

Physics Assessment 2009-2010 Report, College of Science

Date: December 20, 2010

Physics Assessment Committee Members: Huong Nguyen, Maria Babiuc and John Winfrey

Marshall University

Program Review

December 2010

Program: BS in Physics

College: Science

Date of Last Review: December 2009

I. Goals of Physics Program

The mission of the Department of Physics and Physical Science is to provide to our majors grounding in the core subfields of our discipline, and to prepare them for graduate study. The completion of the B.S. in physics prepares the student for graduate school in: physics or engineering, medical school, other health-related professional programs, direct employment in government or industrial laboratories, and assorted other technically related fields.

The physics department has agreed upon the following student learning goals:

- Graduates possess a broad knowledge of the major areas in physics.
- Graduates possess a deep understanding of core areas in physics.
- Graduates possess fundamental physics laboratory and computational skills.
- Graduates experience undergraduate physics research.
- Graduates acquire the skills for success in physics graduate school and/or related industry.

II. Physics Curriculum

The Physics curriculum consists of general core and the advanced physics courses. The core courses in classical mechanics, quantum mechanics, electricity and magnetism, are viewed as an essential foundation to the understanding of specialized topics within physics.

New areas of research are addressed as special applications of material taught in intermediate and advanced course.

The curriculum in physics provides a natural structure for the B.S. physics major. The physics courses fall into the following categories:

- 1) Broad exposure to many topics General Physics in (PHY 211/213) in the first year, General Modern Physics and Modern Physics Laboratory (PHY 320 and PHY421), Mathematical Methods in Physics (PHY 445) in the second year,
- 2) Core courses in Electricity and Magnetism (PHY 300-302), Advanced Classical Mechanics (PHY 330), Statistical and Thermal physics (PHY308), Optics (PHY 304), Quantum Mechanics (PHY 442) and Quantum Mechanics II (PHY 443) in the junior and senior years.
- 3) Upper-level electives we offer courses as Optics (PHY 304), Electronics (PHY 314), Biomedical Physics (PHY 350), Nuclear Physics (PHY 462), Solid State Physics (PHY 425), Labview, and other special topic courses.

PHY 308 (Statistical and Thermal Physics) and PHY 445 (Math Method in Physics) are new physics requirements, which have just been added to the core from last year, and will be the required for students entering the program in 2010. PHY 304 (Optics) and PHY 443 (quantum Mechanics II) have been added this year. The addition of the four new core courses, we believe, will make the Physics Program more current with the ever-changing base of knowledge.

III. Assessment Results

1/ Knowledge and understanding in General Physics as well as Physics Core Subjects

The ETS scores of graduating seniors continue to be used annually, to note trends and identify areas of curriculum weakness. We used "Major Field Test in Physics II", which is employed as an assessment tool by schools and departments at more than 600 colleges and universities globally. This test measures general undergraduate student physics skills, as well as comprehension concepts and problem-solving skills in all of the core subfields in physics.

The Major Field Tests measures the basic knowledge and understanding gained in the core undergraduate curriculum. The tests are two-hour, multiple-choice examinations.

This year we have four B.S. graduates, two of which participated in the tests. The average ETS results are the following:

- For the category of "Introductory Physics" (see charts), our students scored a mean of 42.5, compared to the national average of 47.4 with the standard deviation of 8.2.
- For the category "Advanced Physics", our students scored a mean of 43 in comparison with the national average of 48.5 with the standard deviation of 7.8.
- For the Total Score, this year's students scored 143 in comparison with the national mean of 148.3 with the standard deviation of 8.5.

The results of the Major Field Test this year is consistent with the National Average, considering that the standard deviation was larger than the difference between our mean and the national mean. In addition to this, we had only two students tested, which cannot lead to statistically significant conclusions about performance.

In our previous curriculum, there was a lack of core course materials within the test, and considered physics best practice education. With the addition of the four courses PHY 304, PHY 308, PHY 425 and PHY 443 we believe the scores of our students will improve. We believe all these changes increase the quality of our program.

In the near future, we are going to make additional changes to our program (see below).

2/ Physics Laboratory and Computational Skills

All physics majors are required to take the PHY 202, PHY204 (General Physics Lab) and Advanced Lab (Advanced Optics Lab and Advanced Modern Physics Lab). All the Labs are fully or partially computerized. At the end of the Advanced Modern Physics Lab all students are required to present their work and results to their class and the faculty.

In this 2009- 2010 school year Professor Curt Foltz has written a new 204 Lab Manual that employs research-proven, quality experiments. These experiments are now more closely aligned with the lecture portion of PHY 203.

3/ Undergraduate Capstone and Research Projects

All physics majors are required to participate in undergraduate research and to complete a Capstone project under supervision of faculty members.

- In 2009-2010, five students successfully finished their Capstone projects:

Capstone Projects:

Linville, J.(2010). Improvements in Titanium-Dioxide Thin-Film Dye Sensitized Solar Cells. Capstone project. Supervisor: Fan, X

Lott, C. (2010). General Relativity: An Overview and Solution. Capstone project. Supervisor: Babiuc, M. C.

Hall, S. (2010). Effect of Magnetic Field on Phonoritons. Capstone project. Supervisor: Nguyen. Q. H.

Clements, C. (2010). Measuring the Quality of Small Screen Displays to Create a Standard of Accessibility for the Visually Impaired. Capstone project. Supervisor: Oberly, R.

Hernandez, A. (2010). Thermal Stress on a Rigid Body Measured Using Interferography. Capstone project. Supervisor: Oberly, R.

- This undergraduate research resulted in presentations at national/regional meetings as well as publications in peer reviewed journals.

Dr. Fan, Jon Linville and her other students Matthew Seitz, Tyler Spurlock have presentation on “Development of Flexible Dye-Sensitized Solar Cells” at APS March Meeting in Portland, OR in March 2010 and “High Efficient DSSC on Al Foils” at West Virginia STAR Symposium, Sep, 2010. The results will also be published in West Virginia STAR Symposium proceedings 2010.

Jonathan Thompson, our last year graduate, is a co-author of the presentation “Central Black Hole Growth in Galaxies: Normal, Active, and Merging” by Hamilton, Jetha, & Thompson in International American Astronomical Society Conference: AAS 217th Meeting

Chad Lott, a math major, has been working with Dr. Babiuc in 2010. He presented a poster at the 20th Sigma Xi Annual Research Day, April 23, 2010, with the title "Exploring the First Theoretical Solution of General Relativity" and got a \$134.00 Research Scholar Grant for the project "Mathematics of General Relativity".

Dr. Nguyen has submitted for publication in Journal of Nanoscience and Nanotechnology the paper “*Magnetic Field Effect on Semiconductor-Organic Exciton in Quantum Dot Heterostructures*” resulted from the research done with her undergraduate student Justin Angus from the previous year.

4/ Experience for Graduate School

Physics majors have chance to visit graduate institutions every year. This year under the supervision of Dr. Ralph Oberly the Society of Physics Students made a one day trip to Ohio State University, in Columbus, OH, to visit the Physics Department and learn about the graduate program there in April. From our 4 graduate this year, Charles Clements went to Marshall's Medical Program, and other two students are taking their Master Program at the present.

IV. Faculty

Our faculty are very active in research. Considering we are a small department, we hold a large number of refereed journal publications, participations and presentations at professional meetings, submitted proposals, and awarded grants.

- Our faculty have published or submitted eight papers for publication in peer reviewed journals this year.

Publications:

Wilson, T. E., Oehme, Kasper, M. E., & L. Gossmann, H-J. L. (2010). Superlattice Ultrasonic Generator, accepted for publication in Journal of Physics: Conference Series.

Wilson, T. E. (2010). Generation of coherent pulses of sub-THz longitudinal acoustic phonons in nipi silicon doping superlattices, accepted for publication in Chinese Journal of Physics.

Fei, H., Yang, Y., Rogow, D. L., Fan, X., & Oliver, S. R. J. (2010). Polymer-Templated Nanospider TiO₂ Thin Films for Efficient Photoelectrochemical Water Splitting, Appl. Materials & Interfaces, 2, 974-979.

Angus, J. & Nguyen, Q. H. (2010). Magnetic Field Effect on Semiconductor-Organic Exciton in Quantum Dot Heterostructures. Submitted to Journal of Nanoscience and Nanotechnology.

Nguyen, Q. H. (2010). Exciton Hybridization States in Organic-Semiconductor Heterostructures Containing Quantum Dots, Advances in Natural Sciences: Nanoscience and Nanotechnology, accepted for publication.

Nguyen, Q. H. (2010) " Wannier-Frenkel Exciton in Semiconductor-Organic Systems Containing Quantum Dots" book chapter in "Exciton Quasiparticles: Theory, Dynamics and Applications", edited by F. Columbus, accepted for publication

Babiuc, M.C., Szilagy, B., Winicour, J. & Zlochower Y. (2010). Characteristic Extraction Tool for Gravitational Waveforms, Physical Review D, Ref: DY10728, submitted.

Babiuc, M. C., Winicour, J. & Zlochower Y. (2010). Binary Black Hole Waveform Extraction at Null Infinity, Classical and Quantum Gravity, Ref: 377417, submitted.

- Our faculty presented papers at fifteen professional in different national/professional/international meetings.

Presentations:

Nguyen, Q. H. (2010). Formation of Phonoritons in Organic-Semiconductor Heterostructures, APS March Meeting, Portland, OR, March 15-19.

Nguyen, Q. H. (2010). Electro-Magnetic Effect on Hybrid Exciton in Organic-Semiconductor Quantum Dot Systems. 5th International Conference on Surfaces, Coatings and Nanostructured Materials (NANOSMAT-5) Reims, France , October 18-21.

Nguyen, Q. H. (2010). Wannier Mott-Frenkel Hybrid Exciton in Organic-Semiconductor Heterostructures, Invited Talk at Seoul National University Colloquium, November 14.

Seitz, M., Spurlock, T., Linville, J. & Fan X. (2010). Development of Flexible Dye-Sensitized Solar Cells. APS March Meeting, Portland, OR, March 15-19.

Fan, X., Linville, J., Seitz, M. & Spurlock T.(2010). High Efficient DSSC on Al Foils, West Virginia STAR Symposium, Huntington, WV., Sep. 27-28.

Fan, X., Spurlock, T., Seitz, M. & Linville, J. (2010). Flexible Dye-Sensitized Solar Cells on Al Foils, West Virginia STAR Symposium proceedings, Huntington, WV., Sep. 27-28.

Wilson, T. E., Oehme, M., Kasper, E., & Gossmann, H-J. L. (2010). Superlattice Ultrasonic Generator, 2nd Int. Symposium on Laser Ultrasonics – LU2010, Bordeaux, France, July 7.

Wilson, T. E. (2010). Generation of coherent pulses of sub-THz longitudinal acoustic phonons in nipi silicon doping superlattices, 13th Int. Conf. Phonon Scattering in Condensed Matter – PHONONS2010 Taipei, Taiwan, April 19-23.

Wilson, T. E. (2010). Superlattice Ultrasonic Generation. Invited Physics Department Colloquium. University of Tennessee, Knoxville, November 8.

Wilson, T. E. (2010). Generation of coherent pulses of sub-terahertz longitudinal acoustic phonons in n-i-p-i silicon doping superlattices. APS March Meeting, Portland, OR, March 15-19.

Richards, H & Howard, J. W. (2010). Metastable Decay in the Square-Lattice Ising Model: Restriction to a Single Droplet. 2010 Fall Meeting of the Ohio-Region Section of APS. Marrieta, OH, Oct. 8-9.

Babiuc, M. C. (2010). Gravitational Wave Extraction from a Binary Black Hole using the Cauchy-Characteristic Approach. Theory Meets Data Analysis at Comparable and Extreme Mass Ratios Meeting, Perimeter Institute, Waterloo, Ontario, Canada, June 20-26.

Babiuc, M. C. (2010). Extraction of Gravitational Wave from a Binary Black Hole using the Cauchy-characteristic Approach. 13th Eastern Gravity Meeting, North Carolina State University, Raleigh, NC, May 21-22.

Babiuc, M.C. (2010). Developing Scientific Thinking in the Physics Labs, 2010 AAPT Summer Meeting, Portland, OR, July 17-21.

Babiuc, M. C. (2010). Black Holes and Jets, The 21st Annual Astronomy Weekend, Blackwater Falls State Park, WV, Sept. 9-12.

- Our faculty received grants from NSF, NASA WV Space Consortium and NASA Research Enhancement, NASA WV EPSCoR Research Seed Grant, MU Advance Awards, Summer Research Award, NSF-REU Supplement Award and INCO and Quinlan Travel Award, etc.

Grants:

Babiuc, M. C. (2010). MU-Advance Faculty Fellowship Award: Numerical Simulations and Visualizations of Black Holes. Amount: \$20,000.

Babiuc M. C. (2010). Visiting Scholar, University of Pittsburgh: Research on the Characteristic Joint research with Jeff Winicour, Topic Simulation of Gravitational Radiation from Black Holes. June -July, Amount: \$6,000.

Babiuc, M. C. (PI). (2010). RUI National Science Foundation Award: Precise Computation of Gravitational Waves at Infinity: The Cauchy-Characteristic Approach. Amount: \$ 126,785.

Richards, H. (PI), Babiuc, M. C. (Co-PI). (2010). REU National Science Foundation Award: Computational Science Training at Marshall University for Undergraduates in the Physical and Mathematical Sciences. Amount: \$326,484.

Nguyen, Q. H. (2010). NASA Research Seed Award: Formation of Phonoritons. Amount: \$20,000.

Wilson, T. (2010). NSF Award: REU supplement. Amount: \$6000

- Our faculty have submitted funding proposals to several agencies.

Pending Proposals:

Fan, X (PI). (2010). STEM Scholarship in Appalachian Area. Requested amount \$441,026.

Fan, X. (PI). (2010). NSF Career Grant: Inorganic Nanostructures for Photovoltaics and Photocatalysis. Requested amount: \$457,952.

Fan, X. (Co-PI), Kolling, D (PI). (2010). NSF EPR Spectrometer Acquisition, Co-PI. Requested amount \$257,500

Fan, X. (2010). NSF Interdigitated Nanostructure through Stamping for Photovoltaics, PI, \$348,241.

Wilson, T. (PI). (2010). NSF Renewal proposal: Nanosecond-Pulsed Coherent Acoustic Phonon Generation and Applications. Requested amount: \$378,513

Wilson, T. (PI). (2010). White paper and budget submitted to the Air Force Office of Scientific Research (AFOSR) for funding consideration: Terahertz Acoustic Phonon Scattering: a new diagnostic tool for plasma thruster materials development. Requested amount \$625,000.

- We are also providing professional opportunities to our students:

Student Enrichment Activities:

a. Dr. Oberly, led a group of physics majors to visit the Physics Department at Ohio State University, Columbus, OH, in April 2010 and learn about the graduate program.

b. Dr. Fan supervised Jon Linville to do research on *Dye Sensitized Solar Cells*.

c. Dr. Babiuc worked with Chad Lott on *An Overview and Solution of General Relativity*; with Alan Cowen, an REU summer 2010 research student from Yale University on *Visualizing Numerical Relativity Data for a Head-on Collision of Two Black Holes*; Stephen Turley, a research student supported by her NSF grant on *Developing CUDA Software*; and Jayne Billheimer, a high school senior, on *Gravitational Lensing and Dark Matter Caustics*.

d. Dr. Nguyen had mentored Sarah Hall to do research on *Effect of Magnetic Field on Phonoritons*.

e. Dr. Oberly led Charles Clements to do research on *Measuring the Quality*

of Small Screen Displays to Create a Standard of Accessibility for the Visually Impaired. He also mentored Anthony Hernandez to work on *Thermal Stress on a Rigid Body Measured Using Interferography.*

f. Dr. Howard Richards supervised the summer research of 3 students: Mallory Price (Math, Marshall), working on *Metastable Decay of the Ising Model in the Hyperbolic Plane*; Julie Lang (Math & Physics, Morehead State), working on *Metastable Decay of the Ising Model on Archimedean Solids*; and James Howard (Math and Computer Science, Morehead State), working on *2-Dimensional Ising Model with Single Droplet Constraint*

- Our faculty also serve the physics community as the proposal reviewers, textbook, and research paper reviewers.

Service to Professional Organizations:

Dr. Richards participated in two NSF panels.

Dr. Nguyen reviewed 3 papers and proposals,

Dr. Fan participated in the NSF SBIR proposal panel and reviewed 16 proposals.

Dr. Babiuc refereed one article for *Classical and Quantum Gravity* and three proposals for the Annual SoTL Commons Conference.

Dr. Wilson refereed a paper for the journal *Measurement, Science & Technology.*

- We also promote the visibility and attractiveness of our major program through a series of outreach activities:

Outreach and Recruitment Activities:

Dr. Maria Babiuc organized “Saturday Experiments in Modern Physics”, an outreach program for Fairland High School students (March 6, 2010, at Marshall University). The goal of the program was to make modern physics a more approachable, exciting, and rewarding experience for high-school students. One goal of this program was to inspire to become future scientists. Such events will have positive impact in the recruitment of new college students. Dr. Babiuc was also organized the “Expand Your Horizon 2010 Super Science Saturday” (April 10, 2010, at Marshall University) for statewide middle school students. The title of the workshop facilitated by Dr. Babiuc was: ESTEEM PHYSICS: *Engaging Students Through Exciting Experiments in Modern Physics.* The workshop offered students an interactive exploration in modern physics. The experiments were at the frontline of physics research, but can also be understood at the conceptual level.

Dr. John Winfrey and Dr. Maria Babiuc initiated an “Open-ended Discussion with the Faculty”, at Marshall University, Huntington, West Virginia. The advertisement prose was: “Want to Watch Your Professors Think? Have a burning Science question? Come to monthly 'around the campfire' talks with students, faculty, guests. Anything goes sessions, bring 'everything I always wanted to know but was afraid to ask' questions”. All the departments from COS were represented, both in attending faculty and twenty students.

Our chapter of the Society of Physics Students, guided by Dr. Ralph Oberly, spent two days at Chesapeake Middle School in Proctorville, OH, doing physics demonstrations. The event was coordinated with Middle School science and mathematics teachers who were sought to stimulate more interest in science.

Other outreach programs included faculty participation in High School Annual Science Fairs, Majors, Minors & More! Fairs, and Open Houses.

V. Addition to Physics Curriculum

Together with the additions and improvements to the existing Physics major, our department is planning to add three majors: Chemical Physics, Bio-Physics and Applied Physics to our Physics BS Program.

The students who take the Chemical Physics or Bio-Physics Majors be required to take a half of their required core in Physics and a half in Chemistry/ or Biology Department, in addition to some required elective course in Physics. The Physics department is working closely with the Chemistry and Biology Departments to realize these concentrations in these years.

Appendix: Assessment Student Outcomes

Component / Course / Program Level					
Student Outcome	Person or Office Responsible	Assessment Tool or Approach	Standards/Benchmark	Results/Analysis	Action Taken
(1) Demonstrate Knowledge of Introductory Physics	Department	Educational Testing Service “Major Field Test Physics II” (Reporting Date: January 2004). Topics include: (I) Classical Mechanics; (II) Electricity and Magnetism; (III) Thermodynamics, Optics, and Waves.	Possible Score: 20-100; 35 questions selected from Topics: (I), (II), (III)	2 students, mean=42.5, national mean=47.4, standard deviation 8.2	Add new courses to physics core
(2) Demonstrate Knowledge of Advanced Physics	Department	(IV) Fundamental Concepts of Quantum Mechanics, (V) Special Topics	Possible score: 20-100; 32 advanced questions.	2 students, mean=43, national mean=48.5, standard deviation 7.8 -	Add new courses to physics major core, add new electives

Component / Course / Program Level

Student Outcome	Person or Office Responsible	Assessment Tool or Approach	Standards/Benchmark	Results/Analysis	Action Taken
(3) Total Test Score	Department		Possible Score: 120-200; Topics: (I- V)	2 students, mean=143, national mean=148, standard deviation 8.5	