

## 4.5: Quantum Mechanics

### How do you study something that seemingly makes no sense?

We discuss electrons being in orbits, and it sounds like we can tell where an electron is at any moment. We can draw pictures of electrons in orbit, but the reality is that we just don't know exactly where they are. We will take a quick look at an area of science that even leaves scientists puzzled. When asked about quantum mechanics, Niels Bohr (who proposed the Bohr model of the atom) said, "Anyone who is not shocked by quantum theory has not understood it." Richard Feynman (one of the founders of modern quantum theory) stated, "I think I can safely say that nobody understands quantum theory." So, let's take a short trip into a land that challenges our everyday world...

### Quantum Mechanics

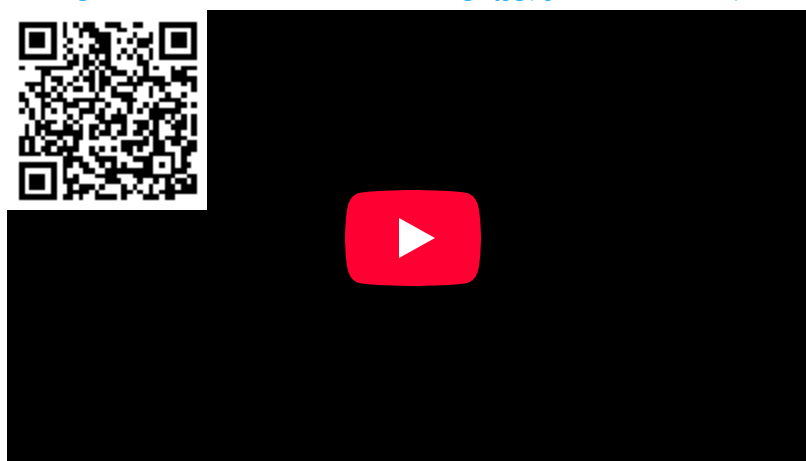
The study of motion of large objects such as baseballs is called mechanics, or more specifically, classical mechanics. Because of the quantum nature of the electron and other tiny particles moving at high speeds, classical mechanics is inadequate to accurately describe their motion. **Quantum mechanics** is the study of the motion of objects that are atomic or subatomic in size and thus demonstrate wave-particle duality. In classical mechanics, the size and mass of the objects involved effectively obscures any quantum effects, so that such objects appear to gain or lose energies in any amounts. Particles whose motion is described by quantum mechanics gain or lose energy in the small pieces called **quanta**.

One of the fundamental (and hardest to understand) principles of quantum mechanics is that the electron is both a particle and a wave. In the everyday macroscopic world of things we can see, something cannot be both. But this duality can exist in the quantum world of the submicroscopic on the atomic scale.

At the heart of quantum mechanics is the idea that we cannot accurately specify the location of an electron. All we can say is that there is a probability that it exists within this certain volume of space. The scientist Erwin Schrödinger developed an equation that deals with these calculations, which we will not pursue at this time.



Figure 4.5.1: Erwin Schrödinger. (Credit: Author Unknown; Source: [http://commons.wikimedia.org/wiki/File:Erwin\\_Schr%25C3%25B6dinger.jpg\(opens in new window\)](http://commons.wikimedia.org/wiki/File:Erwin_Schr%25C3%25B6dinger.jpg(opens_in_new_window)); License: Public Domain)



### Summary

- Quantum mechanics involves the study of material at the atomic level where the particles motion is described by gaining or losing the discrete amounts called quanta.
- In quantum mechanics, electrons exist simultaneously as both a particle and wave.

- This field deals with probabilities since we cannot definitely locate a particle.

## Review

1. What does quantum mechanics help us understand?
2. How does quantum mechanics describe an electron?
3. According quantum mechanics, we cannot specify accurately the location of an electron. However what can we do to describe its location?

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