

**PHY 711 Classical Mechanics and
Mathematical Methods**
10-10:50 AM MWF Olin 103

Plan for Lecture 19:

Continue reading Chapter 7

- 1. Analytic methods for solving Sturm-Liouville equations**
- 2. Eigenvalue solutions**
- 3. Green's function methods**

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Date	F&W Reading	Topic	Assignment
1 Wed, 8/27/2014	Chap. 1	Review of basic principles	#1
2 Fri, 8/29/2014	Chap. 1	Scattering theory	#2
3 Mon, 9/01/2014	Chap. 1	Scattering theory continued	#3
4 Wed, 9/03/2014	Chap. 2	Accelerated coordinate systems	#4
5 Fri, 9/05/2014	Chap. 3	Calculus of variations	#5
6 Mon, 9/08/2014	Chap. 3	Calculus of variations	#6
7 Wed, 9/10/2014	Chap. 3	Hamilton's principle	#7
8 Fri, 9/12/2014	Chap. 3 & 6	Hamilton's principle	#8
9 Mon, 9/15/2014	Chap. 3 & 6	Lagrangians with constraints	#9
10 Wed, 9/17/2014	Chap. 3 & 6	Lagrangians and constants of motion	#10
11 Fri, 9/19/2014	Chap. 3 & 6	Hamiltonian formalism	#11
12 Mon, 9/22/2014	Chap. 3 & 6	Hamiltonian formalism	#11
13 Wed, 9/24/2014	Chap. 3 & 6	Hamiltonian Jacobi transformations	#11
14 Fri, 9/26/2014	Chap. 4	Small oscillations	Begin Take-Home
15 Mon, 9/29/2014	Chap. 4	Normal modes of motion	Continue Take-Home
16 Wed, 10/01/2014	Chap. 4	Normal modes of motion	Continue Take-Home
17 Fri, 10/03/2014	Chap. 4	Normal modes of motion	Take-Home due
18 Mon, 10/06/2014	Chap. 7	Wave motion	#12
19 Wed, 10/08/2014	Chap. 7	Sturm-Liouville Equations	#13
20 Fri, 10/10/2014			

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Department of Physics

News

[Randall D. Ledford Scholarship I in Physics](#)

[Andraea Belanger Awarded Poster Prize](#)

[Ryan Godwin Awarded Predoctoral Fellowship](#)

Events

Wed. Oct 8, 2014
Physics Colloquium:
Granular Physics
 Prof. M. Shattuck*, CUNY
 Olin 101 4:00 PM
 Refreshments at 3:30 PM
 Olin Lobby
 *WVU alum

Wed. Oct 15, 2014
Physics Colloquium:
Quantum Dots
 Prof. S. Geyer, WVU
 Olin 101 4:00 PM
 Refreshments at 3:30 PM
 Olin Lobby

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TITLE: Granular Thermodynamics and Statistical Mechanics

SPEAKER: [Professor Mark D. Shattuck](#)

Department of Physics,
City College of New York

TIME: Wednesday October 8, 2014 at 4:00 PM

PLACE: Room 101 Olin Physical Laboratory

Refreshments will be served at 3:30 PM in the Olin Lounge. All interested persons are cordially invited to attend.

ABSTRACT

Thermodynamics is generally not applicable to systems with energy input and dissipation present, and identifying relevant tools for understanding these far-from-equilibrium systems poses a serious challenge. Excited granular materials have become a canonical system to explore such ideas since they are inherently dissipative due to inter-particle frictional contacts and inelastic collisions. Granular materials also have far reaching practical importance in a number of industries, but accumulated ad-hoc knowledge is often the only design tool.

An important feature of driven granular systems is that the energy input and dissipation mechanisms can be balanced such that a Non-Equilibrium Steady State (NESS) is achieved. This NESS shares many properties of systems in thermodynamic equilibrium. In particular, the structure and dynamics of the NESS are almost identical to equilibrium systems. Further, we present strong experimental evidence for a NESS first-order phase transition in a vibrated two-dimensional granular fluid. The phase transition between a gas and a crystal is characterized by a discontinuous change in both density and temperature and exhibits rate dependent hysteresis. Finally, we measure a "free energy"-like function for the system, whose minimum determines the state of the system.

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Analysis of Sturm-Liouville equations

- General form of equations
- Eigenfunctions and eigenvalues
 - Orthogonal properties
 - Notion of completeness
 - Variational principles
- Green's function solution for inhomogeneous Sturm-Liouville problems
 - Green's function as an eigenfunction expansion
 - Green's function constructed from homogeneous Sturm-Liouville solutions
- Fourier transforms
- Laplace transforms

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