Western Michigan University
College of Arts and Sciences

Department of Physics
RESEARCH REPORT

July 1, 2015–June 30, 2016

Contents

Introduction

This issue marks the 44th in the series of Research Reports issued by the Department of Physics at Western Michigan University. These reports summarize the results of the research activities done by the faculty and their collaborators and students, listing 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 active faculty researchers, Dr. Michael Famiano, who again joined our faculty in the fall of 2015 after a brief hiatus of two years, while working at a software firm. The present report differs from those issued prior to the period January 1, 2013 – June 30, 2014 by not including summaries of the research of all active faculty, and, instead, focuses on the research of one of our faculty members. This research spotlight will continue for future issues of the report. The present report covers the period from July 1, 2015 - June 30, 2016. A quick perusal of this report exhibits the substantial research activities of our faculty.

John A. Tanis, Editor

From the Chair

As always, I thank all of my colleagues for their assistance in helping us document the many and varied research activities in the department. As noted in the Editor's introduction, Dr. Michael Famiano returned to the department at the start of the Fall 2015 semester, and hit the road running with his research in nuclear astrophysics. In this edition, we highlight some of his projects associated with the exploration of the origin of the elements. Welcome back, Mike!

Kirk T. Korista, Chair

Research Spotlight
Michael Famiano, Ph.D.

Heavy Element Production in Type II Supernovae
Collaborators: M.A. Famiano, T. Kajino (NAOJ), W. Aoki (NAOJ), & T. Suda (Tokyo)

Understanding the characteristics of dense nuclear matter has remained a significant question in nuclear physics today. Likewise, the origin of the elements has also drawn significant attention. This project ties both topics together by exploring the dependence of the r-process on the nuclear equation of state.

The r-process is thought to be responsible for the production of over half of the elements heavier than iron and nearly all of the actinides. The nuclear equation of state (EOS) describes the relationship between pressure and density in nuclear matter. A phenomenological model has been developed in which the enrichment of light r-process elements (relative to heavy r-process elements) in metal-poor and extremely-metal-poor stars (EMPs) is found to depend on the stiffness of the nuclear equation of state. Here, an r-process is assumed in which an explosion scenario is halted due to an accretion-induced collapse and a subsequent failed or partial explosion, followed by partial ejection of r-process material. Nucleosynthesis then results in an abundance distribution enriched in the light r-process elements. Initial results suggest that a possible upper limit on the stiffness of the EOS may be constrained by observations, which could complement results of neutron star masses which place lower limits on the EOS stiffness. Additional work is being done to examine neutrino spectra in collapse scenarios and their sensitivity to the EOS.

In this model, we examine logarithmic ratios, in which the mass fractions of two elements A and B are compared to their ratio in the solar system; $[A/B] = \log (A/B)_{*} - \log (A/B)_{sun}$. The model is not only capable of producing extremes in [Sr/Ba] and [Sr/Eu] at very low metallicity, but it is shown to relate the nuclear equation of state (EOS) to the observed upper limits in [Sr/Ba] and [Sr/Eu]. A softer EOS suggests an enhancement of light r-process elements in the early galaxy.

We have explored a previously-proposed model, referred to as the “tr-process” (Boyd et al. 2012), which assumes an r-process in a core-collapse scenario which is halted due to an accretion-induced collapse into a BH or a stalled shock. The model attempts to explain the maximum [Sr/Ba] ejected in a single r-process event; we note that reductions in this ratio may result from mixing between outer and inner ejecta in the explosion or from asymmetric explosion mechanisms. We also note that the observed large values of [Sr/Fe], [Ba/Fe], and [Eu/Fe] (so-called r-II stars) can be reproduced by turbulent ejection (as suggested in Aoki et al. (2013)). The results presented here represent one potential avenue for producing these extremes.

The calculated [Sr/Ba] values are also shown in Figure 1 compared to observed values in the galaxy. The significant changes in the Ba ejection in a collapse scenario results in a dramatic change in the [Sr/Ba] (and [Sr/Eu]) ratios. In a previous paper (Aoki et al. 2013), changes in [Sr/Ba] were suggested to be caused at least in part by turbulent ejection of material in a collapse scenario. It is seen that for a softer EOS, the maximum values in [Sr/Ba] as a function of metallicity can be achieved in a tr-process for partial enrichment of r-process elements in a GCE model. As noted above, the GCE results shown in these figures represent extremes in these ratios as they are produced in collapse scenarios corresponding to the minimum collapse time to a BH. In examining the abundance ratios of [Sr/Ba] as they relate to the EOS, one sees that these ratios generally increase as the EOS softens. However, at some point, the EOS becomes so soft that the collapse time becomes early enough to prohibit Sr ejection, and the ratios of [Sr/Ba] begin to decrease with the softness of the EOS. This may occur for an EOS with a softness somewhere between the Shen EOS and the LS220 EOS, as one sees that the [Sr/Ba] ratios calculated using an LS220 EOS drop below those calculated using a Shen EOS at metallicities -2.5<[Fe/H]<-2.

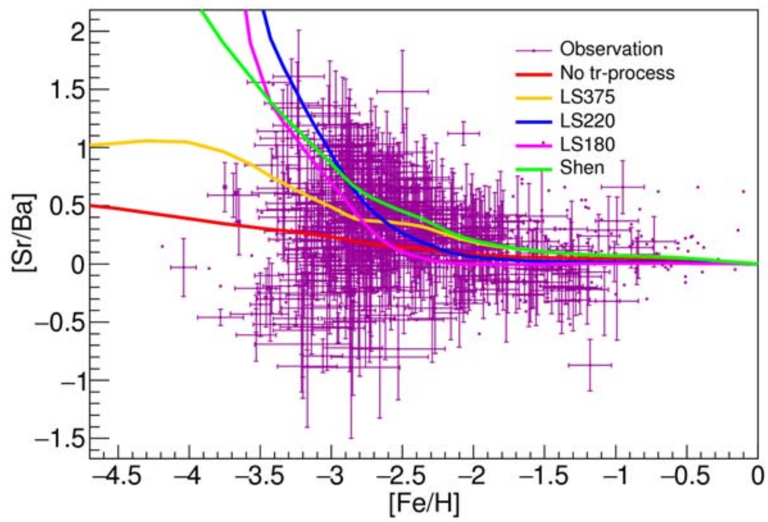

Figure 1. [Sr/Ba] as a function of [Fe/H] for several EOS assumptions compared to observation.

Nuclear Physics Inputs to Type Ia Supernovae

Collaborators: K. Mori (Tokyo), M.A. Famiano, T. Kajino (NAOJ), T. Suzuki (Nihon), J. Hidaka (Meisei), M. Honma (Aizu), K. Iwamoto (Nihon), K. Iwamoto (Tokyo), & T. Otsuka (Tokyo)

Recent experimental results have confirmed a possible reduction in the GT_+ strengths of pf-shell nuclei. These strength functions are directly related β-decay and electron-capture reaction rates. The pf-shell proton-rich nuclei are of relevance in the deflagration and explosive burning phases of Type Ia supernovae. While prior GT strengths result in nucleosynthesis predictions with a lower-than-expected electron fraction, a reduction in the GT_+ strength can result in a slightly increased electron fraction compared to previous shell model predictions, though the enhancement is not as large as previous enhancements in going from rates computed based on an independent particle model.

A shell model parametrization has been developed which more closely matches experimental GT strengths. The resultant electron-capture rates are used in nucleosynthesis calculations for carbon deflagration and explosion phases of Type Ia supernovae, and the final mass fractions are compared to those obtained using more commonly-used rates. The GT strength function for the GXP-type shell model calculation is compared to experimental results and previous evaluations in Figure 2.

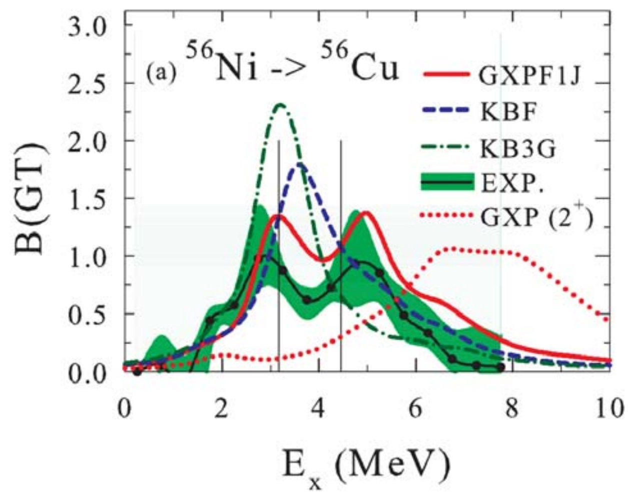

Figure 2. GT strength function for ^{56}Ni compared to experiment and KB-type evaluations.

Type Ia supernovae are thought to result from accreting C-O white dwarfs (WDs) in close binaries (Hoyle & Fowler 1960; Arnett 1996; Hillebrandt & Niemeyer 2000; Boyd 2008; Illiadis 2008). (Here we denote type Ia supernovae as “SNe Ia” and a single type Ia supernova as “SN Ia.”) If the WD reaches a certain critical condition, thermonuclear burning ignited in the electron-degenerate matter results in a cataclysmic explosion of the whole star. Material that is abundant in Fe-peak elements, including some neutron-rich ones, is ejected into the interstellar medium (ISM), contributing to chemical enrichment in galaxies. SNe Ia also play an important role in cosmology to measure the expansion rate of the Universe (Riess et al. 1998; Perlmutter et al. 1999; Schmidt et al. 2008).

The effects of the GXP-type shell model on proton-rich pf-shell nuclei with $23 \leq Z \leq 30$ are studied as they influence nucleosynthesis in SNe Ia. We have examined both stable and unstable nuclei in this region. In particular, the effect on the electron fraction as well as production ratios are evaluated. Mass fractions of nuclei produced in SNe Ia have been compared using both GXP parametrizations and KBF models. Trajectories of mass shells in a WD were used as input into a nuclear reaction network to gauge the effects of variations in nuclear physics inputs, and final nuclear mass fractions in individual shells were computed. Because of computational limitations, the explosion calculation is decoupled from the nuclear reaction network. However, the effects of the nuclear shell model used are evident in the resultant electron fractions and the final mass fractions. Comparisons to solar values indicate that the enhancement in electron fraction, which arises from using the GXP-type model, reduces the overall ^{58}Ni/^{56}Ni and ^{58}Ni/^{56}Fe ratios – though only slightly. This has been an interesting problem addressed by prior evaluations (Brachwitz et al. 2000; Iwamoto et al. 1999).

Screening in Stellar Environments
Collaborators: M. A. Famiano, A. B. Balantekin (Wisconsin), & T. Kajino (NAOJ)

If an astrophysical environment is hot enough (greater than approximately 0.5 MeV or so), screening in the associated nuclear reactions can be modified by the presence of a relativistic electron-positron plasma. For non-zero electron chemical potentials, the effect is compounded as the Debye length (which creates an additional decrease in Coulomb energy with radius between two reacting nuclei) in a plasma can drop significantly, resulting in amplified reaction rates. In a relativistic model, the Debye length decreases with temperature, as shown in Figure 3. The effect of screening is to shift the reaction energy in the cross-section. This can result in an enhancement of nuclear reaction rates, and the reaction rate enhancement factor is studied in several relevant scenarios. For sub- or near-threshold resonances, this could potentially change the reaction rates by a significant amount as the reaction energy effectively shifts the resonance above or below threshold. Possible sites where relativistic plasma screening could have a significant effect on observed results include Big Bang Nucleosynthesis, α-rich freezeout in the r-process, x-ray bursts, and type Ia supernovae in white dwarfs. Most recently, the effects of the screening due to the relativistic electron-positron plasma during the Big Bang Nucleosynthesis have been explored. While the effects of relativistic screening were found to be relatively small in the standard Early Universe models, further work is being done to explore the same effects in the above-mentioned astrophysical sites. Additional work is currently focused on possible effects on the production of ^{56}Ni in type Ia supernovae, effects on light curves (both frequency and duration) in x-ray bursts, and effects on the electron fraction in the astrophysical r-process following α-rich freezeout.

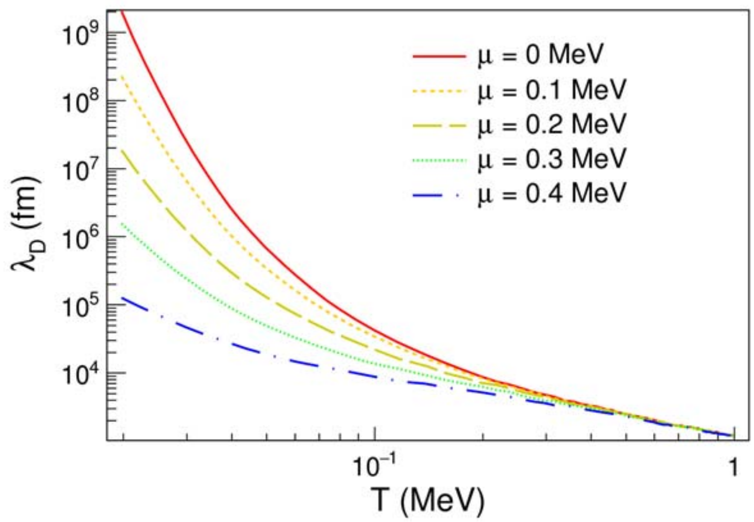

Figure 3. The Debye length for the ^{3}He + ^{7}Be reaction as a function of temperature (in MeV) for several electron chemical potential assumptions.

In this work we explored in detail the consequences of the screening due to the relativistic electron-positron plasma on non-resonant and possible resonances on the secondary reactions destroying A = 7 nuclei during the Big Bang Nucleosynthesis. We found that effects of screening from the relativistic plasma are small even for the reaction with the largest charge, namely ^{3}He + ^{7}Be. We note that this reaction is the least experimentally explored one in the network of BBN reactions.

Even though the effects we find are small, it still is worthwhile to demonstrate how robust our current understanding of the BBN is to effects not previously considered. This is especially important since the instruments scheduled to go online in the future, such as the Thirty Meter Telescope (Skidmore et al. (2015)), will measure the abundances of the light elements resulting from the BBN with greater precision.

Currently, we are concentrating on the effects of relativistic screening in other hot and dense environments, with a modification of the screening model to include higher-order effects.

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Talks

- Nuclear Equation of State Constraints from r-Process Abundance Ratios, University of Tokyo, July 2016.
- Nuclear Mass Measurements and the r-Process, Los Alamos National Laboratory, January 2016.

- Experimental Nuclear Astrophysics at WMU, Colloquium at WMU Physics Department, February 2016.
- Nuclear Astrophysics and the r-Process, Hope College Colloquium, January 2016. Nuclear Equation of State Constraints From r-Process Abundance Ratios, International Nuclear Physics Conference, Adelaide, Australia, September 2016.
- Relativistic Electron-Positron Plasma Screening In Astrophysical Environments, International Nuclear Physics Conference, Adelaide, Australia, September 2016.
- Nuclear Equation of State Constraints From r-Process Abundance Ratios, Nuclei in the Cosmos, Niigata, Japan, June 2016.
- Constraining the Neutron Star Equation of State With Galactic Chemical Evolution, Fourth Annual Workshop on Compact Objects in Michigan, Detroit, MI, March 2016.
- Nuclear Equation of State Constraints from r-Process Abundance Ratios, NAOJ-ECT* Workshop, Many Riddles About Core-Collapse Supernovae: Bethe and Beyond, Mitaka, Tokyo, Japan, June 27 - July 1, 2016.
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Refereed Publications

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M. Krzysiek, M. Kmiecik, A. Maj, P. Bednarczyk, A. Bracco, F.C.L. Crespi, E. Lanza, **E. Litvinova**, N. Paar et al., *Study of the pygmy dipole resonance in 140-Ce via inelastic scattering of 17-O*, <u>Phys. Rev.</u> C, 93, 044330 (2016).

E. Litvinova and P. Ring, *Nuclear shell structure and response with particle-vibration coupling*, Review Book Chapter, Ch. 11 in <u>Relativistic Density Functional for Nuclear Structure</u>, ed. J. Meng (World Scientific, 2016).

Umesh RamnaraIn, Dorothy Nampota & **David Schuster**, *The Spectrum of Pedagogical Orientations of Malawian and South African Physical Science Teachers towards Inquiry*, <u>African Journal of Research in Mathematics, Science and Technology Education</u> - Volume 20, Issue 2, 119-130 (2016).

S. J. Wickramarachchi, T. Ikeda, B. S. Dassanayake, D. Keerthisinghe, and **J. A. Tanis**, *Electron-beam transmission through a micrometer-sized tapered-glass capillary: Dependence on incident energy and angular tilt angle*, <u>Phys. Rev.</u> A 94, 022701 (2016).

D. Keerthisinghe, B. S. Dassanayake, S. J. Wickramarachchi, N. Stolterfoht and **J. A. Tanis**, *Transmission of electrons through insulating PET foils: Dependence on charge deposition, tilt angle and incident energy*, <u>Nucl. Instrum. Meth. Phys.</u> Res. B 382, 67 (2016).

S. J. Wickramarachchi, T. Ikeda, B. S. Dassanayake, D. Keerthisinghe and **J.A. Tanis**, *Incident energy and charge deposition dependences of electron transmission through a microsized tapered glass capillary*, <u>Nucl. Instrum. Meth. Phys.</u> Res. B 382, 60 (2016).

Invited Presentations

C. Burns, *How Low Can Synchrotron Studies Go*, Photon Sciences Seminar, SLAC Accelerator Laboratory, Palo Alto, CA, February 24, 2016.

M. Famiano, *Dependence of Elemental Abundance Ratios in Metal-Poor Stars on the Nuclear Equation of State*, 2nd NAOJ-ECT* Workshop: Many Riddles About Core Collapse Supernovae: 1 Bethe and Beyond, June 27 - July 1, 2016.

M. Famiano, *Nuclear Equation of State Constraints From r-Process Abundance Ratios*, Nuclei in the Cosmos XIV, Niigata, Japan, June 20-24, 2016.

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

M. Famiano, *Constraining the Neutron Star Equation of State With Galactic Chemical Evolution*, Compact Objects in Michigan, Wayne State University, Detroit, MI, March 21, 2016.

T. W. Gorczyca, *Oxygen K-Edge Cross Sections: Comparisons between Theory, Lab, and Observations, Chandra High Energy Transmission Grating (HETG) Group*, MIT Kavli Institute for Astrophysics and Space Research, Cambridge, MA, June 2, 2016.

C. Henderson, *Using Education Research to Improve Undergraduate STEM Teaching: Understanding and Reducing the Knowledge-Practice Gap*, Department of Engineering Education Seminar, The Ohio State University, Columbus, OH, March 24, 2016.

C. Henderson, *Increasing the Impact of Undergraduate STEM Educational Innovations*, Physics Education Research Seminar, The Ohio State University, Columbus, OH, March 24, 2016.

C. Henderson, *Academic Writing in Physics Education Research*, American Association of Physics Teachers Winter Meeting, New Orleans, LA, January 12, 2016.

C. Henderson, *Scaling and Sustaining Instructional Improvements: Four Core Change Strategies*, Next Generation Learning Spaces National Conference, Atlanta, GA, February 29, 2016.

C. Henderson, *Aligning Indicators with Change Strategies*, National Academy of Sciences Committee on Developing Indicators for Undergraduate STEM Education, January 22, 2016.

C. Henderson, Borrego, M. *Change Strategies*, Helmsley Charitable Trust Higher Education STEM Grantee Convening, New York, NY, October 8, 2015.

C. Henderson, *Using Education Research to Improve Undergraduate STEM Teaching: Understanding and Reducing the Knowledge-Practice Gap*, Gordon Research Conference on Undergraduate Biology Education Research, Lewiston, ME, July 13, 2015.

Christensen, W., Lee, L., Dancy, M., & **Henderson, C.**, *Student Evaluations of Instruction and Their Relation to Students' Conceptual Learning Gains*, American Association of Physics Teachers Summer Meeting, College Park, MD, July 27, 2015.

McCormick, M., Barthelemy, R., & **Henderson, C.**, *Women's Persistence in Undergraduate Astronomy: The Roles of Support, Interest, and Capital*, American Association of Physics Teachers Summer Meeting, College Park, MD, July 28, 2015.

E. Litvinova, *Recent progress and future directions of QCD-constrained nuclear structure models*, FRIB Theory Alliance Inaugural Meeting, NSCL/MSU, East Lansing, USA, March 31, 2016.

E. Litvinova, *Single-particle states, resonances and multiplets in relativistic nuclear field theory*, 3rd Topical Workshop on Modern Aspects in Nuclear Structure, Bormio, February 22-28, 2016.

E. Litvinova, *Recent progress on relativistic EFT/NFT: pion dynamics and high-order correlations*, NSCL/MSU Theory Seminar, Michigan State University, East Lansing, USA, September 29, 2015.

E. Litvinova, *Nuclear Field Theory in relativistic framework: isospin dynamics and high-order correlations*, XXII Nuclear Physics Workshop "Marie & Pierre Curie", Kazimierz Dolny, Poland, September 22-27, 2015.

E. Litvinova, *Many-body correlations in the structure of heavy nuclei: recent developments on relativistic models*, Humboldt Kolleg "Interfacing Structure and Reaction Dynamics", Trento, September 1-4, 2015.

E. Litvinova, *Nuclear Field Theory in a relativistic framework: pion dynamics and high-order correlations*, Nuclear Physics Seminar, University of Trento and INFN, Italy, July 13, 2015.

E. Litvinova, *Nuclear Field Theory in a relativistic framework: pion dynamics and high-order correlations*, Nuclear Physics Seminar, University of Milano and INFN, Italy, July 6, 2015.

J. A. Tanis, *Search for Radiative Double Electron Capture in Collisions of Bare Ions with Gaseous Targets*, Taller de Fisica Experimental, Cuernavaca, Mexico, 6 January 2016.

J. A. Tanis, *Radiative Double Electron Capture in Collisions of Bare Ions with Gaseous Targets*, Calvin College, Grand Rapids, Michigan, 5 April 2016

Contributed Presentations

G. VanGyseghem, **T. W. Gorczyca**, and C. P. Ballance, *Near-Threshold, Vibrationally-Resolved Photoionization of Molecular Nitrogen*, The 47th Annual Meeting of the Division of Atomic, Molecular, and Optical Physics, Providence, RI, May 23-27 (2016).

J. Kaur, **T. W. Gorczyca**, and N. R. Badnell, *Perturbative, R-matrix, and MCHF Treatments for Near-Threshold Dielectronic Recombination of Si-like Ions*, The 47th Annual Meeting of the Division of Atomic, Molecular, and Optical Physics, Providence, RI, May 23-27 (2016).

M. Wickramarathna, **T. W. Gorczyca**, C. P. Ballance, and W. C. Stolte, *Double Photoionization of Atomic Oxygen*, The 47th Annual Meeting of the Division of Atomic, Molecular, and Optical Physics, Providence, RI, May 23-27 (2016).

Khatri, R., **Henderson, C.**, Cole, R., Froyd, J., & Friedrichsen, D., *Professional Development Through an Online Workshop: Lessons Learned*, American Association of Physics Teachers Winter Meeting, New Orleans, LA, January 10, 2016.

Knaub, A., Walter, E., **Henderson, C.**, Beach, A., & Williams, C., *Interpreting Self-Reported Data from the Postsecondary Instructional Practices Survey (PIPS)*, American Association of Physics Teachers Winter Meeting, New Orleans, LA, January 11, 2016.

Marshman, E., Maries, A., Yerushalmi, E., & **Henderson, C.**, *From Instructional Goals to Grading Practices: The Case of Graduate TAs*, American Association of Physics Teachers Summer Meeting, College Park, MD, July 27, 2015.

C. Henderson, Cole, R., Froyd, J., Gilbuena, D., & Khatri, R., *Designing Educational Innovations for Sustained Adoption*, American Association of Physics Teachers Summer Meeting, College Park, MD, July 29, 2015.

Rundquist, A., Dancy, M., Corbo, J., **Henderson, C.**, & Martinuk, S., *Faculty Online Learning Communities to Support Physics Teaching*, American Association of Physics Teachers Summer Meeting, College Park, MD, July 29, 2015.

Khatri, R., **Henderson, C.**, Cole, R., & Froyd, J., *Characteristics of Well-Propagated Instructional Strategies and Materials Across STEM Disciplines*, American Association of Physics Teachers Summer Meeting, College Park, MD, July 29, 2015.

Knaub, A., **Henderson, C.**, Beichner, R., Foote, K., & Dancy, M., *From Idea to Implementation: Initiating Studio-Style Reforms in Academic Departments*, American Association of Physics Teachers Summer Meeting, College Park, MD, July 29, 2015.

Dancy, M., Foote, K., Knaub, A., **Henderson, C.**, & Beichner, R., *Promoting Sustained Radical Reforms: Enablers, Barriers and Impacts of Classroom Design*, Physics Education Research Conference, College Park, MD, July 29, 2015.

Khatri, R., **Henderson, C.**, Cole, R., Friedrichsen, D., Froyd, J., Stanford, *Characteristics of Well-Propagated Instructional Strategies Across STEM Disciplines*, Physics Education Research Conference, College Park, MD, July 30, 2015.

Knaub, A., Foote, K., **Henderson, C.**, Dancy, M., & Beichner, R., *From Idea to Implementation: The Initiation of A Studio-Style Reform in Departments*, Physics Education Research Conference, College Park, MD, July 30, 2015.

Rundquist, A., Dancy, M., Corbo, J., **Henderson, C.**, & Martinuk, S., *Faculty Online Learning Communities to Support Physics Teaching*, Physics Education Research Conference, College Park, MD, July 30, 2015.

Walter, E., Williams, C., **Henderson, C.**, Beach, A., & Kowalske, M., *Comparing Self-Report and Observational Data: An Investigation of Faculty Instructional Practices*, NARST 2016 International Conference, Baltimore, MD, April 16, 2016.

C. Henderson, *Making Change Happen: Promoting Productive Use of Evidence-Based Practices*, Working Group Facilitator, 2016 AAAS EnFUSE Symposium, Washington, DC, April 28, 2016.

Froyd, J., Cole, R., Stanford, C., **Henderson, C.**, Khatri, R., & Gilbuena, D., *Helping Principal Investigators of Educational Innovation and Development Projects Develop and Improve a Propagation Plan*, Poster Presentation, 2016 AAAS EnFUSE Symposium, Washington, DC, April 27, 2016.

P. N. S. Kumara, A. Simon, **D. S. La Mantia**, **A. Kayani** and **J. A. Tanis**, *Radiative double electron capture by bare ions in collisions with gas targets*, XXIX International Conference on Photonic, Electronic and Atomic Collisions (ICPEAC 2015), Toledo, Spain, July 2015, Jour. Phys.: Conf. Ser. 635, 092107 (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 H2O molecules colliding with positive O+ ions at keV energies: the role of dissociative excitation*, XXIX International Conference on Photonic, Electronic and Atomic Collisions (ICPEAC 2015), Toledo, Spain, July 2015, Jour. Phys.: Conf. Ser. 635, 032108 (2015).

B. Sulik, 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 J.-Y. Chesnel, *Two- and many-body effects in cation emission from H2O molecules by O+ impact at keV energies: Similarities between ionization of atoms and proton emission from molecules*, XXIX International Conference on Photonic, Electronic and

Atomic Collisions (ICPEAC 2015), Toledo, Spain, July 2015, Jour. Phys.: Conf. Ser. 635, 032118 (2015).

D. Keerthisinghe, B. S. Dassanayake, **S. J. Wickramarachchi**, N. Stolterfoht and **J. A. Tanis**, *Transmission of electrons through insulating PET foils: Charge deposition, angullar and energy dependence*, 21st International Workshop on Inelastic Ion-Surface Collisions (IISC-21), San Sebastian, Spain, October 2015, Book of Abstracts.

S. J. Wickramarachchi, T. Ikeda, B. S. Dassanayake, **D. Keerthisinghe** and **J.A. Tanis**, *Incident energy and charge deposition dependences of electron transmission through a microsized tapered glass capillary*, 21st International Workshop on Inelastic Ion-Surface Collisions (IISC-21), San Sebastian, Spain, October 2015, Book of Abstracts.

N. Kumara, **D. La Mantia**, **A. Kayani**, A. Simon and **J. A. Tanis**, *Radiative double electron capture (RDEC) by bare fluorine ions on a nitrogen target*, 47th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, Providence, RI, Bull. Am. Phys. Soc. 61 (2016), Abstract: J7.00009.

D. La Mantia, **N. Kumara**, **A. Kayani**, A. Simon and **J. A. Tanis**, *Single and double capture in F^{9+} + Ar collisions: Comparison of total capture with capture occurring from the Ar K shell*, 47th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, Providence, RI, Bull. Am. Phys. Soc. 61 (2016), Abstract: J7.00010.

External Grant Activity (Submitted and Awarded)

C. Burns, PI, U. S. Department of Energy, Basic Energy Sciences, Materials Science Program, *Resonant Inelastic X-ray Scattering Studies with Polarization Analysis*, Awarded $300,000 for the period June 1, 2012 – August 31, 2017.

Pnina Ari-gur, PI, **C. A. Burns**, co-PI, other Co-PIs include D. Fleming, M. Atashbar, J. Patten, National Science Foundation, Materials Research Instrumentation, *MRI: Acquisition of an X-Ray Diffraction System for Nanostructured and Advanced Materials Research and Research Education and Outreach*, Awarded $452,399 for the period August 1, 2016 – July 31, 2019.

Michael Famiano, PI, NASA Astrophysics Theory, *Characterizing the Nuclear Equation of State Using Spectroscopic Observables in Metal-Poor Stars*, Awarded $74,151 for the period February 2017 – February 2019.

Michael Famiano, PI, Student Support for Basic Research, Program: LANL LDRD, Awarded $60,000 for the period September 2016 – September 2019.

Michael Famiano, PI, U.S. Department of Energy, Nuclear Physics, *Nuclear Structure and Reactions of Astrophysical Interest*, Requested $633,785 for the period May 2017 - April 2020, pending.

Michael Famiano, PI, National Science Foundation, Astronomy and Astrophysics, *Sensitivity of Elemental Abundances in Metal-Poor Stars to the Nuclear Equation of State*, Requested $97,522 for the period June 2017 - May 2019, pending.

Zbigniew Chajecki, PI, **Michael Famiano**, co-PI, National Science Foundation *MRI: Development of An Active Target at Western Michigan University*, Requested $565,625 for the period October 2016 – September 2017, declined.

Michael Famiano, PI, National Science Foundation, Nuclear Physics, *Nuclear Structure and Reactions of Astrophysical Interest*, Requested $1,187,357 for the period June 2016 – May 2019, declined.

M. Famiano, WMU Support For Faculty Scholars Award, *Finding the Nuclear Equation of State Using Stellar Elemental Abundances*, Requested $1,931, September 15, 2016, awarded.

M. A. Bautista, PI, **T. W. Gorczyca,** co-PI, T. R. Kallman, C. Mendoza, C. P. Ballance, and M. Bergemann, co-PIs, NSF Division of Astronomical Sciences (AST) Program, *From Stars to Active Galactic Nuclei. Photoionization, Photoexcitation, Opacities, and Spectra of Low Ionization Fe-peak Species*. Awarded $600,000 for period 1/1/2014-12/31/2016.

T. W. Gorczyca, PI and **M. A. Bautista**, co-PI, NASA Astrophysics Research and Analysis Program, *A Consistent X-ray Photoabsorption Spectrum for Interstellar Atomic Gas and Silicate Dust*. Awarded $503,141 for period 1/1/2017-12/31/2019.

M. A. Bautista, PI and **T. W. Gorczyca**, co-PI, NASA Astrophysics Research and Analysis Program, *Atomic data for non-LTE analysis of n-capture elements in extremely metal poor stars*, Requested $500,000 for the period 1/1/2017-12/31/2019, declined.

T. W. Gorczyca, PI, NASA Chandra Project, *X-Ray Absorption Model for Atomic Silicon*. Requested $62,000 for period 1/1/2017-12/31/2017, declined.

C. Henderson, PI, A. Beach, co-PI, Helmsley Charitable Trust, *Accelerating Systemic Change: A Research Coordination Network to Transform STEM Education*, Awarded $290,397 for the period March 1, 2016 – February 28, 2019. (This is a subcontract from UT Austin to support the WMU portion of a larger project. Total project funding is $800,000 with collaborating PIs Maura Borrego, UT Austin; Susan Elrod, U Wisconsin Whitewater, Linda Slakey, AAU.)

C. Henderson, PI, Slakey, Elrod, Beach, Borrego, co-PIs, National Science Foundation, *Accelerating Systemic Change Network Inaugural Network Meeting*, Awarded $45,517 for the period July 14, 2016 – July 13, 2017.

C. Henderson, co-PI, Rasmussen, PI and Knaub, Quardokus-Fisher, co-PIs, National Science Foundation, *Exploring the Role of Instructors' Social Networks in Undergraduate STEM Instructional Improvement*, Awarded $49,974 for the period August 3, 2015 – August 2, 2016.

C. Henderson, PI, National Science Foundation, *Collaborative Research: Pathways to Impact: Institutionalizing Change in Engineering Education*, Submitted January 13, 2016, Requested $275,795, declined.

C. Henderson, PI, Slakey, Elrod, Beach, Borrego, co-PIs, National Science Foundation, *Accelerating Systemic Change: A Research Coordination Network to Transform STEM Education*, Submitted January 13, 2016, Requested $499,965, declined.

C. Henderson, co-PI, Horvitz, PI and Garza-Mitchell, DeCamp, co-PIs), National Science Foundation, *Development and Validation of Observational and Self-Report Instruments to Describe Teaching Practices in Online Undergraduate STEM Courses*, Submitted November 3, 2015, Requested $279,155, declined.

C. Henderson, PI, National Science Foundation, *Collaborative Research: How Do Students Respond to Active Learning? A Systematic Review of the Literature*, Submitted November 2, 2015, Requested $28,935, declined.

A. Kayani, PI, Argonne National Laboratory, Faculty and Student Support, *Ion-beam irradiation of high-temp superconductors*, Awarded $15,000, August 2015.

A. Kayani, PI, National Science Foundation, Condensed Matter Physics, Division of Materials Research, *Influence of ion beam induced defect structure and landscape on the vortex pinning characteristics of high temperature superconductor*, 2015-18. Requested $382,655, declined.

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 August 31, 2014 to September 1, 2017.

E. Litvinova, PI, National Science Foundation, *Nuclear superfluidity and spin-isospin response*, September 2013 – August 2016, Awarded $64,883, Status: completed.

E. Litvinova, PI, National Science Foundation CAREER Grant, *From fundamental interactions to emergent phenomena: geometrical aspects of nuclear dynamics*, Requested $590,029, pending.

Laura Tinigin, Peggy McNeal and **David Schuster**, Michigan Science Teachers Association Mini-grant (2015-2016), *Researching, writing and producing a booklet of historical vignettes for integrating history and philosophy of science into science topic teaching*.

J. A. Tanis, PI, and **A. N. Kayani**, co-PI, National Science Foundation, Experimental Atomic and Molecular Physics Program, *Radiative Double Electron Capture (RDEC) of Ions with Quasi-Free Electrons*, Requested $146,739, Awarded $133,532 for the period October 1, 2014 – September 30, 2017.

Notable Awards and Memberships

C. Burns, Member of Advanced Photon Source X-ray Echo Development Group.

T. W. Gorczyca, Fellow, American Physical Society (Division of Atomic, Molecular, and Optical Physics).

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

C. Henderson, Secretary/Treasurer, American Physical Society Forum on Education, March 2014 to present.

C. Henderson, Member, National Academy of Sciences Committee on Developing Indicators for Undergraduate STEM Education, 2015-18.

C. Henderson, Editor, *Getting Started in PER*, an edited volume for the AAPT series Reviews in PER.

A. Kayani, Proposal review committee; Nuclear Energy University program (NEUP), Department of Energy (DOE) initiative USA.

D. Schuster, Member of three-person academic review team conducting a formal Academic Review of the Hunter College Physics Department, for the City University of New York, May 2016.

J. A. Tanis, Highly Charged Ion (HCI) Conference, International Advisory Board, Kielce, Poland for meeting held September 2016. Helped to select and approve the list of conference speakers. Have been a member of the Board since 2010 meeting in Shanghai.

Doctoral Dissertations

Dissanayake, Amila. *Deposition and Characterization of Carbon Nanotubes (CNTs) Based Films for Sensing Applications.* Committee chairperson: Asghar Kayani, Ph.D., fall 2015.

Department of Physics Personnel

Faculty
Bautista, Manuel
Burns, Clement
Buss, Anna (part time)
Chajecki, Zbigniew
Chung, Sung
Famiano, Michael
Gorczyca, Thomas
Henderson, Charles
Kamber, Emanuel
Kayani, Asghar
Korista, Kirk (chair)
Litvinova, Elena
McGurn, Arthur
Miller, Mark (part time)
Pancella, Paul
Paulius, Lisa
Pervin, Muslema (term asst. prof.)
Rosenthal, Alvin
Ryan, Frank (part time)
Schuster, David
Tanis, John

Faculty Emeriti
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

Graduate Students
Ahmed, Ehab
Alali, Hasna Abdullah M
Alshehab, Abdullah Ahmed F
Bandara, Amila
Bokari, Eiman Ahmad
Dibeh, Ali
Dissanayake, Amila
Egorova, Irina
Iqbal, Shahid
Jayathissa, Rasanjali
Kaur, Jagjit
Khanal, Om Bhadra
Khatri, Indiras
Khatri, Raina
Koehler, Katrina Elizabeth
Kumara, Pathirannehelage Nuwan Sisira
La Mantia, David Scott
Lamichhane, Bipin
Niraula, Prashanta Mani
Sadaula, Dev Raj
Shabani Nezhad Navrood, Masoud
VanGyseghem, Gaetan L
Wibowo, Herlik
Wickramarathna, Madhushani Wimarshana
Yang, Jianqing