Useful information for the course

PHYS598 AQG – Atomic Physics & Atomic Quantum Gases

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Course textbook: *Atomic Physics*, by Christopher J. Foot

Course grader: Dmytro Bandak

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Course schedule for Fall 2017

Class:

Location: 222 Loomis

Days/time: Tuesdays and Thursdays at 2:00 pm-3:20 pm (CST)

Office hours:

for B. Gadway: 333 Loomis, Wednesdays at 10 am-11:30 am (and by appointment)

for D. Bandak: 2261 MNTL, Thursdays at 10 am-11 am (and by appointment)

Course Prerequisites

It is expected that all enrolled students will have taken upper-level undergraduate courses on E&M and quantum mechanics (equivalents of UIUC courses 435/436 and 486/487).

Course Goals

One goal of this course is to teach you some of the fundamentals related to the field of atomic, molecular, and optical (AMO) physics. We'd like you to leave the course with a core of knowledge related to the properties of atoms, how they interact with and can be manipulated by electromagnetic fields, and how they interact with each other. To reinforce these basic concepts,

we'll spend the first several weeks of the course discussing atomic structure and the interactions of simplified two-level atoms with static and time-varying electromagnetic fields. Later in the course we'll discuss the physics of ultracold atomic collisions.

We'd also like to leave you with some insight into how atomic physicists approach problems, in terms of what considerations are important for the unusual systems they study – extremely dilute gases of atoms held in ultrahigh vacuum, disconnected from thermal baths. Techniques for coherent control have played an important role in such systems, dating back to the developments of the Rabi and Ramsey methods in the 1930s and '50s. We will turn to discussions of key techniques of modern atomic physics, based largely on advances during the 1970s and '80s in the manipulation of atomic motion with laser light and magnetic fields. These advances paved the way for the creation of quantum gases (Bose-Einstein condensates and degenerate Fermi gases) in dilute atomic vapors. The last several weeks of the course will feature a special emphasis on atomic quantum gases, with discussions of their key properties, methods for their manipulation, and their use in quantum simulation studies.

We hope that you'll leave this course with a broad perspective of the kinds of things that researchers can do with atomic systems, of both applied and fundamental interest. Even if you don't intend to do research in the field of AMO physics, many of the concepts from this course – e.g. the physics of light-atom interactions or techniques for coherent control – can be of relevance to many different disciplines.

Organization of the course

1) Things you'll do before class

   Before lecture you'll be expected to read selected sections from our course textbook or other assigned materials (e.g., a journal article on occasion). The course textbook (*Atomic Physics*, by Christopher Foot) is available at the UIUC bookstore or through online purchase.

2) Things we'll do during in-class meetings

   Our in-class meetings will include lecturing on the topics we're covering and discussions related to assigned journal articles. Please ask as many questions as possible to make this more of a discussion and less of a lecture!

3) Things you'll do outside of class (i.e. how you'll actually learn)

   Homework: as grad students, most of you probably realize that learning largely occurs through active engagement with the material, such as when you're painfully slogging through a difficult homework assignment. A handful of homework sets (about one every other week) will serve as the main basis of assessment for this course (60% of your grade).

   HW turn-ins: roughly every other Friday (dates specified on the course schedule) by 4:30 pm, to be deposited in the yellow drop-off box labeled "598 AQG" on the 2nd floor of Loomis.

Term paper: you will additionally have an end-of-term paper worth 35% of your grade. This paper should focus on a recent experimental result from the field of AMO physics. See the course page (https://courses.physics.illinois.edu/phys598aqg/fa2017/PHYS598AQG-finalpaper.pdf) for more information on this final report.

4) Catching up on state-of-the-art research

A small portion of your grade (5%) will be based on attending two AMO-related talks (seminars or colloquia) throughout the semester and sending me a short email write-up related to the talk. The write-ups should be about one or two paragraphs in length, and can cover what you found interesting about the talk, how it relates to your own research, your thoughts on possible extensions to this work, etc. See the course web page (https://courses.physics.illinois.edu/phys598aqg/fa2017/indexsem.html) for links to the QI/AMO physics seminar schedule and the Physics Department colloquium schedule.

Grading Rubric

Homeworks: 60%
Final project: 35%
Seminars: 5%

Some course policies

Academic integrity: you may work collaboratively with others on the homework assignments, but the write-up you hand in should be written solely by you and represent your own work.

Late assignments: homework assignments and the final report will not be accepted after their specified due dates, except in the cases of a legitimate excuse related to health, professional activities, emergency situations, religious observances, etc. If you have questions regarding whether an excuse is considered “legitimate” or not, just run it by me ahead of time.