# PHYS 572 Fundamentals of Quantum Optics and Atom Optics

---

# Syllabus

**Objectives:** Quantization of light field, quantum states of light, optical coherence theory, atom-photon interaction (quantum and semi-classical theory), system-reservoir coupling, laser cooling and trapping, quantum gases.

**Course Credit:** 3 semester hours
**Meeting Times:** Tuesday and Thursday, 10:50am-12:05pm
**Classroom:** ABL 123
**Audiences:** This is a graduate course for those who are interested in AMO physics. Any undergraduate students who have finished Phys311 and Phys312 are welcome to take this course too.

**Format:** A lecture course with biweekly problem sets, one mid-term exam and a final project.

**Textbook:** no required textbook.

| | | |
|---|---|---|
| **Reference Books:** | *Quantum Optics* | Walls and Milburn |
| | *Optical Resonance and Two-Level Atoms* | Allen and Eberly |
| | *Quantum Optics* | Scully and Zubairy |
| | *Optical Coherence and Quantum Optics* | Mandel and Wolf |
| | *Atom Optics* | Pierre Meystre |

## Course Instructor

*Han Pu*
*Assistant Professor, Department of Physics and Astronomy*
*Office: BRK 309*
*Phone: 713-348-3570*
*Email: hpu@rice.edu*

## *Homework and Grades*

*I plan to assign a homework set every other week, usually due at the beginning of class one week later. Homework sets will be distributed in class.*

***Homework Policy:*** *You are encouraged to discuss the homework problems with your PHYS 572 classmates and with the instructor, but you must write up your solutions independently. Of course, you must not copy from anyone else's solutions.*

***Late Policy:*** *The grade for late homework will be multiplied by a decaying exponential with a time constant of five days. The cutoff is 7 days, after which the solution will be posted online and the homework can no longer be accepted. Late homework must be delivered to the grader for that problem set and the student must write "Late" and the date and time on the front page.*

| | | |
|---|---|---|
| **Grading Weights:** | Homework: | 30% |
| | Mid-term: | 30% |
| | Final Project: | 40% |

## *Course Content*

1. Quantum Mechanics background: density operator, second quantization
2. Quantization of light field
3. Quantum states of light
4. Quantum coherence functions
5. Beam splitter and interferometer
6. Non-classical states
7. Bunching and anti-bunching, HBT experiment
8. Atom-photon interaction
9. Jaynes-Cummings model and Dicke model
10. Dressed states and application
11. Spontaneous emission
12. Optical Bloch equations
13. Maxwell-Bloch equations
14. Pulse propagation
15. Coherent phenomena in three-level systems
16. Laser cooling and trapping
17. Quantum gases

---

*Any student with a disability requiring accomodations in this class is encouraged to contact the instructor after class. Additionally, students should contact the Disabled Student Services office in the Ley Student Center.*

---