Resonance Wire Loop (WA-9405)

Introduction

The Resonance Wire Loop demonstrates standing waves on a closed circular wire. It can also be used to show the phenomena of de Broglie matter waves.

Equipment Setup

Figure 1. The proper experimental setup for using the Resonance Wire Loop in a vertical orientation.

Additional equipment required

- Wave Driver (WA-9855)
- 2× Banana Plug Patch Cords (SE-9751)
- Any of the following function generators:
  - 850 Universal Interface (UI-5000)
  - 550 Universal Interface (UI-5001)
  - Sine Wave Generator (WA-9867)
  - Function Generator (PI-8127)
- *Optional:* Support for holding the Wave Driver above the table top

Theory

In 1913, Bohr formulated the well-known planetary model of the atom. In the model, an electron orbiting farther from the nucleus is in a higher energy state than one in a closer orbit. Radiation of light from the electron occurs when the electron moves from a higher energy level to a lower energy level. This model solved the mystery of atomic spectra.

However, the fact that electrons may occupy only certain energy levels confounded Bohr and other investigators. The electron was considered to be a particle that could orbit around its nucleus at any radial distance (depending on its speed). However, this does not happen. The mystery of discrete energy levels can be understood by considering the electron to be not a particle, but a matter wave.

Louis de Broglie presented the idea of matter waves in 1924. He suggested that a wave was associated with every particle. The wavelength of a matter wave is inversely proportional to the particle's momentum. A Bohr orbit exists where an electron matter wave reinforces itself constructively. In this view, the electron is thought of as though its mass and charge are spread out into a standing wave surrounding the atomic nucleus. The wavelength of the matter wave must fit evenly into the circumferences of the orbits. The innermost orbit has a circumference of one electron wavelength, the second orbit has a circumference of two electron wavelengths, and so on. For each orbit, the electron has a unique speed, and therefore a unique wavelength.

The PASCO Wire Loop will have standing waves at discrete frequencies, each one corresponding to a unique wavelength.

Setup Procedure

1. Mount the Wave Driver (WA-9855) either vertically (upright) or horizontally as desired. Ensure there is sufficient room for the Resonance Wire Loop.
2. If the Wave Driver is mounted horizontally, adjust the banana plug on the Resonance Wire Loop until it is perpendicular to the plane of the loop.
3. Insert the banana plug into the drive post of the Wave Driver. If the Wave Driver is mounted horizontally, make sure the loop is oriented so that the banana plug is at the highest point.
4. Connect the Wave Driver to one of the function generators listed under **Additional equipment required**.
5. Start driving the Wave Driver at about 5 Hz, with approximately 1 mm of amplitude, and slowly increase the frequency.
6. As the frequency is increased, the wire will begin to vibrate in various modes with an odd number of anti-nodes present. These nodes are a graphic demonstration of how electrons can have a resonant frequency as they orbit the nucleus.

For more information on connecting and using the Wave Driver and function generator, see the manuals for the Wave Driver and your function generator of choice.

Technical Support

Need more help? Our knowledgeable and friendly Technical Support staff is ready to answer your questions or walk you through any issues.

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Limited Warranty

For a description of the product warranty, see the Warranty and Returns page at www.pasco.com/legal.

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