Rev. C* **79**, 014305 (2009).
28. "Axial and Reflection Asymmetry of the Nuclear Ground State," P. Möller, R. Bengtsson, B.G. Carlsson, P. Olivius, T. Ichikawa, H. Sagawa, A. Iwamoto, *Atomic Data and Nuclear Data Tables* **94**, 758 (2008).
29. "JUSTIPEN--The Japan U.S. Theory Institute for Physics with Exotic Nuclei," D. J. Dean, *Nuclear Physics News*, vol. 18, no. 4, p. 21 (2008).
30. "Phase transition in exotic nuclei along the $N=Z$ line," M. Hasegawa, K. Kaneko, T. Mizusaki and Y. Sun *Phys. Lett. B* **656**, 51 (2007).
31. "Proton single-particle energies in ^{23}F ," Angelo Signoracci and B. Alex Brown, *Phys. Rev. C* **75**, 024303 (2007).
32. "Tensor interaction contributions to single-particle energies," B. A. Brown, T. Duguet, T. Otsuka, D. Abe, T. Suzuki, *Phys. Rev. C* **7**, 4061303 (2006).

Articles submitted for publication, conference proceedings, and lectures

33. "Combinatorial nuclear level-density model," H. Uhrenholt, S. Åberg, P. Möller, T. Ichikawa, arXiv:0901.1087 (2009).
34. "Ab initio shell-model calculation for O-18 in a restricted no-core model space," S. Fujii and B. R. Barrett, arXiv:0902.2169 (2009).
35. "Theory and applications of Coulomb excitation," C. A. Bertulani, arXiv:0908.4307 (2009).
36. "Interplay between Compound and Fragment Aspects of Nuclear Fission and Heavy-Ion Fusion," A. Iwamoto, T. Ichikawa and P. Möller, *Proceedings of the*

- 3rd International Conference on Current Problems in Nuclear Physics and Atomic Energy (NPAE-Kiev2010), June 7 to June 12, 2010, Kiev, Ukraine (Los Alamos Preprint Number LA-UR-10-06151).
37. "Benchmark calculation of no-core Monte Carlo shell model in light nuclei," T. Abe, P. Maris, T. Otsuka, N. Shimizu, Y. Utsuno, and J. P. Vary, AIP Conf. Proc. **1355**, 173 (2011).
 38. "Ab initio calculations for Be-isotopes with JISP16," P. Maris, Journal of Physics: Conference Series **445**, 012035 (2013).
 39. "Brownian shape dynamics in fission," Jørgen Randrup and Peter Möller, EPJ web of Conferences **63**, 02009 (2013).
 40. "Isospin-invariant Skyrme energy-density-functional approach with axial symmetry," J.A. Sheikh, N. Hinohara, J. Dobaczewski, T. Nakatsukasa, W. Nazarewicz, and K. Sato, arXiv:1403.2427 (2014).

Conferences and Workshops (jointly organized or held at JUSTIPEN)

1. 6th CNS International Summer School, Center for Nuclear Study (CNS), the University of Tokyo in RIKEN, Wako-shi (Aug. 28 – Sep. 1, 2007)
2. The 1st JUSTIPEN-LACM Workshop, Oak Ridge (March 5-8, 2007)
3. The 2nd LACM-EFES-JUSTIPEN Workshop, Oak Ridge (January 23-25, 2008)
4. JUSTIPEN-EFES-Hokkaido-UNEDF workshop, Hokkaido (July 21-25, 2008)
5. The 3rd LACM-EFES-JUSTIPEN Workshop (February 23-25, 2009, Oak Ridge)
6. The 8th CNS-EFES International Summer School, August 26-September 1, 2009, Riken and University of Tokyo (Japan)
7. 3rd Joint Meeting of the APS Division of Nuclear Physics and the Physical Society of Japan: Session 1WA: Workshop on Physics of Exotic Nuclei (October 13, 2009) Hawaii
8. JUSTIPEN workshop December 7-9, 2009 at RIKEN (Japan)
9. The 4th LACM-EFES-JUSTIPEN Workshop (March 15-17, 2010, Oak Ridge)
10. The 9th CNS-EFES International Summer School (August 18-24, 2010, RIKEN, Wako-Campus, Japan)
11. University of Aizu-JUSTIPEN-EFES Symposium on "Cutting-Edge Physics of Unstable Nuclei," November 10-13, 2010, University of Aizu (Aizu-Wakamatsu, Japan)
12. "Probing Neutron-proton pair correlations, cross section measurements, reaction mechanism and pairing Models," Workshop of RIKEN, Nishina Center, Wako, Japan, 19-20 November 2010
13. The 5th LACM-EFES-JUSTIPEN Workshop (March 15-17, 2011, Oak Ridge)
14. Long-term workshop Dynamics and Correlations in Exotic Nuclei, YITP Kyoto (20th September – 28th October, 2011)
15. "JUSTIPEN workshop on supercomputing at CCP2012," Oct. 15 and Oct. 16 2012 (afternoons), at the "Conference on Computational Physics (CCP2012)," Kobe, Japan
16. 6th LACM-EFES-JUSTIPEN Workshop, Oak Ridge (Oct. 31 – Nov. 2, 2012)
17. JUSTIPEN-JUSEIPEN Joint Workshop, RIKEN Wako Campus (9-12 December 2013)

Impact in nuclear physics

JUSTIPEN had a notable impact that goes beyond the theory of exotic nuclei. Through its success, this grant has inspired similar efforts in other fields of nuclear physics. Examples are JUSEIPEN (Japan-US Experimental Institute for Physics with Exotic Nuclei) at RIKEN RIBF in Japan and FUSTIPEN (France-U.S. Theory Institute for Physics with Exotic Nuclei) at GANIL/Caen in France, CUSTIPEN (China-U.S. Theory Institute for Physics with Exotic Nuclei) at Peking University in China, and GAUSTEQ (Germany-U.S. Nuclear Theory Exchange Program for QCD Studies of Hadrons & Nuclei) at GSI/Darmstadt in Germany.