



Western Michigan University
College of Arts and Sciences



Department of Physics
RESEARCH REPORT
January 1, 2013 – June 30, 2014

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Introduction

This is the 42nd in a series of Research Reports issued by the Department of Physics at Western Michigan University. These reports summarize the results of the research activities by the faculty, 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 active faculty researchers, Dr. Elena Litvinova, who joined our faculty in the fall of 2013. This differs from past issues of the Research Report, which included summaries of the research of all of our active faculty. It is planned to continue this research spotlight for each issue of this report. The present report covers the period from January 1, 2013 through June 30, 2014, in variance from the past few years. With this issue we go back to our earlier custom of issuing a report covering each academic year. I hope that you will take a short look at this report exhibiting the substantial research activities of our faculty.

John A. Tanis, Editor

From the Chair

Welcome to the latest issue of our long-running series of Department of Physics Research Reports. The purpose of this volume is to illuminate and enumerate the research activities among the wide and varied program areas which our faculty and students have engaged in during the time period January 1, 2013 to June 30, 2014. While not exhaustive, it does also serve to encapsulate most of our research in a single document.

The department has begun undergoing significant change. During the time span of this report, our longtime colleague in nuclear theory, Dean Halderson, retired, and we hired a new colleague who works in nuclear theory, Elena Litvinova, and are in the process of hiring another in experimental nuclear physics. Construction is just now underway for the Facility for Rare Isotope beams on the campus of Michigan State University, and we intend to exploit this opportunity. Other changes have appeared on the horizon, and these, I am confident, will lead to opportunities to move the department in new and exciting research directions.

I thank my colleagues for their time in submitting their contributions to this volume, and I greatly appreciate the efforts and patience of the editor, John Tanis, and office staff Jenny Snyder, who brought it all together.

Kirk T. Korista, Chair

Research Spotlight
ELENA LITVINOVA, Ph.D.



Elena Litvinova joined the WMU Department of Physics in the fall of 2013, following a year as a Theory Fellow at the Michigan State University National Superconducting Cyclotron Laboratory. She earned her Ph.D. from the Joint Institute for Nuclear Research in Dubna, Russia in 2003, then worked as a senior scientist at the Institute of Physics and Power Engineering in Obninsk, Russia. Litvinova joined the Technical University of Munich as an Alexander von Humboldt Fellow in 2005, and was a research associate at the GSI Helmholtzzentrum in Darmstadt, Germany from 2007-12 before moving to Michigan State.

Dr. Litvinova's research focuses primarily on nuclear structure theory, with emphasis on finding high-precision solutions to the relativistic nuclear many-body problem. Applications of this research include exotic nuclear systems and nuclear astrophysics. Notably, Litvinova received a National Science Foundation grant during her first year at WMU, providing support to hire a postdoctoral researcher, Dr. Caroline Robin. She has also brought two exceptional doctoral students to WMU, Irina Egorova (Russia) and Fulbright Scholar Herlik Wibowo (Indonesia).

This Research Report will demonstrate that Dr. Litvinova as a very active and productive researcher, publishing refereed papers and presenting invited talks at conferences and other universities and institutes. Western Michigan University is truly fortunate to have Dr. Litvinova as a member of its faculty.

Major Activities

1. Collaboration with the theory group from NSCL/MSU and experimental groups at NSCL and RIKEN. a) A comparative study of the nuclear Gamow-Teller response (GTR) within conceptually different state-of-the-art approaches is performed. Three nuclear microscopic models are considered: (i) the recently developed by our group charge-exchange relativistic time blocking approximation (RTBA) based on the covariant density functional theory, (ii) the shell model (SM) with an extended $jj77$ model space and (iii) the non-relativistic quasiparticle random-phase approximation (QRPA) with a Brueckner G-matrix effective interaction. We studied the physics cases where two or all three of these models can be applied. The Gamow-Teller response functions are calculated for ^{208}Pb , ^{132}Sn and ^{78}Ni within both RTBA and QRPA. b) The strength distributions for higher multipoles of spin-isospin response have been predicted

for unstable nuclei ^{132}Sn and ^{28}Si . The corresponding measurements are completed and the data analyses are well under way.

Results. The strengths obtained for ^{208}Pb are compared to data that enables a firm model benchmarking. For the neutron-rich nucleus ^{132}Sn , also SM calculations are performed within the model space truncated at the level of a particle-hole (ph) coupled to vibration (phonon) configurations. This allows a consistent comparison to the RTBA where ph+phonon coupling is responsible for the spreading width and considerable quenching of the GTR. Perspectives for further model developments are outlined. b) For the first time, with the recently developed charge-exchange RTBA, the spin-isospin strength is calculated up to high excitation energy (90 MeV) beyond the standard particle-hole approximation. Comparison to the new data from NSCL looks very promising.

2. Collaboration with GSI (Darmstadt) and INFN (Catania). An update on the isoscalar-isovector splitting of the pygmy dipole resonance (PDR) in nuclei with a sizable neutron skin is obtained. Inelastic alpha-scattering excitation cross sections are calculated for electric dipole excitations in ^{124}Sn based on the transition densities obtained from the relativistic quasiparticle time-blocking approximation (RQTBA) of our group in the framework of a semiclassical model for the reaction mechanism developed by INFN.

Results. The calculation provides the missing link to directly compare the results from the microscopic RQTBA calculations to recent experimental data measured via the $(\alpha, \alpha'\gamma)$ reaction, which show a structural splitting of the low-lying E1 strength often denoted as pygmy dipole resonance. The experimentally observed splitting is reproduced by the cross section calculations, which allow drawing a definite conclusion on the isospin character of the PDR. The role of superfluidity effects is understood on both qualitative and quantitative levels.

3. We explain, for the first time, the low-energy anomaly reported in several experimental studies of the radiative dipole strength functions in medium-mass nuclei. These strength functions at very low γ -energies correspond to the γ -transitions between very close nuclear excited states in the quasicontinuum and attract an increasing interest because of their substantial astrophysical impact. We show that the low-energy enhancement of the strength functions in highly-excited compound nuclei is explained by nucleonic transitions from the thermally unblocked single-quasiparticle states to the single-(quasi)particle continuum. This result is obtained within the finite-temperature quasiparticle random phase approximation in the coordinate space with exact treatment of the single-particle continuum and exactly eliminated spurious translational mode. The case of radiative dipole strength functions at the nuclear excitation energies typical for the thermal neutron capture is illustrated for $^{94,96,98}\text{Mo}$ and $^{116,122}\text{Sn}$ in comparison to available data.

Results. It is concluded that in the processes, such as the radiative neutron capture, the enhancement of the radiative strength functions (RSF) at low γ -energies is significant in some

nuclei. A mechanism for this enhancement is proposed and validated theoretically. Such an enhancement means, in particular, that the so-called Brink-Axel hypothesis about the energy-independence of the nuclear RSF is not valid for the soft γ -rays and, consequently, the astrophysical r-process nucleosynthesis simulations have to be at least studied for the sensitivity to the revealed energy dependence.

4. A two-phonon version of the relativistic quasiparticle time blocking approximation introduces a new class of many-body models for nuclear structure calculations based on the covariant energy density functional. As a fully consistent extension of the relativistic quasiparticle random phase approximation, the relativistic two-phonon model implies fragmentation of nuclear states over two-quasiparticle and two-phonon configurations coupled to each other. In particular, we show how the lowest two-phonon 1- state, identified as a member of the $[2+ \times 3-]$ quintuplet, emerges from the coherent two-quasiparticle pygmy dipole mode in vibrational nuclei. Calculations for neutron-rich tin and nickel isotopes are performed.

Results. The inclusion of the two-phonon configurations into the model space allows a quantitative description of the positions and the reduced transition probabilities of the lowest 1- states in tin isotopes 112,116,120,124-Sn as well as the low-energy fraction of the isovector dipole strength below the giant dipole resonance without any adjustment procedures. The model is applied to the low-lying dipole strength in neutron-rich 68,70,72-Ni isotopes. Recent experimental data for 68-Ni are reproduced fairly well.

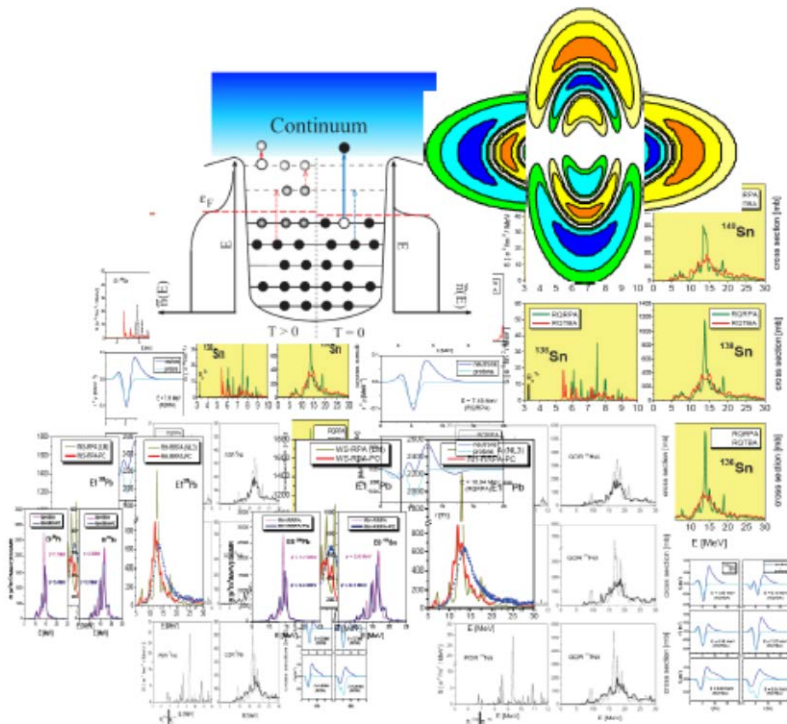
5. Collaboration with experimental groups from TU-Darmstadt, Germany, and RCNP Osaka, Japan. The electric isovector giant dipole resonance (IVGDR) in 208-Pb has been measured with high energy resolution with the (p,p') reaction under extreme forward angles [A. Tamii et al., Phys. Rev. Lett. 107, 062502 (2011)] and showed considerable fine structure. The aim of the present work is to extract scales characterizing the observed fine structure and to relate them to dominant decay mechanisms of giant resonances. Furthermore, the level density of $J = 1$ states is determined in the energy region of the IVGDR. Characteristic scales are extracted from the spectra with a wavelet analysis based on continuous wavelet transforms. Comparison with corresponding analyses of $B(E1)$ strength distributions from microscopic model calculations in the framework of the quasiparticle phonon model and our relativistic time blocking approximation allow an identification of giant resonance's decay mechanisms responsible for the fine structure.

Results. The values of the most prominent scales can be reasonably well reproduced by the microscopic calculations although they generally yield a smaller number of scales. The inclusion of complex configurations in the calculations changes the $E1$ strength distributions, but the impact on the wavelet power spectra and characteristic scales is limited. In both models the major scales are already present at the one-particle one-hole level indicating Landau damping as a dominant mechanism responsible for the fine structure of the IVGDR, in contrast to the

isoscalar giant quadrupole resonance, where fine structure arises from the coupling to low-lying surface vibrations. The back-shifted Fermi gas model parameterization [Rauscher et al., Phys. Rev. C56, 1613 (1997)] describes the level-density data well, while other phenomenological and microscopic approaches fail to reproduce absolute values or the energy dependence or both.

6. Continuing collaboration with TU-Darmstadt. The $^{112,120}\text{Sn}(\gamma,\gamma')$ reactions below the neutron separation energies have been studied at the superconducting Darmstadt electron linear accelerator S-DALINAC for different endpoint energies of the incident bremsstrahlung spectrum. Dipole strength distributions are extracted for ^{112}Sn up to 9.5 MeV and for ^{120}Sn up to 9.1 MeV. A concentration of dipole excitations is observed between 5 and 8 MeV in both nuclei. Missing strength due to unobserved decays to excited states is estimated in a statistical model. A fluctuation analysis is applied to the photon scattering spectra to extract the amount of the unresolved strength hidden in background due to fragmentation of the strength. The strength distributions are discussed within different model approaches, such as the quasiparticle-phonon model and the recently developed two-phonon relativistic time blocking approximation allowing for an inclusion of complex degrees of freedom beyond the initial particle-hole states.

Results. It is found that the new relativistic two-phonon model (4) provides a very reasonable description of the fine structure of the low-energy spectra. At the same time, it indicates that the missing higher-order configurations, such as 3 particle - 3 hole ones should be included in the self-consistent model and opens a way of tackling them in the time-blocking approximation.



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Invited Talks

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

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

Spin-isospin response of exotic nuclei in a relativistic framework, The Fourth Conference on Nuclei and Mesoscopic Systems NMP14, East Lansing, Michigan, USA, May 5-9 2014.

Nuclear shell structure and response in relativistic framework, Nuclear Physics Colloquium, Mississippi State University, March 3, 2014.

Nuclear shell structure and response toward the limits of mass, isospin and temperature, Physics Division Seminar, Argonne National Laboratory, February 3, 2014.

Low-energy nuclear response: structure and underlying mechanisms, Nuclear Astrophysics Seminar, University of Notre Dame, November 25, 2013.

WMU Department of Physics
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D. Keerthisinghe, B. S. Dassanayake, S. Wickramarachchi, A. Ayyad, N. Stolterfoht and J. A. Tanis, *Transmission and Guiding of Fast Electrons through Insulating PET Nanocapillaries*, AIP Conference Proceedings, (AIP, New York, 2013), pp. 36-39.

T. Elkafrawy, A. Warczak, A. Simon and J. A. Tanis, *Evidence for Radiative Double Electron Capture (RDEC) in F^{9+} on Carbon Collisions*, AIP Conference Proceedings, (AIP, New York, 2013), pp. 64-67.

T. Elkafrawy, A. Warczak, A. Simon and J. A. Tanis, *Single-photon emission correlated to double-electron capture by bare ions: background processes*, Phys. Scr. **T156**, 014047 (2013).

N. Winters, A. Warczak, **J. A. Tanis**, T. Gassner, A. Gumberidze, C. Kozhuharov, S. Hagmann, P. M. Hillenbrand, N. Petridis, R. Reuschl, M. Schwemlein, R. Strzalka, D. Sierpowski, U. Spillmann, S. Trotsenko, G. Weber, D. F. A. Winters, Z. Yin and Th. Stöhlker, *A study of radiative double electron capture to bare chromium ions at the ESR*, Phys. Scr. **T156**, 014048 (2013).

S. J. Wickramarachchi, B. S. Dassanayake, D. Keerthisinghe, T. Ikeda and J. A. Tanis, *Dependence of electron transmission on charge deposited in tapered glass macrocapillaries at a tilt angle of 5.0°* , Phys. Scr. **156**, 014057 (2013).

A. M. Ayyad, B. S. Dassanayake, D. Keerthisinghe, T. Ikeda, A. Kayani and J. A. Tanis, *Transmission of fast highly charged ions through straight and tapered glass capillaries*, Phys. Scr. **156**, 014058 (2013).

D. Keerthisinghe, B. S. Dassanayake, S. Wickramarachchi, N. Stolterfoht and J. A. Tanis, *Charge deposition dependence and energy loss of electrons transmitted through insulating PET nanocapillaries*, Nucl. Instrum. Meth. Phys. Res. B **317**, 105 (2013).

S. J. Wickramarachchi, T. Ikeda, D. Keerthisinghe, B. S. Dassanayake and J. A. Tanis, *Angular dependence of electron transmission through a micro-sized tapered glass capillary*, Nucl. Instrum. Meth. Phys. Res. B **317**, 101 (2013).

C. L. Zhou, M. Simon, T. Ikeda, S. Guillous, W. Iksandar, A. Méry, J. Rangama, H. Lebius, A. Benyagoub, C. Grygiel, A. Müller, M. Döbeli, **J. A. Tanis** and A. Cassimi, *Transmission of slow highly charged ions through glass capillaries: Role of the capillary shape*, Phys. Rev. A **88**, 050901(R) (2013).

Invited Presentations

C. Burns, *Opportunities for Inelastic X-ray Scattering with an MBA Lattice*, APS Upgrade MBA Lattice Workshop, Argonne, Illinois, October 21, 2013.

C. Burns, *Spectroscopy/Inelastic Scattering with an MBA Lattice*, APS Upgrade MBA Lattice Workshop, Argonne, Illinois, October 22, 2013.

T. W. Gorczyca, *Comprehensive X-Ray Absorption Models for Oxygen and Neon*, One Day Symposium on Laboratory Astrophysics at the CfA, Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, April 26, 2013.

T. W. Gorczyca, *RMPS Calculations for atoms@C₆₀*, Atomic and Molecular Winter Workshop, Auburn University, Auburn, AL January 3, 2013.

T. W. Gorczyca, *Comprehensive X-ray Absorption Models for Atomic Oxygen and Neon*, 2014 American Astronomical Society Meeting: Bridging Laboratory Astrophysics, Boston, MA, June 2, 2014.

T. W. Gorczyca, *Photoionization of Confined Atoms: Endofullerenes and Beyond*, Université de Paris Sud, Laboratoire Aimé Cotton, Orsay, France, March 28, 2014.

C. Henderson, *The Challenges of Spreading and Sustaining Research-Based Instruction in Undergraduate STEM*, Invited Seminar, Center for Teaching and Learning, Indiana University Purdue University Indianapolis, Indianapolis, IN, February 11, 2013.

C. Henderson, *Assessment for Course and Program Improvement*, Invited Talk, Physics Department Chairs Conference, College Park, MD, June 7, 2014.

C. Henderson, *The Challenges of Spreading and Sustaining Research-Based Instruction in Undergraduate STEM*, Invited Seminar, Teaching and Learning Center, University of Maryland, College Park, MD, February 5, 2013.

C. Henderson, *An Introduction to Physics Education Research Teaching Methods*, Invited Mini-Course, XXII Taller Internacional: Nuevas Tendencias en la Enseñanza de la Física (XXII International Workshop: New Trends in Physics Teaching), Puebla, Mexico, May 29-June 1, 2014.

C. Henderson, *Facilitating Change in Undergraduate STEM*, Invited Talk, National Academies of Science Committee on Attracting and Retaining Students to Complete 2- and 4-year Undergraduate Degrees in STEM, Washington, DC, September 11, 2013.

M. Dancy and **C. Henderson**, *Developing a Research-based Model for Educational Transformation*, Invited Talk, American Association of Physics Teachers 2013 Summer Meeting, Portland, OR, July 17, 2013.

C. Turpen, **C. Henderson**, and M. Dancy, *Moving Beyond Telling Individual Faculty About Educational Innovations*, Invited Talk, American Association of Physics Teachers 2013 Summer Meeting, Portland, OR, July 17, 2013.

Asghar Kayani, *Ion beam analysis: Tool to explore near surface region*, Seminar, King Khalid University Abha, Saudi Arabia, May 2013.

Asghar Kayani, *Localized Surface Plasmon Resonance Induced Metal Nanostructures*, Seminar, King Khalid University Abha, Saudi Arabia, May 2013.

E. Litvinova, *Spin-isospin response of exotic nuclei in a relativistic framework*, Fourth Conference on Nuclei and Mesoscopic Systems NMP14, May 5-9 2014, East Lansing, Michigan, USA.

E. Litvinova, *Nuclear shell structure and response in relativistic framework*, Nuclear Physics Colloquium, Mississippi State University, March 3, 2014

E. Litvinova, *Nuclear shell structure and response toward the limits of mass, isospin and temperature*, Physics Division Seminar, Argonne National Laboratory, February 3, 2014.

E. Litvinova, *Low-energy nuclear response: structure and underlying mechanisms*, Nuclear Astrophysics Seminar, University of Notre Dame, November 25, 2013.

E. Litvinova, *Nuclear shell structure and response toward the limits of mass and isospin*, EURISOL Topical Meeting “Going to the limits of mass, temperature, spin and isospin with heavy radioactive ion beams”, Krakow, Poland, July 1-3, 2013.

E. Litvinova, *Nuclear spin-isospin response within relativistic self-consistent many-body approach*, Gordon Research Conference on Nuclear Chemistry 2013 “At the intersection of Nuclear Structure and reactions”, New London, NH, June 9-14, 2013.

E. Litvinova, *Low-energy nuclear response: structure and underlying mechanisms*, 4th Workshop on Nuclear Level Density and Gamma Strength, Oslo, Norway, May 27-31, 2013.

E. Litvinova, *Recent Developments in Extended Density Functional Theories*, APS Physics April Meeting 2013, Denver, Colorado, April 13-16, 2013.

E. Litvinova, *Relativistic many-body approach to physics of exotic nuclei*, Physics Colloquium, Western Michigan University, Kalamazoo, USA, April 1, 2013.

S. J. Wickramarachchi, T. Ikeda, **D. Keerthisinghe**, **B. S. Dassanayake** and **J. A. Tanis**, *Temporal dependence of electron transmission through funnel shaped micro-sized glass capillaries*, 23rd Conference on the Application of Accelerators in Research and Industry, San Antonio, TX, May 2014.

D. Keerthisinghe, **B. S. Dassanayake**, **S. Wickramarachchi**, N. Stolterfoht and **J. A. Tanis**, *Transmission of electrons through insulating PET nanocapillaries: Angular dependence*, 23rd Conference on the Application of Accelerators in Research and Industry, San Antonio, TX, May 2014.

Contributed Presentations

E. E. Elhoussieny, M. Bautista, T. R. Kallman, J. Garcia, *Time-dependent Photoionization of Gaseous Nebulae: Time-dependent Version of XSTAR*, 2014 Meeting of the American Astronomical Society, AAS Meeting #224, id.221.18

M. Bautista, C. Mendoza, J. S. Boswell, C. Ajoku, *AtomPy: an open atomic-data curation environment*, 2014 Meeting of the American Astronomical Society, AAS Meeting #224, id.119.03

C. Mendoza, J. S. Boswell, M. Bautista, *AtomPy: A Cloud Atomic-data Service for Astrophysical Applications*, 2013 Meeting of the American Astronomical Society, AAS Meeting #222, id.114.02.

M. Bautista, V. Fivet, P. Quinet, C. Mendoza, T. R. Kallman, *Uncertainties in Atomic Data and Their Propagation Through Spectral Models*, 2013 Meeting of the American Astronomical Society, AAS Meeting #222, id.114.01.

A. Urech, **M. Bautista, T. R. Gull, H. Hartman, V. Fivet**, *Iron Mining Eta Carinae's Archived Spectra and Benchmarking Atomic Data*, 2013 Meeting of the American Astronomical Society, AAS Meeting #221, id.431.02.

E. E. Elhoussieny, M. Bautista, J. Garcia, T. R. Kallman, *Time-Dependent Photoionization of Gas Outflows in AGN*, 2013 Meeting of the American Astronomical Society, AAS Meeting #221, id.430.07

T. Gorczyca, J. Garcia, M. Bautista, C. Mendoza, E. Gatuzz, T. R. Kallman, *Comprehensive X-ray Absorption Models for Atomic Oxygen and Neon*, 2014 Meeting of the American Astronomical Society, AAS Meeting #224, id.106.04

T. W. Gorczyca, M. F. Hasoglu, S. T. Manson, and C. P. Ballance, *Photoionization of Endohedral Atoms Using R-matrix Methods: Application to Xe@C₆₀*, 43rd Annual Meeting of the Division of Atomic, Molecular, and Optical Physics, Quebec City, Quebec, Canada, June 3-7 (2013).

W. C. Stolte, Z. Felfli, A.Z. Msezane, R. Guillemin, G. Ohrwall, S.-W. Yu, J. A. Young, D. W. Lindle, **T. W. Gorczyca, N. C. Deb, A. Hibbert, and S. T. Manson**, *Inner-shell Photoionization of Atomic Chlorine: Experiment and Theory*, 43rd Annual Meeting of the Division of Atomic, Molecular, and Optical Physics, Quebec City, Quebec, Canada, June 3-7 (2013).

T. W. Gorczyca, M. F. Hasoglu, S. T. Manson, and C. P. Ballance, *Photoionization of Xe@C₆₀ Using R-matrix Methods*, Abstracts, 28th International Conference on Photonic, Electronic, and Atomic Collisions, Lanzhou, China, July 24 - 30 (2013).

T. W. Gorczyca and M. F. Hasoglu, *K-Shell Photoionization of Oxygen*, Abstracts, 28th International Conference on Photonic, Electronic, and Atomic Collisions, Lanzhou, China, July 24 - 30 (2013).

T. W. Gorczyca, T.-G. Lee, and M. S. Pindzola, *Photoionization-Excitation and Double Photoionization of He@C₆₀*, Abstracts, 28th International Conference on Photonic, Electronic, and Atomic Collisions, Lanzhou, China, July 24 - 30 (2013).

T. W. Gorczyca, D. Nikolic, K. T. Korista, G. Ferland, and N. R. Badnell, *Suppression of Dielectronic Recombination at Finite Densities*, Abstracts, 28th International Conference on Photonic, Electronic, and Atomic Collisions, Lanzhou, China, July 24 - 30 (2013).

C. Henderson, *The Challenges of Spreading and Sustaining Research-Based Instruction in Undergraduate STEM*, Center for Engineering Education Research Speaker Series, Michigan State University, Lansing, MI, April 2, 2013.

C. Henderson, *The Challenges of Spreading and Sustaining Research-Based Instruction in Undergraduate STEM*, Physics Education Research Colloquium, Purdue University Indianapolis, West Lafayette, IN, March 8, 2013.

C. Henderson, *Change Strategies for the Improvement of Undergraduate Physics Instruction*, Plenary Lecture, Foundations and Frontiers in Physics Education Research Conference, Bar Harbor, ME, June 21, 2013.

C. Henderson, R. Cole, J. Froyd, and R. Khatri, *Collaborative Research: Increasing the Impact of TUES Projects Through Effective Propagation Strategies: A How-To Guide for PIs*, Poster 385, NSF-TUES PI meeting, Washington, DC, January 24, 2013.

M. Dancy, and C. Henderson, *Collaborative Research: From Dissemination to Adoption: A Study of the Instructional Change Process in Faculty Most Likely to Succeed*, Poster 356, NSF-TUES PI meeting, Washington, DC, January 24, 2013.

K. Quardokus and C. Henderson, *Using social network analysis to inform education reform efforts in atmospheric science departments*, contributed talk, 2013 American Meteorological Society National Meeting, Austin, TX, January 8, 2013.

C. Henderson and R. Cole, *Propagating Educational Innovations to have an Impact on Faculty Practice*, Workshop A2, NSF-TUES PI meeting, Washington, DC, January 24, 2013.

K. Quardokus, and **C. Henderson**, *Using Department-Level Social Networks to Inform Instructional Change Initiatives*, Contributed Talk, NARST 2014 Annual Meeting, April 1, 2014, Pittsburg, PA.

R. Khatri, **C. Henderson**, R. Cole, R. Stanford, and J. Froyd, *Case Studies of Successfully Propagated Educational Innovations*, Contributed Talk, American Association of Physics Teachers 2013 Summer Meeting, Portland, OR, July 16, 2013.

C. Henderson, C. Turpen, M. Dancy, and **T. Chapman**, *The Mismatch Between Faculty and Their Institutions Regarding the Assessment of Teaching Effectiveness*, Contributed Talk, American Association of Physics Teachers 2013 Summer Meeting, Portland, OR, July 17, 2013.

R. Barthelemy, C. Henderson, and B. VanDusen, *The Demographics and Experiences of Graduate Students in PER*, Contributed Talk, American Association of Physics Teachers 2013 Summer Meeting, Portland, OR, July 16, 2013.

A. Hasan, **O. Abu-Haija**, **A. Kayani**, and **E. Y. Kamber**, *Electron Capture in Low-Energy Ne^{4+} - H_2O Collisions*, Division of Atomic, Molecular and Optical Meeting of the American Physical Society, Quebec City, Canada, June 2013, Bull. Am. Phys. Soc. 58, No. 6 (2013), Abstract: D1.00154.

A. R. McGurn, *Transmission in a 1D split-ring resonator metamaterial containing a nonlinear barrier: soliton modes*, SPIE Meeting, Moscone Convention Center, February 19, 2014; published in Proc. SPIE 8994, Photonic and Phononic Prop. Eng. Nanostr. **IV**, 89941C (2014).

U. Ramnarain and **D. Schuster**, *The pedagogical orientation of South African physical sciences teachers in inquiry teaching*, Proceedings, European Science Education Research Association (ESERA), Nicosia, Cyprus, 2-7 Sept 2013.

D. Schuster, *Solving kinematic problems mentally from basics by conceptual story-logic*, American Association of Physics Teachers Michigan Meeting, Kalamazoo, MI, April 2014.

D. Keerthisinghe, **B. S. Dassanayake**, **S. Wickramarachchi**, **A. Ayyad**, N. Stolterfoht and **J. A. Tanis**, *Guiding of electrons through insulating PET nanocapillaries*, Division of Atomic, Molecular, and Optical Meeting of the American Physical Society, Quebec City, Quebec, Canada, June 2013, Bull. Am. Phys. Soc. 2013, DAMOP **58**, Abstract: G5.00003.

S. J. Wickramarachchi, **D. Keerthisinghe**, **B. S. Dassanayake**, **J. A. Tanis** and T. Ikeda, *Elastic and inelastic transmission of electrons through tapered glass capillaries*, Division of Atomic, Molecular, and Optical Meeting of the American Physical Society, Quebec City, Quebec, Canada, June 2013, Bull. Am. Phys. Soc. 2013, DAMOP **58**, Abstract: H5.00007.

T. Elkafrawy, A. Warczak, A. Simon and **J. A. Tanis**, *Radiative Double Electron Capture in $F^{9+} + C$ Collisions*, 23rd International Seminar on Ion-Atom Collisions, Beijing, China, July 2013, Abstracts, p. 52.

D. Keerthisinghe, **B. S. Dassanayake**, **S. J. Wickramarachchi**, **A. Ayyad**, N. Stolterfoht and **J. A. Tanis**, *Transmission of energetic electrons through insulating PET nanocapillaries*, International Conference on Photonic, Electronic and Atomic Collisions, Lanzhou, China, July 2013, Book of Abstracts ID: 17191.

S. J. Wickramarachchi, T. Ikeda, **D. Keerthisinghe**, **B. S. Dassanayake** and **J. A. Tanis**, *Broadening in the energy distribution of electron beams transmitted through a micrometer-sized tapered glass capillary*, International Conference on Photonic, Electronic and Atomic Collisions, Lanzhou, China, July 2013, Jour. Phys.: Conf. Proc. **488**, 132006 (2014).

Asma M. Ayyad, **B. S. Dassanayake**, **D. Keerthisinghe**, T. Ikeda, **A. Kayani** and **J. A. Tanis**, *Transmission of 16 MeV O^{5+} ions through straight and tapered glass capillaries*, International Conference on Photonic, Electronic and Atomic Collisions, Lanzhou, China, July 2013, Book of Abstracts ID: 17783.

S. J. Wickramarachchi, T. Ikeda, **D. Keerthisinghe**, **B. S. Dassanayake** and **J. A. Tanis**, *Transmission of electrons through tapered glass capillaries: Temporal dependence*, 45th Annual Meeting of the Division of Atomic, Molecular, and Optical Meeting of the American Physical Society, Madison, Wisconsin, June 2014, Bull. Am. Phys. Soc. **59**, Abstract ID: BAPS.2014.DAMOP.B8.4.

D. Keerthisinghe, **S. Wickramarachchi**, **J. A. Tanis**, N. Stolterfoht and **B. S. Dassanayake**, *Direct and indirect transmission of electrons through insulating PET nanocapillaries*, 45th Annual Meeting of the Division of Atomic, Molecular, and Optical Meeting of the American Physical Society, Madison, Wisconsin, June 2014, Bull. Am. Phys. Soc. **59**, Abstract ID: BAPS.2014.DAMOP.B8.8.

S. J. Wickramarachchi, T. Ikeda, **D. Keerthisinghe**, **B. S. Dassanayake** and **J. A. Tanis**, *Temporal dependence of electron transmission through funnel shaped micro-sized glass capillaries*, 23rd Conference on the Application of Accelerators in Research and Industry, San Antonio, TX, May 2014, Book of Abstracts, #111 WED-IBA01-3.

D. Keerthisinghe, **B. S. Dassanayake**, **S. Wickramarachchi**, N. Stolterfoht and **J. A. Tanis**, *Transmission of electrons through insulating PET nanocapillaries: Angular dependence*, 23rd Conference on the Application of Accelerators in Research and Industry, San Antonio, TX, May 2014, Book of Abstracts, #66 THU-AMP05-4.

External Grant Activity (Submitted and Awarded)

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, NASA Project, *The Coolest Iron-Peak Species in Astrophysics*, Awarded \$490,628, Supplemental award \$173,221 for the period November 20, 2010 – November 1, 2013.

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.

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 June 1, 2012 – August 31, 2016.

C. A. Burns, PI, Advanced Photon Source Graduate Student Support. Received \$11,511 to help support a graduate student (Xuan Gao) carrying out research at the Advanced Photon Source, January 1, 2013 - May 31, 2013.

C. Burns, PI, L. Paulius, co-PI, Department of Energy, *Argonne National Laboratory Equipment Grant*, Awarded: \$1,080,000, 2014.

M. Famiano, PI, NSF Program: Nuclear Structure and Reactions, *Probing Exotic Nuclear Masses and Structure Relevant to Heavy Element Nucleosynthesis Award #PHY-1204486*. Awarded \$240,000 for the period August 2012 - August 2015.

B. Tsang, PI, B. Lynch, **M. Famiano** and S. Yenello, Co-PIs. U.S. DOE Program: Research opportunities at Rare Isotope Beam Facilities, *Determination of the Equation of State of Asymmetric Nuclear Matter*, Awarded \$1,200,000 (WMU Portion: \$151,016). September 2010 - September 2015. Funding for travel and graduate student support only.

Bickley, PI, W. Mittig, **M. Famiano**, U. Garg, Co-PIs, NSF Program: Major Research Instrumentation, *Development of an Active Target Time Projection Chamber to Study Reactions Induced by Exotic Beams*. Awarded \$688,984, October 1, 2009 - September 30, 2013.

T. W. Gorczyca, PI and K. T. Korista, Co-PI, NASA Astrophysics Research and Analysis Program, for project entitled *Improved Simulations of Astrophysical Plasmas: Computation of New Atomic Data*, funded \$280,000 for period April 1, 2011 – March 31, 2014.

C. Henderson, Co-PI (with M. Dancy, PI) NSF DUE, *Collaborative Research: From Dissemination to Adoption: A Study of the Instructional Change Process in Faculty Most Likely to Succeed*. Awarded \$249,998 for the period August 15, 2010 - July 31, 2013.

C. Henderson, PI, NSF DUE, *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 DUE, *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 15, 20 – August 31, 2014.

C. Henderson, PI, NSF DUE, *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 DUE, *Collaborative Research: Increasing the Impact of TUES Projects through Effective Propagation Strategies: A How-To Guide for PIs*. Awarded \$506,206 for the period January 1, 2012 – January 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, August 2014, Awarded \$30,000.

E. Litvniova, PI, NSCL at Michigan State University, *Exotic nuclear systems*. Awarded \$20,857.

E. Litvinova, PI, National Science Foundation, *Nuclear superfluidity and spin-isospin response*. Awarded \$64,883.

D. Schuster (PI), W. W. Cobern, B. Adams, and Adriana Undreiu NSF-ASA, *Assessing pedagogical content knowledge of inquiry science teaching*, 2006 - 2013, Brooks Applegate.

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.

Notable Awards and Memberships

N. Berrah, Davisson-Germer Prize, American Physical Society for her outstanding contributions to atomic physics, 2014.

C. Burns, Chair of the Beamline Advisory Team (BAT) for the Ultra-high Resolution Inelastic X-ray Scattering Beamline under construction at NSLS-II, Brookhaven, New York. (This is one of the six beamlines planned as part of the \$900 million project).

C. A. Burns, Co-organizer for the *NSLS-II Early Experiment Workshop: Inelastic X-ray Scattering (IXS) Focused Session*, October 1, 2013. Co-editor of the workshop report.

C. A. Burns, Co-organizer for the *Spectroscopy/Inelastic Scattering Breakout Session of the APS Renewal Workshop*. October 22, 2013. Gave the summary presentation and co-edited the workshop report.

C. Henderson, Senior Editor, Physical Review Special Topics – Physics Education Research, April 2012 - 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 - March 2017 (elected position).

M. A. Famiano, WMU Emerging Scholar Award, 2013.

M. A. Famiano, Physical Society of Japan Research Award, 2013.

Doctoral Dissertations

Ayyad, Asmaa. Interaction of Fast Highly Charged Ions with Insulating Straight and Tapered Glass Capillary Surfaces, December 2013. Committee chairperson: John Tanis, Ph.D.

Ganapathy, Subramanian. Localized Surface Plasmon Resonance Induced Structure-Property Relationships of Metal Nanostructures, April 2013. Committee chairperson: Asghar Kayani, Ph.D.

Gao, Xuan. Development of Polarization Analysis for Resonant Inelastic X-ray Scattering, December 2013. Committee chairperson: Clement Burns, Ph.D.

Garratt, Elias. Compositional and Structural Analysis of Nitrogen Incorporated and Ion Implanted Diamond Thin Films, April 2013. Committee chairperson: Asghar Kayani, Ph.D.

Hamam, Khalil. Organic Solar Cells Based on High Dielectric Constant Materials: An Approach to Increase Efficiency, June 2013. Committee chairperson: Clement Burns, Ph.D.

Li, Chengyang. Studies of the Quantum Phase Transition in Chromium Using Inelastic X-ray Scattering and AB Initio Methods, June 2014. Committee chairperson: Clement Burns, Ph.D.

Nandasiri, Manjula. Engineered Interfaces and Nano-scale Thin Films for Solid Oxide Fuel Cell Electrolytes, April 2013. Committee chairperson: Asghar Kayani, Ph.D.

Master's Theses

Dumitriu, Laurentiu. Theoretical Modeling of Near-threshold Shape Resonance Behavior in Experimental Photodetachment Experiments, June 2013. Advisor: Thomas Gorczyca, Ph.D.

Harris, Justin. Electron Capture by Multiply Charged Ions from Molecular Targets, April 2014. Advisor: Emanuel Kamber, Ph.D.

Towers, Sarah. Forbidden Fe II Emission Line Fluxes from the Weigelt Knots of Eta Carinae, April 2014. Advisor: Manuel Bautista, Ph.D.

Department of Physics Personnel

Faculty

Bautista, Manuel
Berrah, Nora
Burns, Clement
Chung, Sung
Famiano, Michael
Gorczyca, Thomas
Halderson, Dean
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
Wuosmaa, Alan

Faculty Emeriti

Bernstein, Eugene
Hardie, Gerald
Kaul, Dean
Poel, Robert
Shamu, Robert
Soga, Michitoshi

Staff

Easley, Katie
Gaudio, Benjamin
Hoffmann, Chris
Kern, Allan
Krum, Lori
Welch, Rick

Research Associates

Bilodeau, Rene
Fang, Li
Mendoza, Claudio
Murphy, Brendan
Neumeyer, Xaver
Nolte, Jeffrey
Osipov, Timur
Teodoro, Marian
Walter, Emily
Xiong, Hui

Graduate Students

Ahmed, Ehab Elsayed Elhoussieny
Alali, Hasna Abdullah M
Alasmari, Aeshah Mushabbab A
Alghamdi, Ahmed Abdulrahman A
Ali, Safaa Saeid Mohamed
Almeshal, Abdelkareem Mohammed I
Alshehab, Abdullah Ahmed F
Awni, Rasha Abbas Abdullah
Ayyad, Asmaa M.
Bedoor, Shadi A.
Bokari, Eiman Ahmad
Carpino, John F.
Chakraborti, Priyanka
Dibeh, Ali
Dissanayake, Amila C.
Dumitriu, Laurentiu Dan
Gao, Xuan
Ganapathy, Subramanian Vilayur
Garratt, Elias J.
Genanu, Mohammed Hussein Bashar Hasan
Hamam, Khalil Jumah Tawfiq
Harris, Justin S.
Ibrahim, Mohamed Elsayed Elhoussieny
Ahmed
Iqbal, Shahid
Jayathissa, Rasanjali
Kaur, Jagjit

Keerthisinghe, Darshika
Khatri, Indiras
Khatri, Raina M.
Khosravi Dehaghi, Soroush
Koehler, Katrina Elizabeth
Kumara, Pathirannehelage Nuwan Sisira
Labriola, Gina M.
Li, Chengyang
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