Physics Graduate Program

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Joel Giedt, Associate Department Head
History, Recognitions, Achievements

Oldest technological university in the US (1824)
Ivar Giaever
GE Research,
Ph.D. at RPI, 1964
Noble Prize, 1973
Professor at RPI (1988-2005)
Alumni Hall of Fame, 1998

Tunneling phenomena in superconductors
(research performed at GE in 1960)
Heidi Newberg  
B.S. at RPI, 1987  
Professor at RPI (1988-)  
Gruber Prize in Cosmology, 2007, shared  
Breakthrough Prize in Fundamental Physics, 2015, shared

Supernova Cosmology Project:  
provided strong evidence that the  
expansion of our universe is accelerating;

S. Perlmutter et al., The Astrophysical  
Noble Prize, 2011
Shirley Ann Jackson
First African-American woman to receive a doctorate from MIT— in any field, 1973
President and Professor of Physics at RPI (1999-)

Co-Chair of the President's Intelligence Advisory Board (2014-)
President's Council of Advisors on Science and Technology (PCAST) (2009-2014)

Fellow and past president of the
American Association for the Advancement of Science (AAAS)

Professor of physics at Rutgers University (1991-1995)
AT&T Bell Laboratories (1976-1991)
• First science & engineering school in the country (1824)
• Dutch origin (Van Rensselaer)
• 6400 UGs, 1200 Gs
• 60% Engr, 30% Sci, 10% else
• Most faculty are research active
• Majority of research is externally funded
Physics Department Facts

- 22 faculty (3 joint)
- 4 lecturers
- 8 APS Fellows, 5 AAAS Fellows, 3 MRS Fellows
- ~240 UGs
- ~38 Gs
- ~4 Postdocs

- External research funded by:
  NSF, NASA, DOE, DARPA, ARL, ARO, ONR, DHS, DTRA
Admission Requirements

• Undergraduate GPA (suggested minimum):  3.2
  
  *Students are normally expected to have taken intermediate-level courses in mechanics, electricity and magnetism, quantum physics, statistical mechanics, and experimental physics*

• GRE general test (suggested minimum:)
  
  - V: 150
  - Q: 158
  - A: 3.5

• GRE Subject Test in Physics (suggested minimum:) 600

• TOEFL score of 250 CBT/100 iBT/600 PBT (IELTS 7.0 or PTE 68)
Teaching/Research Assistantships, and Fellowships

- TA: $23,000 (academic year); (summer RA possible)
- RA: $23,000 (academic year); $7,667 (summer)
  $30,667 (calendar year)

- Fellowship: competitive stipend (calendar year) + waiver of fees

All of the above forms of support carries full tuition waiver for 9-15 credits for TAs and 12-15 credits for RAs and Fellowship recipients.

Normally, all of our incoming graduate students are supported as TAs.
Grad School

• #1 advanced coursework that builds on strong UG education/preparation

• #2 grad school is about focusing on a research project, becoming an expert in something, making significant findings & publishing them

• #3 skills as scientist and professional (speaking, writing, analysis, computational, experimental, theoretical, organizational, etc.)
Program Summary

• 72 credits
• Qualifying Exam
  (can be waived: GRE Physics subject 700+ or RPI core courses A- or better)
• Candidacy exam
• Thesis defense/Dissertation

Two Main Components
  ➢ Coursework
  ➢ Research
Qualifying Exam*

• Classical Mechanics (including special relativity)
• Electromagnetism (including special relativity)
• Quantum Mechanics
• Thermodynamics/Statistical Mechanics

➢ Administered in August and January
➢ Must be passed by August of the beginning of the second year for fall entry (normally three attempts)
➢ There is an appeal process.

* Waived with GRE Physics Subject 700+ or RPI core courses A- or better
Ph.D. Timeline

• Typical time to complete = 5 yrs
• **Limit of 7 yrs** (5 yrs if formally entering with a M.S.)
• Candidacy typically taken in the 3rd year, but should be passed at least 1 year prior to defense
• 3.0 or higher GPA (individual core courses with a grade lower than B are also cause for concern)
• Dissertation credits make up a lot of the total
Yiping Zhao
Professor at University of Georgia
Ph.D. at RPI, 1999

Hasan Guclu
Prof. at Istanbul Medeniyet University
Prof. at University of Pittsburgh
Ph.D. at RPI, 2005

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Casey Doyle
Sandia Natl. Lab
Ph.D. at RPI, 2018

Matt Newby
Professor at Temple University
Ph.D. at RPI, 2013

Lauren O’Malley
MITRE
Ph.D. at RPI, 2008

Panagiotis Karampourniotis
IBM Cambridge
Ph.D. at RPI, 2017
Major Research Areas

Astronomy and Astrophysics
Computational astronomy, galactic structure and evolution, large astronomical surveys, dark matter.

Optical Physics
Plasmonic structures, light-matter interaction, terahertz spectroscopy, quantum optics and photon entanglement.

Nanoscience and Nanomaterials
Nanoelectronics, Nanophotonics, nanostructures, nano-bio interfaces.

Energy Research
Energy harvesting, conversion and transfer, solid-state lighting, complex systems and networks.

Condensed Matter
Molecular electronics, quantum molecular dynamics, semiconductor materials and devices, thin film morphologies and transport, low-dimensional systems.

Particle Physics
Direct detection of dark matter, lattice field theory, neutrinoless double beta decay.

Statistical Physics
Complex systems and networks, social dynamics, transport, flow, and cascading failures in complex networks.

https://science.rpi.edu/sites/default/files/PhysicsGraduateProgramInformation.pdf
Research Centers at RPI

- Collaborations
- Interdisciplinary research

Center for Computational Innovations (CCI)
Center for Biotechnology and Interdisciplinary Studies (CBIS)

Center for Materials, Devices, and Integrated Systems (CMDIS)
Center for Future Energy Systems (CFES)

Data Science Research Center (DSRC)
Network Science and Technology Center (NeST)
Institute for Data Exploration and Applications (IDEA)
National Labs, Industry, Collaborations

• Los Alamos National Laboratory
• Oak Ridge National Laboratory
• Army Research Laboratory
• LNGS (Italy): XENON 100/XENON1T (Dark Matter)
• Sloan Digital Sky Survey
• IBM
• GE
• Lockheed Martin
• ...
Questions?

Admission Requirements and Program Information:

https://science.rpi.edu/physics/programs/graduate

https://science.rpi.edu/sites/default/files/PhysicsGraduateProgramInformation.pdf

https://science.rpi.edu/sites/default/files/RPI_Physics_GradSchool_AIP.pdf

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Additional Program Details
Required/Core Courses

- Quantum Mechanics I (4 cr)
- Quantum Mechanics II (4 cr)
- Statistical Mechanics (4 cr)
- Electrodynamics (4 cr)
- Colloquium (four semesters, 4x1 cr)
Elective Requirement

- 12 credits
- 6 with PHYS or ASTR prefix
- 4000 or 6000 level*
- Pre-approved list in handbook
- Other course may be approved upon review by graduate program director

* Of these 12 credits of technical electives, at least 6 credits must have a PHYS or ASTR prefix, and at least 6 credits must be at the 6000 level (a single class can be counted towards both requirements). In addition, in satisfying degree requirements, at least two-thirds of the total credit hours, excluding thesis, must contain the suffix numbers 6000-7999, with the further limitation that no more than 15 credit hours of 4000-4990 courses are to be allowed.
Elective Courses (PHYS/ASTR)

- PHYS 4620: Elementary Particle Physics
- PHYS 4810: Computational Physics
- PHYS 4960: Density Functional Theory
- PHYS 4960: Photonics
- PHYS 4960: Optical Properties of Materials
- PHYS 6530: Quantum Mechanics III
- PHYS 6710: Theory of Solids I

- ASTR 4120: Observational Astronomy
- ASTR 4220: Astrophysics
- ASTR 4240: Gravitation and Cosmology
- ASTR 4510: Origins of Life: A Cosmic Perspective
- ASTR 6250: Interstellar Medium
- ASTR 6900: Astrophysics Seminar
Elective Courses (examples)

• ...
• CSCI 6100 Machine and Computational Learning
• CSCI 6360 Parallel Computing
• ...
• MATH 4700 Foundations of Applied Mathematics
• MATH 6660 Stochastic Processes and Modeling
• ...
• MTLE 4150 Kinetics in Materials Systems
• MTLE 4160 Semiconducting Materials
• ...
Further Notes

• Most of the rest of the 72 credits will be dissertation credits.
• You should have at least 9 credits/semester as a TA, and at least 12 credits/semester as an RA.
Qualifying Exam

• Classical Mechanics (CM, 5 problems, including special relativity)
• Electromagnetism (EM, 5 problems, including special relativity)
• Quantum Mechanics (QM, 6 problems)
• Thermodynamics/Statistical Mechanics (SM, 4 problems)

➤ These may be passed individually
  [3/5 (CM), 3/5 (EM, 4/6 (QM, 2/4 (SM)).
➤ Passing score is 6/10 pts on each problem.
➤ Physics GRE score of 700 or above waives the exam
➤ Parts may be waived with A or A- in certain courses taken at RPI
➤ Spelled out in Grad Program Handbook
Robert Resnick (1923 – 2014)
Professor at RPI (1956-1993)
Jim Napolitano
M.S. at RPI, 1977
Professor at RPI (1992-2015)