



**Western Michigan University**  
**College of Arts and Sciences**



**Department of Physics**  
**RESEARCH REPORT**  
July 1, 2014–June 30, 2015

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## **Introduction**

This issue marks the 43<sup>rd</sup> in a series of Research Reports issued by the Department of Physics at Western Michigan University. These reports summarize the research activities done by the faculty and their students, including publications, presentations (invited and contributed), research proposals (submitted and awarded), notable awards and memberships, and Ph.D. and master's degrees granted. In addition, this issue presents a spotlight on the work of one of our new faculty researchers, Dr. Zbigniew Chajecki, who joined our faculty in the fall of 2014. Again, as noted in the previous report recently published, the present issue differs from those in the past and does not include summaries of the research done by all of our active faculty. It is planned to continue with a research spotlight for each issue of this report. The present report covers the period from July 1, 2014 through June 30, 2015. Hence, with this issue we are back to our earlier custom of issuing a report covering each academic year. A short look at this report will exhibit the substantial research activities of our faculty.

On a personal note, I would like to thank Ms. Jenny Snyder for her immense help in editing and preparing the report. Without her support, the report would not have been possible.

*John A. Tanis, Editor*

## **From the Chair**

In this edition of our research report, we have placed the spotlight on our newest faculty colleague, Dr. Zbigniew Chajecki, whose research in experimental nuclear physics probes two major problems today in astrophysics – the role of the rapid neutron capture process in the origin of elements heavier than iron, and the equations of state associated with core-collapse supernovae and neutron stars. As always, I thank all of my colleagues for their assistance in documenting the many and varied research activities in the department.

*Kirk T. Korista, Chair*

**Research Spotlight**  
**ZBIGNIEW CHAJECKI, PH.D.**



Zbigniew ChajECKI joined the WMU Department of Physics in fall 2014. Dr. ChajECKI received the Ph.D. in nuclear physics in 2009 from the Ohio State University, where his dissertation research focused on global conservation laws and two-particle correlations at the Relativistic Heavy Ion Collider. Following that, he joined the National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University as a research associate before coming to WMU.

Dr. ChajECKI's research is in the area of nuclear astrophysics. His main focus is on various aspects of nuclear physics that allow us to better understand astrophysical environments like the creation of heavy elements and astrophysical objects like neutron stars.

Two major questions drive Dr. ChajECKI's research interests and program at WMU:

*I) What are the fission probabilities of nuclei near the termination of the r-process path?*

The r-process is a nucleosynthesis process that occurs in an astrophysical environment and is responsible for the creation of about half of the nuclei heavier than iron. The neutron-rich nuclei are created by rapid neutron capture of heavy seed nuclei (e.g.,  $^{56}\text{Fe}$ ). Despite the recent scientific progress in this area there are still a lot of unknowns about the r-process such as the astrophysical sites where the process occurs.

*II) What is the symmetry term of the nuclear equation-of-state at densities and asymmetries approaching those of neutron stars?*

Neutron stars are fascinating astrophysical objects that have relatively small sizes (about 11 km in radius) but very large masses (about 2 solar masses, which is roughly 600,000 times more massive than the Earth). Moreover, they are mostly composed of neutrons (up to 95 percent). To understand the interior of neutron stars, we have to improve our understanding of the Equation of State of nuclear matter and its density dependence, in particular the symmetry energy.

Dr. ChajECKI runs a research program to address these outstanding questions. The first component of his program is devoted to fission of exotic nuclei, the second focuses on the experimental constraints of the Equation of State of nuclear matter (question II). These two programs are outlined below.

## Research Activities

### I. Fission of exotic nuclei

Understanding nuclear fission is important in understanding the r-process as it has an impact on the abundance of heavy nuclei. The final r-process abundances may be affected by fission cycling, as fragments produced from the fission of heavy nuclei provide a source of seed nuclei that feed back into the r-process cycle. Beta-delayed and neutrino-induced fission may also play a role in limiting the r-process yields of thorium and uranium isotopes, which are cosmological chronometers. The current challenge is that most of the known fission barriers are for stable nuclei or those near stability. Therefore, theorists have to rely on extrapolations of known fission barriers to the neutron-rich side, introducing large uncertainties in the theoretical predictions. Thus, measurements of fission barriers and fission fragment distributions over a wide range of neutron-rich nuclei are crucial. Most of these nuclei cannot be directly measured and require an accurate extrapolation of measurements closer to the valley of stability.

To address those challenges, Dr. Chajecki has an experiment approved at the NSCL to measure the fission probabilities of  $^{196}\text{Pb}$ . The fission of  $^{196}\text{Pb}$  has not been measured yet, but the fission barriers are known for a few other isotopes of Pb, closer to the valley of stability. The new measurement will establish the isotropic trend in the fission barriers of Pb nuclei. Additionally, Dr. Chajecki proposed in his letter to the NSCL Program Advisory Committee (PAC) a development of samarium and erbium beams at the NSCL that will open new areas for investigations of the fission barriers of exotic nuclei that have not yet been explored. The letter received positive feedback emphasizing the commitment of the NSCL Lab to the fission program run by the PIs: “The PAC (Program Advisory Committee) views a program to investigate fission barriers as an important new scientific direction for the NSCL...” (NSCL PAC 38, 2014).

### 2. Equation of State of nuclear matter approaching neutron stars

Along with r-process nucleosynthesis, the subsequent nascent neutron star can be explored with a study of the symmetry term of the nuclear EOS, which governs nearly every macroscopic property of neutron stars. One of the most compelling questions concerns the density and momentum dependence of the symmetry energy, governing the extrapolation of the EOS to matter relevant to neutron star structure. In a neutron-rich system, the symmetry mean field potential repels neutrons and attracts protons; the magnitude of this effect depends strongly on the splitting of nucleon effective masses.

Dr. Chajecki has investigated observables related to this effect by measuring Sn+Sn collisions at  $E/A=50$  MeV and 120 MeV. From these studies, theoretical and experimental coalescence-invariant primordial neutron and proton spectra were constructed by combining free nucleons at a given velocity with those bound in light nuclei (clusters) moving at the same velocity. Comparisons of data to theoretical calculations (Improved Quantum Molecular Dynamics) suggest that the effective mass splitting evolves from  $m_n^* > m_p^*$  to  $m_n^* < m_p^*$  with increasing temperature or density. Additional data and theoretical studies with a wider range of transport models are urgently needed to resolve this issue.

In order to gauge the accuracy and efficacy of the coalescent-invariant models adopted, Dr. Chajecki is planning two approved experiments at the NSCL. The principal goal of those experiments is to measure particle spectra for protons, deuterons, tritons,  $^3\text{He}$  and alphas to obtain precise single and double coalescence-invariant neutron-to-proton ratios for heavy-ion collisions. This will place stringent constraints on the density and momentum dependence of the symmetry energy and benchmark the reliability of transport models that are required to extract effective mass constraints.

### **Opportunities for students**

Students working with Dr. Chajecki have unique opportunities to participate in a leading edge scientific program. A wide range of short- and long-term projects for undergraduate and graduate students originate from Dr. Chajecki's research interests. The opportunities will help students develop their programming skills, including the analysis of experimental data and modeling various aspects of nuclear physics while using large-scale computing farms. Students also have a chance for hands-on experience in working with electronics and particle detectors and an opportunity to be involved in the design process and the construction of the scientific equipment (e.g., detectors).

Chen Gongxiaohui, a former WMU student, participated in a low-energy nuclear physics experiment while doing research in Dr. Chajecki's group. Chen took several trips and spent 2 weeks in December 2014 at the NSCL where she was exposed to various aspects of research in experimental nuclear physics and had a unique opportunity to work with senior scientists in the field. Chen joined the Illinois Institute of Technology in 2015 as a graduate student.

Jared Foote, a second former member of Dr. Chajecki's group, was recently admitted to the graduate program at Indiana University. Jared was involved in building the Ion Chamber detector at WMU that will be used in the fission experiment. Two current members of the group, Om Bhadra Khanal (graduate student) and Justin Swaim (undergraduate student), are working on finishing the construction of the Ion Chamber detector.

**WMU Department of Physics**  
**Refereed Publications**

E. Gatuzz, **J. Garcia**, **C. Mendoza**, T. R. Kallman, **M. A. Bautista**, and **T. W. Gorczyca**, *Physical Properties of the Interstellar Medium Using High-resolution Chandra Spectra: O K-edge Absorption*, *Astrophys. J.* **790**, 131 (2014).

**M. M. Al-Amar**, **K. J. Hamam**, G. Mezei, R. Guda, **C. A. Burns**, *Stability and degradation of unencapsulated CuPc bilayer heterojunction cells under different atmospheric conditions*, *Solar Energy Mat. and Solar Cells* **121**, 152 (2014).

N. Kujala, A. Macrander, X. Shi, R. Reininger, **X. Gao**, and **C. Burns**, *Ray tracing simulation of 1-BM beamline at the Advanced Photon Source for polarization analyses of synchrotron optics*, *Proc. SPIE 9207*, Adv. X-Ray/EUV Optics and Comp. IX, 92070F (2014).

**K. J. Hamam**, **M. M. Al-Amar**, G. Mezei, R. Guda, and **C. Burns**, *High dielectric constant response of modified copper phthalocyanine*, *Jour. Mol. Liq.* **199**, 324 (2014).

K. W. Brown et al., **Z. Chajecki**, *Interplay between sequential and prompt two-proton decay from the first excited state of  $^{16}\text{Ne}$* , *Phys. Rev. C* **92**, 034329 (2015).

R.J. Charity et al., **Z. Chajecki**, *Spin alignment of excited projectiles due to target spin-flip interactions*, *Phys. Rev. C* **91**, 024610 (2015).

K. Wimmer, D. Bazin, A. Gade, J. A. Tostevin, T. Baugher, **Z. Chajecki**, D. Coupland, **M. A. Famiano**, T. K. Ghosh, G. F. Grinyer, M. E. Howard, M. Kilburn, W. G. Lynch, B. Manning, K. Meierbachtol, P. Quarterman, A. Ratkiewicz, A. Sanetullaev, R. H. Showalter, S. R. Stroberg, M. B. Tsang, D. Weisshaar, J. Winkelbauer, R. Winkler, and M. Youngs, *Elastic Breakup Cross Sections of Well-Bound Nucleons*, *Phys. Rev. C* **90**, 064615 (2014).

R. Shane et al., **Z. Chajecki**, *S $\pi$ RIT: A time-projection chamber for symmetry-energy studies*, *Nucl. Instrum. Meth.* **A784**, 513 (2015).

K. W. Brown et al., **Z. Chajecki**, *Two-proton decay from the isobaric analog state in  $^8\text{B}$* , *Phys. Rev. C* **90**, 027304 (2014).

K. W. Brown, R. J. Charity, L. G. Sobotka, **Z. Chajecki** et al., *Observation of long-range three-body Coulomb effects in the decay of  $^{16}\text{Ne}$* , *Phys. Rev. Lett.* **113**, 232501 (2014).

H. Agakishiev et al., **Z. Chajecki** [STAR Collaboration], *Event-plane dependent dihadron correlations with harmonic  $v_n$  subtraction in Au+Au Collisions at  $\sqrt{s_N} = 200$  GeV*, Phys. Rev. C **89**, 041901 (2014).

G. Jhang et al., **Z. Chajecki**, *Study of the Nuclear Symmetry Energy at  $p \sim 2p_0$  with  $S\pi RIT$ -TPC*, JPS Conf. Proc. **6**, 030136 (2015).

**M. Famiano**, R. Boyd, T. Kajino, T. Onaka, **K. Koehler** and **S. Hulbert**, *Determining Amino Acid Chirality in the Supernova Neutrino Processing Model*, Symmetry **6**, 909 (2014).

T. Kajino, A. Tokuhsa, G.J. Mathews, T. Yoshida and **M. A. Famiano**, *Ultra High-energy Neutrinos via Heavy-meson Synchrotron Emission in Strong Magnetic Fields*, ApJ **782**, 70 (2014).

N. Kobayashi, T. Nakamura, Y. Kondo, J.A. Tostevin, Y. Utsono, N. Aoi, H. Baba, **R. Barthelemy**, **M. A. Famiano**, et al., *Observation of a  $p$ -Wave One-Neutron Halo Configuration in  $^{37}\text{Mg}$* , Phys. Rev. Lett. **112**, 242501 (2014).

T. K. Steinbach, M. J. Rudolph, Z. Q. Gosser, **M. A. Famiano** et al., *Measuring the Fusion Cross-Section of Light Nuclei With Low-intensity Beams*, NIMA **743**, 5 (2014).

**M. F. Hasoglu**, **S. A. Abdel-Naby**, E. Gatuzz, **J. Garcia**, T. R. Kallman, **C. Mendoza**, and **T. W. Gorczyca**, *K-shell Photoabsorption of Magnesium Ions*, Astrophys. J Supp. **214**, 8 (2014).

E. Gatuzz, **J. Garcia**, T. R. Kallman, **C. Mendoza**, and **T. W. Gorczyca**, *ISMabs: A Comprehensive X-ray Absorption Model for the Interstellar Medium*, Astrophys. J **800**, 29 (2015).

T. G. Lee, C. P. Ballance, **S. A. Abdel-Naby**, J. L. King, **T. W. Gorczyca**, and M. S. Pindzola, *R-matrix with Pseudostates Study of Single Photon Double Ionization of Endohedral Be and Mg Atoms*, J. Phys. B **48**, 065201 (2015).

N. R. Badnell, G. J. Ferland, **T. W. Gorczyca**, **D. Nikolic**, and G. A. Wagle, *Bootstrapping Dielectronic Recombination from Second-row Elements and the Orion Nebula*, Astrophys. J **804**, 100 (2015).

P. Shekhar, M. Demonbrun, M. Borrego, C. Finelli, M. Prince, **C. Henderson**, and C. Waters, *Development of an Observation Protocol to Study Undergraduate Engineering Student Resistance to Active Learning*, Intern. Jour. Eng. Ed. **31**, 597 (2015).

M. McCormick, **R. S. Barthelemy**, and **C. Henderson**, *Women's Persistence into Graduate Astronomy Programs: The Roles of Support, Interest, and Capital*, Jour. Women and Minorities Sci. Eng., **20**(4), 317 (2014).



**R. Barthelemy**, M. McCormick, and **C. Henderson**, *Barriers Beyond Equity: An Exploratory Study of Women Graduate Students' Career Pathways in Astronomy. International, Jour. Gender, Sci. Tech.* **7** (2015).

B. Van Dusen, **R. S. Barthelemy**, and **C. Henderson**, *Educational trajectories of graduate students in physics education research*, *Phys. Rev. Spec. Top. – Phys. Ed. Res.* **10**, 020106 (2014).

K. T. Foote, **X. Neumeyer**, **C. Henderson**, M. H. Dancy, and R. J. Beichner, *Diffusion of research-based instructional strategies: The case of SCALE-UP*, *International Journal of STEM Education* **1**, 10 (2014).

K. Quardokus and **C. Henderson**, *Promoting Instructional Change: Using Social Network Analysis to Understand the Hidden Structure of Academic Departments*, *Higher Ed.* **70**, 315(2015).

**R. Khatri**, M. McCormick, and **C. Henderson**, *Understanding Women's Gendered Experiences in Physics and Astronomy Through Microaggressions*, Proceedings (peer reviewed) of the 2014 Physics Education Research Conference, P. V. Engelhardt, A. D. Churukian, and D. L. Jones (eds.), 38 (2015). College Park, MD: AAPT.

K. Foote, **X. Neumeyer**, **C. Henderson**, M. Dancy, and R. Beichner, *SCALE-UP Implementation and Intra-Institutional Dissemination: A Case Study of Two Institutions*, Proceedings (peer reviewed) of the 2014 Physics Education Research Conference, P. V. Engelhardt, A. D. Churukian, and D. L. Jones (eds.), 83 (2015). College Park, MD: AAPT.

**C. Henderson**, E. Marshman, A. Maries, E. Yerushalmi, and C. Singh, *Instructional Goals and Grading Practices of Graduate Students after One Semester of Teaching Experience*, Proceedings (peer reviewed) of the 2014 Physics Education Research Conference, P. V. Engelhardt, A. D. Churukian, and D. L. Jones (eds.), 111 (2015). College Park, MD: AAPT.

**R. Khatri**, **C. Henderson**, R. Cole, and J. Froyd, *Learning About Educational Change Strategies: A Study of the Successful Propagation of Peer Instruction*, Proceedings (peer reviewed) of the 2014 Physics Education Research Conference, P. V. Engelhardt, A. D. Churukian, and D. L. Jones (eds.), 131 (2015). College Park, MD: AAPT.

E. Yerushalmi, E. Marshman, A. Maries, **C. Henderson**, and C. Singh, *Grading Practices and Considerations of Graduate Students at the Beginning of their Teaching Assignment*, Proceedings (peer reviewed) of the 2014 Physics Education Research Conference, P. V. Engelhardt, A. D. Churukian, and D. L. Jones (eds.), 287 (2015). College Park, MD: AAPT.

**O. Abu-Haija**, **J. Harris**, A. Hasan, **A. Kayani**, and **E. Y. Kamber**, *Electron transfer reactions in collisions of Low Energy  $Ne^{q+}$  ( $q = 3 - 5$ ) Ions with  $CO_2$  and  $H_2O$  Molecules*, *Int. J. Mass Spect.* **385**, 19 (2015).

M. Leroux, K. J. Kihlstrom, S. Holleis, M. W. Rupich, S. Sathyamurthy, S. Fleshler, H. P. Sheng, D. J. Miller, S. Eley, L. Civale, **A. Kayani**, **P. M. Niraula**, U. Welp, W-K. Kwok, *Rapid Doubling of the Critical Current of  $YBa_2Cu_3O_{7-\delta}$  Coated Conductors for Viable High-speed Industrial Processing*, arXiv:1509.07556 (2015).

M. R. Baig, M. S. Algarawi, Mansoor Ali, S. S. Al-Ghamdi, **A. Kayani**, *Optical modifications induced by proton irradiation in PM-355 solid state nuclear detector*, J. Optoelec. Adv. Mat. **17**, 165 (2015).

C. Brennan, X. Pursley, R. O. Song, E. A. Torres-Isea, **A. Bokari**, **A. Kayani**, V. Sih, *Robustness of n-GaAs Carrier Spin Properties to 5 MeV Proton Irradiation*, Appl. Phys. Lett. **106**, 072403 (2015)

M. Goad, **K. Korista**, *Interpreting broad emission-line variations - I. Factors influencing the emission-line response*, Monthly Notices of the Royal Astronomical Society **444**, Issue 1, 43-61 (2014).

R. Edelson, **K. Korista** and 44 co-authors, *Space Telescope and Optical Reverberation Mapping Project. II. Swift and HST Reverberation Mapping of the Accretion Disk of NGC 5548*. Astrophys J **806**, Issue 1, article 129, 14 pp. (2015).

G. DeRosa, **K. Korista** and 49 co-authors, *Space Telescope and Optical Reverberation Mapping Project. I. Ultraviolet Observations of the Seyfert 1 Galaxy NGC 5548 with the Cosmic Origins Spectrograph on Hubble Space Telescope*. Astrophys J **806**, Issue 1, article 128, 15 pp. (2015).

**E. Litvinova**, *Isospin transfer modes in exotic nuclei*, EPJ Web of Conf. 93, 01019 (2015).

**E. Litvinova**, *Nuclear response theory with multiphonon coupling in a relativistic framework*, Phys. Rev. C 91, 034332 (2015).

**E. Litvinova**, B.A. Brown, D.-L. Fang, T. Marketin, R. G. T. Zegers, *Benchmarking nuclear models for Gamow-Teller response*, Phys. Lett. B 730, 307 (2014).

E. Lanza, A. Vitturi, **E. Litvinova**, D. Savran, *Population of dipole states via isoscalar probes: the splitting of pygmy dipole resonance in  $^{124}\text{Sn}$* , Phys. Rev. C 89, 041601(R) (2014).

I. Poltoratska, R. W. Fearick, A. M. Krumbholz, **E. Litvinova**, H. Matsubara, P. von Neumann-Cosel, V. Yu. Ponomarev, A. Richter, and A. Tamii, *Fine structure of the isovector giant dipole resonance in  $^{208}\text{Pb}$ : Characteristic scales and level densities*, Phys. Rev. C **89**, 054322 (2014).

L. Pellegrini, **E. Litvinova** and AGATA Collaboration, *Pygmy Dipole Resonance in  $^{124}\text{Sn}$  populated by inelastic scattering of  $^{17}\text{O}$* , Phys. Lett. B 738, 519 (2014).

Özel-Tashenov, J. Enders, H. Lenske, A. M. Krumbholz, **E. Litvinova**, P. von Neumann-Cosel, I. Poltoratska, A. Richter, G. Rusev, D. Savran, and N. Tsoneva, *Low-energy dipole strength in  $112,120\text{-Sn}$* , Phys. Rev. C **90**, 024304(2014).

**B. Rai** and **A. R. McGurn**, *Multiplicity of transmission coefficients in photonic crystal and split ring resonator waveguides with Kerr nonlinear impurities*, Phys. Rev. B **91**, 085113(2015).

**R. Taibu**, D. Rudge and **D. Schuster**, *Textbook Presentations of Weight: Conceptual Difficulties and Language Ambiguities*, Physical Review Special Topics: Physics Education Research, **11**, 010117 (2015).

J.-Y. Chesnel, Z. Juhász, E. Lattouf, **J. A. Tanis**, B. A. Huber, E. Bene, S. T. S. Kovács, P. Herczku, A. Méry, J.-C. Poully, J. Rangama, and B. Sulik, *Anion emission from water molecules colliding with positive ions: Identification of binary and many-body processes*, Phys. Rev. A **91**, 06070(R) (2015).

**D. Keerthisinghe**, **B. S. Dassanayake**, **S. J. Wickramarachchi**, N. Stolterfoht and **J. A. Tanis**, *Elastic and inelastic transmission of electrons through insulating polyethylene terephthalate nanocapillaries*, Phys. Rev. A **92**, 012703 (2015).

## Invited Presentations

**Z. Chajecki** et al., *Chemical potential scaling of the particle production in heavy ion collisions*, 4th International Symposium On Nuclear Symmetry Energy, Liverpool, England, July 7-9, 2014.

**Z. Chajecki**, et al., *Scaling properties of light-cluster production*, Fourth Joint Meeting of the Nuclear Physics Divisions of the American Physical Society and The Physical Society of Japan, Waikooloa Village, Hawaii, October 7-11, 2014.

**Z. Chajecki**, B. Tsang, W. Mittig, W. Lynch, **A. Kayani**, **P. Pancella**, D. Bazin, M. Cortesi, *Development of WeMATar (Western Michigan Active Target) - An active target time projection chamber for fast rare isotope beam experiments*, Active Target and Time Projection Chambers for Nuclear Physics Experiments Workshop, East Lansing, Michigan, May 18-20, 2015.

**T. W. Gorczyca**, *X-ray Absorption Spectroscopy in Atoms, and Extensions to Molecular and Solid-State Environments*, workshop titled Charge Exchange X-rays in Current and Future Astrophysical Research: To the Memory of Alex Dalgarno, Institute for Theoretical Atomic and Molecular Physics, Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, April 15, 2015.

**T. W. Gorczyca**, *Near-Threshold Phenomena in Dielectronic Recombination of  $S^{2+}$  and in Vibrationally-Resolved Photoionization of  $N_2$* , Southeast Laboratory Astrophysics Community (SELAC) Workshop titled Laboratory Astrophysics for Beyond Hubble: Fundamental Processes from the NIR to the FUV, Pine Mountain, Georgia, March 23, 2015.

**C. Henderson**, *The Knowledge-Practice Gap in Undergraduate STEM Instruction: How Big is it and Why Does it Exist?*, Invited Talk, Discipline Based Education Research Symposium, University of Nebraska-Lincoln, Lincoln, Nebraska, March 8, 2015.

**C. Henderson**, *Improving Undergraduate STEM Instruction: Lessons for Change Agents from each of the Four Core Changes Strategies*, Invited Talk, Seattle Pacific University, February 10, 2015.

**C. Henderson**, *“Plenary: Change in Higher Education: Improving Undergraduate STEM Teaching*, Invited Panelist, APLU Science and Mathematics Teaching Imperative 2015 National Conference, New Orleans, Louisiana, June 4, 2015.

**C. Henderson**, *Understanding Institutional Change, Engaging Institutional Leadership, and Assessing the Climate for Change*, Invited Talk, APLU Workshop on Engaging Faculty, New Orleans, Louisiana, June 5, 2015.

**C. Henderson**, *Increasing the Use of Evidence-Based Teaching in Undergraduate STEM: An Introduction to Four Core Change Strategies*, Invited Talk, Common Vision Workshop, Alexandria, Virginia, May 2, 2015.

**C. Henderson**, *Bridging the Knowledge-Practice Gap in Undergraduate Physics Education*, Invited Talk, American Physical Society 2015 April Meeting, Baltimore, Maryland, April 12, 2015.

**C. Henderson**, *Improving undergraduate STEM instruction: Lessons for change agents from each of the four core change strategies*, Invited Talk, Michigan State University STEM Center Colloquium, Lansing, Michigan, March 4, 2015.

**C. Henderson**, *The Challenges of Spreading and Sustaining Research-Based Instruction in Undergraduate STEM*, Invited Plenary Talk, Conference on Research in Undergraduate Mathematics Education, Pittsburgh, Pennsylvania, February 19, 2015.

**C. Henderson**, M. Dancy, and C. Turpen, *Evaluating Teaching Effectiveness: Lack of Alignment Between Instructors, Institutions, and Research Recommendations*, Invited Talk, American Association of Physics Teachers 2015 Winter Meeting, San Diego, California, January 5, 2015.

**C. Henderson**, *Instructor Use of Research-Based Pedagogy: Sources of Knowledge, Persuasion, and Support for Sustained Implementation*, Invited Talk, Integration of Strategies that Support Undergraduate Education in STEM: Linking Local & National Initiatives, Washington, DC, September 26, 2014.

**C. Henderson**, *Improving Undergraduate STEM Instruction: Using Complexity Leadership Theory to Plan for Emergent Change*, Invited Talk, University of Colorado Boulder DBER Group Meeting, Boulder, Colorado, December 3, 2014.

**C. Henderson**, *Funding from the National Science Foundation (NSF): Keys to a Successful Proposal*, Invited Workshop, WMU Research and Desserts, Kalamazoo, Michigan, October 31, 2014.

**C. Henderson**, *Using Complexity Leadership Theory to Plan for Emergent Change*, Invited Panelist and Workshop Leader, White House-CU Boulder STEM Education Workshop, Boulder, Colorado, September 22, 2014.

**C. Henderson**, *The Knowledge-Practice Gap in Physics Teaching: How Big Is it and Why Does it Exist?*, Invited Talk, American Association of Physics Teachers 2014 Summer Meeting, Minneapolis, Minnesota, July 28, 2014.

M. Dancy, K. Foote, R. Beichner, and **C. Henderson**, *A Widely Disseminated, Discipline Crossing, Radical Reform: The SCALE-UP Story*, Invited Talk, American Association of Physics Teachers 2014 Summer Meeting, Minneapolis, Minnesota, July 29, 2014.

E. Yerushalmi, E. Marshman, A. Maries, C. Singh, and **C. Henderson**, *From Instructional Goals to Grading Practices: The Case of Graduate TAs*, Invited Talk, American Association of Physics Teachers 2014 Summer Meeting, Minneapolis, Minnesota, July 30, 2014.

**E. Litvinova**, *Nuclear field theory in a relativistic framework: recent results on nuclear structure*, Nuclear Physics Seminar, GANIL (Caen, France), May 26, 2015.

**E. Litvinova**, *The impact of isospin dynamics on nuclear shell structure*, 5th Int. Workshop on Nuclear Level Density and Gamma Strength, Oslo, Norway, May 18 - 22, 2015.

**E. Litvinova**, *Nuclear field theory in a relativistic framework: isospin dynamics and high-order correlations*, Nuclear Physics Seminar, Ohio University, April 7, 2015.

**E. Litvinova**, *Nuclear field theory in a relativistic framework*, Triangle Nuclear Theory Colloquium, University of North Carolina, Chapel Hill, North Carolina, December 2, 2014.

**E. Litvinova**, *Theoretical models for superheavy nuclei: Density functional theory and beyond, Summary talk on theory strategies for superheavy elements*, ECOS-ENSAR Town Meeting, Orsay, France, October 28-31, 2014.

**E. Litvinova**, *Isospin transfer modes in exotic nuclei*, International Symposium on Capture Gamma-Ray Spectroscopy 15, Dresden, Germany, August 25-29, 2014.

**E. Litvinova**, *Nuclear field theory in a relativistic framework: recent developments and applications*, Nuclear theory seminar, TRIUMF, Vancouver, Canada, July 29, 2014.

**J. A. Tanis**, *Transmission of Electrons through Micrometer-sized Glass Capillaries and Differences with Ions*, 6<sup>th</sup> Conference on Elementary Processes in Atomic Systems (CEPAS 2014), July 9, 2014.

## Contributed Presentations

D. Macaluso, A. Mueller, A. Kerlin, D. Gross, **M. Bautista**, N. Sterling, **R. Bilodeau**, *Absolute Photoionization of  $Br^+$  and  $Rb3^+$  Ions for the Determination of Elemental Abundances in Astrophysical Nebulae*, 2015 APS Division of Atomic, Molecular and Optical Physics Meeting, Columbus, Ohio, June 8-12, 2015.

**M. Teodoro**, T. R. Gull, **M. Bautista**, D. J. Hillier, G. Weigelt, *On the changes in the physical properties of the ionized region around the Weigelt structures in  $\eta$  Carinae over the 5.54-yr spectroscopic cycle*, 2015 Meeting of American Astronomical Society, AAS Meeting #225, id.344.21.

N. Kujala, A. Macrander, X. Shi, R. Reininger, **X. Gao**, and **C. Burns**, *Ray tracing simulation of beamline 1-BM at the Advanced Photon Source for polarization analyses of synchrotron optics*, SPIE Conference on Advanced in X-ray/EUV Optics and Components IX, San Diego, California, August 19, 2014.

**M. A. Famiano**, *Induced Amino Acid Chirality from Strong Magnetic Fields in Interstellar Environments*, Astrobiology Science Conference 2015, Chicago, Illinois, June 15 - 19, 2015.

**I. Dumitriu**, **R. C. Bilodeau**, N. D. Gibson, C. W. Walter, **T. W. Gorczyca**, A. Aguilar, D. Rolles, Z. D. Pesic, and **N. Berrah**, *Inner-Shell Photodetachment of Nickel Negative Ions*, 46th Annual Meeting of the Division of Atomic, Molecular, and Optical Physics, Columbus, Ohio, June 8-12 2015.

**J. Kaur**, **T. W. Gorczyca**, and N. R. Badnell, *Near-Threshold Dielectronic Recombination Studies of Si-Like Ions*, 46th Annual Meeting of the Division of Atomic, Molecular, and Optical Physics, Columbus, Ohio, June 8-12, 2015.

**G. VanGyseghem**, **T. W. Gorczyca**, and C. P. Ballance, *Near-Threshold, Vibrationally-Resolved Photoionization of Molecular Nitrogen*, 46th Annual Meeting of the Division of Atomic, Molecular, and Optical Physics, Columbus, Ohio, June 8-12, 2015.

M. Rupich, A. Koshelev, D. Miller, K. Kihlstrom, L. Civale, S. Eley, **A. Kayani**, S. Sathyamurthy, S. Fleshler, Q. Li, V. Solovyov, T. Ozaki, U. Welp, W.-K. Kwok, M. Leroux, *Engineered Pinning Landscapes for Enhanced 2G Coil Wire*, 12<sup>th</sup> European Conference on Applied Superconductivity, Lyon, France, September 6-10, 2015.

**C. Henderson**, *Improving Undergraduate STEM Education: Strategies for Institution- and Department-Level Change Initiatives*, STEM Education Colloquium, University of Illinois Urbana-Champaign, Urbana, Illinois, August 22, 2014.

**C. Henderson**, and A. Beach, *Using Complexity Leadership Theory to Plan for Emergent Change*, Contributed Session, APLU Science and Mathematics Teaching Imperative 2015 National Conference, New Orleans, Louisiana, June 4, 2015.

**C. Henderson**, and J. Froyd, *A How-To Guide for Education Developers Who Want to Increase the Impact of Their Work*, Contributed Workshop, National Organization of Research Development Professionals 2015 Annual Research Development Conference, Bethesda, Maryland, May 1, 2015.

C. Ogilvie and **C. Henderson**, *Achieving Large-scale STEM Education Improvement at a Research University*, Contributed Talk, Transforming Institutions: 21<sup>st</sup> Century Undergraduate STEM Conference, Indianapolis, Indiana, October 24, 2014.

**E. Walter**, A. Beach, **C. Henderson**, and C. Williams, *Measuring Postsecondary Teaching Practices and Departmental Climate: The Development of Two New Surveys*, Contributed Talk, Transforming Institutions: 21st Century Undergraduate STEM Conference, Indianapolis, Indiana, October 24, 2014.

**E. M. Walter**, A. L. Beach, **C. Henderson**, and C. T. Williams, Development and preliminary validation of the Survey of Climate for Instructional Improvement (SCII). Paper presented at the Annual Conference for the American Educational Research Association, Chicago, Illinois, April 2015.

**E. M. Walter**, **C. Henderson**, A. L. Beach, and C. T. Williams, *Development and preliminary validation of the Postsecondary Instructional Practices Survey (PIPS)*, Paper presented at the Annual Cof the American Educational Research Association, Chicago, Illinois, April 2015.

C. Williams, **E. M. Walter**, **C. Henderson**, A. L. Beach, and C. T. Williams, *Describing undergraduate STEM teaching practices: A comparison of instructor self-report instruments* Paper presented at the Annual Conference of the National Association for Research in Science Teaching, Chicago, Illinois, April 2015.

K. Grunert, **C. Henderson**, A. Beach, and **E. Walter**, Training faculty with the Teaching Dimensions Observation Protocol (TDOP): Process and pitfalls. Presented at the 246th National Meeting of the American Chemical Society, Denver, Colorado, March 2015.

**A. Knaub**, **C. Henderson**, R. Beichner, M. Dancy, and K. Foote, *Understanding the Spread of Research-Based Instructional Strategies: A Case Study of SCALE-UP*, Contributed Talk, APS March Meeting 2015, San Antonio, Texas, March 5, 2015.



W. Christensen, L. Lee, **C. Henderson**, and M. Dancy, *How Do Student Evaluations of Instruction Relate to Students' Conceptual Learning Gains*, Contributed Talk, American Association of Physics Teachers 2015 Winter Meeting, San Diego, California, January 5, 2015.

E. Marshman, A. Maries, C. Singh, E. Yerushalmi, and **C. Henderson**, *From Instructional Goals to Grading Practices: The Case of Graduate TAs*, Contributed Poster, American Association of Physics Teachers 2014 Summer Meeting, Minneapolis, Minnesota, July 29, 2014.

K. Foote, **X. Neumeyer**, **C. Henderson**, M. Dancy, and R. Beichner, *Studying the Spread of Research-Based Instructional Strategies: Rich Case Study of SCALE-UP*, Contributed Talk, American Association of Physics Teachers 2014 Summer Meeting, Minneapolis, Minnesota, July 29, 2014.

**R. Khatri** and **C. Henderson**, *The Propagation of Peer Instruction: A Case Study*, Contributed Talk, American Association of Physics Teachers 2014 Summer Meeting, Minneapolis, Minnesota, July 30, 2014.

K. Foote, **X. Neumeyer**, **C. Henderson**, M. Dancy, and R. Beichner, *Diffusion of Research-Based Instructional Strategies: The Case of SCALE-UP*, Contributed Poster, American Association of Physics Teachers 2014 Summer Meeting, Minneapolis, Minnesota, July 29, 2014.

**E. Litvinova**, *Impact of isospin dynamics on nuclear shell structure*, International Nuclear Physics Conference 'Nuclear Structure and Dynamics', Portoroz, Slovenia, June 14-19, 2015.

**E. Litvinova**, *Isospin transfer modes in exotic nuclei*, DNP Meeting 2014, Hawaii, October 7-11, 2014.

**R. Taibu** and **D. Schuster**, *Teaching and Assessing Conceptual and Language Issues: Learning Gains and Students' Views*, Michigan section of the American Association of Physics Teachers, Flint, Michigan, April 2015.

**J. A. Tanis**, **S. J. Wickramarachchi**, T. Ikeda, *Electron transmission through micrometer-sized glass capillaries and differences with ions*, 6<sup>th</sup> Conference on Elementary Processes in Atomic Systems, Bratislava, Slovakia, July 2014, Contributed Papers, p. 9.

**D. Keerthisinghe**, **B. S. Dassanayake**, **S. J. Wickramarachchi**, N. Stolterfoht and **J. A. Tanis**, *Elastically and inelastically transmitted electrons through insulating PET nanocapillaries*, 6th Conference on Elementary Processes in Atomic Systems, Bratislava, Slovakia, July 2014, Contributed Papers, p. 194.

**S. J. Wickramarachchi**, T. Ikeda, **D. Keerthisinghe**, **B. S. Dassanayake** and **J. A. Tanis**, *Elastic and inelastic guiding of electrons through micrometer-sized funnel-shaped glass capillaries*, 6th

Conference on Elementary Processes in Atomic Systems, Bratislava, Slovakia, July 2014, Contributed Papers, p. 273.

**P. N. S. Kumara, A. Kayani and J. A. Tanis**, *Radiative double electron capture by bare ions*, 17<sup>th</sup> International Conference on the Physics of Highly Charged Ions, Bariloche, Argentina, September 2014, Book of Abstracts, p. 57.

**N. Kumara, A. Simon, D. La Mantia, A. Kayani and J. A. Tanis**, *Search for radiative double electron capture (RDEC) by fully-stripped ions in gas targets*, 46th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, Columbus, Ohio, June, 2015, Bull. Am. Phys. Soc. **60** (2015), Abstract ID: BAPS.2015.DAMOP.P5.3.

### External Grant Activity (Submitted and Awarded)

**M. A. Bautista, PI**, National Science Foundation, *From Stars to Active Galactic Nuclei. Photoionization, Photoexcitation, Opacities, and Spectra of Low Ionization Fe-peak Species*, Awarded \$602,160 for the period August 15, 2013 – July 31, 2016.

**M. A. Bautista (PI), T. W. Gorczyca (Co-PI)**, T. R. Kallman, **C. Mendoza**, C. P. Ballance, and M. Bergemann, NSF Division of Astronomical Sciences (AST) Program, *From Stars to Active Galactic Nuclei. Photoionization, Photoexcitation, Opacities, and Spectra of Low Ionization Fe-peak Species*, funded \$600,000 for period January 1, 2014 – December 31, 2016.

**M. A. Bautista, PI**, University of West Georgia (contracted by National Science Foundation), *Expanding the Atomic Database for Nebular and Stellar Neutron-Capture Abundance Determinations*, Awarded \$18,927 for the period August 1, 2014 – July 31, 2015.

**M. A. Bautista, PI**, NASA Project, *Atomic Data for X-ray Photoabsorption by Trace Elements*, Awarded \$60,586 for the period June 1, 2015 – May 30, 2018.

**C. A. Burns, PI**, U. S. Department of Energy, Basic Energy Sciences Program – Materials Science, *Resonant Inelastic X-ray Scattering Studies with Polarization Analysis*, Awarded \$300,000 for the year period from June 1, 2012 – August 31, 2016.

**C. Burns, PI, L. Paulius, co-PI**, National Science Foundation. *Proposal for an REU Site in Physics at Western Michigan University*, Requested \$354,617 (not awarded).

**Z. Chajecski, PI**, National Science Foundation, *Probing Nuclear Matter using stable and radioactive beams with focus on observables relevant to astrophysics: the r-process and neutron stars*, Requested (not awarded) \$633,245.

**Z. Chajecski, PI**, National Science Foundation Major Research Instrumentation, *MRI: Development of WeMATar (Western Michigan Active Target) – An active target time projection chamber for fast rare isotope beams*. Requested \$555,516 (not awarded).

**T. W. Gorczyca, PI**, NASA Chandra Project, for project titled *Comprehensive X-Ray Absorption Models for Oxygen and Neon*, funded \$60,000 for period January 1 – December 31, 2014.

**C. Henderson, PI**, Iowa State University HHMI Subcontract Award, *Assessing the Impact of the Iowa State HHMI Project 2.0*. Awarded \$117,684 for the period October 1, 2014 – September 30, 2019.

**C. Henderson, PI**, NSF University of Michigan Subcontract, *Assessing the Impact of the UM REBUILD Project*. Awarded \$103,699 for the period October 1, 2014 – September 30, 2016.

**C. Henderson, Co-Director** (with A. Beach, Co-Director), US Department of Education *Fulfilling the Promise: Institutional Transformation to Support Student Success*. Awarded \$3,217,512 for the period October 1, 2014 – September 30, 2018.

**C. Henderson, PI**, NSF IUSE, *Collaborative Research: Understanding and Reducing Student Resistance as a Barrier to Faculty Change*. Awarded \$37,846 for the period September 1, 2013 – August 31, 2016. (This is one of four collaborative proposals, with total project funding of \$500,000. Collaborating PIs are Cinthia Finelli, U of MI, Michael Prince, Bucknell, Lisa McNair, VA Tech, Cindy Waters, North Carolina A&T.)

**C. Henderson, PI** (with A. Beach, T. Greene, M. Grunert, and S. Stapleton, Co-PIs), NSF WIDER, *WIDER: EAGER: Evidence-based Instructional Practices at WMU: An Examination of Instructor Practices, Institutional Climate, and Social Networks*, Awarded \$299,536 for the period September 14, 2012 – August 31, 2014.

**C. Henderson, PI**, NSF TUES, *Collaborative Research: Sustainable Diffusion of Research-Based Instructional Strategies: A Rich Case Study of SCALE-UP*. Awarded \$190,852 for the period September 1, 2012 – August 31, 2015. (This is one of three collaborative proposals, with total project funding of \$599,991. Collaborating PIs are M. Dancy, University of Colorado Boulder, and B. Beichner, North Carolina State University.)

**C. Henderson, PI**, NSF TUES, *Collaborative Research: Increasing the Impact of TUES Projects through Effective Propagation Strategies: A How-To Guide for PIs*. Awarded \$506,206 awarded for the period January 1 2012 – December 31, 2015. (This is the lead of three collaborative proposals, with total project funding of \$814,878. Collaborating PIs are R. Cole, University of Iowa, and J. Froyd, Texas Engineering Experiment Station.)

**C. Henderson, PI**, Iowa State HHMI Subcontract, *Assessing the Impact of the Iowa State HHMI Project*. Awarded \$114,216 for the period November 14, 2010 – August 31, 2014.

**A. N. Kayani**, Argonne National Laboratory, Summer Support, Awarded \$20,000.

**E. Litvinova, PI**, National Science Foundation, *Spin-isospin response of exotic nuclei: fine structure, quenching and beta-decay properties*. Awarded \$284,233 for the period September 1, 2014 – August 31, 2017.

**E. Litvinova, PI**, National Science Foundation, *Effects of superfluidity on nuclear spin-isospin response*. Awarded \$64,556.

I. Abdel-Qader, PI, **L. Paulius, co-PI**, National Science Foundation, *A Collaborative Mentoring Community Model for the Recruitment, Retention, and Career Advancement of Women in STEM*. Requested \$3,349,142 (not awarded).

U. Ramnarain (PI) and **D. Schuster (Collaborator)**, National Research Foundation, South Africa, *The Pedagogical Content Knowledge of Physical Science Teachers for Inquiry-Based Science Teaching*. 2013-2015 (completed).

**J. A. Tanis, PI, A. N. Kayani, Co-PI**, *Radiative Double Electron Capture (RDEC) of Ions with Quasi-Free Electrons*, National Science Foundation, Experimental Atomic and Molecular Physics Program, October 1, 2014 – September 30, 2017. Awarded \$133,532.

### Notable Awards and Memberships

**C. Henderson**, Senior Editor, Physical Review Special Topics – Physics Education Research, April 2012 to present.

**C. Henderson**, Co-Director (and Co-Founder), WMU Center for Research on Instructional Change in Postsecondary Education, May 2014 – Present.

**C. Henderson**, Secretary/Treasurer, American Physical Society Forum on Education, March 2014 to March 2017 (elected position).

**A. N. Kayani**, Member Proposal Review Committee, Nuclear Energy University Program, Department of Energy.

**J. A. Tanis**, *Conference on Elementary Processes in Atomic Systems (CEPAS)*, Guest Editor for Conference Proceedings published in European Physics Journal D, 2014-15.

## Doctoral Dissertations

**Bedoor, Shadi.** *Structural Evolution in the Neutron Rich-Nuclei 14B.* Committee chairperson: Alan Wuosmaa, Ph.D., summer II 2014.

**Keerthisinghe, Darshika.** *Energy, Angular and Charge Deposition Dependence of Electron Transmission through Insulating Polyethylene Terephthalate Nanocapillaries for Narrow Beam Production.* Committee chairperson: John Tanis, Ph.D., spring 2015

**Wickramarachchi, Samanthi.** *Electron Transmission through Micrometer Sized Funnel-shaped Tapered Glass Capillaries and Electron Micro-beam Production.* Committee chairperson: John Tanis, Ph.D., summer I 2015.

## Department of Physics Personnel

### **Faculty**

Bautista, Manuel  
Burns, Clement  
Chajecki, Zbigniew  
Chung, Sung  
Gorczyca, Thomas  
Henderson, Charles  
Kaldon, Philip (part time)  
Kamber, Emanuel  
Kayani, Asghar  
Korista, Kirk (chair)  
Litvinova, Elena  
McGurn, Arthur  
Miller, Mark (part time)  
Pancella, Paul  
Paulius, Lisa  
Rosenthal, Alvin  
Ryan, Frank (part time)  
Schuster, David  
Skokov, Vladimir  
Tanis, John

### **Faculty Emeriti**

Bernstein, Eugene  
Halderson, Dean  
Hardie, Gerald  
Kaul, Dean  
Poel, Robert

### **Staff**

Gaudio, Benjamin  
Hoffmann, Chris  
Kern, Allan  
Krum, Lori  
Snyder, Jennifer  
Welch, Rick

### **Research Associates**

Knaub, Alexis  
Nolte, Jeffrey

Robin, Caroline  
Teodoro, Mairan  
Walter, Emily

### **Graduate Students**

Ahmed, Ehab Elsayed Elhoussieny  
Al-Fadhili, Fadhil Khalaf Dahash  
Al-Khayat, Rabee Behnam Kheder  
Alali, Hasna Abdullah M  
Alasmari, Aeshah Mushabbab A  
Alghamdi, Ahmed Abdulrahman A  
Almeshal, Abdelkareem Mohammed I  
Alshehab, Abdullah Ahmed F  
Awni, Rasha Abbas Abdullah  
Bedoor, Shadi  
Bokari, Eiman Ahmad  
Chakraborti, Priyanka  
Dibeh, Ali  
Dissanayake, Amila C.  
Egorova, Irina  
Iqbal, Shahid  
Jawad, Hind Jasim Jawad  
Jayathissa, Rasanjali  
Kaur, Jagjit  
Keerthisinghe, Darshika  
Khatri, Indiras  
Kumara, Pathirannehelage Nuwan Sisira  
La Mantia, David S.  
Madiligama Ralalage, Amila S B  
Mohammad, Hussein Khudhayer M  
Niraula, Prashanta Mani  
Razooqi, Mohammed Abdulwahhab  
Sabbar, Ehsan Hamyan  
Shabani Nezhad Navrood, Masoud  
Tunusi, Lubna Taher S  
VanGyseghem, Gaetan L.  
Wibowo, Herlik  
Wickramarachchi, Samantha J.  
Wickramarathna, Madhushani Wimarshana  
Yang, Jianqing