**Rutherford’s Discovery**

Often we can look at or touch an object to learn about it. Sometimes, objects are too small or too large for us to learn about them this way. When this happens, we need to use indirect measurement techniques.

Ernest Rutherford realized that atoms and subatomic particles that make up an atom are much too small to be measured directly (say, by using a ruler or other measurement device). Rutherford and his colleagues designed an experiment to measure the characteristics of atoms indirectly. The scientists used a thin piece of gold foil at which they directed alpha particles, which were like very small bullets. Though they could not see the atoms in the gold foil, they knew that if they watched where the alpha particles went after hitting the gold foil, they could draw conclusions about what was inside of the gold atoms. Alpha particles are very small, but they are heavy. They also travel quickly, and they have a positive electrical charge. When the alpha particles exited the foil after colliding with the gold atoms in the foil, they were detected with a specially designed screen that Rutherford placed around the experiment. The screen would light up at the point of the collision where the alpha particles stuck it. At the time of Rutherford’s experiment, the physicist thought the composition of an atom resembled plum pudding (chocolate chip cookie); electrons positioned throughout the atom surrounded by a soup of positive charges that would balance out the negative. Rutherford believed that each fired alpha particle would travel through the “pudding” of positive and negative charges in the gold foil, deflect only slightly as they encountered other positive charges, hit the special screen, and light up. Most of the alpha particles went through the foil with no change in direction as expected. But he was surprised to see that once in awhile one of the alpha particles would deflect right back at the source! Upon this discovery, Rutherford exclaimed: “It was almost as incredible as if you fired a fifteen-inch shell at a piece of tissue paper and it came back and hit you!" This experiment led Rutherford to conclude that an atom is actually mostly empty space with a small, dense, positively charged nucleus in its center.