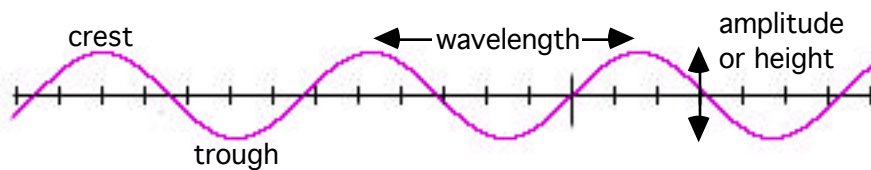


VOCABULARY

AMPLITUDE Amplitude in a wave refers to the amount of energy in a wave. In a sound wave, amplitude is a measure of loudness. In a light wave, it's a measure of brightness.

ANATOMY OF A WAVE:



ARECIBO RADIO TELESCOPE The largest single dish (1,000 foot diameter) telescope.

ARRAY When multiple radio telescope are electronically connected together.

ELECTROMAGNETIC SPECTRUM The entire range of 'light.' Visible light is only a small portion of the electromagnetic spectrum. The full range is divided up according to wavelengths. In order of *increasing frequency* and *decreasing wavelengths*, it goes: Radio waves, infrared, visible light, ultraviolet, x-rays and gamma rays.

FREQUENCY Frequency is a measurement of the number of waves that pass a fixed point in one second. Frequency is measured in units of 'cycles per second' called hertz.

INTERFEROMETER When two or more radio telescopes (perhaps miles apart) are electronically connected together and pointed at the same radio source. This increases resolution. The name interferometer arises from the way the two separate signals come together. The signals that neatly overlap reinforce and strengthen the image, while signals that do not overlap 'interfere' with each other and simply cancel each other out.

LIGHT Light is a form of energy that has both wave and particle properties. Light is emitted in 'packets' of energy called photons and travels at 300,000 km/second (186,000 miles/second). Light is actually more than just what we see – the entire range of light covers radio waves, infrared, visible light, ultraviolet, x-rays and gamma rays. This entire range is known as the electromagnetic spectrum.

VOCABULARY Continued:

LOBES Jets of visually invisible material ejected millions of light years out of some galaxies. Visible only with radio telescopes.

PULSARS Strong radio sources that pulse rapidly out of the cores of some dead stars.

QUASARS The most distant and energetic objects ever discovered.

RADIOGRAPH A visualization of what a part of the sky would 'look' like if we could actually see radio waves.

RADIO SOURCE Any object in space that emits detectable radio waves.

RADIO TELESCOPE An instrument designed to detect natural radio waves emitted from objects in space.

RADIO WAVES The part of the electromagnetic spectrum with the lowest frequency and the longest wavelengths. We can detect radio waves with wavelengths between 1 millimeter and 30 meters. Radio waves carry low levels of energy and are invisible to the human eye.

RESOLUTION The limits of detailed structure that can be observed. For example, modern radio telescopes can observe detail as small as one arc-second. (one arc-second is 3600th of one degree of arc. In human terms, that's the size of a dime viewed from two miles away!)

WAVELENGTH The distance between crests or peaks of adjacent waves.



SOME IMPORTANT PLACES & NAMES IN RADIO ASTRONOMY

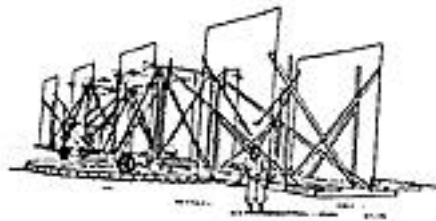
Arecibo Radio Telescope The largest radio telescope in the world. The dish is 1,000 feet in diameter and lies nestled between several hills in Puerto Rico.

Green Bank, West Virginia The National Radio Astronomy Observatory is located there, where many interesting radio telescopes are located.

Karl Jansky The father of radio astronomy. He discovered radio emissions coming from the Milky Way while working on a radio communications system for Bell Telephone Laboratories in 1931.

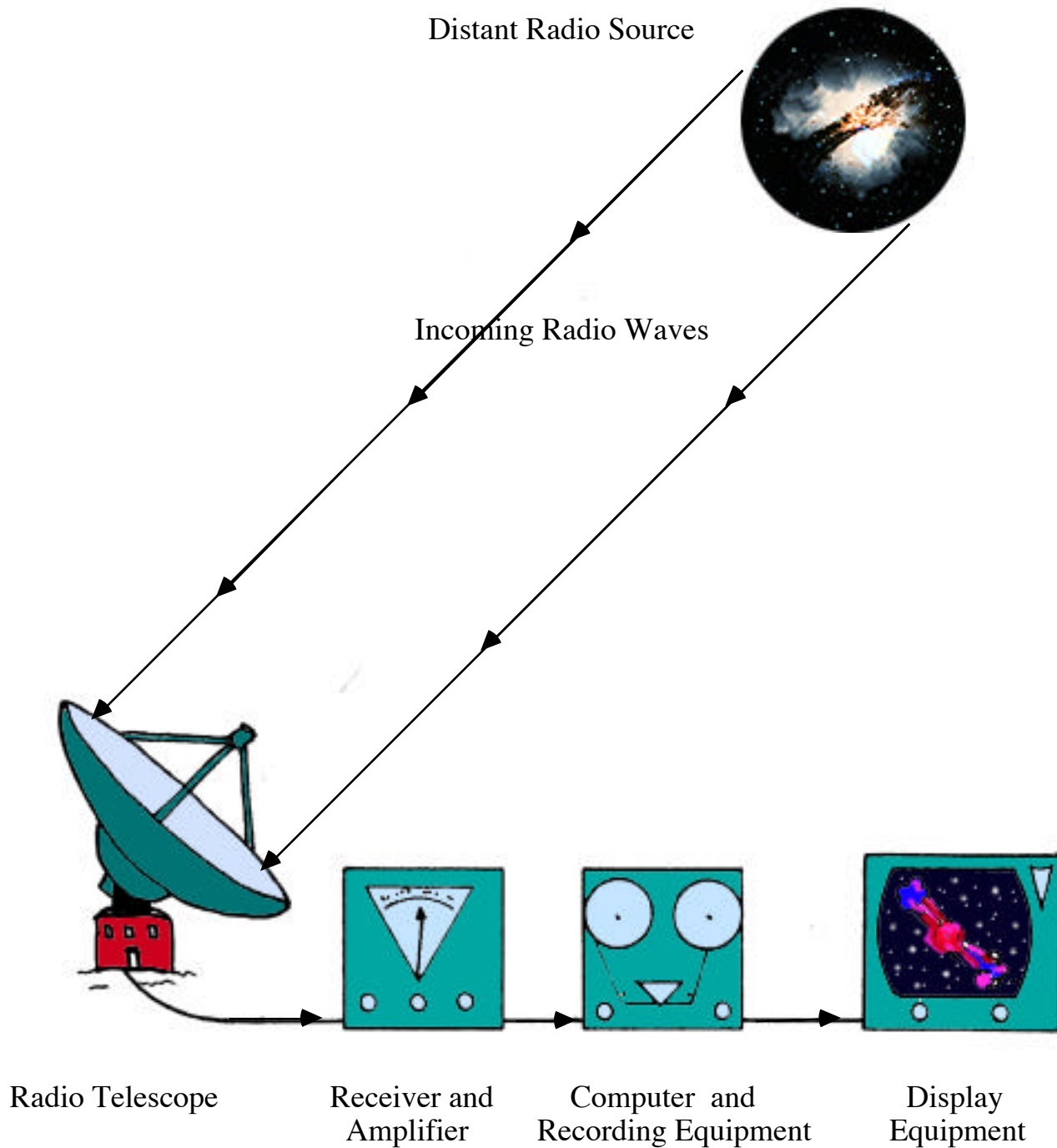
VLA Very Large Array An array of twenty-seven 82-foot diameter radio telescopes, all connected to form one large telescope. It covers an area of about 20 miles by 20 miles in the New Mexico desert. The VLA is effectively the largest radio telescope in the world (Arecibo is the largest single dish, while the VLA uses 27 smaller ones covering a larger area.).

Parkes CSIRO Radio Telescope A 64-meter moveable dish telescope in Australia.



Karl Jansky's First Radio Telescope, 1931.

HOW A RADIO TELESCOPE WORKS



TRUE OR FALSE

1. Radio waves are an invisible form of light. (T)
2. X-rays are a form of radio wave. (F – X-rays are an invisible form of light, but they are a high frequency/short wavelength/high energy form of light. Radio waves are a low frequency/long wavelength/low energy form of light.)
3. Radar and Microwaves are both forms of radio waves. (T – Microwaves represent high-end radio waves and Radar is just below microwaves – see diagram on page 7)
4. When you listen to the radio, you are actually hearing radio waves. (F – Radio waves are used by both radio and TV to carry signals, but what you hear and see are generated by electronics in your radio and TV that read the signals carried in the radio waves. If you could actually hear radio waves, you wouldn't need a radio!)
5. Radio Telescopes are really just large directional radio antennas. (T)
6. Radio Telescopes can also be used for communications if so desired. (T – They were used to communicate with the Voyager Space Probes, for example.)
7. Using a Radio Telescope with a dish the diameter of a football field, if we observed one of the strongest radio sources in the sky, the energy received would only be enough to heat one gram of water 0.001 Celsius. (T – Radio signals are all very, very weak.)
8. Radio Telescopes can only receive signals, they cannot send signals. (F – They have sent signals to space probes as well as intragalactic greetings to any aliens who care to listen!)
9. The largest single radio telescope dish is 500 feet in diameter. (F – Arecibo Telescope in Puerto Rico is 1,000 feet in diameter – that's bigger than 3 football fields end-to-end!)
10. The first radio signals from space were discovered in 1931. (T – by Karl Jansky, but the study of radio signals didn't begin in full until after World War II.)
11. Radio Telescopes, like their optical cousins, can only be used on clear, dark nights. (F – Actually, they can be used day or night, clear or cloudy.)
12. Quasars, discovered first by Radio Telescopes, are the most distant and the most powerful objects ever discovered. (T)

RADIO ASTRONOMY WORD SEARCH



Find the following words hidden in the puzzle below. They are written horizontally, vertically and diagonally. Good luck!

ANTENNA ARECIBO ARRAY DISH ENERGY
FREQUENCY GALAXY GASES INVISIBLE JANSKY
JUPITER LIGHT LOBES PULSARS QUASARS
RADIOGRAPH SATURN SOURCE SPECTRUM STARS
SUN TELESCOPE WAVELENGTH

W	S	P	Q	M	N	P	U	L	S	A	R	S	A	Q	U
I	A	S	G	U	R	A	D	I	O	G	R	A	P	H	R
N	R	V	T	I	A	A	O	G	U	G	A	S	E	S	E
V	E	H	E	A	F	S	N	H	R	O	R	L	S	O	H
I	C	Z	L	L	R	J	A	T	C	N	R	H	A	X	D
S	I	L	E	H	E	S	U	R	E	D	A	L	T	X	P
I	B	C	S	L	Q	N	K	P	S	N	Y	Z	U	F	Y
B	O	N	C	Z	U	X	G	S	I	E	N	E	R	G	Y
L	C	L	O	B	E	S	L	T	U	T	H	A	N	I	F
E	J	A	P	G	N	D	I	S	H	N	E	C	J	P	E
H	I	L	E	U	C	A	R	E	C	I	F	R	G	H	A
J	A	N	S	K	Y	S	P	E	C	T	R	U	M	Y	J



BIBLIOGRAPHY

(Useage Guide: Y=Young Student Book / T=Teacher Resource / A=Adult or Older Student Level)

Beatty & Chaikin, *The New Solar System, 2nd Ed.* Cambridge: Cambridge University Press, 1990. (High school to college age level) (A)

Braus, Judy, Editor, *NatureScope: Astronomy Adventures*, Washington, D.C.: National Wildlife. (YT)

Fraknoi, Andrew, Editor, *The Universe at your Fingertips: An Astronomy Activity and Resource Notebook*, San Francisco: Astronomical Society of the Pacific, 1995. (T)

Goldsmith, Donald, *Supernova! The Exploding Star of 1987*, New York: St. Martin's Press, 1989. (TA)

Grice, Noreen, *Touch the Stars*, Boston: Charles Hayden Planetarium. A Braille astronomy book. (YTA)

Gutsch, William, *1001 Things Everyone Should Know about the Universe*, New York: Doubleday, 1999. (YTA)

Harrington & Pascuzzi, *Astronomy For All Ages, Discovering the Universe Through Activities for Children and Adults*, Old Saybrook, CT: The Globe Pequot Press, 1994. (YTA)

Moeschl, Richard, *Exploring the Sky, 100 Projects for Beginning Astronomers*, Chicago: Chicago Review Press, 1989. (TA)

Pasachoff, *A Field Guide to the Stars and Planets*, Boston: Houghton Mifflin Co., 2000. (A good general handbook--highly recommended) (TA)

Verschuur, Gerrit, *The Invisible Universe Revealed: The Story of Radio Astronomy*, New York: Springer-Verlag, 1987. (A)