Physics @ WPI
Class of 2024!

Doug Petkie
Department Head & Professor of Physics
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Visit the Physics Department homepage at:
www.wpi.edu/+physics
Overview of the Physics Community

Presentations

- Overview of our community and programs
- Lyuba Titova, Associate Professor of Physics
- Patrick O’Mullan, Sophomore
- Zoe Mutton, Junior
- Tom Young, Senior
- Jake Bouchard, BS/MS Physics Student

- Engage with me or one of several students via email or Zoom
Congratulations!
A Fundamental Approach to Problem Solving

- Ask important questions! → Discover solutions!

- Solve Puzzles
  - Basis for all sciences & engineering

- Make a difference!
  - Opens Doors!

(Courtesy: Caltech/MIT/LIGO Lab)

Worcester Polytechnic Institute
Bacteria-Powered Gear → Active Matter

Research related to Kunta Wu’s group at WPI

~400 μm size gears

Aranson et al. PNAS (2010)

Worcester Polytechnic Institute
Academics @ WPI: Overview: The WPI Plan

The WPI Plan

Worcester Polytechnic Institute
Academics @ WPI: Overview: Projects

Great Problems Seminar (Dave Medich and Power the World)
Humanities & Arts Project
Interactive Qualifying Project, IQP
Major Qualifying Project, MQP
Independent Study Unit/Project
Humanities & Arts Project

- **Class of 1879 Prize for Outstanding Projects in the Humanities**
  - Two physics majors win the top HUA prize!

- **Aviv Breast**: “An Ethical Framework for the Genetic Engineering of Animals,” advisor: John Sanbonmatsu

- **Erin Morissette**: “Acoustics of the Clarinet and Spaulding Recital Hall,” advisor: Douglas Weeks
Pioneering Project-Based Learning: IQP

WPI was founded on the principle that students learn most effectively by applying theory to practice. WPI has 50 years of experience integrating projects into our undergraduate curriculum.

50+ PROJECT CENTERS WHERE STUDENTS ARE SOLVING REAL-WORLD CHALLENGES

6/7 CONTINENTS WHERE WPI STUDENTS ARE MAKING AN IMPACT

100% OF STUDENTS RECEIVE A GLOBAL PROJECT SCHOLARSHIP (AS OF CLASS OF 2022)
ABCDE terms and IQP: Switzerland

- Nancy Burnham, Prof of Physics
  - Switzerland Site Director
- Blake Currier, Assistant Teaching Profess or Physics
  - Co-instructor
Physics @ WPI: The Community

• ~20 physics graduates/yr (~80 PH/PHA majors)
• 19 full-time faculty
• 2 staff, 2 administrators
• ~25 graduate students
• ~25 Peer Learning Assistants
• Several research laboratories (Soft-Matter / Nanoscience / biophysics / photonics)
• Most activities in Olin Hall, some at Gateway Park
• THE PHYSICS LOUNGE!
Physics @ WPI: Programs

- Physics (PH) major (15 physics courses, 6 other)
- Applied Physics (PHA) major (15 physics, 6 focused)
- Physics HS Teacher Preparation Program (as a PH or PHA major)
  - Physics with Initial Massachusetts Teaching License
- Double majors, esp. Mathematics and ME
- BS/MS program in four-five years
- Minor in Physics (6 physics courses, w/capstone)
- Minor in Nanoscience (6 courses in PH, CH, BIO)
- Minor in Astrophysics (6 courses in PH)
Physics @ WPI: The Curriculum

• 30 courses of coordinated study in the technical fields

• Mathematics

  Provides the grammar, physics provides the literature!
  9 courses - 2 courses at MA3000 level or higher

• Physics (15 courses, includes MQP)
  - one course (or more) from each of the 5 principle areas (next slide)

• Other (6 courses) MA, ENG, CS, Business ...
  Use to ‘double-count’ for minors or double majors
  Build out additional strengths
Physics @ WPI: Principle Areas

Mechanics

Electromagnetism

Experimental physics

Quantum physics

Thermal & statistical mechanics

Worcester Polytechnic Institute
Physics @ WPI: Options, Options,...

1. Physics
   Recommended Courses
   PH 3402 Quantum Mechanics II
   PH 511 Classical Mechanics
   PH (DU) Selected Readings in Physics

2. Computational Physics
   Recommended Courses
   MA 3271 Numerical Methods for Linear and Non-Linear Systems
   MA 4411 Numerical Solutions of Differential Equations
   PH (DU) Numerical Techniques in Physics

3. Optics
   Recommended Courses
   PH 2501 Photonics
   PH 2502 Lasers
   PH 3504 Optics

4. Biophysics
   Recommended Courses
   ES 3061 Introduction to Biodynamics
   ME/BME 3601 Biomechanics
   ME/BME 3606 Biofluids
   PH 3506 Statistical Physics
   PH (DU) Review of Biophysics

5. Nuclear Science and Engineering
   Recommended Courses
   NSE 3001 Introduction to Nuclear Science and Engineering
   NSE 5201 Applied Nuclear Physics
   PH (DU) Nuclear Physics Applications
   PH 3903 Nuclear Physics

6. Thermal Physics
   Recommended Courses
   PH 3901 Principles of Thermodynamics
   PH 3902 Heat Transfer
   PH 3903 Convective Flows
   PH 3904 Turbulent Flows
   PH 3905 Heat Transfer
   PH 3906 Convective Flow
   PH 3907 Turbulent Flow
   PH 3908 Heat Transfer
   PH 3909 Convective Flow
   PH (DU) Review of Biophysics

Related Courses
ECE 2311 Continuous-Time Signal and System Analysis
ECE 2312 Discrete-Time Signal and System Analysis
ECE 3901 Control Engineering I
MA 6291 Applied Complex Variables
PH 3402 Quantum Mechanics II
PH 3902 Solid State Physics
PH 3903 Nuclear Physics
PH 3904 Optics
PH 3905 (Graduate) Quantum Mechanics
PH 3933 (Graduate) Electromagnetic Theory

https://www.aapt.org/Programs/contests/winnersfull.cfm?id=5542&theyear=2014
Physics @ WPI: Career Pathways
The Bigger Picture of Statistics

Status of Physics Bachelors One Year After Degree, Classes of 1996 through 2018

- Employed
- Physics or Astronomy Graduate Study
- Graduate Study in Other Fields
- Unemployed

Percent: 0%, 10%, 20%, 30%, 40%, 50%, 60%

https://www.aip.org/statistics/whos-hiring-physics-bachelors

Worcester Polytechnic Institute
Physics Alumni Data

- 2013-2016

Employers
- Arrowsight, Inc.
- Arup
- Asylum Research
- Comsol
- ConBnuum Energy Technologies
- ExxonMobil
- General Dynamics – Electric Boat
- IISC Bangalore
- IPG Photonics (2)
- Juniper Networks
- MIT Photonics
- MIT Lincoln Laboratory
- Medica Corp
- Meditech
- Paytronix
- Raytheon Company
- Thompson Public Schools
- University of Arizona, School of Information
- Worcester Public Schools
- WPI

Graduate Schools
- Brown University
- Harvard University
- Louisiana State University
- Manhattan College
- MIT (2)
- Northeastern University
- Northwestern
- Temple University
- Tufts University
- University of Albany
- University of Massachusetts
- University of Tennessee
- University of Waterloo
- WPI (3)

Double Majors
- Aerospace Engineering
- Biochemistry
- Computer Science
- Electrical & Computer Engineering
- Mathematical Sciences
- Mechanical Engineering
Physics Teaching Profession

- Starting pay ~$48K, school year 9 mo base
- Mid-career ~$75K, school year 9 mo base
- Retire before age 60 w/ pension - 87.5%
- 74 days not under contract (breaks & holidays)
- 78% teaching in year 5†
- Intellectual challenge and satisfaction rated equal to or higher than private sector STEM careers††
- Considerable shortage! (5.00 – 4.21) †††
  - Spec. Ed. – Severe/Profound Disability 4.61
  - Spec. Ed. – Visually Impaired 4.59
  - Physics 4.53
  - Mathematics 4.42
  - Chemistry 4.42

†2015 U.S. Dept. of Ed
Public School Teacher Attrition and Mobility in the First Five Years: Results From the First Through Fifth Waves of the 2007–08 Beginning Teacher Longitudinal Study
††http://www.aip.org/statistics
†††2014 AAEE (American Association of Employment in Education)
Educator Supply and Demand in the United States Report

Worcester Polytechnic Institute
Student Chapters and Rankings


Worcester Polytechnic Institute’s Physics program was ranked #10 out of 263 schools nationwide. This puts the school’s program in the Top 5% of all Physics programs in the United States. WPI improved its position 1 slot over the previous year’s ranking of 11.

See the full ranking by Physics major.
Sampling of MQPs (Senior Projects)

Quantum Random Walks
Austen Couvertier, Swarnadeep Majumder
Advisor: P.K. Aravind

VIFs in cellular dynamics
Yu Jing
Advisor: Professor Qi Wen

Spatially Resolved Photoluminescence Spectroscopy of 2D Nanomaterials
Members: Patrick Fitzgerald
Advisor: Lyubov Titova

Hydrogen Peroxide Propulsion System for Small Satellites
Finn O’Brien PH/AE, Kevin Martin AE, Eric Pereira ME
Advisors: Nikolaos Gatsonis, Germano Iannacchione
Sponsor: MIT Lincoln Laboratory
Ludwig (ECE), Lyubov Titova and Alex Zozulya (PH)

Applying Cluster Computing With Raspberry Pi’s to Numerical General Relativity
Zachary Chester
Advisors: Shanshan Rodriguez and Leo Rodriguez

High Accuracy Electrodynamical Calculations using Hermite Finite Elements
Siddhant Pandey
Advisor: L. R. Ram-Mohan

Experimental measurement of anisotropy for an Iridium-192 source using gafchromic dosimetry
Group: Nicole Beinstein and Kenneth Fong
Advisor: David Medich

Devising an Optimal Procedure to Study the Relationship Between Cytoskeletal Stiffness and Contractile Force in Cells
Aline Tomasian
Advisor: Qi Wen

Simulation of the propagation of Terahertz waves in linear and nonlinear media
Miguel Aranda
Advisors: Reinhold Ludwig (ECE), Lyubov Titova and Alex Zozulya (PH)
Hearing from and Engaging with our Physics Community

Patrick O'Mullan  
(Ph/CS) '22  
pjomullan@wpi.edu

Tom Young  
Physics Teacher Program  
tayoung@wpi.edu

Jacob Bouchard  
BS, MS, PhD Student  
jnbouchard@wpi.edu
Hearing from and Engaging with our Physics Community

Caroline Jaeger
Physics/Env&Sustainability Studies '22
cjaeger@wpi.edu

Megan Varney, She/her/hers
B.S., M.S. Physics 2021
Research Assistant - Wu Lab
Resident Advisor - Institute Hall
Secretary – SIAM
mevarney@wpi.edu

Zoe Mutton
Society of Physics Students - President
Ketones A Cappella - Music Director
zmmutton@wpi.edu

Worcester Polytechnic Institute
Professor Lyubov Titova: Research and Outreach

**RESEARCH COMMUNITIES**

**2019-2020 CLARE BOOTHE LUCE RESEARCH SCHOLARS**

Through a Clare Boothe Luce Research Scholar grant from the Henry Luce Foundation, the School of Arts & Sciences provides research awards to support traditionally underrepresented undergraduate women in math, computer science, physics, and robotics engineering.

- **Hope Chalmers '20**
  - Major: Physics
  - Mentor & research advisor: Lyubov Titova

- **Caroline Jorgensen '22**
  - Major: Physics
  - Mentor & research advisor: Lyubov Titova

- **Alexa Ostapenko '20**
  - Major: Computer Science and Information Sciences
  - Mentor: Carolina Hsu; research advisor: Lyubov Titova

- **Katherine Hudak '21**
  - Major: Physics
  - Mentor: Lyubov Titova; research advisor: Lyubov Titova

- **Megan Venney '21**
  - Major: Physics
  - Mentor & research advisor: Lyubov Titova

Lyubov Titova, associate professor of physics, works with a student in her Ultrafast THz and Optical Spectroscopy Lab.
Patrick O'Mullan

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