Optical Physics, Quantum Information, and AMO Physics
Wyant College of Optical Sciences, University of Arizona
Fall 2022

Information for prospective PhD students

Optical Sciences faculty – Optical Physics/AMO/Quantum Information experiments

Brian P. Anderson
Associate Dean for Graduate Academic Affairs, Wyant College of Optical Sciences
Professor of Optical Sciences

Please contact for any questions, discussions about PhD program. Bose-Einstein condensation, quantum turbulence, superfluidity, quantized vortices. *(Not currently taking new PhD students.)*

https://www.optics.arizona.edu/person/brian-p-anderson
520-626-5825
bpa@optics.arizona.edu
Office: 622
Labs: 566

Matt Eichenfield
SPIE Endowed Chair in Optical Sciences
Associate Professor of Optical Sciences

Novel microsystems for Classical and Quantum Information Processing

https://www.optics.arizona.edu/person/matthew-eichenfield
520-626-5398
eichenfield@arizona.edu
Office: 521

Saikat Guha
Nasser Peyghambarian Endowed Chair in Optical Sciences
Professor of Optical Sciences
Director of the Center for Quantum Networks

Quantum information processing with optics, quantum communication (experiment and theory, quantum information and photonics)

https://www.optics.arizona.edu/person/saikat-guha
520-621-7595
saikat@optics.arizona.edu
Office: 523

Poul Jessen
Chair of Quantum Information and Control, Wyant College of Optical Sciences
Professor of Optical Sciences

Laser cooling and trapping, optical lattices, quantum control

http://www.optics.arizona.edu/person/poul-jessen
520-621-8267
poul.jessen@optics.arizona.edu
Office: 604
Labs: 564, 568, 570

R. Jason Jones
John Paul Schaefer Endowed Chair in Optical Sciences
Professor of Optical Sciences
Ultrafast optical science and precision frequency comb spectroscopy
http://www.optics.arizona.edu/person/r-jason-jones
520-621-4358
rjjones@optics.arizona.edu
Office: 625
Labs: 572, 576, 578, 656

Pavel Polynkin
Research Professor of Optical Sciences
Ultraintense nonlinear optics
http://www.optics.arizona.edu/person/pavel-polynkin
520-621-2864
ppolynkin@optics.arizona.edu
Office: 606
Labs: 666, 668

Dal Wilson
Assistant Professor of Optical Sciences
Cavity optomechanics and quantum optics
https://www.optics.arizona.edu/person/dalziel-wilson
520-621-2548
dalziel@optics.arizona.edu
Office: 650

Optical Sciences faculty - Optical Physics/AMO/Quantum Information theory

Rolf Binder
Professor of Optical Sciences
Optical properties of semiconductor structures and semiconductor lasers
https://www.optics.arizona.edu/person/rolf-binder
520-621-2892
binder@optics.arizona.edu
Office: 632

Miro Kolesik
Professor of Optical Sciences
Nonlinear optics of ultrashort pulses, semiconductor laser modeling, statistical mechanics
https://www.optics.arizona.edu/person/miroslav-kolesik
520-621-4602
kolesik@acms.arizona.edu
Office: 538

Masud Mansuripur
Chair of Optical Data Storage, Wyant College of Optical Sciences
Professor of Optical Sciences
Physical nature of electromagnetic fields physics. *(Not currently taking new PhD students.)*
https://www.optics.arizona.edu/person/masud-mansuripur
520-621-4879
masud@optics.arizona.edu
Office: 638

Jerry Moloney
Professor of Optical Sciences
Computational methods, nanophotonics, VECSEL design, extreme nonlinear optics (also directs experimental research)
https://www.optics.arizona.edu/person/jerome-moloney
520-621-6755
jml@acms.arizona.edu
Office: 536

Ewan Wright
Professor of Optical Sciences
Femtosecond pulse propagation, ultrafast nonlinear optics, theory of ultracold dilute gases physics. *(Not currently taking new PhD students.)*
http://www.optics.arizona.edu/Wright/
520-621-2406
ewan.wright@optics.arizona.edu
Office: 636

Optical physics research groups outside of Wyant College of Optical Sciences

Optical Sciences graduate students may join research groups and do their PhD research outside of the Wyant College of Optical Sciences.

Mohammed Hassan
Assistant Professor
Attosecond microscopy, electron dynamics experiments
http://www.hassan.lab.arizona.edu/
520-626-1435
mohammedhassan@email.arizona.edu
Department of Physics

Vanessa Huxter
Assistant Professor
Ultrafast nonlinear spectroscopy experiments
https://huxtergroup.arizona.edu/
520-621-2114
vhuxter@email.arizona.edu
Department of Chemistry and Biochemistry

Oliver Monti
Professor
Interfacial structure and dynamics in organic photovoltaic cells experiments
http://labmonti.cbc.arizona.edu/
520-626-1177
monti@email.arizona.edu
Department of Chemistry and Biochemistry

Arvinder Sandhu
Professor
Ultrafast lasers, high harmonic generation, ultrafast atomic and molecular dynamics experiments
http://www.physics.arizona.edu/~sandhu/
520-621-6820
sandhu@physics.arizona.edu
Department of Physics

John Schaibley
Assistant Professor
2D material optoelectronic physics experiments
http://schaibleylab.com/
520-626-5112
johnschaibley@email.arizona.edu
Department of Physics

See also:

All research specialties at the Wyant College of Optical Sciences
https://www.optics.arizona.edu/research/research-specialties

Research areas of the Department of Physics
http://www.physics.arizona.edu/physics/research.php

Physical Chemistry Faculty in the Department of Chemistry and Biochemistry
http://www.cbc.arizona.edu/faculty_physical

Graduate courses in Optical Sciences involving Optical Physics, Quantum Physics, Quantum Information

OPTI 501	Electromagnetic Waves – (Mansuripur)
OPTI 503A	Mathematical Methods for Photonics and Optics – (Mansuripur)
OPTI 507	Solid-State Optics – (Binder)
OPTI 511L	Lasers and Solid State Devices Laboratory – (Wilson)
OPTI 511R	Optical Physics and Lasers - (Jones) – *An introductory course in Quantum Mechanics. Not usually necessary for most optical physics students**
OPTI 541A/B/C	Introduction to Lasers – (Jones)
OPTI 544	Foundations of Quantum Optics – (Jessen)
OPTI 547	The Beam Propagation Method – (Kolesik)
OPTI 549	Atom Optics – (Anderson) *(not available every year)*
OPTI 551	Computational Optics: Nonlin. Light-Matter Interact. – (Kolesik)
OPTI 557	Laser Engineering and Applications – (Polynkin)
OPTI 560	Quantum Nanophotonics – (Fan)
OPTI 561	Physics of Semiconductors – (Binder)
OPTI 570	Quantum Mechanics – (Anderson)
OPTI 571L	Optical Physics Computational Lab – (Wright)
OPTI 583	Computational Optics – (Kolesik) *(not available every year)*
OPTI 595B	Information in a Photon – (Guha)
OPTI 600G/K/L	Optical Resonators and Cavity Optomechanics – (Wilson)
OPTI 646	Quantum Information and Computation – (Jessen)
OPTI 647	Photonic Quantum Information Processing – (Gagatsos)
OPTI 792	Directed Introductory Graduate Research – (all professors)

Independent Study of topics not listed is also possible (up to 6 credits will count towards PhD coursework requirements).

For a full list of Graduate courses in Optical Sciences, see:
https://www.optics.arizona.edu/osc-students/courses

PhD Course and Exam Requirements

All students must take 8 or 9 "core" courses (generally in the first two years of the program). The Qualifying Exam tests the material on four topics covered in the core courses taken during the first year. This exam is taken in the week before the fall semester of the second year of the PhD program.

The specific core courses and the order in which they are taken will slightly depend on the chosen research area and advisor's recommendations, and may be different than another student's core courses. Optical Physics and Quantum Information students will take a sequence of courses that places emphasis on quantum mechanics and quantum optics. For these students, a typical course sequence is listed below, spanning the first two years of the PhD program; this example sequence satisfies core course requirements and other first-year academic requirements. Other course sequences are possible. Specific courses that satisfy core course requirements are listed in bold.

EXAMPLE COURSE SEQUENCE for first two years for Optical Sciences PhD students doing research in ***Optical Physics or Quantum Information***

Fall, First year

- **OPTI 501 – Electromagnetic Waves** *(tested on Qualifying Exam)*
- **OPTI 502 – Optical Design and Instrumentation** *(tested on Qualifying Exam)*
- **OPTI 570 – Quantum Mechanics** *(tested on Qualifying Exam)*
- OPTI 792 – Directed Introductory Graduate Research (1 to 3 credits)

Spring, First year

- **OPTI 544 – Foundations of Quantum Optics** *(tested on Qualifying Exam)*
- **OPTI 505R – Diffraction & Interferometry** *(tested on Qualifying Exam)*
- Elective course, such as **OPTI 595B – Information in a Photon**
- OPTI 792 – Directed Introductory Graduate Research (1 to 3 credits)

Fall, Second year

- **OPTI 507– Solid-State Optics**
- **OPTI 541A – Introduction to Lasers (1 unit)**
- A 1-unit lab course: OPTI 511L – Laser laboratory or OPTI 571L – Optical Physics Computational Lab
- Elective course, such as OPTI 646 – Quantum Information and Computation, or OPTI 647 – Photonic Quantum Information Processing

Spring, Second year

- **OPTI 503A – Mathematical Methods for Photonics and Optics**
- Electives, independent study, labs, or thesis units

Qualifying Exam

The qualifying exam is to be taken by all PhD students after the first full year in the PhD program, and is offered at the beginning of the second year in the program during the week before classes start in the fall. The qualifying exam is a written exam that covers 4 topics:

- Electromagnetic Waves (**OPTI 501**),
- Optical Design and Instrumentation (**OPTI 502**),
- Diffraction and Interferometry (**OPTI 505R**),
- Optical Physics (OPTI 511R, *or* **OPTI 570 and OPTI 544**).

Comprehensive Exam

The comprehensive exam is comprised of a written portion and an oral presentation in front of a committee of four faculty members. The exam involves the preparation of a written report and oral discussion and questioning of a research topic typically involving the student's research, and how the research relates to various topics in optics. The exam is typically given only after a student has become fully engaged in a research group, and is typically taken in the third full year in the PhD program.

Coursework requirements for the PhD

45-54 credit hours of coursework must be completed for the PhD. This does not include thesis credit hours. The 45 credit-hour minimum is allowable with the permission of the research advisor. Optical Physics and Quantum Information advisors typically approve this waiver for their students. Up to 6 of credit hours may be taken through independent study rather than formal courses. Assuming the 45-credit-hour waiver is obtained, one possible full set of courses (and associated number of credit hours) that would satisfy the coursework requirements is as follows:

Core courses (25 credit hours in this list)

OPTI 501	Electromagnetic Waves (3)
OPTI 502	Optical Design and Instrumentation (3)
OPTI 570	Quantum Mechanics (3)
OPTI 505R	Diffraction and Interferometry (3)
OPTI 544	Foundations of Quantum Optics (3)
OPTI 595B	Information in a Photon (3)
OPTI 541A	Introduction to Laser Physics (1)
OPTI 507	Solid-State Optics (3)
OPTI 503A	Mathematical Methods for Photonics and Optics (3)

Lab requirements (2 lab courses are required. 2 credit hours in this list)

OPTI 511L	Lasers and Solid State Devices Laboratory (1)
OPTI 571L	Optical Physics Computation Laboratory (1)

OPTI 792 – 2 units are required, but strongly recommended to take 4-6 units in Year 1

Electives

Assuming

- *that the 27 units of core and lab courses listed above are taken*
- *6 total units of OPTI 792 are taken in the first year,*

*then **12 additional credit hours** would be needed. The following courses are often of interest to optical physics and quantum information students.*

OPTI 541B/C	Introduction to Lasers (2 – Spring)
OPTI 547	Beam Propagation Method (3 – Spring)
OPTI 561	Physics of Semiconductors (3 – Fall)
OPTI 600G/J/K	Cavity Optomechanics (2 – Fall)
OPTI 646	Quantum Information and Computation (3 – Fall)
OPTI 647	Photonic Quantum Information Processing (3 – Fall)
OPTI 551	Computational Optics: Nonlin. Light-Matter Interact. (1 – Spring)
OPTI 560	Quantum Nanophotonics (3 – Spring)
OPTI 595B	Information in a Photon (3 – Spring)
OPTI 599	Independent Study courses on topics of your choice (1-6 units)

Please feel free to contact the Assoc. Dean for Graduate Academic Affairs, Prof. Brian Anderson, bpa@optics.arizona.edu, for any questions.