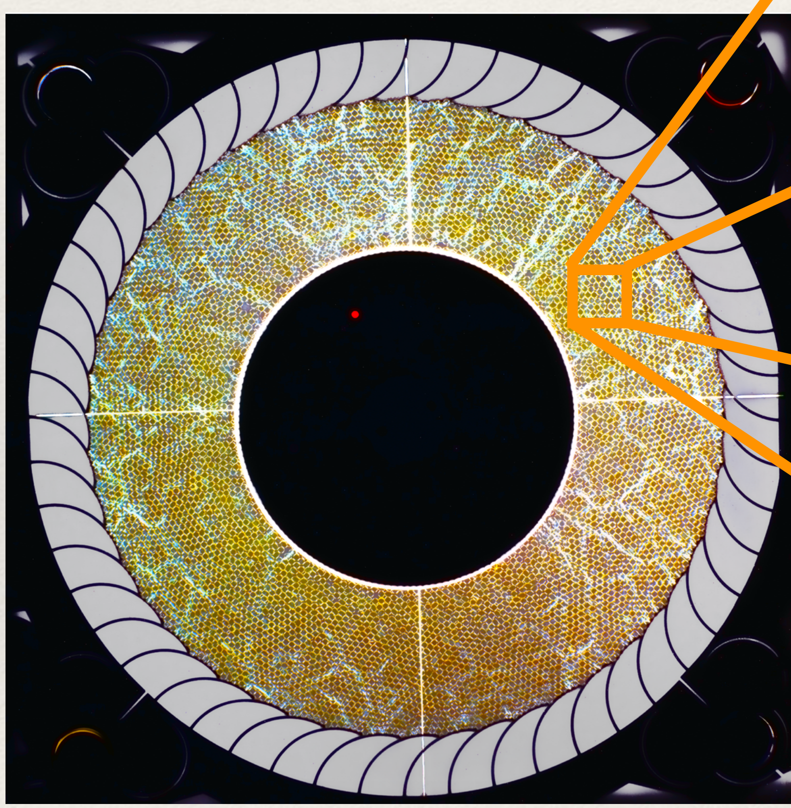
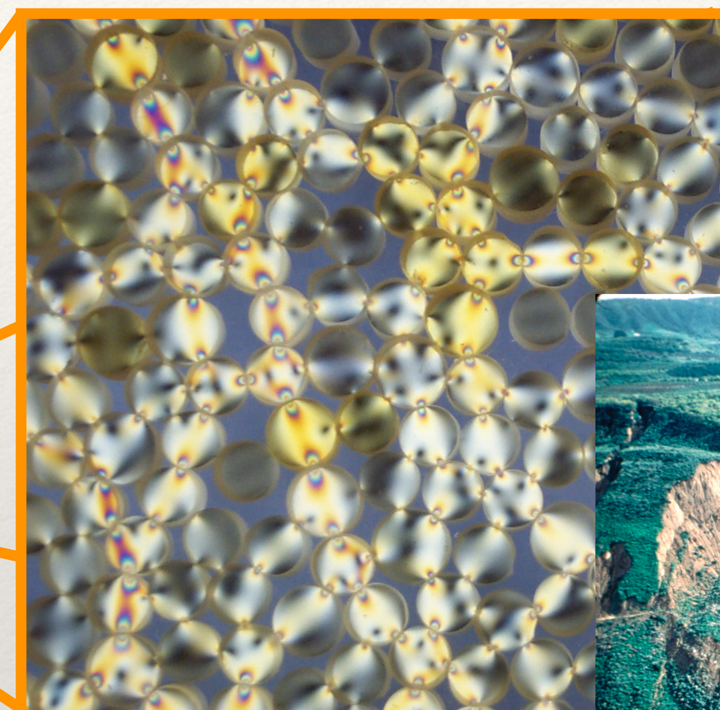
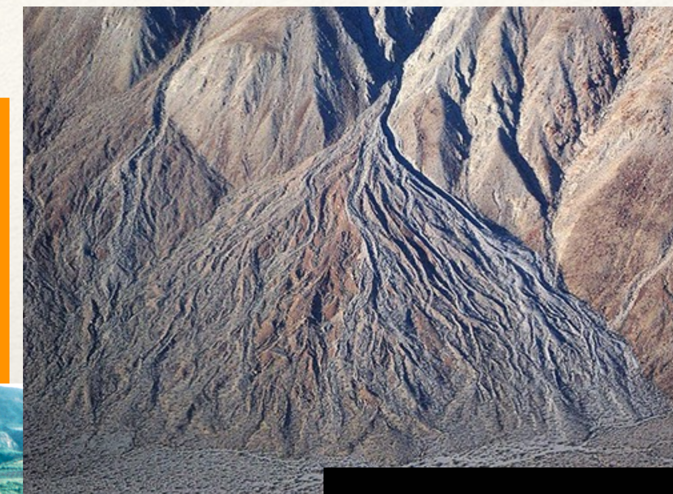
Welcome to Physics 308:
Prof. Ted Brzinski

Are you in the right place?

- Are you an astronomy/physics/astrophysics/math major?
- Do you like tricky problems? Or learning new problem solving strategies?
- Do you like to explore how simple rules can produce surprising or complex outcomes?

Who am I? Prof. Ted Brzinski

I do mechanics + statistical/nonlinear physics! How do simple constituents produce complicated or surprising phenomena?

Things I do other than physics: biking, hiking, cooking, coffee'ing, playing with my kids, watching movies, reading comics and books, playing video games

Motivation for class format:

- Not enough time for all details in class!
- Cognitively important to see things multiple times in multiple ways (research-proven!)
- Independent learning is a great compliment to communal study:
    - Work through examples.
    - Scribble notes.
    - Work some unassigned problems
- Class as a way of reinforcing, testing, and contextualizing your independent learning

Class format

- Classes:
  - Monday — lecture/discussion
  - Wed/Fri — group work/group presentations

Class format

- Deadlines for each topic/week (11:59 PM):
  - Notes on readings/lecture (**Monday** - no more than 30 minutes, or [even better] write as you read!)
  - Rough draft solutions (**Friday**)
  - Peer feedback (**2nd Monday** ~30 minutes)
  - Pretty (final) solutions (**2nd Wed.**)
  - Quiz (**2nd Thursday**, 15 minutes)

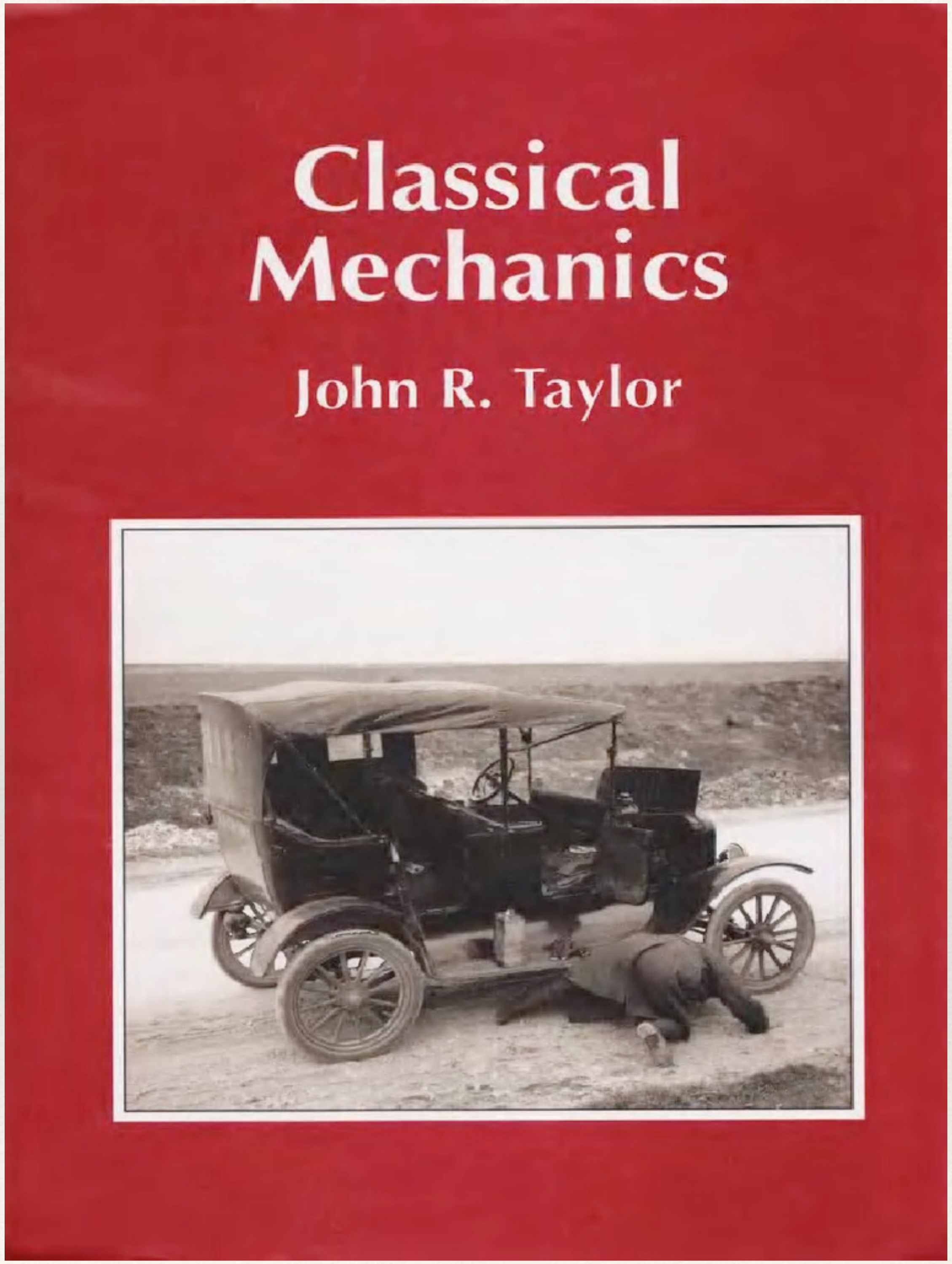
This week

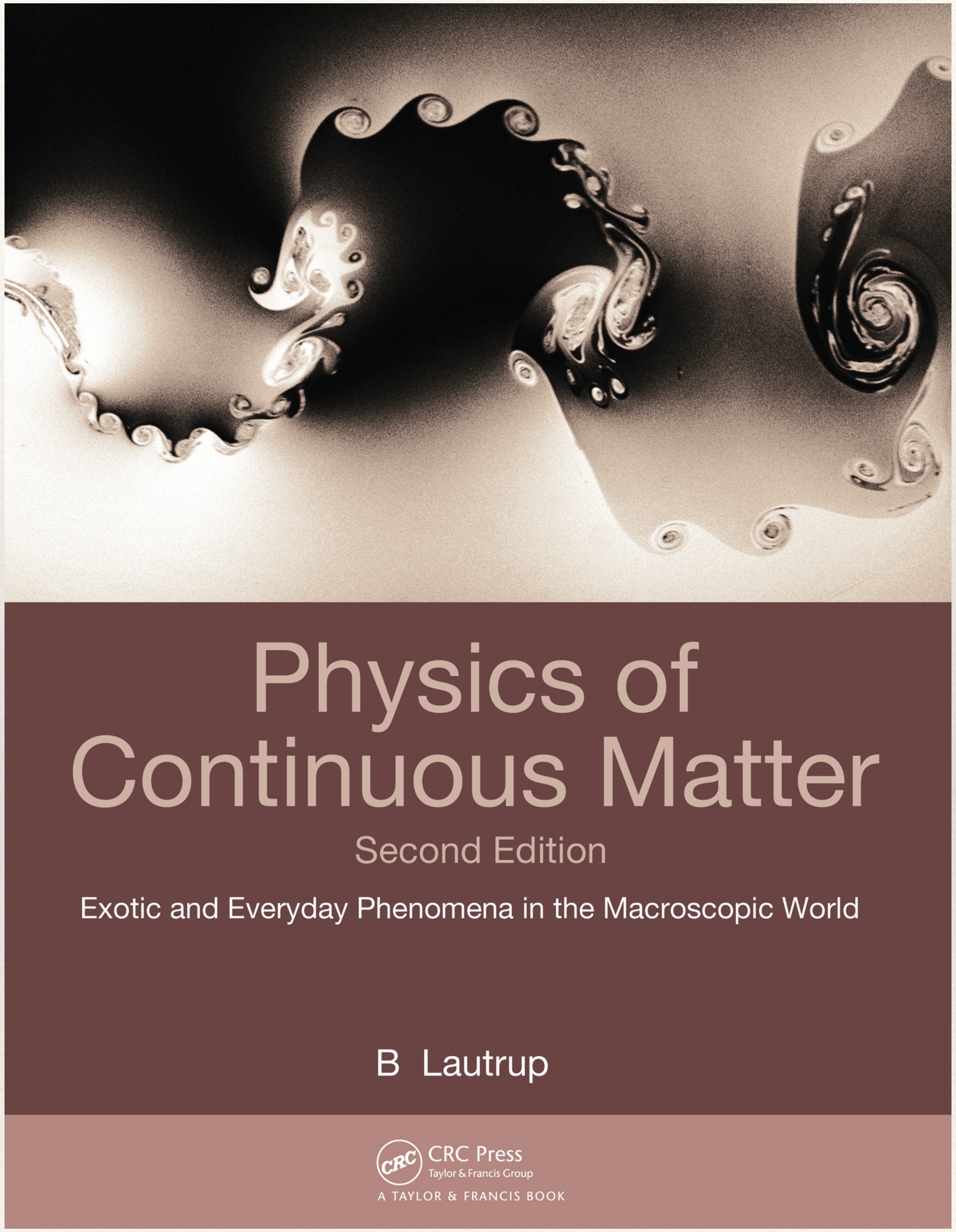
- Reading notes due Wed. Instead of Monday!
- Friday - mathstravaganza! Work out one of the indicated problems *independently* before class. Each group will share their solutions, then choose one to present.

Next week

- No class Monday! (Labor Day)
- Reading notes and peer feedback due Tuesday (instead of Monday). Peer feedback at noon, reading notes at the usual 11:59 PM.

Textbooks


Classical Mechanics
John R. Taylor


Physics of Continuous Matter
Second Edition
Exotic and Everyday Phenomena in the Macroscopic World
B Lautrup
CRC Press
Taylor & Francis Group
A TAYLOR & FRANCIS BOOK

Newton’s Laws

- 1 -
- 2 -
- 3 -

Newton's Laws

- 1 - Objects keep moving (or not) unless you push 'em.
- 2 - Objects change how they're moving proportionally to how hard and how long you push them:

  $$F = ma \Rightarrow dv = \frac{F}{m} dt$$

- 3 - When you push a thing, it pushes you back!

Newton's Laws

- Newton's 3rd law → conservation of momentum (see reading!)
- Newton's 2nd law → conservation of energy

$$F = m\frac{dv}{dt} = m\frac{dv}{dx}\frac{dx}{dt} = mv\frac{dv}{dx}$$

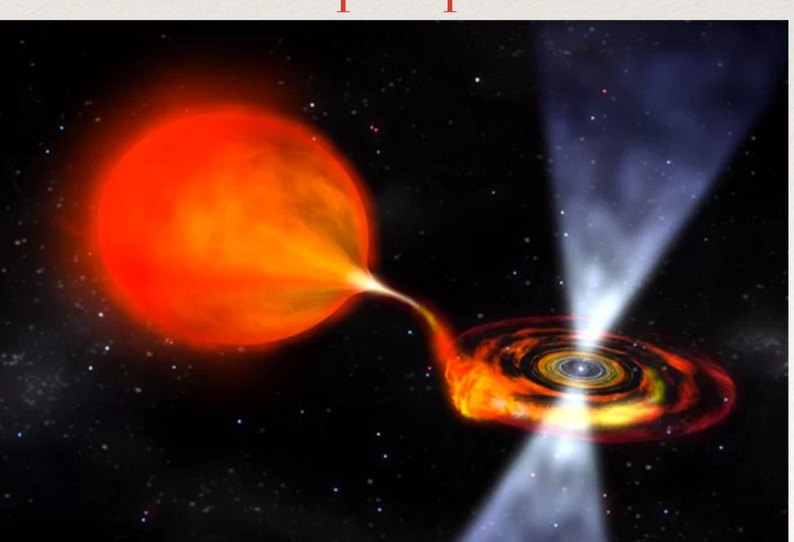
$$\Rightarrow F\ dx = mv\ dv \Rightarrow F \cdot \Delta x = \frac{1}{2}mv^2$$

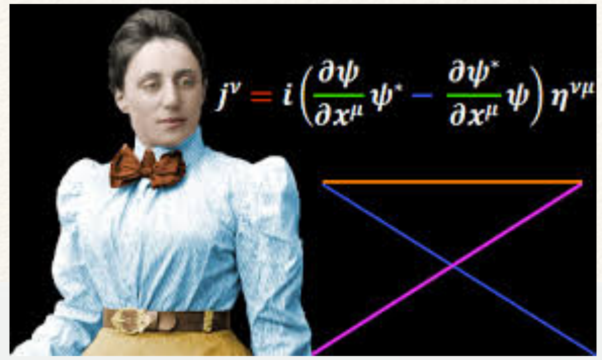
Conservation laws:

Angular momentum

Image courtesy of space.com

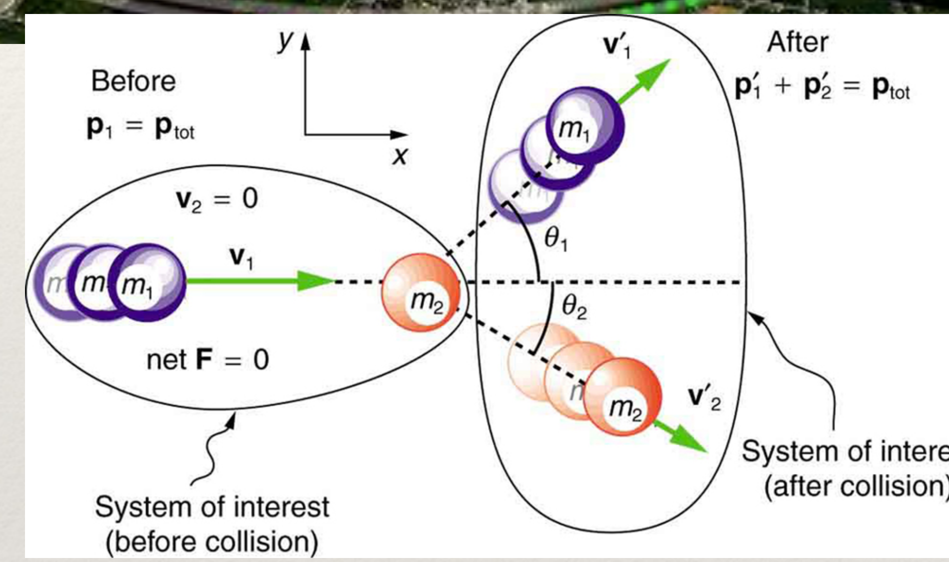
Neutron star spin up

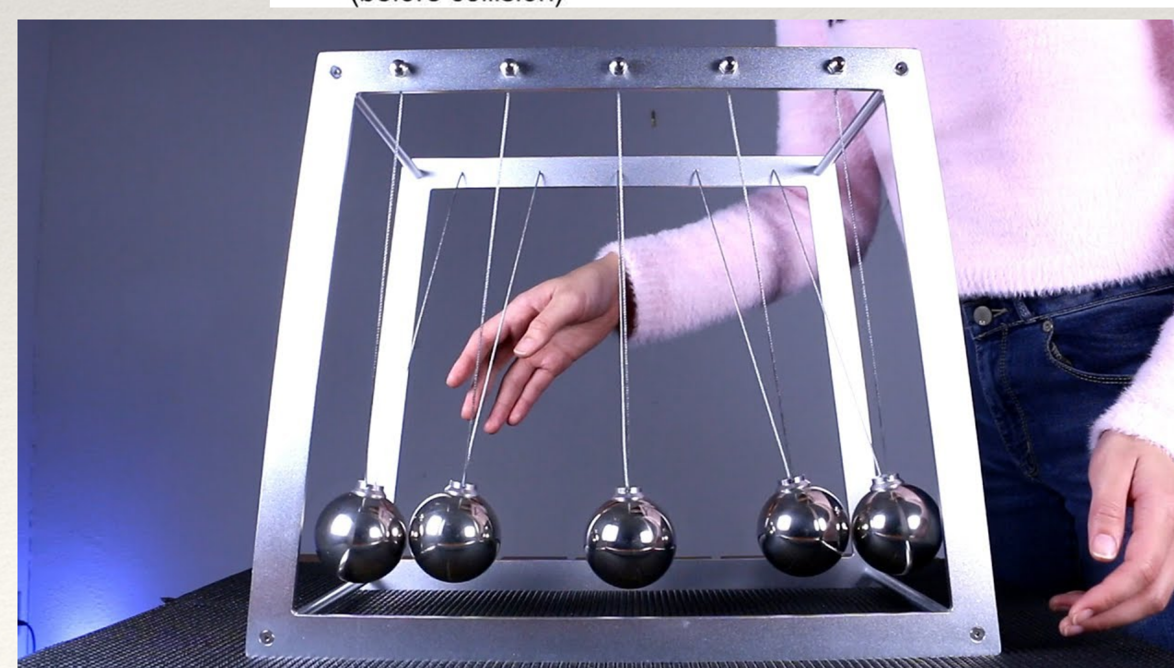




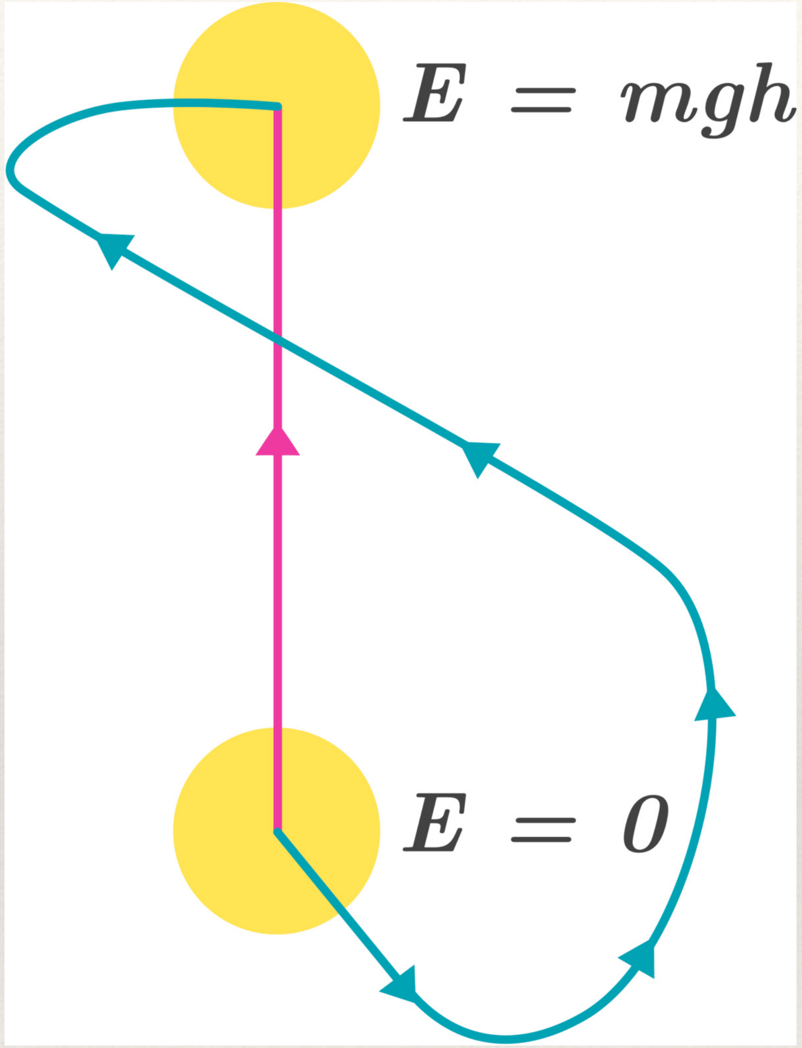
Energy and momentum

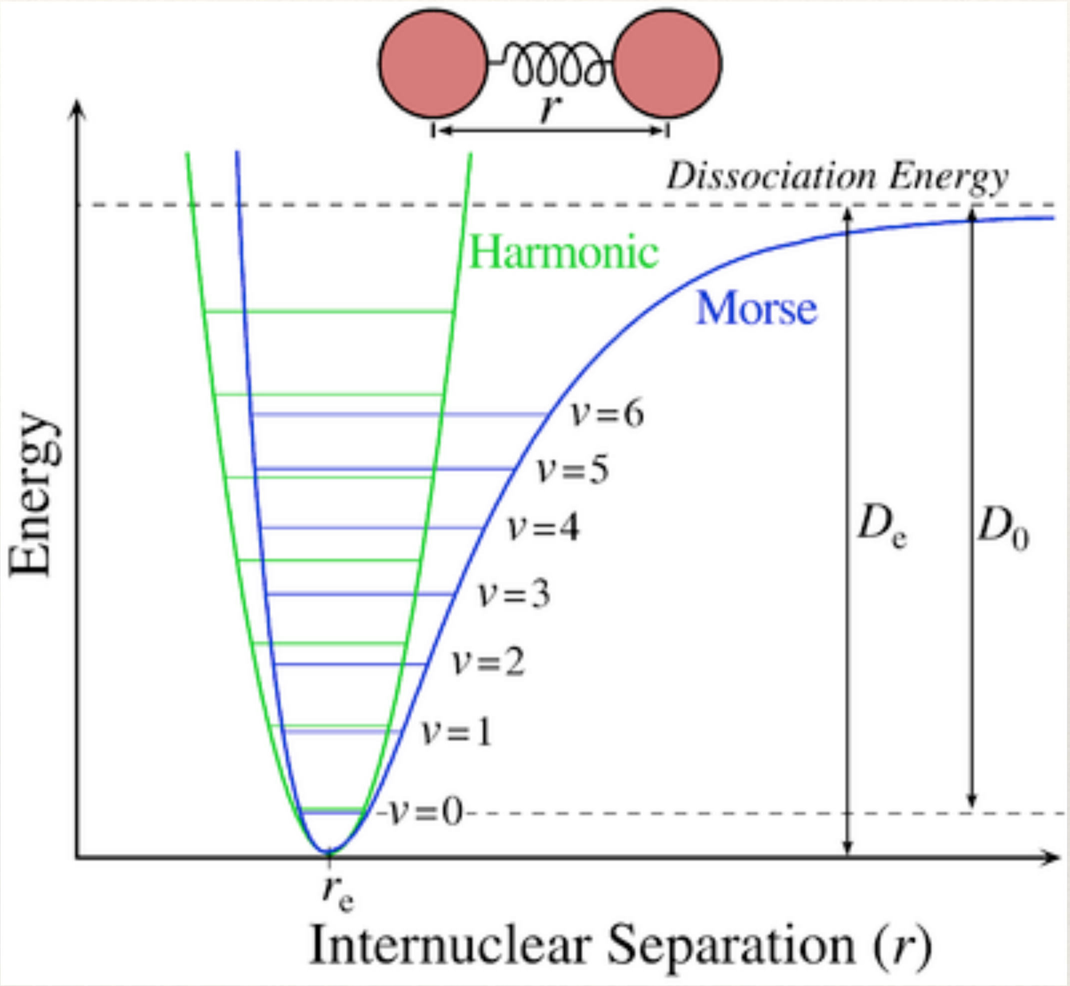
images courtesy of CERN



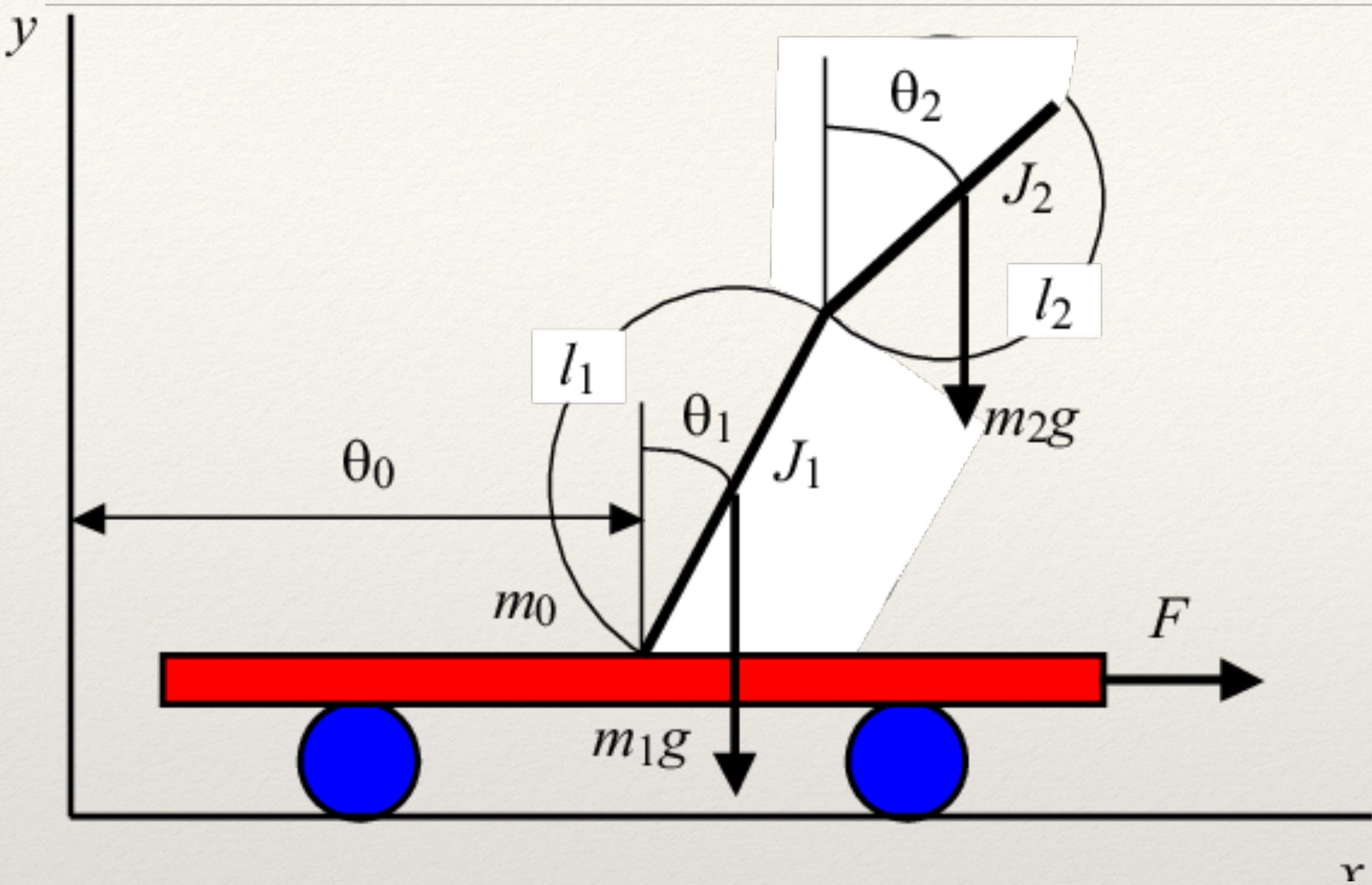


Conservative forces





Lagrangian mechanics



$$\mathcal{L} = T - V$$

$$S = \int dt L[x(t), \dot{x}(t); t]$$

$$\frac{\partial \mathcal{L}}{\partial x} = \frac{\partial}{\partial t}\frac{\partial \mathcal{L}}{\partial \dot{x}}$$

Mechanics beyond free-body diagrams

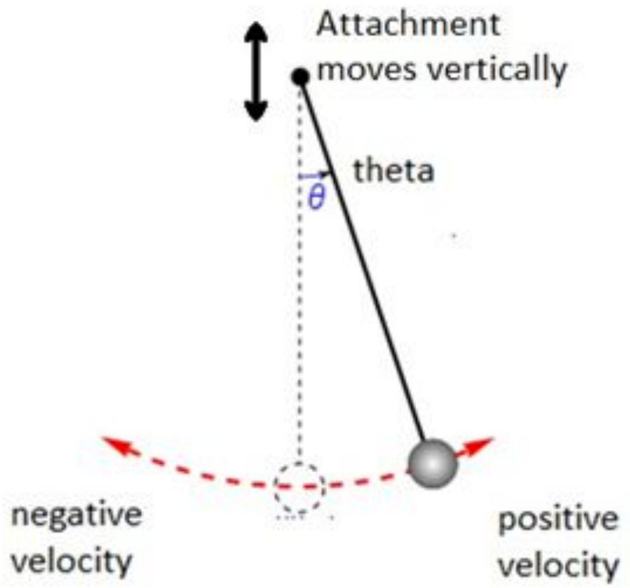
Hamilton's equations

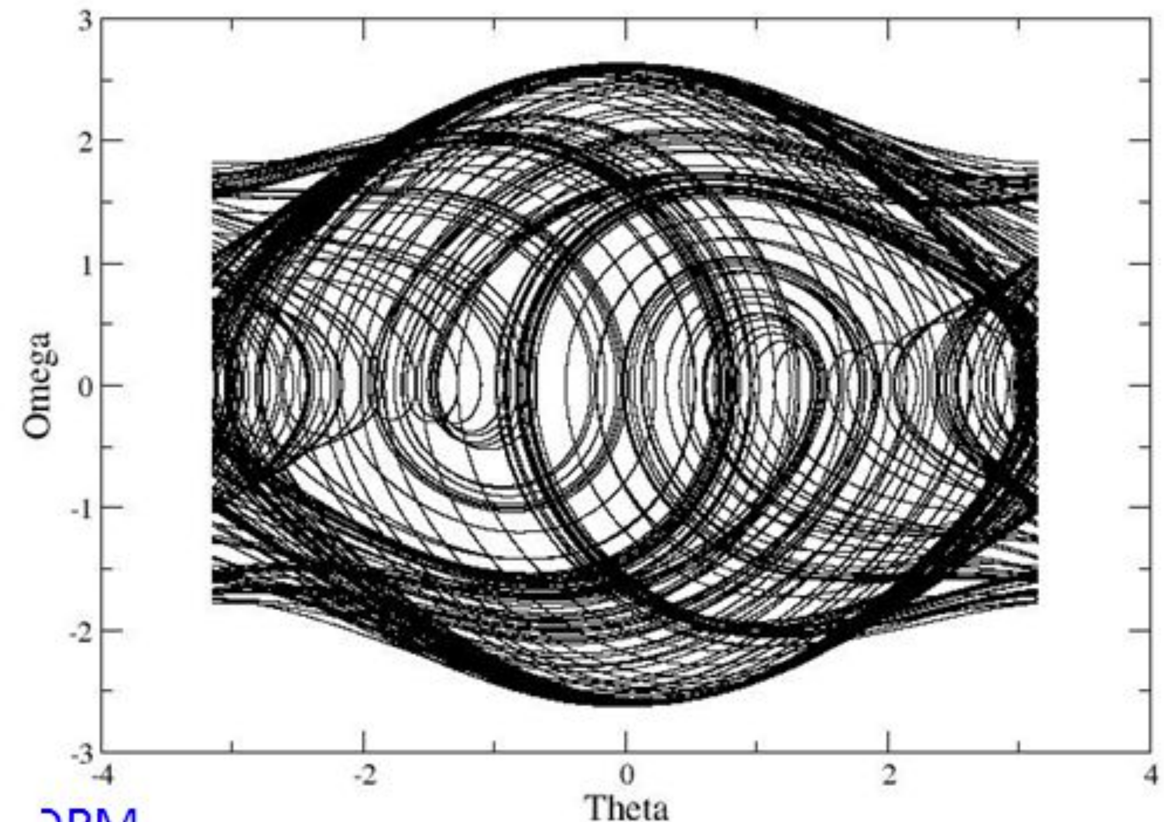
$$\mathcal{H}(\boldsymbol{p}, \boldsymbol{q}, t) = \sum_{i=1}^{n} p_i \dot{q}^i - \mathcal{L}(\boldsymbol{q}, \dot{\boldsymbol{q}}, t)$$

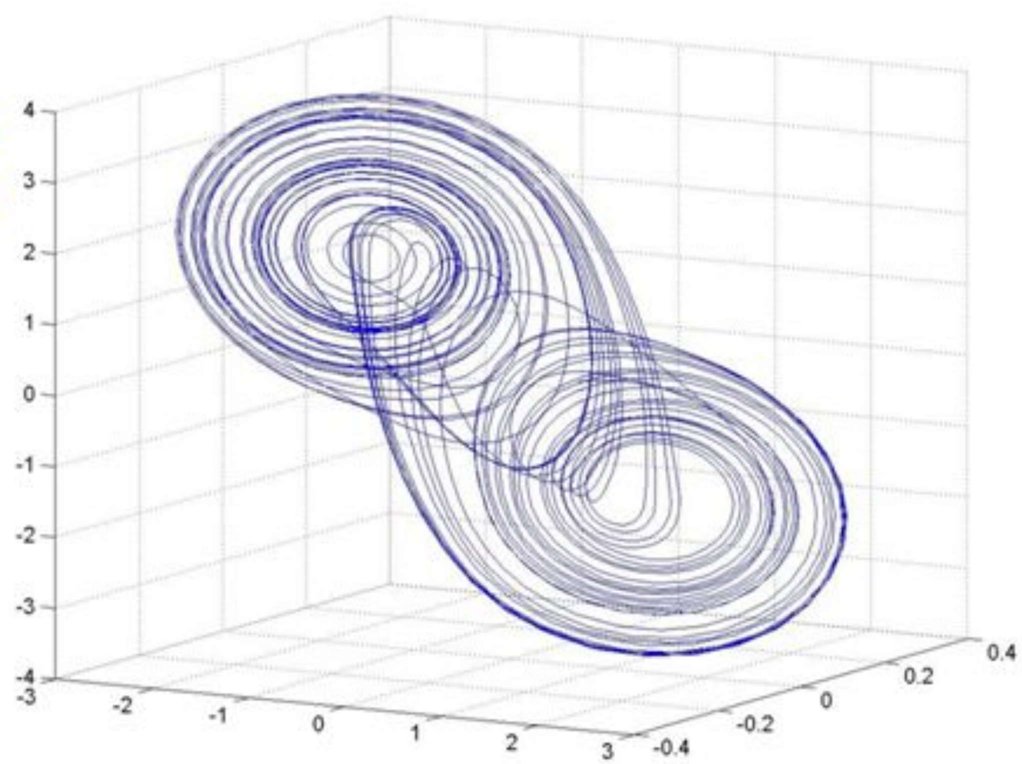
$$\boxed{\frac{\mathrm{d}\boldsymbol{p}}{\mathrm{d}t} = -\frac{\partial \mathcal{H}}{\partial \boldsymbol{q}} \quad , \quad \frac{\mathrm{d}\boldsymbol{q}}{\mathrm{d}t} = +\frac{\partial \mathcal{H}}{\partial \boldsymbol{p}}}$$

Nonlinear dynamics

Driven Pendulum with friction

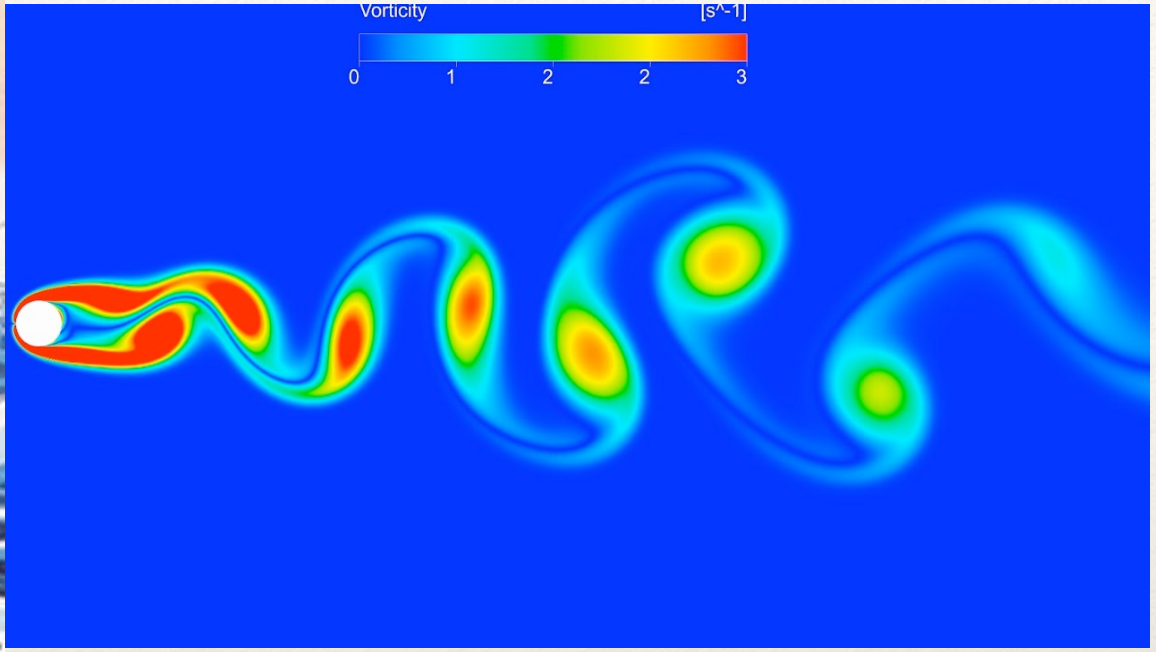


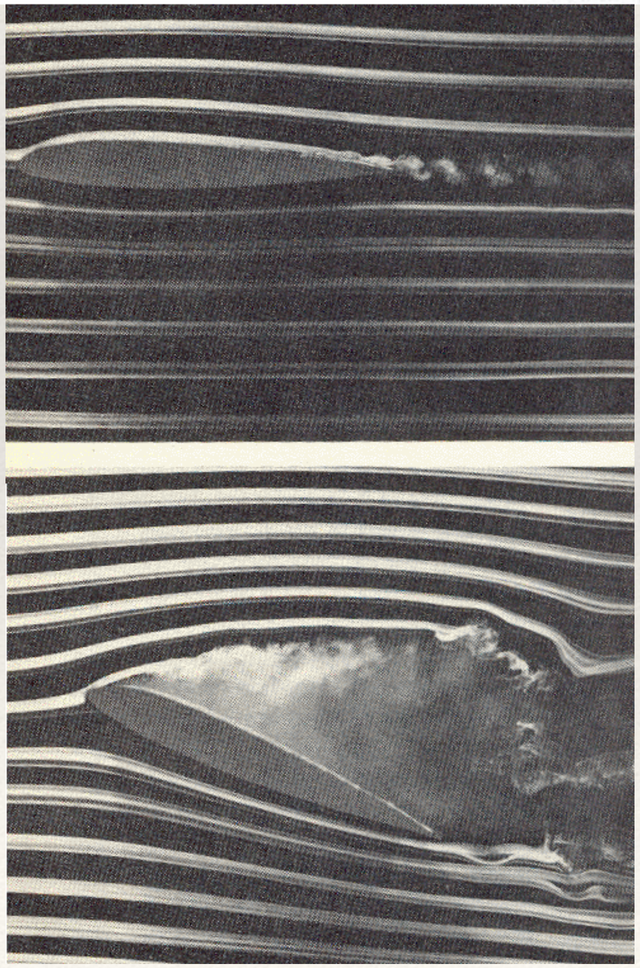




Chaotic attractor in phase space

Fluid dynamics





How to get help in this class [everyone will need it!]

- Office of Academic Resources — help with study skills/effective reading/time management (I wish I had this!), tutors available!
- Ask questions (of me and your peers!) in class!
- Come to office hours — I am here to help!
- Try #phys308 in the dept. slack to get help from peers, Dylan, or (occasionally) me.

How to succeed in Ted's classes (based on prior end-of-semester feedback)

- Go to the office hours prepared with questions, initial work.
- Use office hours preemptively and regularly.
- Work with peers.
- Do the readings, and attempt at least a hand-wavey strategy for related problems *as you read*.

Your feedback

- Surveys: few weeks in, 7 weeks in, right before finals period
- Anonymous but required/full participation credit requires you fill it in [but what you say doesn't effect grade]
- I take it seriously! This whole class is an experiment with a new (to me) way of teaching and learning. If the learning outcomes for any of you are worse than a regular lecture would be, we need to tweak things!

For the gritty details ….

- Moodle has a (very) little. All coursework submission will happen here!
- Class syllabus/website is the main place for info! https://squishlab.github.io/PhysH308/ (linked on moodle)