Radio Astronomy for Amateurs

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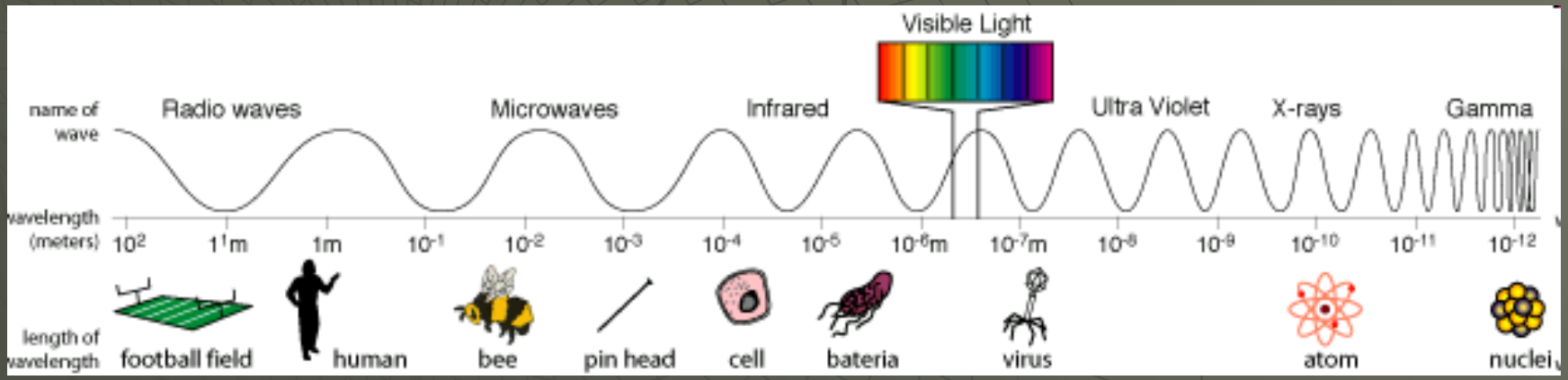
AG6CI

Outline

- Radio Astronomy Basics:
  - What, How, Why
- How Amateurs can participate and contribute

What is Radio Astronomy?

- The Study of the non-visible parts of the Electromagnetic Spectrum
- Many times more information than in visible light



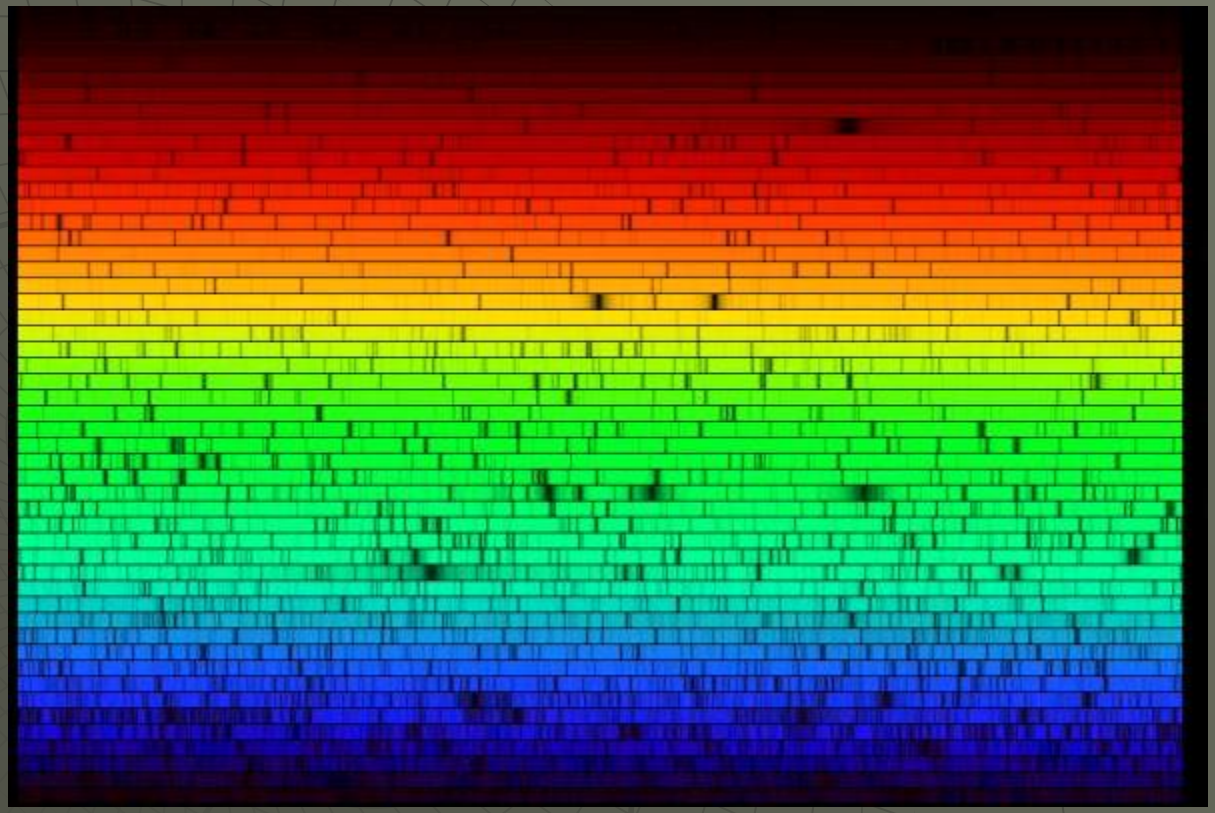
Basic Concepts

- Every Object above Absolute Zero emits Electromagnetic Radiation, even humans.
- Radio signals are also generated by any charged particles moving in a magnetic field
- Frequency, wavelength, and energy are all related mathematically
- We usually use Frequency when describing radio signals, wavelength for Optical signals, and energy for gamma and X Rays

Composition and Motion

- Hot Gasses emit specific wavelengths
- Cold Gasses and dust absorb specific wavelengths
- These "signatures" combined with Doppler effects can tell us how fast an object is moving, in what direction, and what it is made of

High Resolution Solar Spectrum

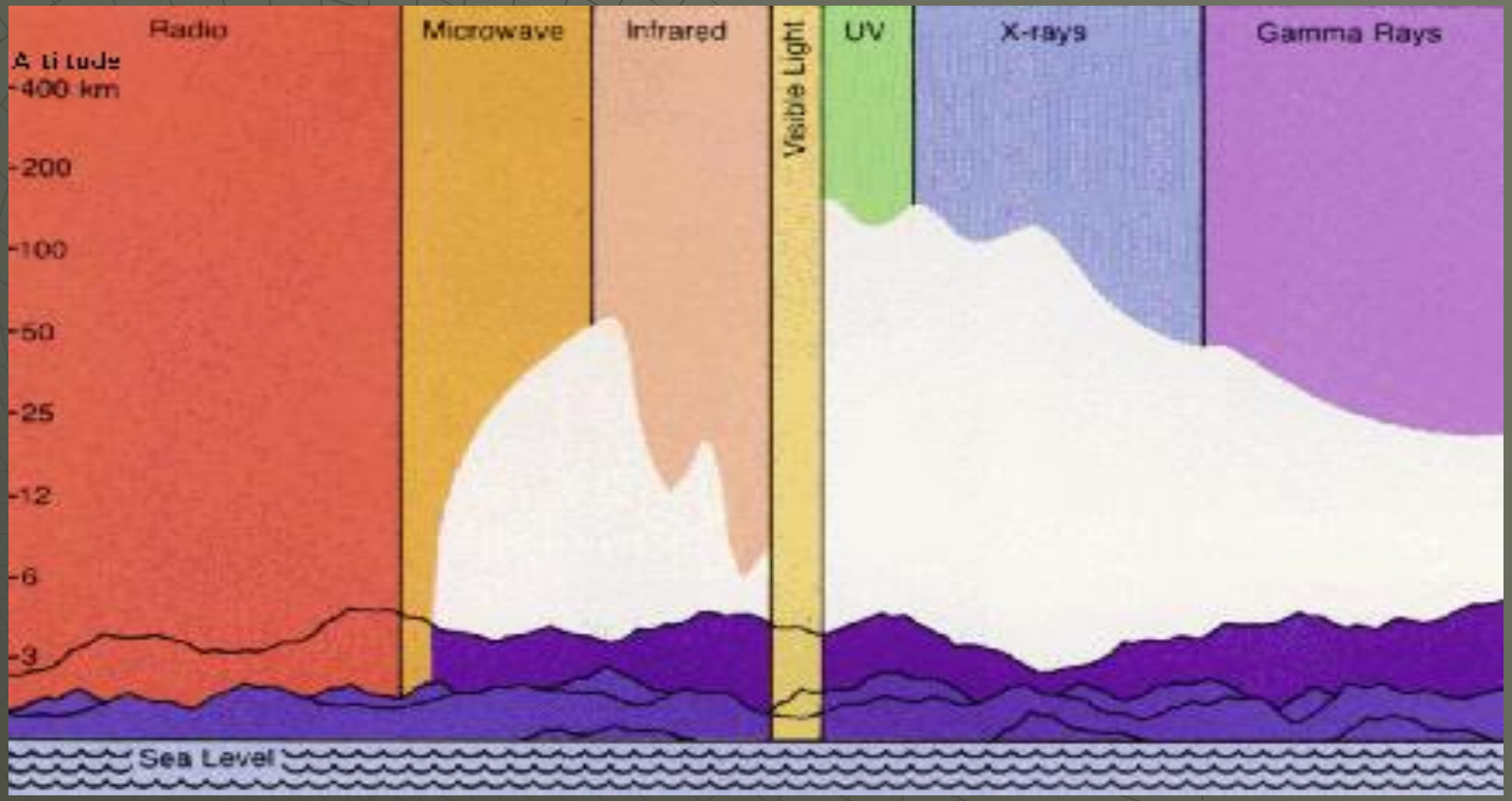


Why Radio Astronomy?

- To give us a more complete picture of the universe.
- Some objects are most active in radio frequencies, so they are more visible there
- Some frequencies penetrate interstellar gas and dust far better than visible light.

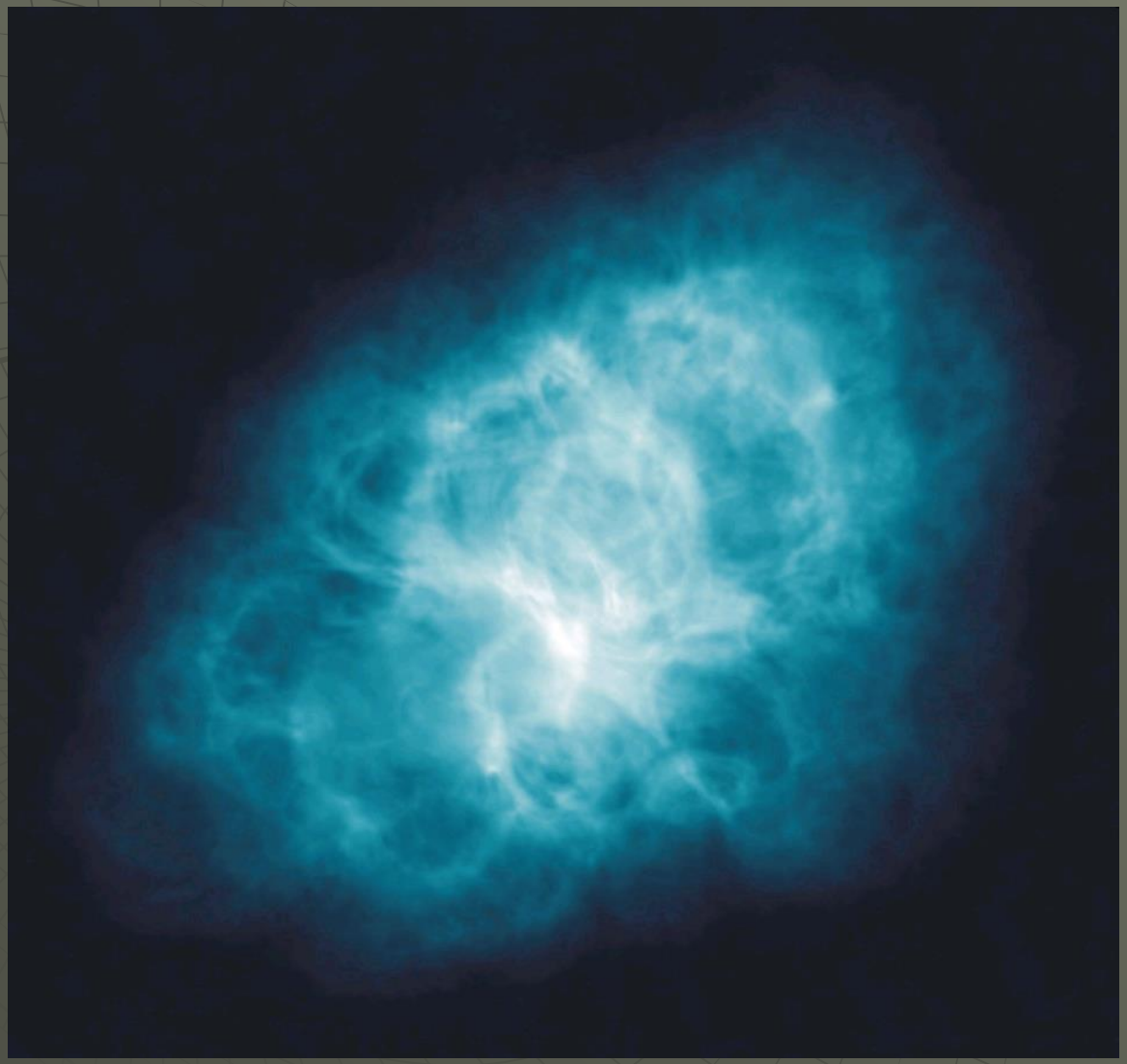
The Effect of the Atmosphere

- The amount of radiation reaching us depends on wavelength



M51 Visible + Neutral Hydrogen

Crab Nebula (M1) Radio Image



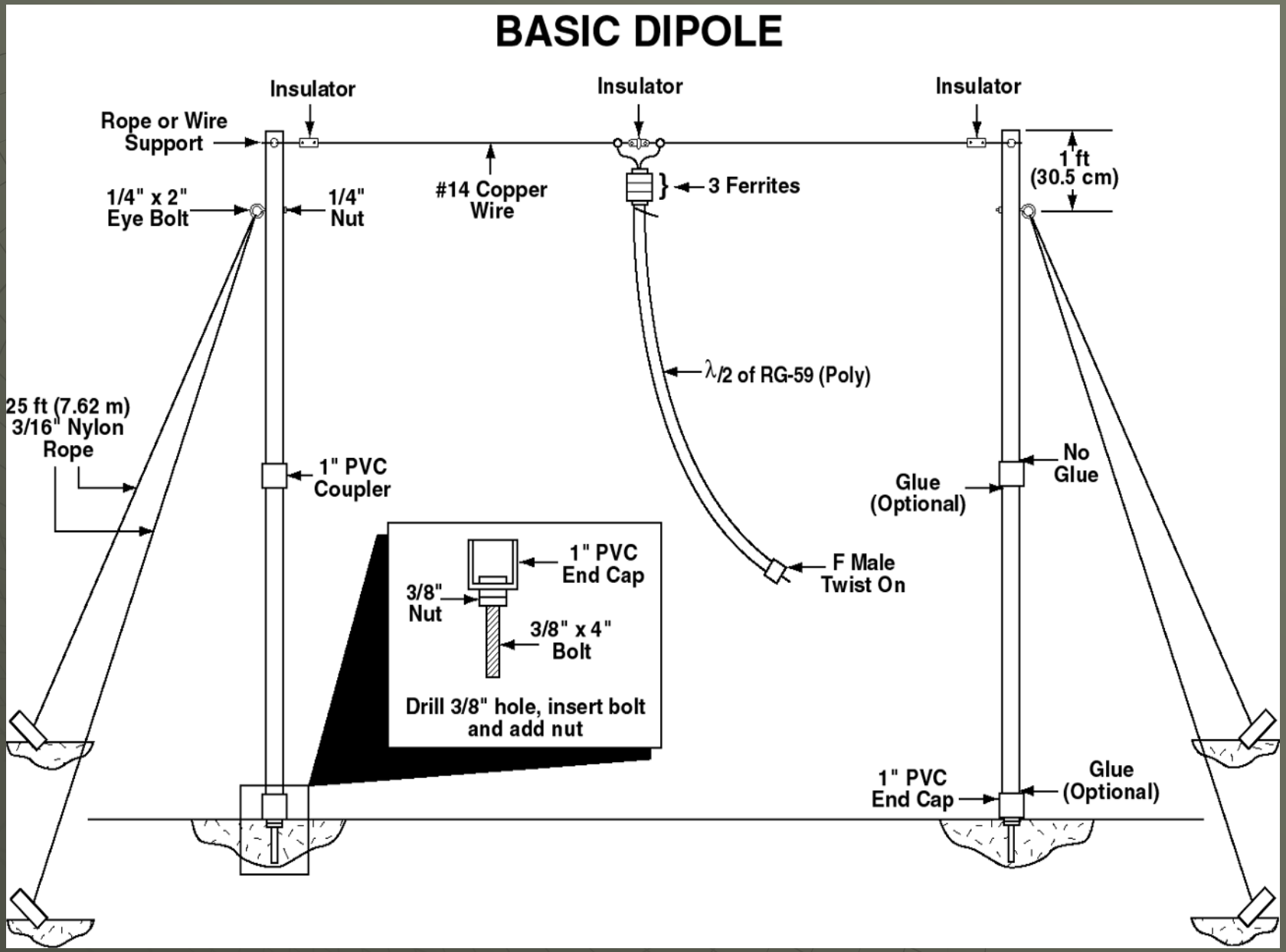
How a Radio Telescope Works

- The Antenna collects the radio waves from space
- The Radio Receiver converts the radio signal to a signal the computer can measure
- The computer collects the signals over time to build up a picture.

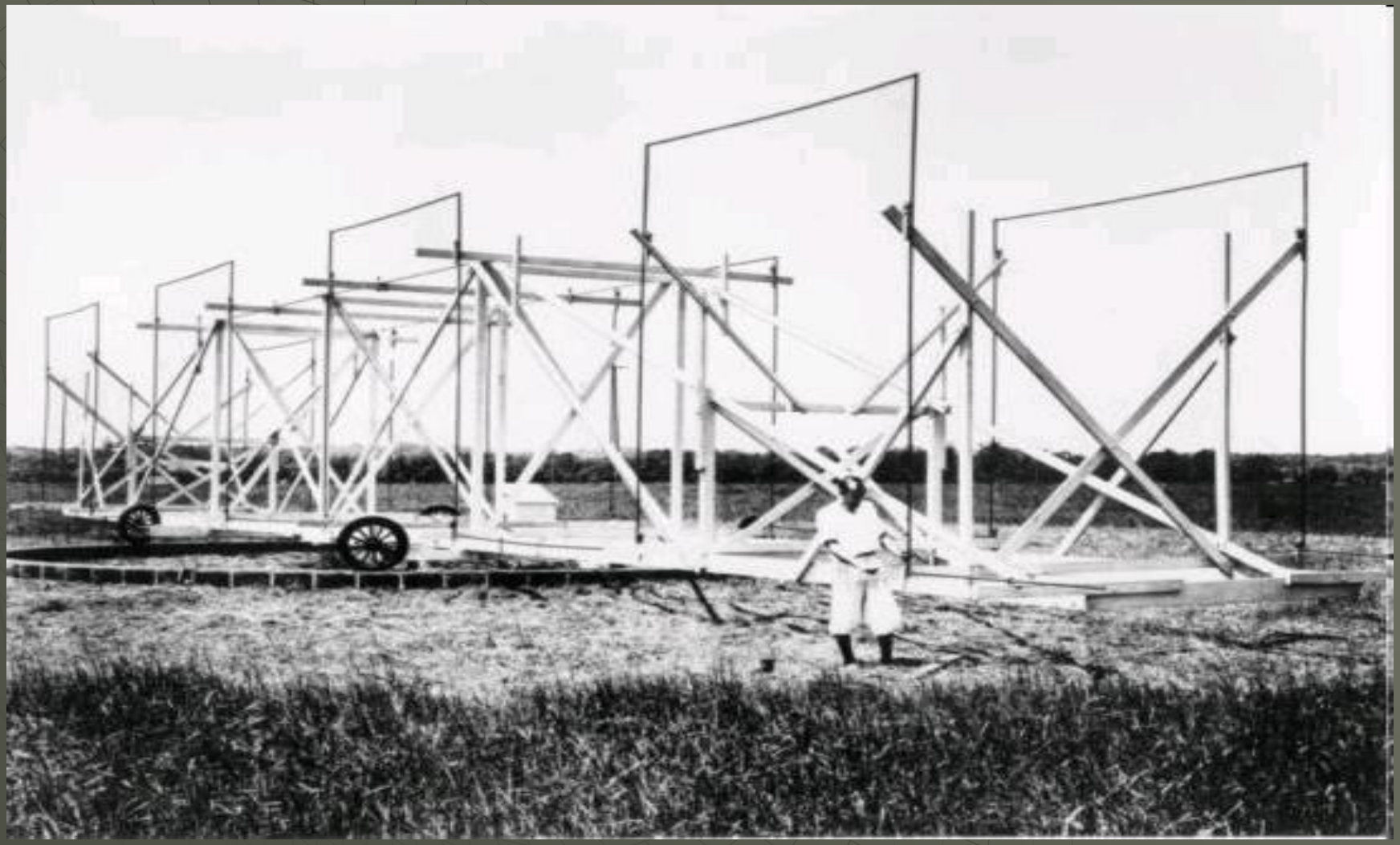
Radio Astronomy Antennas

- The simplest antenna is a Dipole
  - ½ Wavelength of wire
  - Antenna connected to the center
- Dipoles can be combined to provide more gain and directivity
- Reflectors and Directors can be added to give more gain also
- Can be made of simple materials

BASIC DIPOLE



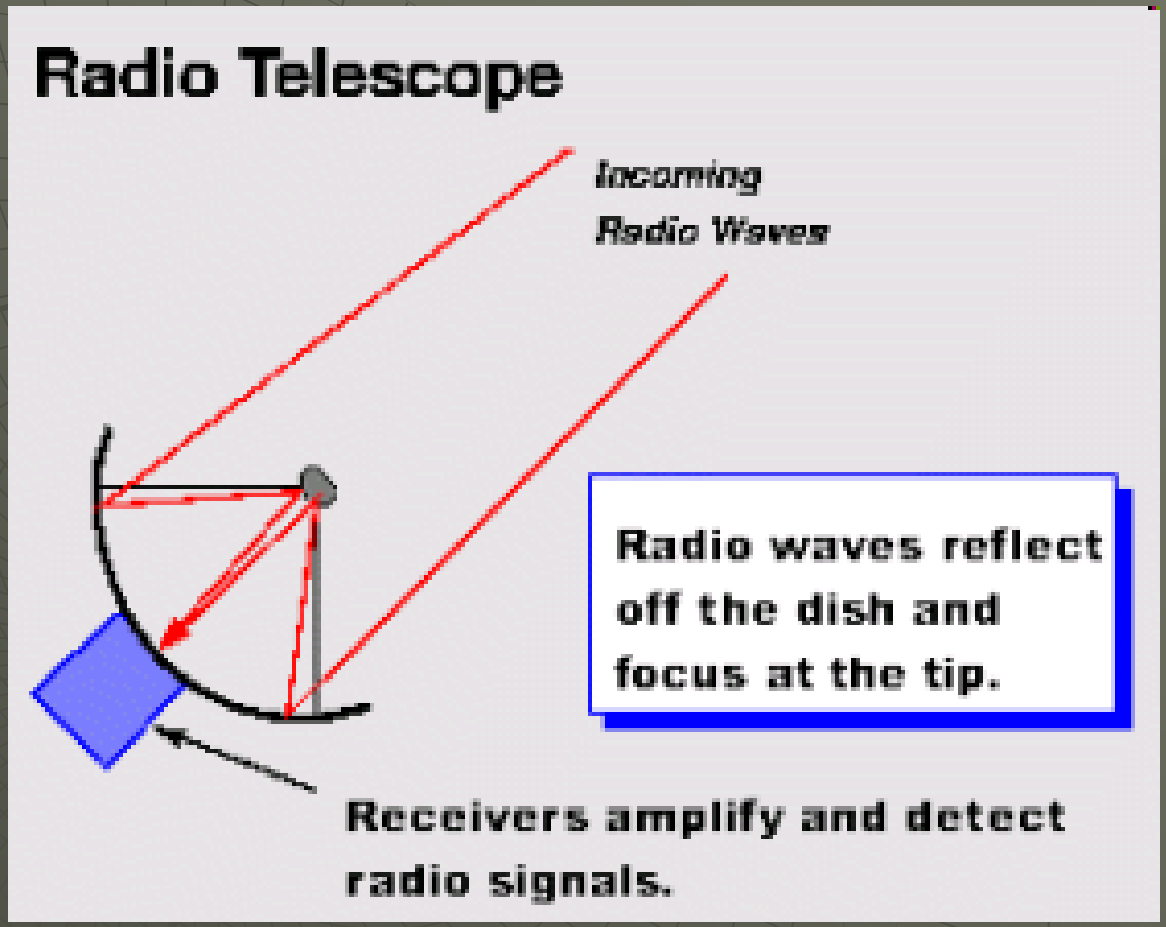
Karl Jansky's Antenna



Jansky's Merry-go-Round

- Built in 1932
- Designed for 20.5 MHz
- 2 Wavelength long "Bruce Array"
- Each segment is 12 feet, ¼ wave
- One driven element + reflector
- 100 feet across, 20 feet tall
- Rotated on 4 Model-T wheels on a circular track

A Dish Antenna



Dish Antenna Basics

- The dish is just a high gain, narrow beam-width antenna.
- Exactly like a reflecting telescope
- Gain and beam width are functions of frequency (wavelength) and dish size
- Good gain and resolution at low frequencies require a large dish

Robert C. Byrd Green Bank Telescope (GBT)

GBT Facts

- Worlds Largest Fully Steerable Radio Telescope: 100 x 110 meters
- More than two acres of reflecting surface
- 17 million pounds
- In the middle of the National Radio Quiet Zone
- Approximately equal to a human eye

Radio Observing for Amateurs

- Sudden Ionospheric Disturbances
- Radio Jove
- The IBT
- Meteor Showers
- Bright Galactic Objects

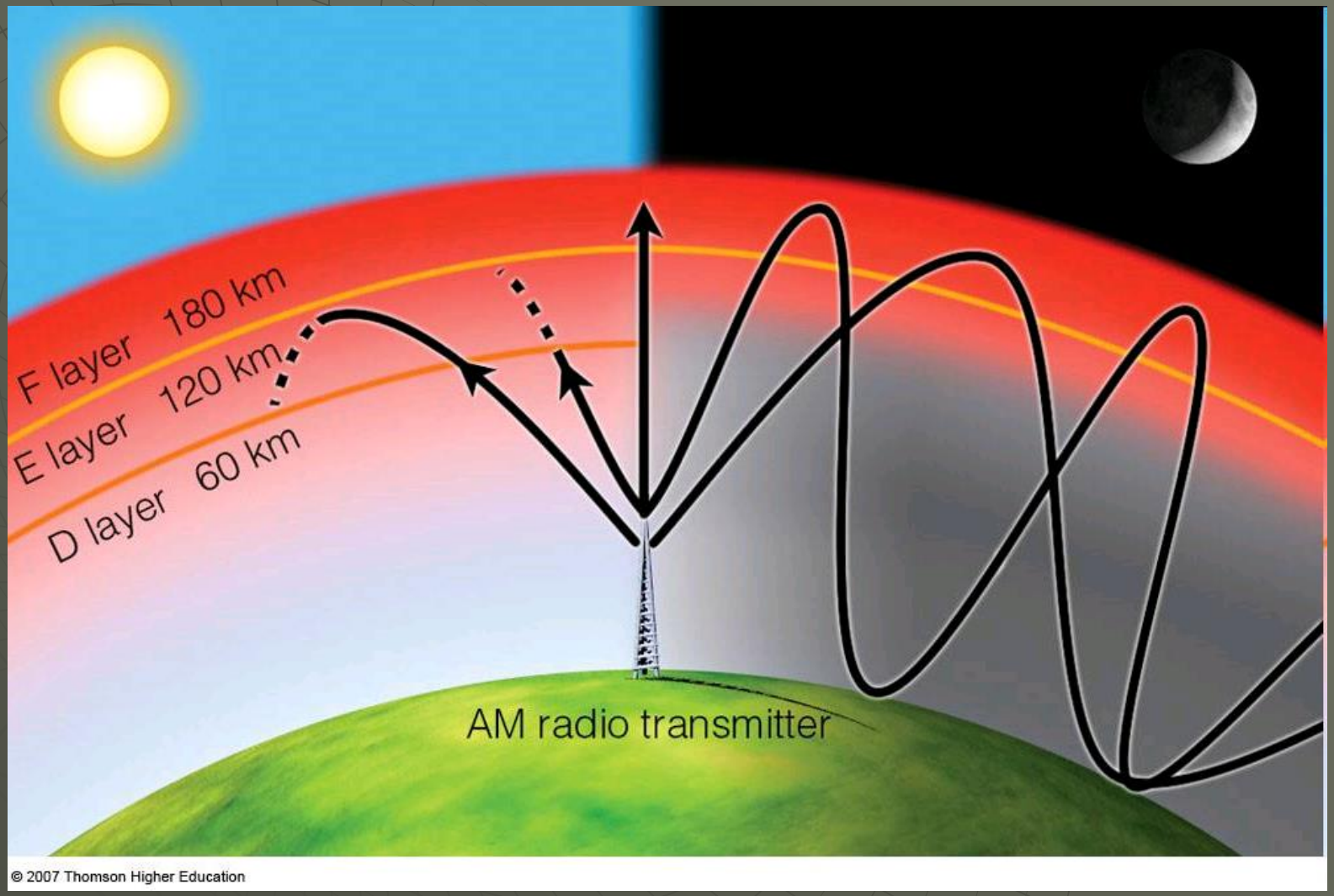
Solar System Radio Astronomy

- Radio signals from objects in our solar system
  - Sun, Jupiter/IO, Spacecraft
- Effects of the Sun and other objects on terrestrial radio propagation
  - Solar wind, CMEs, Flares
  - Gamma Ray Bursts
  - Meteor Showers

Radio Signals and the Ionosphere

- The ionosphere is a layer of ionized gasses in the atmosphere that absorb and reflect radio waves.
- The ionosphere is heavily affected by the sun: daily, seasonally, and by events.
- Lightning drives a phenomenon called Schumann resonances
- The state of the ionosphere can be monitored by listening for distant radio stations.

Radio Signals and the Ionosphere



AAVSO and Stanford SID Monitors

- Listen to low frequency beacons and monitor for changes in signal levels.
  - Below the AM radio band
- Some monitoring can be done with just a sound card and an antenna
- Most monitors are home-built from plans on the internet
- Stanford and SARA have a packaged monitor for schools

Radio Jove

- Observing the Sun and the Jupiter/IO System at 20 MHz
- Started and supported by NASA
- Active on-line community
- System can be purchased as a kit for < $200

NRAO/SARA IBT

The Itty Bitty Telescope

- Uses a small satellite dish
- Detects thermal emission from the sun, people, warm surfaces
- Also detects satellites, of course...
- Can be bought as a complete kit for about $80

Meteor Showers

- Radio signals reflected off the ionized trails left by meteors as they enter the atmosphere
- Standard FM radio receiver
  - Digital works best
- External antenna
- Monitor a distant FM station
  - Lists available on-line

UHF and Microwaves

- Detect and Map galactic radio sources
- Detect pulsars
- Search for ET
- Popular frequencies are 408 and 1420MHz

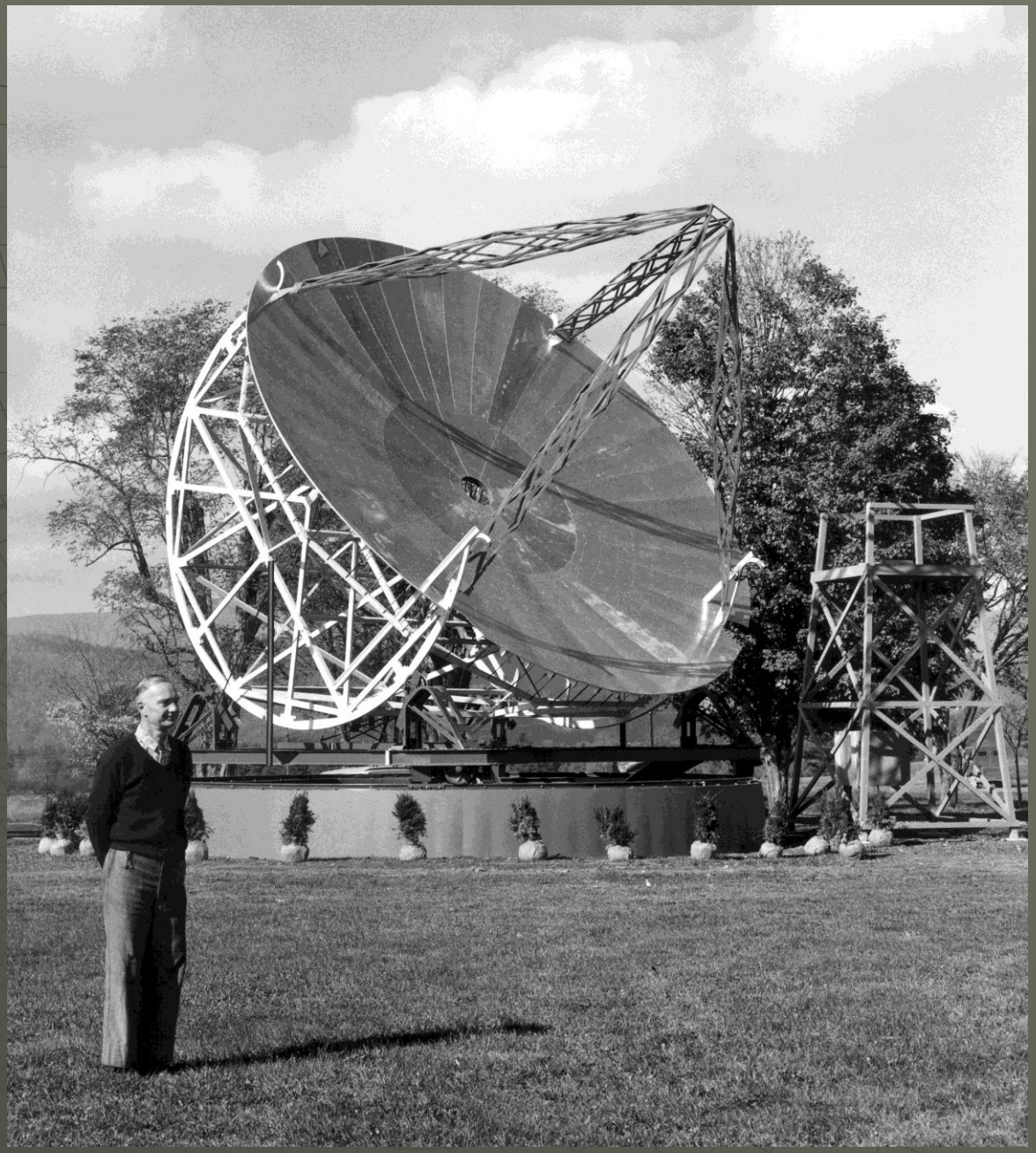
UHF and Microwaves

- Usually based on unwanted old-style satellite dishes (often free)
- Off-the-shelf communications receivers cover the desired bands
- RA Specific equipment and complete radio telescopes are available from on-line sources starting around $1800

UHF and Microwaves

- FunCube Dongle
  - SDR Receiver - 64MHz to 2GHz
  - Large online support community
- Digital TV antenna
  - Bow-tie arrays
- Channel 37: 608-614MHz
  - Reserved for Radio astronomy

Grote Reber, W9GFZ, inspired by Jansky's discovery of radio radiation coming from the center of the Milky Way, built his own radio telescope in his back yard in Illinois to study this radiation. Reber was able to confirm Jansky's discovery by using a receiver at 160 MHz (1.9 meters wavelength) to detect radio emission from the Milky Way in 1938. Reber confirmed that the amount of radiation was strongest in the direction of the center of the Milky Way, and also discovered bright radio sources in Cygnus and Cassiopeia for the first time.



Reber's Map of the Radio Sky

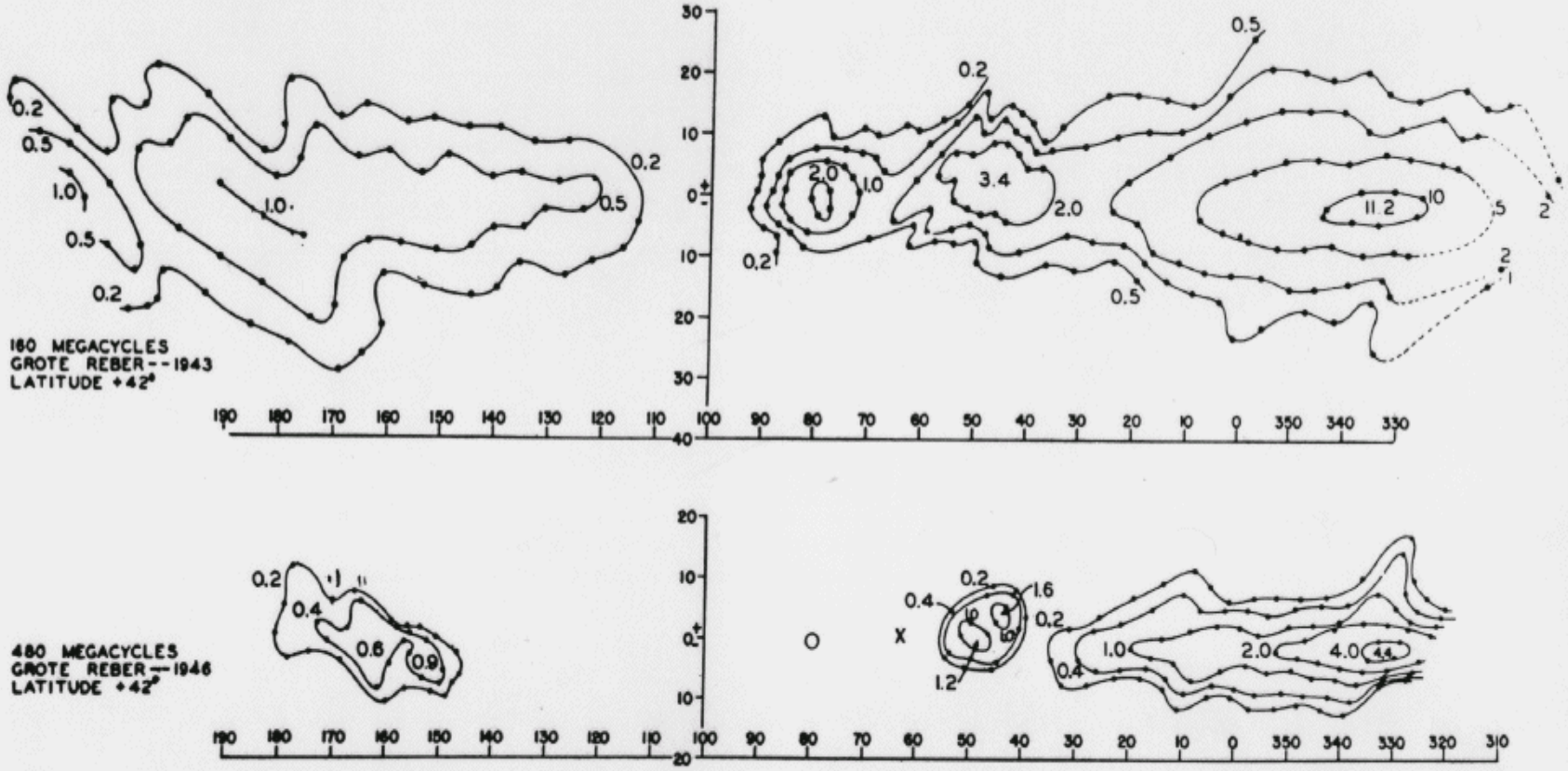


FIG. 7—Contours of constant intensity at 160 MHz and 480 MHz, taken at Wheaton, Illinois.

Robert Ferguson Observatory

- All volunteer public observatory at Sugarloaf Ridge State Park
- Open monthly for public viewing
- Afternoon program of Solar and Radio Astronomy Observing
- Evening program for the night sky
- Classes and Private Events
- Next public event on 15-September

Where to learn more

- Society for Amateur Radio Astronomy:
  - http://www.radio-astronomy.org/
- The SETI League:
  - http://www.setileague.org/
- AAVSO:
  - http://www.aavso.org/
- Radio Jove:
  - http://radiojove.gsfc.nasa.gov/
- NRAO:
  - http://www.nrao.edu/
- VLF:
  - www.vlf.it