Demonstrations: comparative measurements with rulers, indirect measurements with lasers scattered from hidden targets; Geiger counter and sources

What's important:
•outline of course
•where to find text and digital resources
•assignments and grading scheme
•introduction to measurement

Text: Mod. Phys. 1.A
Problems: none

Course Outline

Physics 120 is a 13-week calculus-based course with approximately 33 lectures (plus in-class tests):
•11 lectures on modern physics, from quarks to cosmology
•22 lectures on linear and rotational mechanics.

Support material

There are two texts to provide the student with written material to supplement the lectures.
•For the first 11 lectures, the text is "Modern Physics: from Quarks to Galaxies" by Boal. Use the fifth edition, which is substantially revised compared to the previous editions.
•For the remaining lectures, the text is "Physics for Scientists and Engineers" by Fishbane, Gasiorowicz and Thornton. You may use either the first or second edition; the second edition is somewhat shorter, but contains slightly more examples and much-improved graphics. The problems for the assignments are **not** drawn from the texts for PHYS120. Fishbane *et al*. is also used for PHYS121.

Both texts are available from the SFU bookstore. The Modern Physics text is available **on-line** without charge, as are copies of the lectures.

The **on-line** material is available at **http://www.sfu.ca/~boal**.

Assignments and grading scheme

Evaluation of student performance is based upon 8 - 9 problems assignments, 3 mid-term examinations written in class, and a single 3-hour final examination written after classes are concluded. The marking scheme is weighted as follows:

Assignments	15%
First mid-term exam	10%
Second mid-term exam	15%
Third mid-term exam	15%
Final exam	45%

When the enrolment for this course is large (more than 150 students), the letter grades are close to the Faculty of Science averages for large first year courses:

A	18%
B	34%
C	33%
D	6%
F	8%

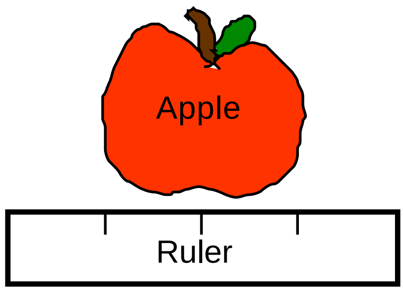
The assignments are generated and marked by computer using the Capa system developed at Michigan State University. Each assignment consists of several template problems with numerical or multiple choice answers. While all students receive the same problems for a given assignment, the parameters in each problem are unique for each student. More details in the student handouts or at **http://www.sfu.ca/~boal**. Face-to-face help is available in the Physics Open Lab for two afternoons every week.

Let's begin the course.....

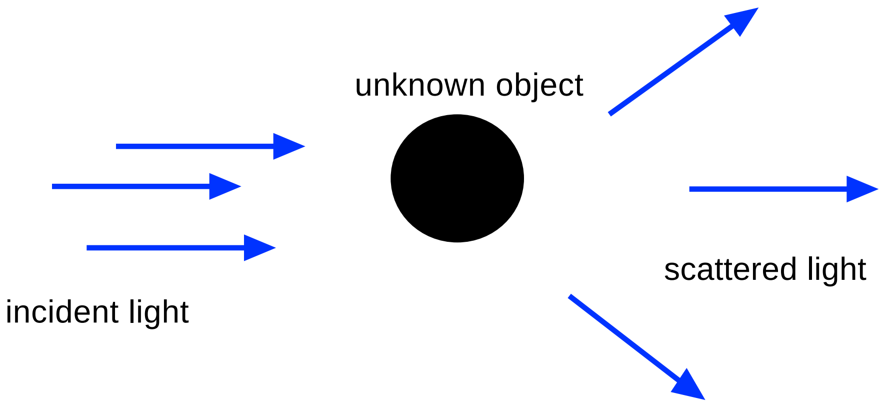
How we measure what we can't see

The first section of this course deals, in part, with the subatomic world, which is characterized by tiny sizes and tiny masses compared to human standards. How do we measure such small sizes and masses?

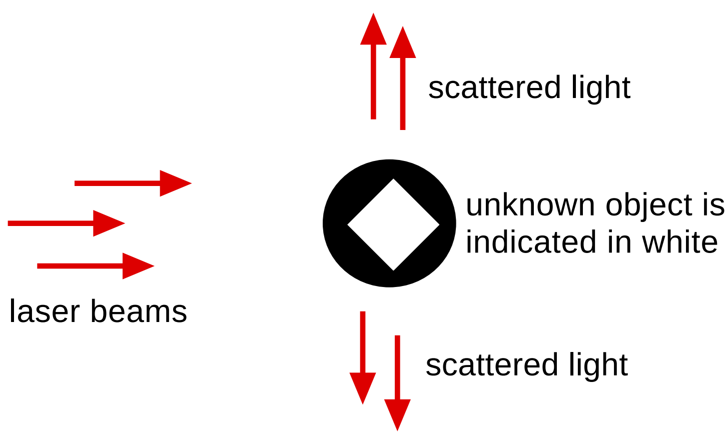
Consider first how we perform measurements on conventional, macroscopic objects. We define a standard length, using a ruler, and make a direct comparison of the object in question against the standard length. For example, determine the diameter of an apple by comparing it, visually, against a standard ruler:



Suppose that we can't "see" the object directly? Then we can use a probe, such as light, to scatter from the object (*demonstration*)



In the demo, the object is hidden from view, but its shape is reflected in the pattern of the scattered light

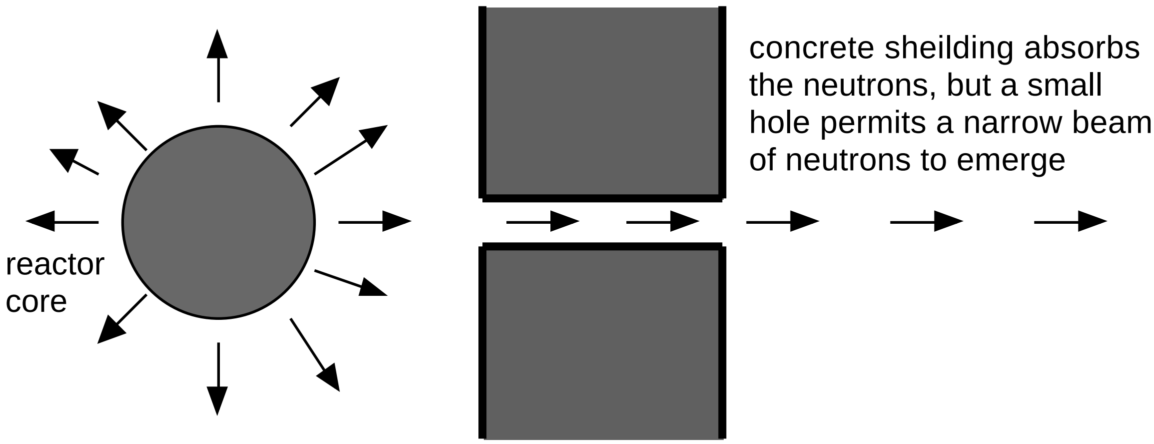


Atoms are neither square, nor stationary: they rotate, vibrate and (in a gas or liquid) translate, so that the scattering process averages over orientations and positions. These scattering experiments are **probabilistic** in nature, and they measure:
(i) the probability of a particle being scattered at all
(ii) the probability of scattering in a given direction.

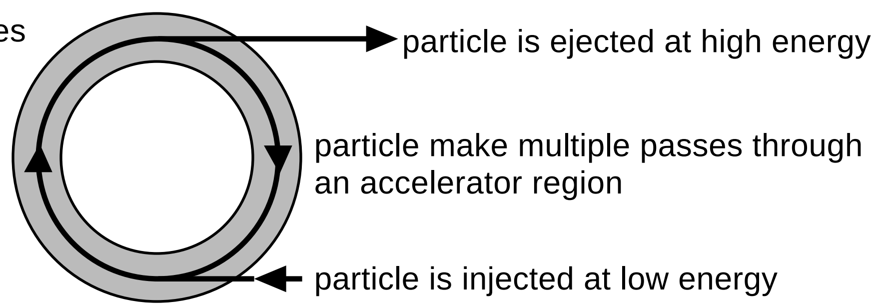
The technique of "inverting" a scattering measurement to obtain the shape of the hidden object does not always yield unique shape: one can imagine several shapes that could give the particular scattering pattern in the diagram above.

Scattering experiments can use both charged and neutral beams of particles:

Example: low energy neutrons are emitted in all directions from a nuclear reactor



Example: charged particles can be manipulated by magnetic fields to have a circular path, where they are accelerated by electric fields to very high energies.



To recap from high school math, we define probability as **P**, with the properties that:

P = 1	if a given event or measurement always occurs (i.e., **P**=1 if it always rains on the weekend)
P = 0	if a given event or measurement never occurs (i.e., **P**=0 if it never rains on the weekend)
0 < **P** < 1	if a given event or measurement sometimes occurs (i.e., **P**=0.5 if it rains every second weekend).