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## Overview and Learning Objectives

This is a one semester undergraduate course in thermodynamics and statistical mechanics. Statistical Mechanics is probably the most difficult, and most interdisciplinary courses in the undergraduate (and graduate) curriculum. It starts with *all* of physics, and combines this starting point with challenging concepts (at least for me) to make predictions about real things.

The structure and tentative order of the course will follow (but not slavishly) our excellent text book by Blundell and Blundell, [see below](#). We will also draw examples from Daniel Schroeder's (also excellent) book, [see below](#) and Zemansky and Dittman's 7th edition of the 1937 classic textbook on thermodynamics, [see below](#). Lecture notes of what is discussed in class will be provided. Weekly homeworks will be assigned.

### 1. Preliminaries

Basic Combinatorics and the Stirling Approximation: Chapter 1

Heat: Chapter 2

Probability Distributions: Chapter 3

Temperature and the Boltzmann Factor: Chapter 4

### 2. Kinetics of ideal gasses

Boltzmann velocity distribution: Chapter 5

Ideal gas law: Chapter 6

Flux through a hole: Chapter 7

Cross sections and the mean free path: Chapter 8

### 3. Basic Thermodynamics

The first law, heat capacity, isothermal and adiabatic expansions: Chapters 11, 12

The second law: Chapters 13, 14

Thermodynamic potentials: Chapter 16

Rods and Magnets: Chapter 17

### 4. Basic Statistical Mechanics

Partition Functions: Chapter 20  
Partition Function of Ideal Gas: Chapter 21  
The equipartition theorem: Chapter 19  
Black Body Radiation: Chapter 23

#### 5. Chemical potential

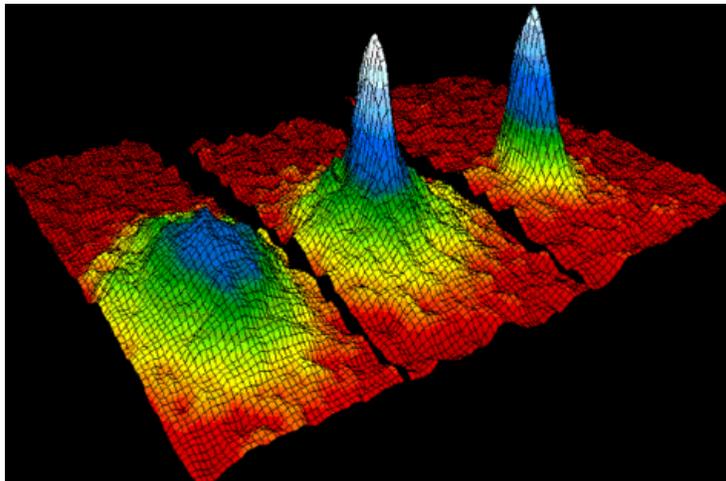
The grand partition function: Chapter 22  
Chemical thermodynamics: Chapter 22 and Schroeder 5

#### 6. Quantum Gasses

Fermi and Bose Distributions 29  
The Fermi Gas: Chapter 30 and Schroeder 7  
The Bose Gas: Chapter 30 and Schroeder 7

The goal of this course is for you to be able to solve physics problems associated with these topics. The homeworks are designed to help you achieve this goal.

The image below shows the velocity-distributions for a gas of rubidium atoms, indicating the formation a Bose-Einstein condensate. For this and related experiments, Eric Cornell, Carl Weinman, Wolfgang Ketterle received the 2001 Nobel Prize. Left: just before the appearance of a Bose-Einstein condensate. Center: just after the appearance of the condensate. Right: after further evaporation, leaving a sample of nearly pure condensate. We will discuss Bose condensation at the end of the course.



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#### Lecture Instructor:

Professor, Derek Teaney: [derek.teaney @ stonybrook.edu](mailto:derek.teaney@stonybrook.edu)



Derek Teaney  
Department of Physics & Astronomy  
PO Box 3800  
Stony Brook, NY 11764-3800

Office: Physics C-135  
Office Hours: Physics C-134 (Nuclear Theory Common Room)

(631)632-4489, Fax 9718

Teaching Assistant: Georgios Papachatzakis. The TA will communicate via email, Georgios.Papachatzakis @stonybrook.edu

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## Schedules and Format

The course consists of lectures, homework, midterm and final exams, and office hours.

### Lectures, class meetings, and lecture notes

The course consists of three in person lecture hours:

Lecture Hours: TuTh 9:45-11:05 a.m. in Harriman 112

Detailed lecture notes will be given. But, these notes are not a book, and are not a substitute for going to class.

### Homework submitted online:

Homework is a significant part of the course. It will be assigned approximately weekly, and students should expect to spend approximately 10 hours a week on homework. There will be approximately 12 assignments during the semester.

Homework will be collected online through blackboard. Students will need to produce a scan (of reasonable quality) of their homework, and submit it electronically as a single pdf document. Individual jpegs are not acceptable and will not be graded. For a typical student, the program CamScanner, which can be installed on any modern phone, is a useful tool to scan handwritten pages and convert them to a single pdf document.

Homework will be accepted late, but will be penalized at 5% per day. Homework turned in after ten days will receive up to 50% of the maximum grade.

### Exams

*The final exam:*

The final exam is on Tuesday, May 9th, 2023 from 8:00 A.M. -- 10:45 A.M (yikes that is early!) in our class room.

*The two midterms and quizzes:*

The precise date for the two Midterms will be announced at a later time. There may be one or more quizzes, depending on timing. These will be announced, and *not* a "pop" quiz.

### Office Hours:

Office hours are 3:00pm on Wednesday either in the the Nuclear Theory Common room (C134) or in my office (C135). You can stop by at other times, but I could be busy.

Our TA is Georgios Papachatzakis. His office ours will be held once a week.

### Technical requirements:

Students will need to produce a scan (of reasonable quality) of their weekly homework, and submit it electronically as a single pdf document. Individual jpegs and other formats will not be accepted. For most students, the app CamScanner, which can be installed on any modern phone, is a useful tool to scan handwritten pages and convert them to a single pdf document. This can be submitted to brightspace. You will need some kind of calculator for exams.

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## Grade Determination and Homework

The grading will be based *roughly* on the following table. I reserve the right to change these proportions (within reasonable limits) as the course progresses to provide the best overall assessment of the class as a whole. My intent of course is to follow these guidelines.

Homework and Quizzes	15%
Midterm Exam 1	20%
Midterm Exam 2	25%
Final Exam	40%

There may be one or two pre-announced (i.e. NOT pop) quizzes.

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## The Book and Resources

The required book for the course is

*Concepts in Thermal Physics* by Blundell and Blundell. Features short chapters and many examples.

Some other books which I used when preparing the course are:

1. *An Introduction to Thermal Physics* by Daniel Schroeder. Excellent discussion of chemical concepts and should be used in conjunction with any AP chemistry book. I will draw the problems on chemistry from largely this book.
  2. *Heat and Thermodynamics* by Zemansky and Dittman. A classic textbook, first published in 1937. As a student I especially appreciated the discussion of experiment. I have the sixth edition.
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## Other Items

### Required e-mail communication

Email to your University email account is an important way of communicating with you for this course. For most students the email address is `firstname.lastname@stonybrook.edu`. It is your responsibility to read your email received at this account.

### Student Accessibility Support Center:

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, Stony Brook Union Suit 107, (631) 632-6748, or at `sasc@stonybrook.edu`. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

#### Academic Integrity:

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology and Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at [http://www.stonybrook.edu/commcms/academic\\_integrity/index.html](http://www.stonybrook.edu/commcms/academic_integrity/index.html)

#### Critical Incident Management:

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.