



# Snippets of Science from Fermilab

PS 2 (3-8) Elaborate

## VISUALIZING SMALLEST

**Challenge:** Can you create a life-size model of an atom?

**Goal:** Create a scale model of a hydrogen atom in order to understand how much empty space an atom contains.

**Fermilab Connection:** Fermilab scientists study the smallest component of matter and measure incredibly small distances. This investigation will help students understand the vast empty areas within the atom or nucleus and that the atom is mostly empty space.

### Preparation

Envisioning the vast distances of outer space may be a difficult task for students. The distances in subatomic space are even more mind-bending, and therefore it is necessary to give students the opportunity to visualize and measure the relative distances involved with atomic and subatomic space.

### Procedure

1. Place the pin in the rubber stopper.
2. Attach the 10 m string to the head of the pin. Stretch out the string.
3. If the nucleus of a hydrogen atom were the size of the head of a pin (1 mm), then the first electron in the atom would be an average of 10 meters away.
4. If you allow the average BB (2 mm) to represent the size of a quark, then the proton (which is a hydrogen nucleus) would be represented by a circle 8 meters in diameter. (Use a string or yarn to make this circle that is 23 meters in circumference.)
5. Remember the atom model we are creating is three-dimensional and your model extends both above your head and down below the floor.
6. Ask the question, "What occupies the large sphere representing either a proton or a neutron?"
7. Place the three BBs (representing quarks) equidistant around the circle you created. Discuss what you are observing.
8. There are three quarks in a proton. The quarks are assumed to be in rapid motion and held within the proton space by spring-like forces carried by other particles called "gluons." At any given point in time, a quark could be said to be occupying any part of this sphere. This is why we can say that the three quarks "fill" or occupy the entire empty space.
9. Estimate how far the electron from the first model would be from the proton, which has a diameter of 8 meters. (Answer: 80,000 meters or about 50 miles)

**GRADE LEVEL**  
Grades 3–8 with modifications

### MATERIALS

- Rubber stopper
- Pin with brightly-colored 1-mm head
- Meter stick or tape measure
- Two pieces of string – 10 m, 23 m
- 3 BBs or something similar in size

**Fermilab Resources:**  
Click on the linked resources!

[Nature's Scale](#)

[What is the world made of?](#)

[Where do particle names come from?](#)