Quantum mechanics also predicts that the wave function for the hydrogen atom in the ground state is spherically symmetrical; hence, the electron can be found in a spherical region surrounding the nucleus. This is in contrast to the Bohr theory, which confines the position of the electron to points in a plane. This result is often interpreted by viewing the electron as a cloud surrounding the nucleus, called an *electron cloud.* The density of the cloud at each location is related to the probability of finding the electron at that location. The most probable distance for the electron's location in the ground state is equal to the first Bohr radius.

Analysis of each of the energy levels of hydrogen reveals that the most probable electron location in each case is in agreement with each of the radii predicted by the Bohr theory. The discrete energy levels that could not be explained by Bohr's theory can be derived from Schrödinger's wave equation. In addition, the de Broglie wavelengths account for the allowed orbits that were unexplainable in Bohr's theory. Thus, the new quantum-mechanical model explains certain aspects of the structure of the atom that Bohr's model could not account for.

Although probability waves and electron clouds cannot be simply visualized as Bohr's planetary model could, they offer a mathematical picture of the atom that is more accurate than Bohr's model. The material presented in this chapter is only an introduction to quantum theory. Although we have focused on the simplest example—the hydrogen atom—quantum mechanics has been successfully applied to multi-electron atomic structures. In fact, it forms the basis for understanding the structure of all known atoms and the existence of all molecules. Although most scientists believe that quantum mechanics may be nearly the final picture of the deepest levels of nature, a few continue to search for other explanations, and debates about the implications of quantum mechanics continue.

SECTION REVIEW

1. Is light considered to be a wave or a particle? Explain your answer.

2. How did de Broglie account for the fact that the electrons in Bohr's model are always found at certain distinct distances from the nucleus?

3. Calculate the de Broglie wavelength of a proton moving at 1.00×10^4 m/s.

4. What is the physical significance of the square of the Schrödinger wave function, $|\psi|^2$?

5. Why is the electron sometimes viewed as an electron cloud?

6. **Critical Thinking** In classical physics, the accuracy of measurements has always been limited by the measuring instruments used, and no instrument is perfect. How is this limitation different from that formulated by Heisenberg in the uncertainty principle?