Introduction

This unit describes the setup, operation and applications of a Very Small Radio Telescope (VSRT) developed by the MIT Haystack Observatory as an education tool to bring radio astronomy into the classroom. Based on commercially available satellite television receivers and MIT developed interferometry electronics, the VSRT is a robust set of equipment for exploring the properties of radio waves, using a low cost, safe and highly efficient source of radio waves - a compact fluorescent lightbulb (CFL). The interferometer electronics compare the signal from dual detectors and input the results via a single USB connector. The software is downloadable from the MIT Haystack Observatory website and runs on various versions of Windows™.

The primary goal of this unit is to study the properties of radio waves and compare and contrast them with visible light waves. The activities and experiments are applicable for upper middle school and high school students in the disciplines of general science, physical science and physics. With many of today's technological devices depending on radio waves and their properties, it is useful to expose students to this invisible portion of the electromagnetic spectrum and allow students to inquire and explore radio waves.

Some of the activities of this unit concern the transmission and polarization properties of both visible light waves and invisible radio waves. One activity compares and contrasts the ability of light and radio waves to transmit through materials such as water, ice, paper, cardboard, motor oil, plastic and others with some unanticipated results. Another activity explores the polarized nature of light by testing the polarization of many visible light sources including lightbulbs, light emitting diodes, digital displays using LCDs and visible lasers. By studying these phenomena, students are allowed to experiment and explore these properties of visible light and radio waves.

Experiments geared primarily for high school physics students include studying the transmission of radio waves through materials of varying thickness and learning about absorption of waves/radiation in the material. Another experiment in physics is the quantitative confirmation of the Inverse Square Law, where the power of the radio waves from the CFL decrease proportionally to the square of the distance between the source and the detector. An extension of the polarization activity, the Malus Law experiment allows students to measure the transmission through a pair of polarizers as the orientation between the polarizers is changed. Also included is the measurement of the wavelength of the radio waves by Young's interference method, where the wavelength is nearly 1 inch. Finally, a measurement of the Sun's angular width is included for physics students or science club members with advanced mathematical analysis skills.

Additional resources included in this unit are:

1. VSRT Introduction
2. VSRT Assembly Manual
3. VSRT Software Installation Instructions
4. Basic VSRT Operation
5. Series of VSRT Memos

While the experiments listed have been tested with repeatable results, the authors certainly encourage teachers to develop other activities and experiments to use the VSRT system. We welcome your feedback and questions regarding this **V**ersatile **S**ystem for learning about **R**adio **T**elescopes unit.

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