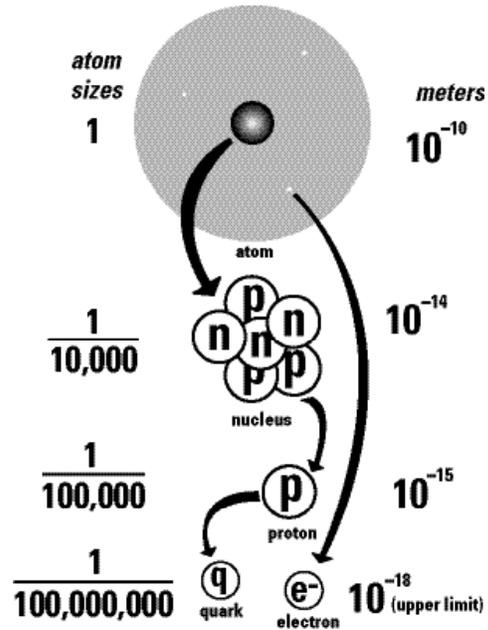# Sizing Up Protons

NOVA Activity **The Elegant Universe**

At one time, physicists used instruments called bubble chambers to detect what happened when they collided particles like protons together. But how big is a proton? In this activity, find out how big a proton would be if you scaled an atom to the diameter of Earth.

Colliding Protons

When physicists collided particles together in a bubble chamber, they were trying to produce new particles to study. One of the particles used in these collisions was the proton, a particle that, along with neutrons, makes up the nucleus of an atom. An atom's nucleus is much smaller than the whole atom, typically by a factor of 10,000. But how small is that? Read the following comparison of sizes and then do a calculation to find out just how small a proton is.

- Picture a circular pond with a diameter equal to the length of an Olympic swimming pool, which is about 165 feet (50 meters). If an atom were the size of this pond, the nucleus would be the size of a pencil eraser —1/5-inch diameter (about 5 millimeters)—floating in the middle of the pond.

- Inside a nucleus are neutrons and protons, which occupy a space about 100,000 times smaller than the whole atom. In the pond example, a proton would measure about 1/50th inch (0.5 millimeters) in diameter—about the size of a pinpoint.

- Given the information above, what would the diameter of a proton be if the diameter of an atom were as big as the diameter of Earth—about 8,000 miles (13,000 kilometers)? Once you have calculated how big the proton would be, find a visual analogy to represent that number. Is there anything around your home, school, or town that would be about the diameter of the proton if it were in an atom that was the diameter of Earth?

atom sizes		meters
1	atom	10^{-10}
$\dfrac{1}{10,000}$	nucleus	10^{-14}
$\dfrac{1}{100,000}$	proton	10^{-15}
$\dfrac{1}{100,000,000}$	quark electron	10^{-18} (upper limit)

Source: The Particle Adventure
www.particleadventure.org/

8,000 miles (13,000 kilometers)