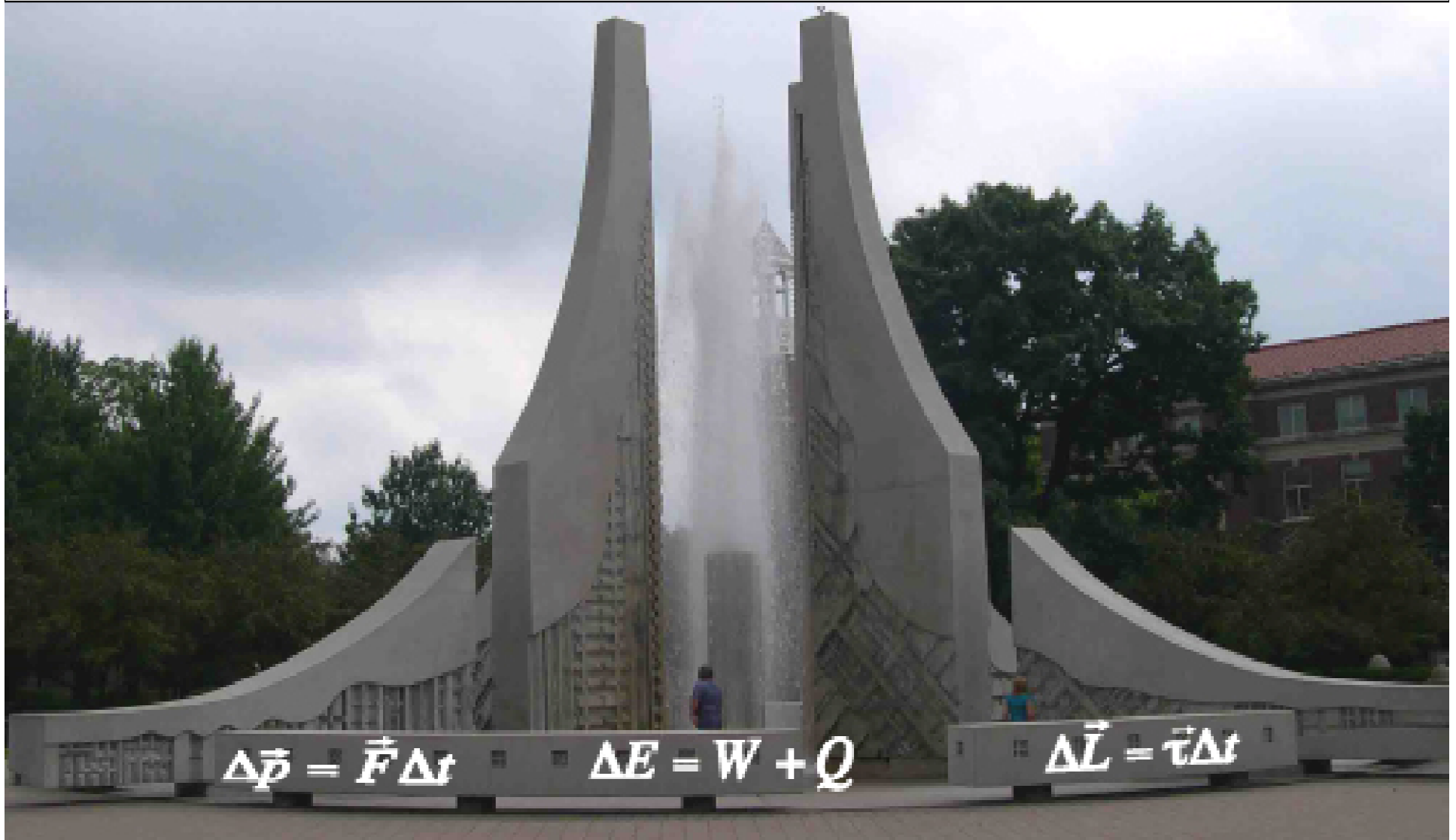


# PHYS 172: Modern Mechanics

Spring 2012

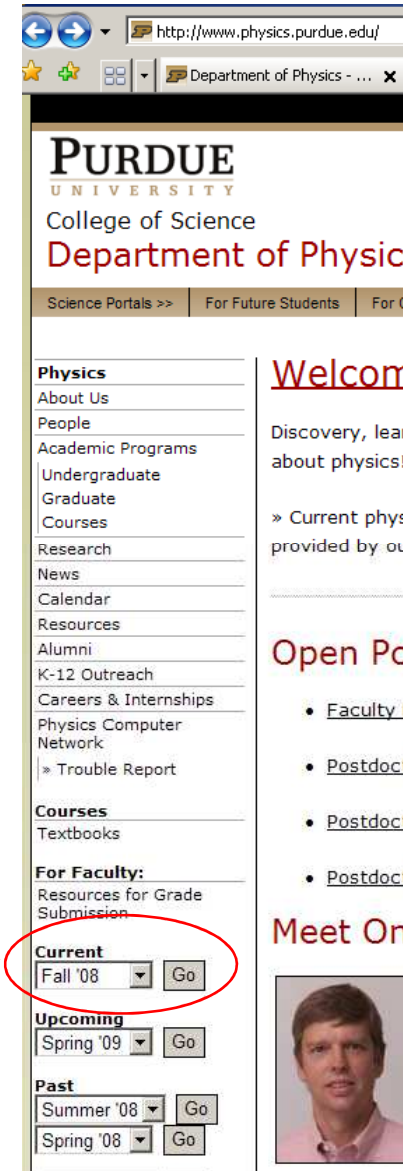


Lecture 1: Matter & Interactions

Read: Ch 1.1-1.5

## To do AS SOON AS POSSIBLE:

1. Obtain the **textbook** (campus bookstores, used is OK, **but you are responsible for material in the 3<sup>rd</sup> Edition!**).
2. Obtain the **Lab Manual** (from bookstore).
3. Obtain an **iClicker** audience response remote (not a CPS pad).
4. Register for **WebAssign**, the on-line homework service.
5. Register your iClicker on **CHIP**, your on-line gradebook.
6. Click on the course **URL** for any late announcements, lecture notes etc:  
[www.physics.purdue.edu/academic\\_programs/courses/phys172](http://www.physics.purdue.edu/academic_programs/courses/phys172)  
(or poke around Physics home page, [www.physics.purdue.edu](http://www.physics.purdue.edu))



For those of you who brought your iClicker with you today, let's do a test run:



Turn the Power on.

After the question is declared “Open”, choose one:

- A. My last physics class was in high school.
- B. My last physics class was in college.
- C. I have never taken a physics class.
- D. I have never heard of Physics.
- E. None of the above.

**NOTE:** From now on, always bring your iClicker to lecture with you. The clicker questions count towards your grade.

iClicker questions may be asked any time during lecture: don't be late!

During the first week you will:

- Attend the two scheduled lectures, on Tuesday and Thursday.
- Attend the Recitation session assigned to you by the Registrar.
- Log in to WebAssign and complete “HW #1” by **midnight Thurs, Jan 12**. Note due dates for subsequent HWs.
- Lab meetings will not be held during the first week. Instead, log in to WebAssign and complete “Lab #1 Orientation” by Tuesday, Jan 17.

Attendance is required for three evening exams this semester:

Exam 1:	Wednesday, Feb 8	8:00-9:30 pm
Exam 2:	Wednesday, Mar 7	8:00-9:30 pm
Exam 3:	Wednesday, Apr 11	8:00-9:30 pm
	(ELLT 116)	

# Lectures, Recitations & Problem of the Week

- On the PHYS 172 Home Page:
  - Lecture slides – posted in advance of the lecture – typically 2 days.
  - Recitation problems for the following week
  - Problem of the Week – additional problem solving practice

## Milestones from the last century of physics:

Discovery of x-rays (1895)

Radioactivity (1896-1902)

Atoms - electrons (1896), nuclei (1911), neutrons (1932)

Relativity (Einstein 1905, 1916)

Quantum Mechanics (1920s....)

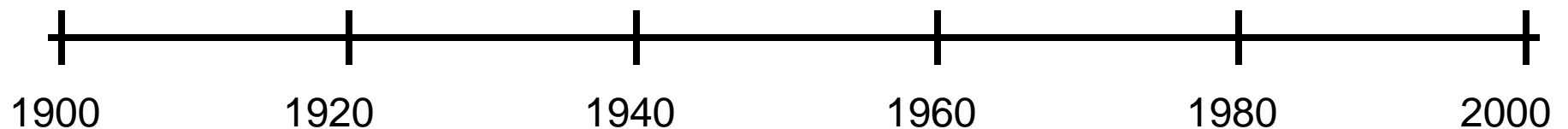
Nuclear fission (atom bomb, nuclear power), fusion  
(hydrogen bomb, Sun) (1940s....)

Transistors, semiconductors, superconductors (1940s....)

Big Bang theory, cosmic microwave background (1960s...)

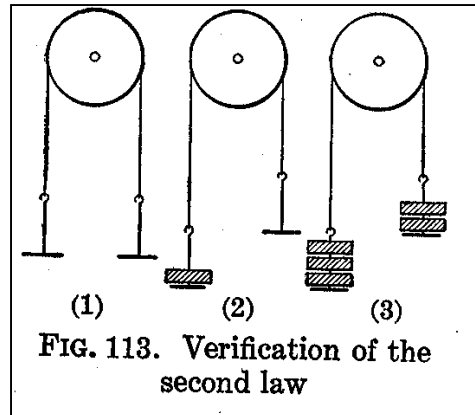
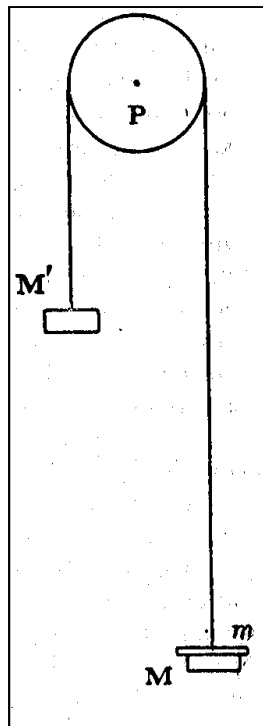
Quarks, Standard Model of Particle Physics(1960s....)

Dark Matter, Dark Energy.....(1990s....)



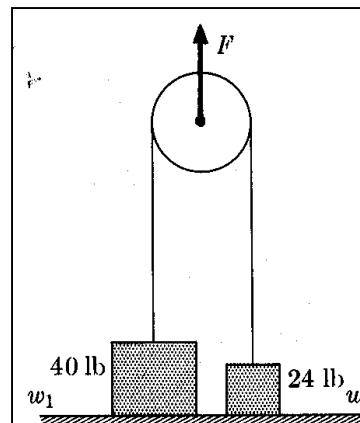
# Milestones from the last century of physics *education*:

1910,  
18th edition  
of Ganot.

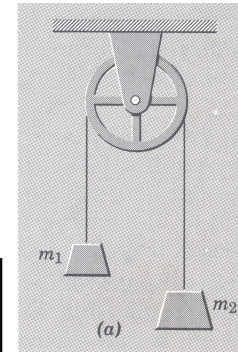


1928, 1938  
Millikan et al.

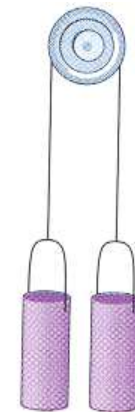
1949  
Sears &  
Zemansky



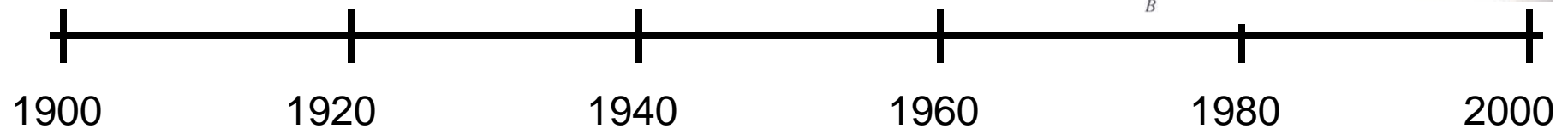
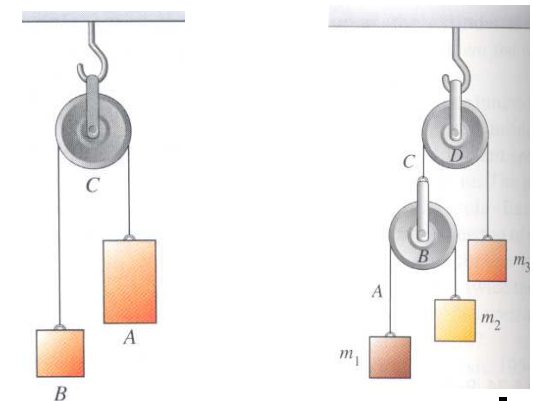
1960 Halliday &  
Resnick (from 1977)



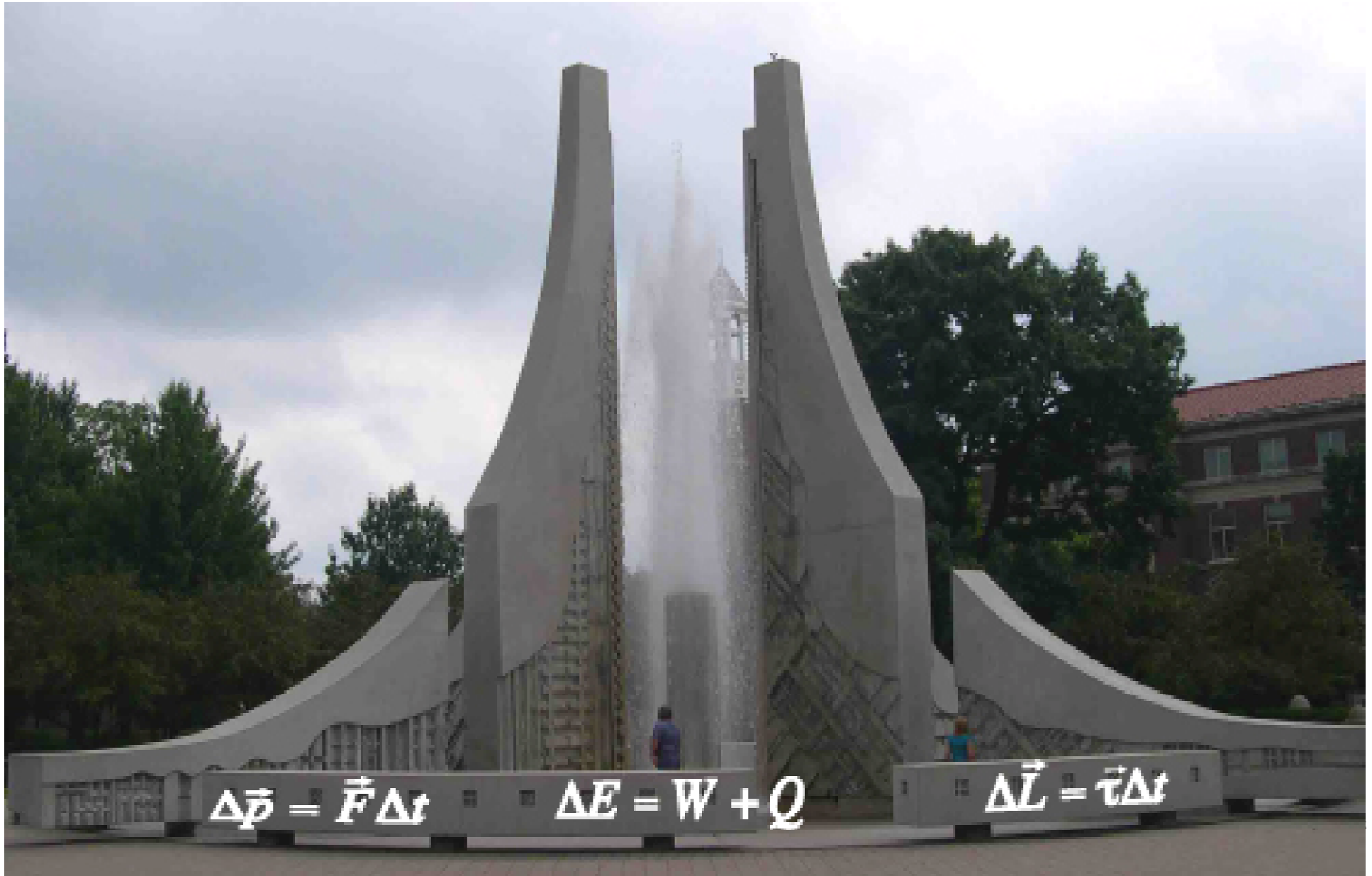
2004 H&R/Cummings



2004 S&Z/Young



We will explain an enormous range of physics with just a few fundamental principles.





# What is MODERN MECHANICS?

We will explain an enormous range of physics with just a very few fundamental principles.

Matter can be described in terms of atoms that interact with each other.

We will learn to create simple models for complex situations.

We will use powerful computer graphics to simulate real physical behavior.

We will show how mechanics plus real atomic behavior leads to thermodynamics: Mechanics  $\Rightarrow$  Temperature!

We will use powerful computer graphics to simulate real physical behavior.

VPython program for Moon Voyage, which students will write themselves during Lab #3. No prior programming experience needed!)



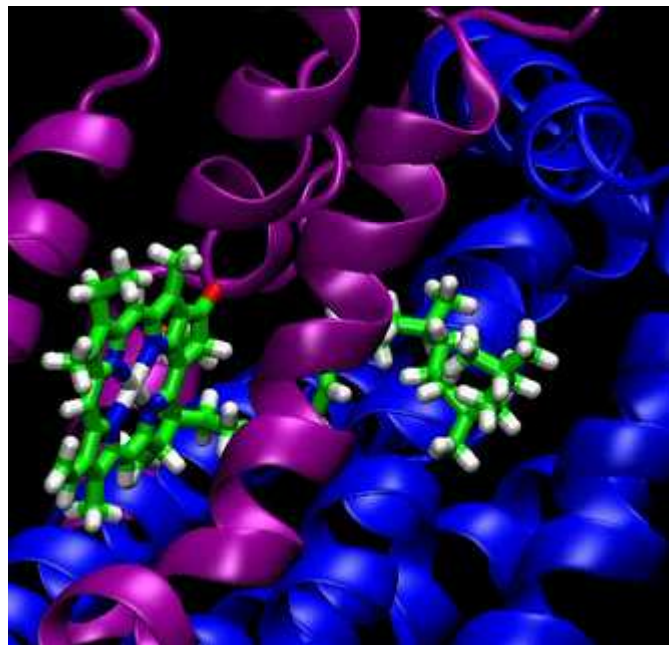
MoonVoyage.py



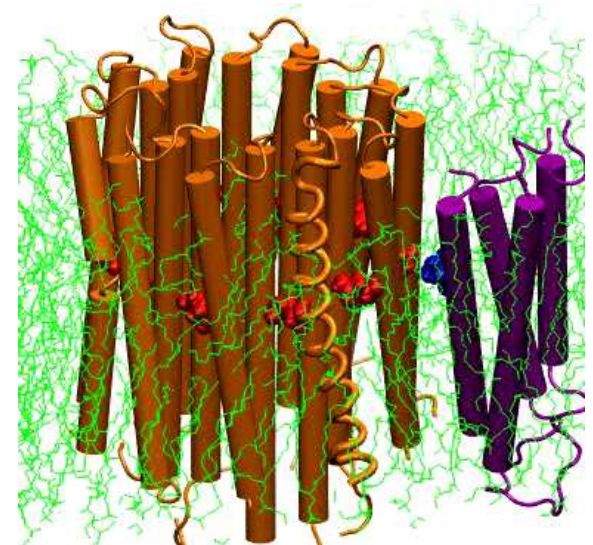
Stars.py



Crystal.py



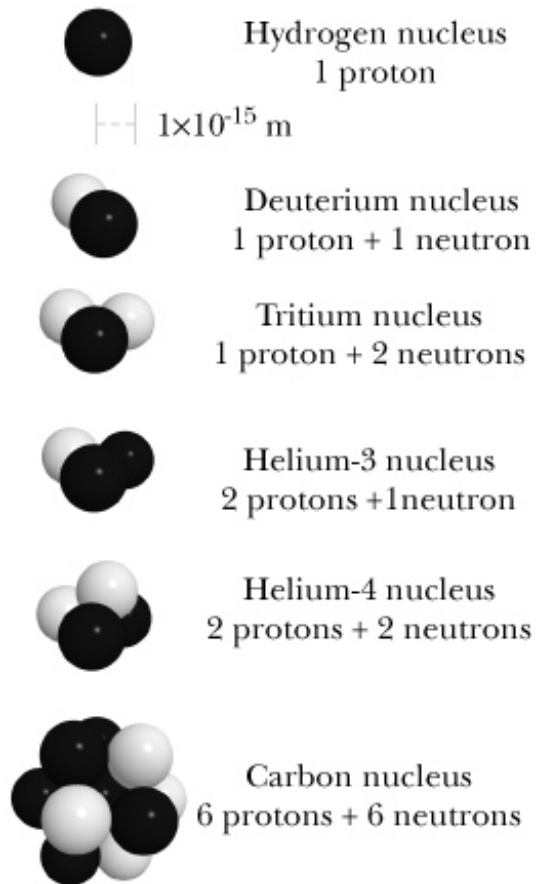
Molecular simulation: 320,171 atoms  
Cytochrome  $b_6f$  protein of photosynthetic organism  
(by S. Savikhin's group)



Spinning part of ATP synthase  
by Aksimentiev

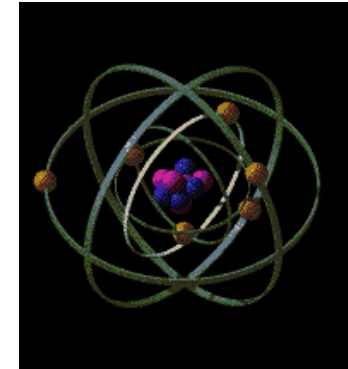
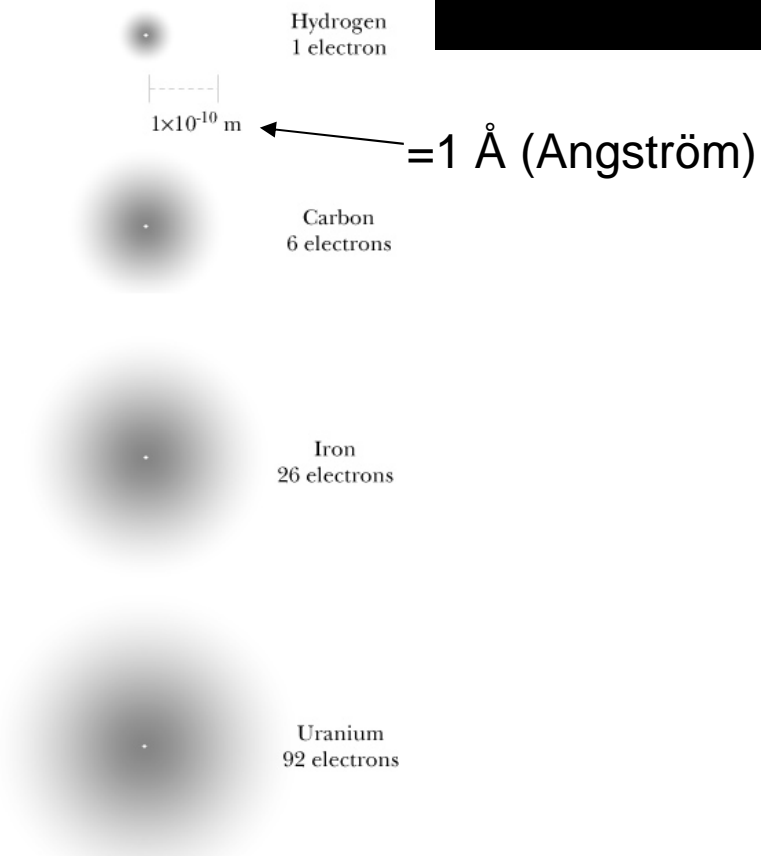
# Kinds of matter

## Nuclei



Interacting protons and neutrons

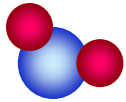
## Atoms



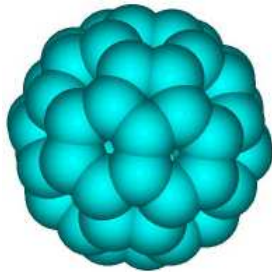
Interacting nuclei and electrons

# Kinds of matter

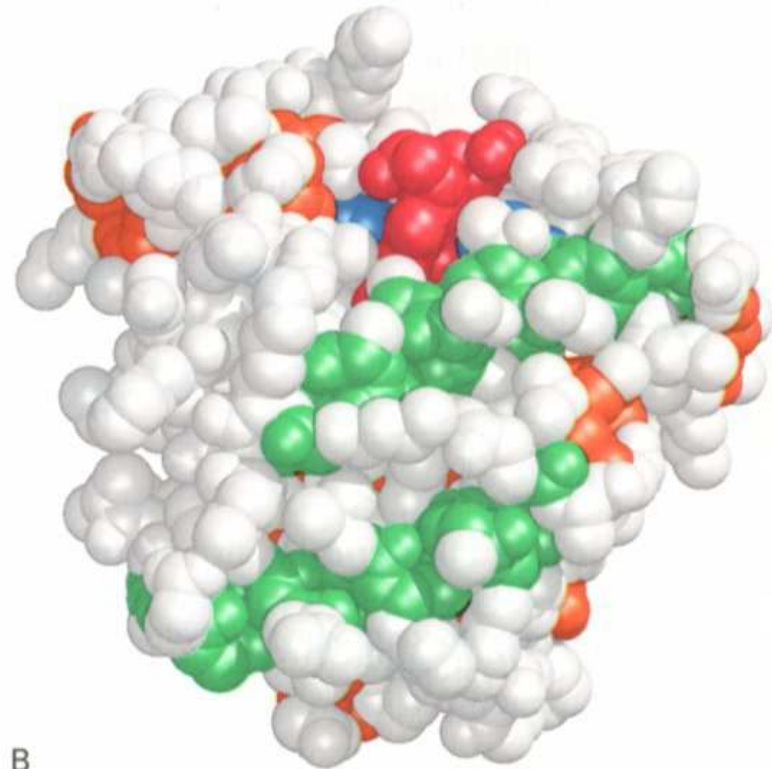
**Molecules:** Interacting atoms: several atoms bond together:  
The physical and chemical properties of  
a molecule differ from those of the constituent atoms



H<sub>2</sub>O - water



C60 (soccer ball molecule)



B

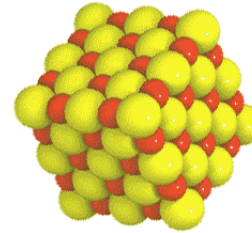
Protein molecule (myoglobin)

# Kinds of matter

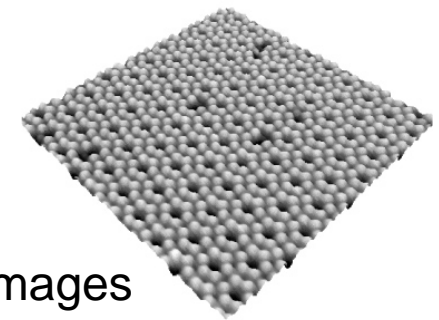
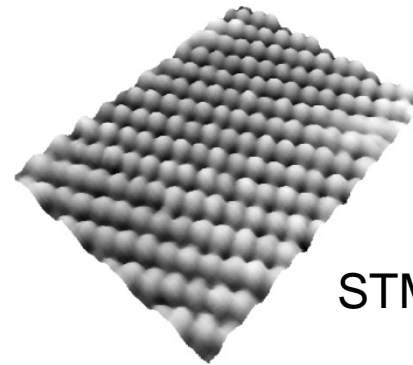
**Solids:** Interacting molecules and atoms  
Billions of atoms or molecules come together  
Atoms are fixed in 3D array



Salt  
crystal



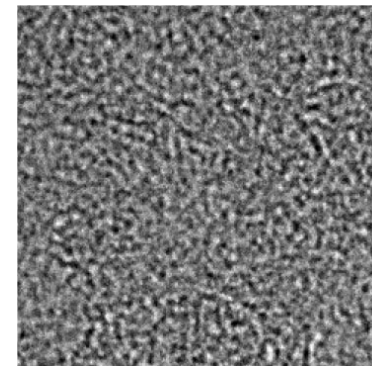
Silicon crystal



STM images



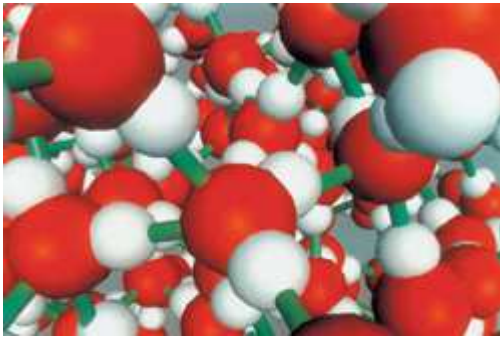
Amorphous Germanium



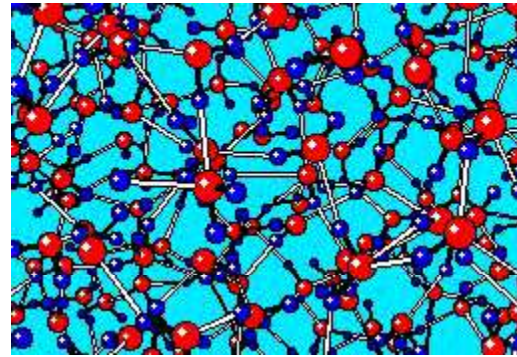


# Kinds of matter

**Liquids:** Atoms are still bond to each other but can freely slide along each other



Water



<http://www.fos.su.se/physical/lars/liquid.html>

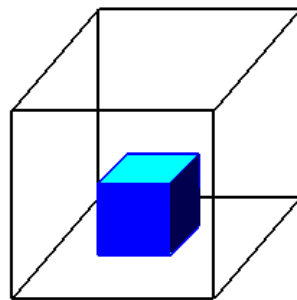
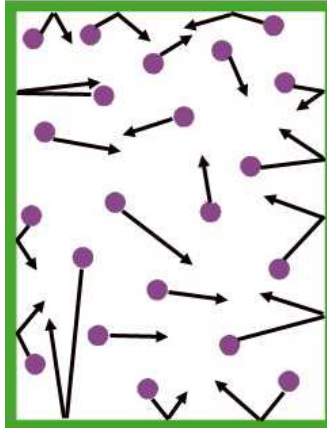
Dynamics is complex: we will not consider liquid in detail in this course

# Kinds of matter

## **Gases:**

Atoms are not bound to each other

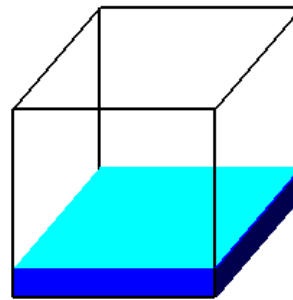
Energy of atoms is too large and Interatomic forces are broken



**Solid**

Holds Shape

Fixed Volume

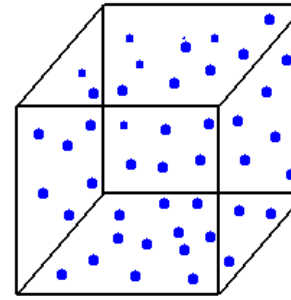


**Liquid**

Shape of Container

Free Surface

Fixed Volume



**Gas**

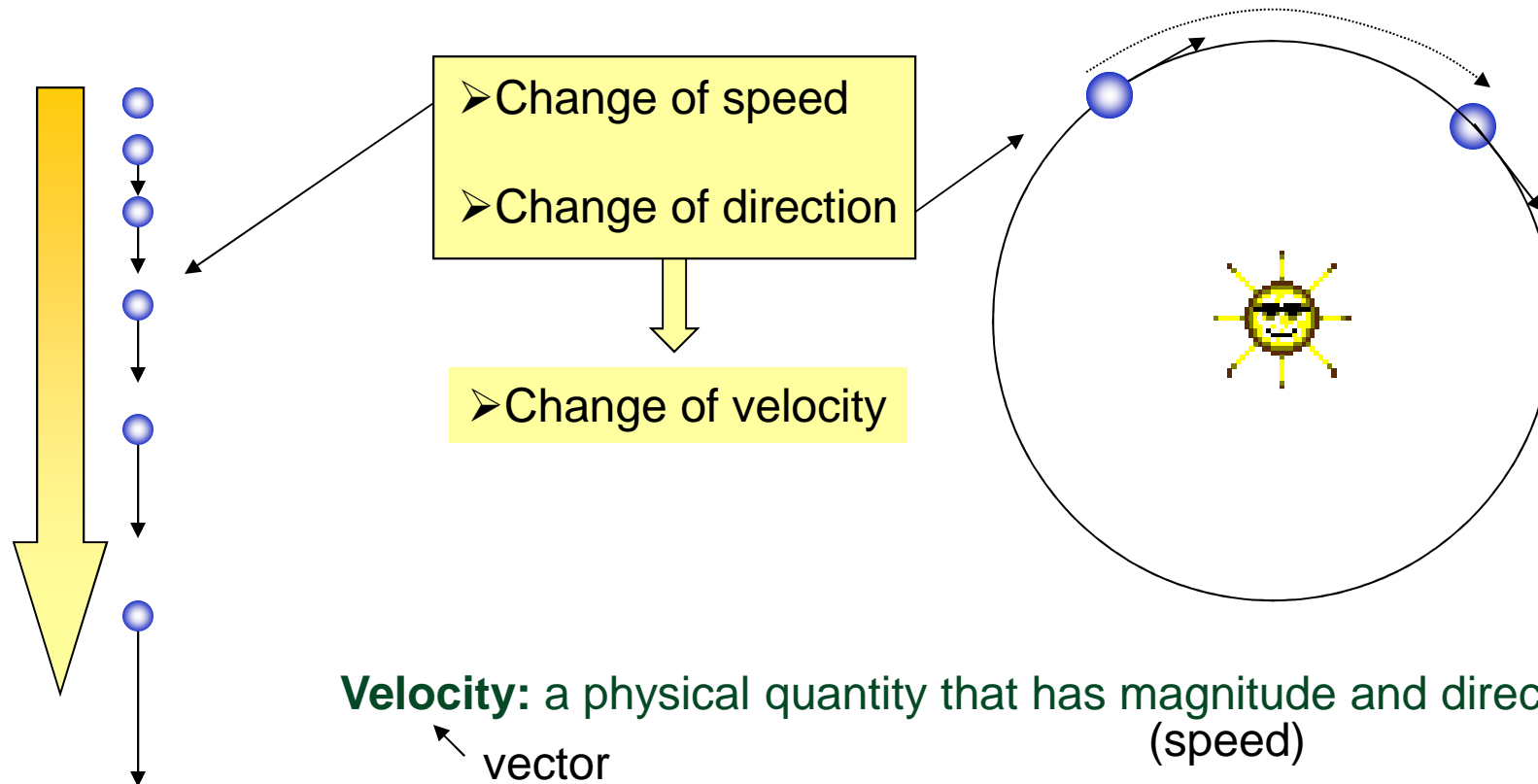
Shape of Container

Volume of Container

# Detecting interactions

Objects made of matter interact with each other: Gravitationally  
Electrically  
Magnetically  
Through strong and weak interaction

Detecting interaction:





# Indicators of interaction

- Change of velocity *Braking in your car*
- Change of identity  $H_2 + O_2 \rightarrow H_2O$
- Change of shape *bending a wire*
- Change of temperature *heating pot of water on a hot stove*
- Lack of change when change is expected *balloon floating in sky*

Interactions cause change  
No interaction – no change - boring

## **TO DO THIS WEEK:**

Reading Assignment: read Ch 1, sections 1-5 for today, sections 6-11 for Thursday.

**Special attention: review vector algebra! (for clicker questions next lecture and for recitation)**

Go to your assigned Recitation this week.

Turn in the first WebAssign HW by Thursday night.

Do the first Lab on WebAssign by Tuesday of next week.

Register your iClicker before the next lecture.