Final Technical Report

Project Title: "FUSTIPEN—the France-U.S. Theory Institute for Physics with Exotic Nuclei"
Grant Number: DE-FG02-10ER41700
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1. Description of Project

FUSTIPEN, the France-U.S. Theory Institute for Physics with Exotic Nuclei, was an international venue for theoretical research on the physics of nuclei during an era of particularly active experimental investigations of rare isotopes, see http://fustipen.ganil.fr/. It was dedicated to collaborative research between U.S.-based and French nuclear physicists, drawing on the complementary expertise in the two countries. The grant provided travel and local support for visits by U.S. nuclear physicists to GANIL, where the FUSTIPEN offices are located, and also supported collateral travel to other French research institutions.

To facilitate contacts of French scientists with U.S. visitors at FUSTIPEN, the French grant supplied funding for French physicists to visit GANIL to collaborate with U.S. FUSTIPEN visitors. In addition, GANIL provided two offices and secretarial help for U.S. visitors.

During its course the U.S. grant supported many U.S. scientists for collaborative travel under FUSTIPEN auspices. Moreover, the French grant provided local support for several U.S. scientists to participate in FUSTIPEN-related activities. Many of these visits were augmented by a locally organized workshop on the specific topic of the collaboration between the parties involved.

2. Scientific Collaborations

The table shows the number of visits and collaborations resulting from FUSTIPEN

Year	Visitors	Publications
2011	12	2
2012	15	6
2013	7	6
2014	13	4
2015	13	3
2016	9	6
2017	Not applicable	1
Total	**69**	**28**

3. FUSTIPEN activities

Several workshops/lectures were organized at GANIL around the collaboration topics since the last report. They are listed below. Detailed information about these activities can be found at http://fustipen.ganil.fr/Conferences/.

FUSTIPEN Topical Meetings:

1. *Probing two-nucleon correlations using reactions*, March 18, 2011
2. *Effective field theories for nuclear structure studies,* March 3, 2011
3. *Neutron-proton pair correlations in N~Z nuclei,* February 3, 2011
4. *Probing two-nucleon correlations using reactions,* March 18, 2011
5. *Bridging the Atlantic with Exotic Isotope Physics,* January 18-19, 2011
6. *Low-energy nuclear collective modes and excitations*, May 24-25, 2012
7. *The Structure of Heavy Nuclei*, April 16-17, 2012
8. *Understanding light nuclei microscopically*, March 20-21, 2012
9. *Theory of Nuclear Fission*, January 4-6, 2012
10. *The Microscopic Description of Light Nuclei*, 3/11-3/12/13
11. *Dipole collectivity in Nuclei*, 10/3-10/4/13
12. *Understanding Nuclear Structure and Reactions Microscopically, including the Continuum*, 3/17-3/21, 2014
13. *Structure of the neutron star crust: experimental and observational signatures*, May 26-27, 2014
14. *Recent Advances in the Nuclear Shell Model*, June 19-20, 2014
15. *Challenges in the microscopic description of nuclear large amplitude collective dynamics*, October 13-14, 2014
16. *New Directions for Nuclear Structure and Reaction Theories*, March 16-20, 2015
17. *Fission-fragments in low-energy fission: a gauge for macroscopic and microscopic influences,* October 21-22, 2015

18. *Future directions for nuclear structure and reaction theories: Ab initio approaches for 2020,* March 14-18, 2016
19. *Dynamical cluster formation and correlations in heavy--ion collisions, within transport models and in experiments*, May 17-19, 2016
20. *Fission at FUSTIPEN II: recent observables and their modeling*, May 3-4, 2016

FUSTIPEN Lectures/Colloquia:

1. Lectures on Effective Field Theories, 2/28 – 3/2/2011
2. Description of nuclear reaction observables including coupling to the continuum, July 3, 2012
3. Neutron Proton Pairing, April 24, 2012
4. Dynamical description of low energy nuclear reactions, January 12, 2012
5. Nuclear ab-initio and reaction frameworks within the Gamow Shell Model, 5/17/13
6. Multidimensional stochastic treatment of fission dynamics, 5/24/13
7. Challenges in Nuclear Astrophysics, 7/4-7/5/13
8. Nuclear structure and double-beta decay, 3/7/14
9. Non-exponential and oscillatory quantum decays, 5/28/14
10. Nucleus as an Open System: New Effects and Theoretical Challenges, 5/30/14
11. Atomic nucleus: mesoscopic physics, quantum chaos and fundamental symmetries, 6/3/14
12. Proton-neutron pairing correlations in the nuclear shell model, 6/10/14
13. The GRETINA physics program, 4/5/2016

Many physicists from other European countries, Asia and Canada participated in the topical meetings supported in part by French FUSTIPEN grant. The exchange and collaboration between French and U.S. scientists is also strengthened by several jointly organized workshops held in France and the U.S.

Broader Impact

FUSTIPEN had an impact beyond its funding of scientific exchange. Through its success, this grant has inspired similar efforts in other fields of nuclear physics. As an example, we mention CUSTIPEN (China-U.S. Theory Institute for Physics with Exotic Nuclei) at Peking University in Beijing.

4. Publications and reports

1. *The French-US Theory Institute for Physics with Exotic Nuclei,* G. Bertsch, S. Gales, W. Nazarewicz, and M. Ploszajczak, Nuclear Physics News **21**, 42 (2011).
2. *Charge radii and neutron correlations in helium halo nuclei,* G. Papadimitriou, A. T. Kruppa, N. Michel, W. Nazarewicz, M. Płoszajczak, and J. Rotureau, Phys. Rev. C **84**, 051304 (2011).

3. *Weakly bound systems, continuum effects, and reactions,* Y. Jaganathen, N. Michel and M. Ploszajczak, Journal of Physics: Conference Series **403**, 012022 (2012).
4. *Symmetry breaking and fluctuations within stochastic mean-field dynamics: Importance of initial quantum fluctuations,* D. Lacroix, S. Ayik and B. Yilmaz, Phys. Rev. C **85**, 041602 (2012).
5. *Asymptotic normalization coefficients and continuum coupling in mirror nuclei,* J. Okołowicz, N. Michel, W. Nazarewicz, M. Płoszajczak, Phys. Rev. C **85** 064320 (2012).
6. *On the origin of nuclear clustering, J. Okolowicz, M. Ploszajczak, W. Nazarewicz,* Prog. Theor. Phys. Supplement **196**, 230 (2012).
7. *Pairing dynamics in particle transport,* G. Scamps, D. Lacroix, G. F. Bertsch, and K. Washiyama Phys. Rev. C **85**, 034328 (2012).
8. *Ab-initio take on effective single-particle energies in doubly closed shell nuclei*, T. Duguet, G. Hagen, Phys. Rev. C **85**, 034330 (2012).
9. *Ab-initio No-Core Gamow Shell Model calculations with realistic interactions,* G. Papadimitriou, J. Rotureau, N. Michel, M. Płoszajczak, and B.R. Barrett, Phys. Rev. C **88**, 044318 (2013).
10. *Bound states of dipolar molecules studied with the Berggren expansion method,* K. Fossez, N. Michel, W. Nazarewicz, M. Płoszajczak, Phys. Rev. A **87**, 042515 (2013).
11. *Geometry of the shears mechanism in nuclei,* P. Van Isacker and A.O. Macchiavelli, Phys. Rev. C **87**, 061301(R) (2013).
12. *Spectroscopy of ^{26}F to Probe Proton-Neutron Forces Close to the Drip Line*, A. Lepailleur et al., Phys. Rev. Lett. **110**, 082502 (2013).
13. *Shell-model derivation of the shears mechanism,* P. Van Isacker, J. Phys.: Conf. Series **445**, 012013 (2013).
14. *Toward understanding the microscopic origin of nuclear clustering,* J. Okołowicz, W. Nazarewicz and M. Płoszajczak, Fortschr. Phys. **61**, 66 (2013).
15. *Near-threshold correlations of neutrons,* J. Okołowicz, M. Płoszajczak and W. Nazarewicz, Acta Physica Polonica B **45**, 331 (2014).
16. *Gamow shell model description of proton scattering on ^{18}Ne,* Y. Jaganathen, N. Michel and M. Płoszajczak, Phys. Rev. C **89**, 034624 (2014).
17. *Precise comparison of the Gaussian expansion method and the Gamow shell model,* H. Masui, K. Kato, N. Michel, M. Płoszajczak, Phys. Rev. C **89**, 044317 (2014).
18. *Probing nuclear forces beyond the drip-line using the mirror nuclei ^{16}N and ^{16}F,* I. Stefan *et al.,* Phys. Rev. C **90**, 014307 (2014).
19. *Bound and resonance states of the dipolar anion of hydrogen cyanide: competition between threshold effects and rotation in an open quantum system,* K. Fossez, N. Michel, W. Nazarewicz, M. Ploszajczak, Y. Jaganathen, Phys. Rev. A **91**, 012503 (2015).
20. *Description of the proton and neutron radiative capture reactions in the Gamow shell model*, K. Fossez, N. Michel, M. Płoszajczak, Y. Jaganathen, and R. M. Id Betan, Phys. Rev. C **91**, 034609 (2015).

21. *The No-Core Gamow Shell Model: Including the continuum in the NCSM*, B. R. Barrett, G. Papadimitriou, N. Michel, M. Płoszajczak, Proceedings of the 14th International Conference on Nuclear Reaction Mechanisms, Varenna (Italy), June 15-19, 2015.
22. *Consistent analysis of one-nucleon spectroscopic factors involving weakly- and strongly-bound nucleons*, J. Okołowicz, Y.H. Lam, M. Płoszajczak, A.O. Macchiavelli, N.A. Smirnova, Phys. Lett. B **757**, 303 (2016).
23. *Light cluster production at NICA*, N. U. Bastian, P. Batyuk, D. Blaschke et al. Eur. Phys. J. A **52**, 244 (2016).
24. *Nuclear rotation in the continuum*, K. Fossez, W. Nazarewicz, Y. Jaganathen, N. Michel, M. Płoszajczak, Phys. Rev. C **93**, 011305 (2016).
25. *Resonant spectra of quadrupolar anions,* K. Fossez, Xingze Mao, W. Nazarewicz, N. Michel, W.R. Garrett, M. Płoszajczak, Phys. Rev. A **94**, 032511 (2016).
26. *Symmetries and deformations in the spherical shell model,* P. Van Isacker, S. Pittel, Phys. Scr. **91**, 023009 (2016).
27. *Properties of isoscalar-pair condensates,* P. Van Isacker, A.O. Macchiavelli, P. Fallon, S. Zerguine, Phys. Rev. C **94**, 024324 (2016).
28. *Astrophysical S-factor for 6Li(p,g)7Be in the coupled-channel Gamow shell model,* G.X. Dong, K. Fossez, N. Michel, M. Płoszajczak, J. Phys. G: Nucl. Part. Phys. **44**, 045201 (2017).