SUNRISE

GROUND RADIO LAB

Partnership Between

SunRISE
Sun Radio Interferometer Space Experiment

sunrise.umich.edu

RADIO JOVE 2.0

radiojove.gsfc.nasa.gov

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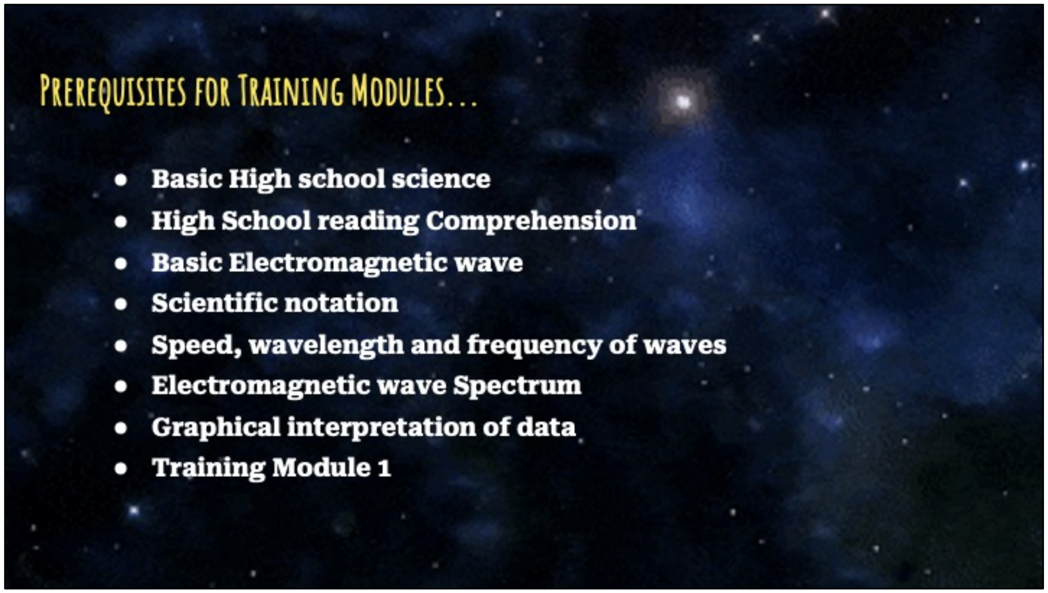
Please share Radio jove funding

Training Module 2.0

Basic Radio Telescope Operation

https://sunrise.umich.edu/

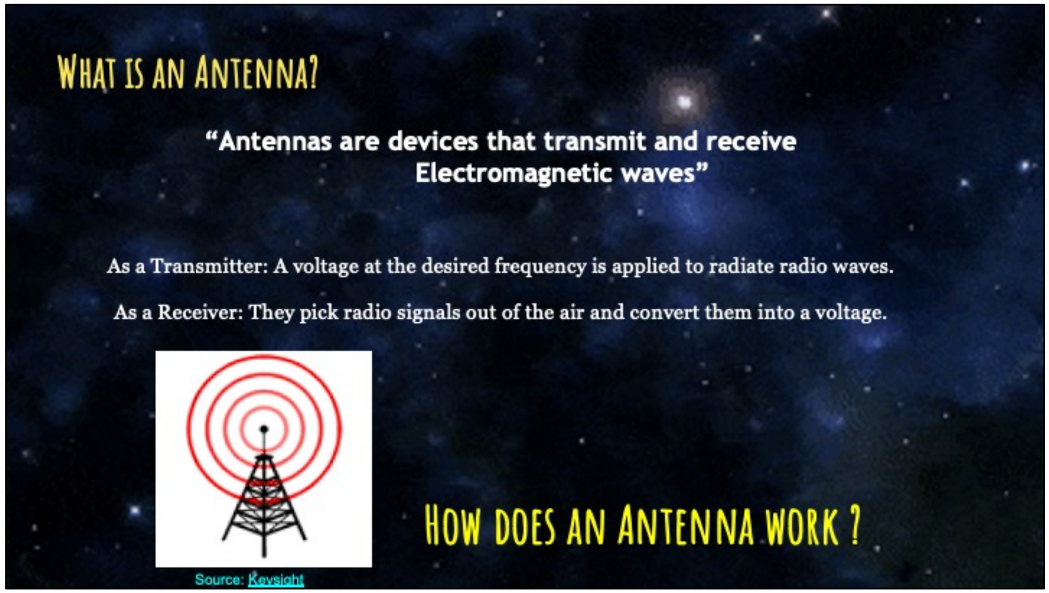


How is the electromagnetic spectrum divided? The EM spectrum is typically divided into seven fields: radio waves, microwaves, infrared radiation, visible light, ultraviolet, x-rays and gamma rays. The field order is determined by wavelength and frequency. Radio waves lie at one end of the spectrum, where wavelengths are at their longest and frequencies at their lowest. Gamma rays sit at the other end of the spectrum, where wavelengths are much shorter and frequencies are much higher. According to estimates, radio wavelengths can be as long as 10,000 kilometers (km) and frequency rates below 3 kilohertz (kHz). At the other end of the radio range, wavelengths can be as short as 1 meter (m) and frequencies as high as 300 megahertz (MHz), which is where the microwave range begins.

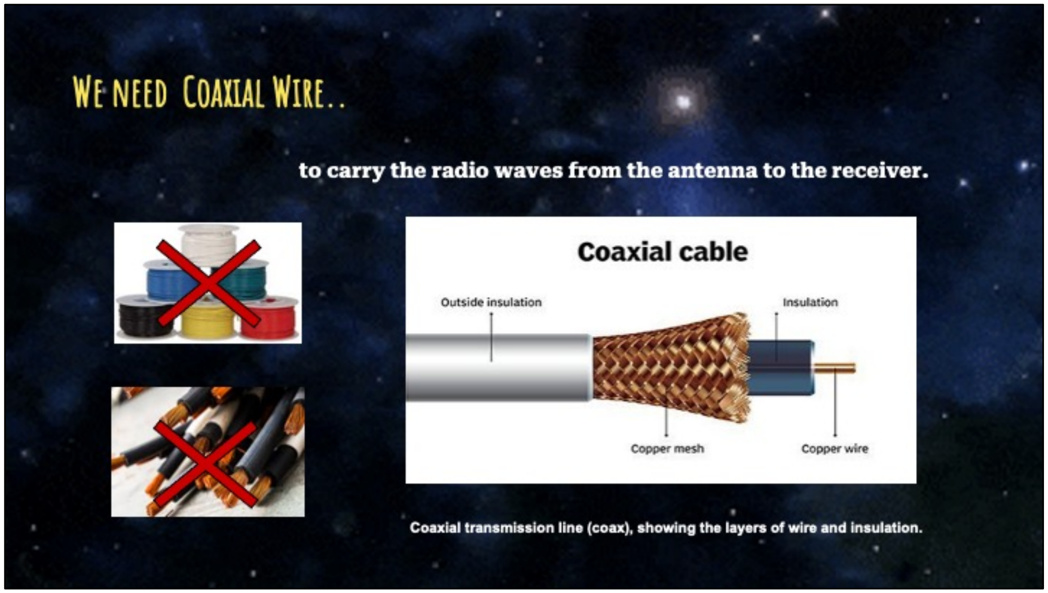
Microwave wavelengths range from around 1 m to 1 millimeter (mm), and frequencies range from about 300 MHz to 300 gigahertz (GHz). However, the exact figures vary depending on the source. In addition, some sources treat microwaves as a type of radio wave, rather than a separate category. Antennas are designed to transmit and receive EM waves at specific frequencies. Their design is also determined by such factors as direction, movement and signal strength. This is why antennas come in so many different shapes and sizes. For example, car antennas are designed much differently from television antennas, and both types of antennas are designed much differently from microwave antennas and cell phone antennas.

OUTLINE. . .

- **Radio Telescope or Antenna**
  - **What is an Antenna**
  - **How does an Antenna works**
  - **Antenna as Receiver**
  - **SunRISE/Jove Radio Antenna**

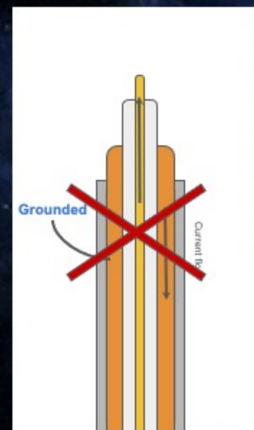


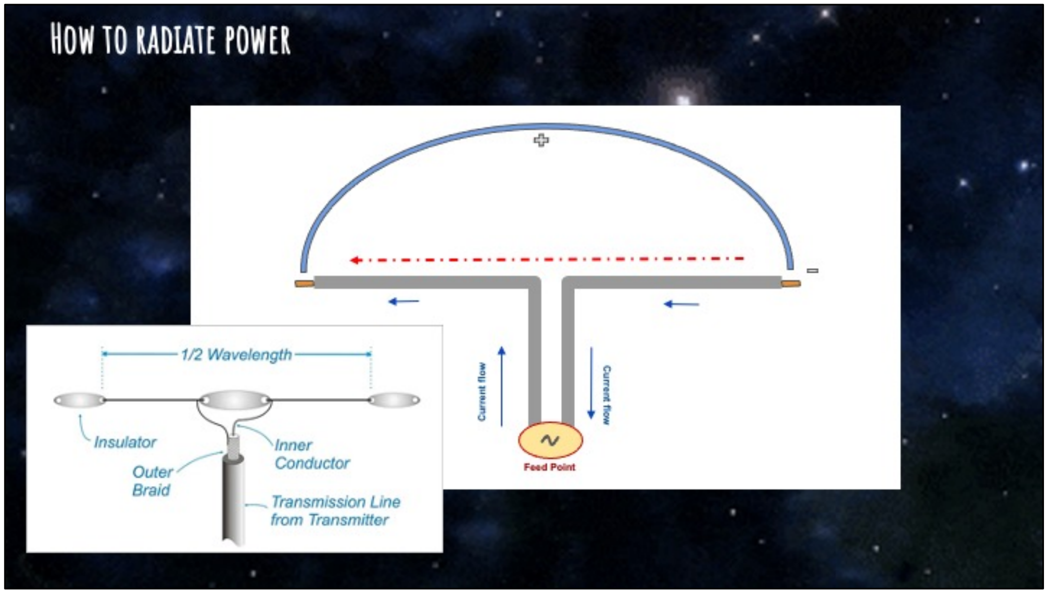
What is an antenna? An antenna is a specialized transducer that converts electric current into electromagnetic (EM) waves or vice versa. Antennas are used to transmit and receive non ionizing EM fields, which include radio waves, microwaves, infrared radiation (IR) and visible light. Radio wave antennas and microwave antennas are used extensively throughout most industries and in our day-to-day lives. Infrared and visible light antennas are less common. They're still deployed in a variety of settings, although their use tends to be more specialized



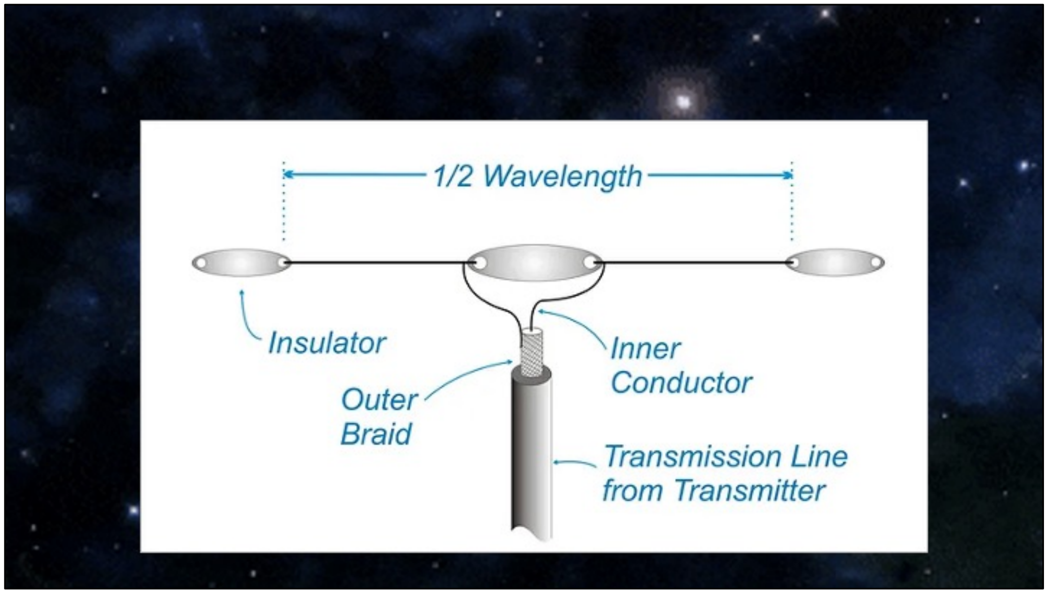
Coaxial cable, or coax, is a type of electrical cable consisting of an inner conductor surrounded by a concentric conducting shield, with the two separated by a dielectric; many coaxial cables also have a protective outer sheath or jacket.

Coaxial Wire...





The actual process of transmission is one that involves a few technical ideas, and it's generally where people choose to stop learning. We assure you, though, that understanding the fundamentals isn't too difficult to comprehend. In order for a transmitter to send a signal through an antenna, an electrical current must be sent through the antenna and generate a magnetic field. Instead of simply sending out a signal at a particular frequency, the antenna sends out signals that have either their frequency or amplitude modulated. Frequency modulation (FM) and amplitude modulation (AM) are the two most common ways that information is packaged in radio waves. When you breakdown the frequency of your favorite radio station, you notice that there's a lot of information contained in, say, channel 99.9 on your stereo. The signal is modulated to contain mono audio information (left and right speakers), a pilot tone, AM suppressed carrier information, and text information.


1/2 Wavelength
Insulator
Inner
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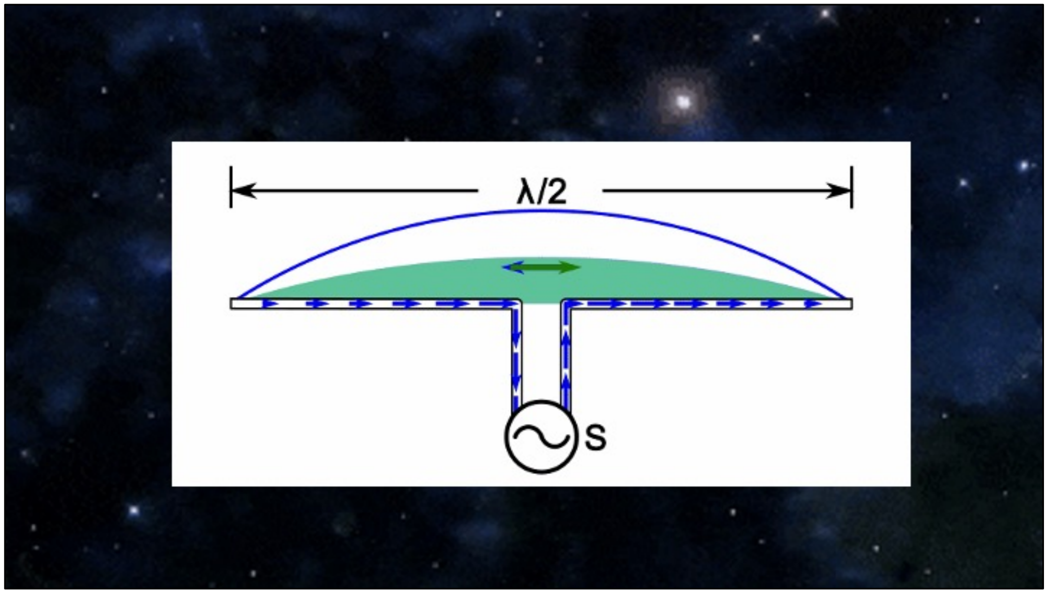
Outer
Braid
Transmission Line
from Transmitter


λ/2
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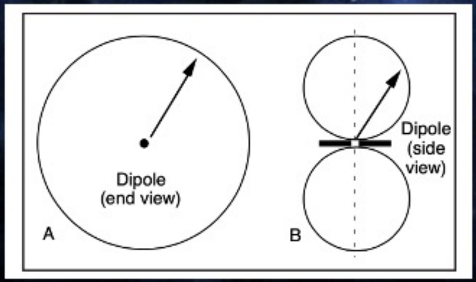
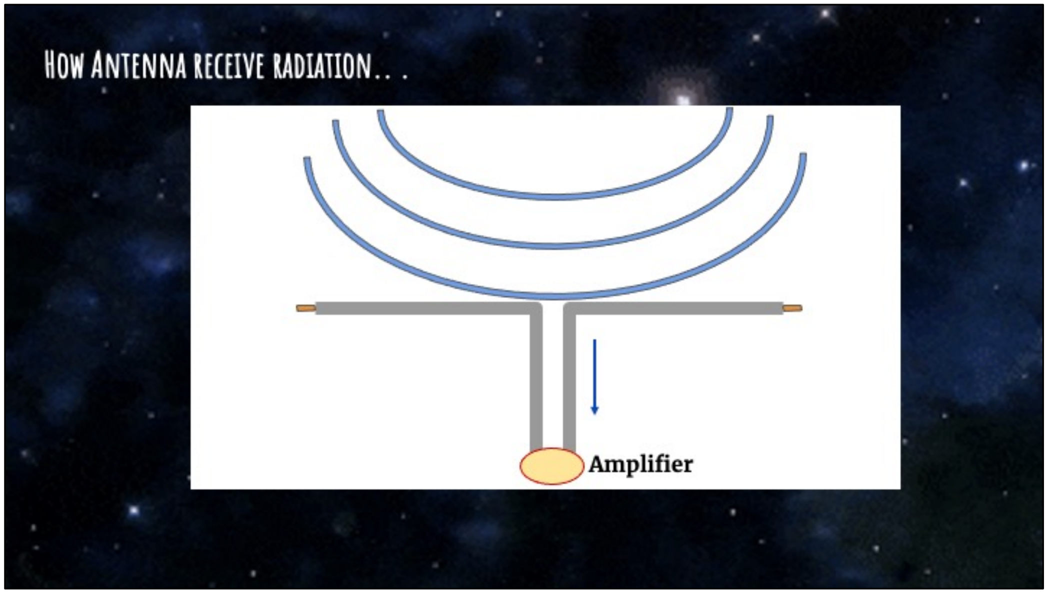
Dipole Antenna Radiation pattern…

Free-space dipole antenna pattern. The dashed line in (B) represents the plane of the pattern in (A).

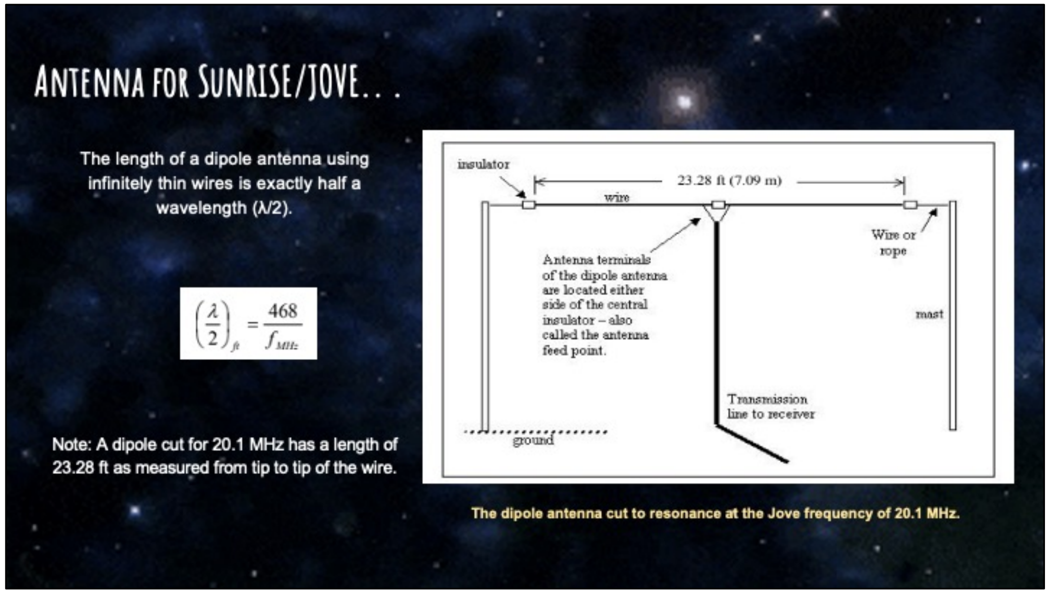


Once the RF voltage source is applied to the center of the two sections in the antenna then the flow of voltage & current throughout the two conductive elements can generate an electromagnetic or radio wave signal to be radiated outside of the antenna. At the center of this antenna, the voltage is minimum and the current is maximum. In opposition, the current is minimum & the voltage is maximum at the antenna's ends. This is the current distribution of dipole antenna. The dipole antenna radiation pattern diagram is shown below which is vertical to the axis of the antenna. The radiation pattern is the graphical depiction of the antenna's radiation properties. The antenna's radiation pattern will describe how the antenna will emit energy into space.



Dipole Antenna Transmitter
At the transmitter section, the dipole antenna generates the radio waves. A voltage at the preferred frequency is provided to the antenna. So the voltage across the elements of this antenna and the flow of current throughout them will create magnetic as well as electric waves. A transmitter in an antenna is the fundamental element that is created with a conductor. Here Conductor carries an electric current where the intensity of the current will fluctuate over time & change into RF radiation that transmits in space.

Dipole Antenna Receiver
At the receiver section, the electromagnetic wave flowing over the dipole antenna will induce a little voltage. As a result, the antenna will become the source of signal for the input of the receiver. The receiver of an antenna performs the reverse operation of the transmitter. It receivers RF radiation & changes it into electric currents within an electric circuit which is connected to the antenna.



A Dipole Antenna

The dipole is very simple to built. it is just two equal lengths of wire suspended above the ground (fig). A transmission line is con- nected to the antenna wires at a central insula- tor. Signals from the antenna travel down the transmission line to the receiver. The length of the wires and their height above ground are determined by the operating wavelength of the antenna. Just as an organ pipe is tuned to resonance by adjusting its length, the dipole wires must be cut to length. The tip to tip dimension (the length of both wires plus the central insulator) is very close to half a wavelength (l /2). While metric units are mandatory in science class, it turns out to be pretty handy to measure the length of our dipole in feet, since most tape measures still use feet and inches. The formula for computing the tip to tip length (L) of a dipole antenna in feet is:

$L = 468/f$ ……….(1)

where (f) is the frequency in MHz. The best frequencies for listening to Jupiter are in the range of 18 to 22 MHz. So, let's pick 20.1 MHz, which is near the middle of the range. This is the same frequency used by SunRISE/Radio Jove. Using formula (1), we obtain a dipole length of 23.28 feet (23 feet, 3 inches). A stranded, moderately heavy gauge wire such as Radio Shack #278- 1329 is recommended, although just about any strong copper wire (insulated or bare) can be used. In order to work properly, the antenna must be raised up off the ground, but how far? A good height turns out to be around ten feet (0.2 l), which makes it easy to support the ends of the dipole between a pair of poles. The poles can be metal tubing, PVC pipe, or wooden 2x2s.


Excellent...
Let's move to the building a Radio Telescope.
Thanks for attention!
PDF