Radio Astronomy and Amateur Radio

Glenn MacDonell
VE3XRA
3 August 2010

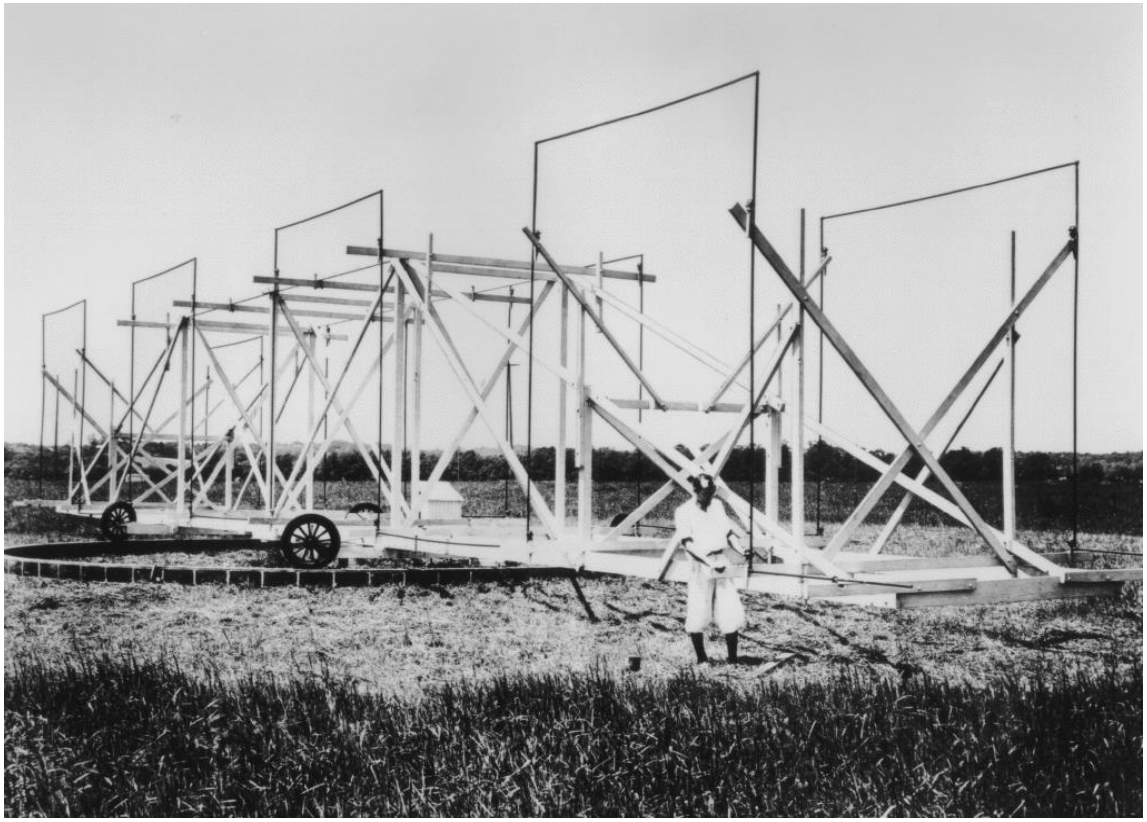
Radio Astronomy

- The study of objects in the sky using radio frequencies
- Very young field

History of Radio Astronomy

- Basic work on electro-magnertic radiation laid the groundwork
- Karl Jansky 1933
- Grote Reber 1937 (W9GFZ)
- John Kraus (W8JK)

Karl Jansky 1933



- Jansky – investigate static that might interfere with planned transatlantic short wave communications

- Rotatable antenna 20.5MHz (14.5m)

- 3 types of static found:
  - Nearby thunderstorms
  - Distant thunderstorms
  - Faint steady hiss

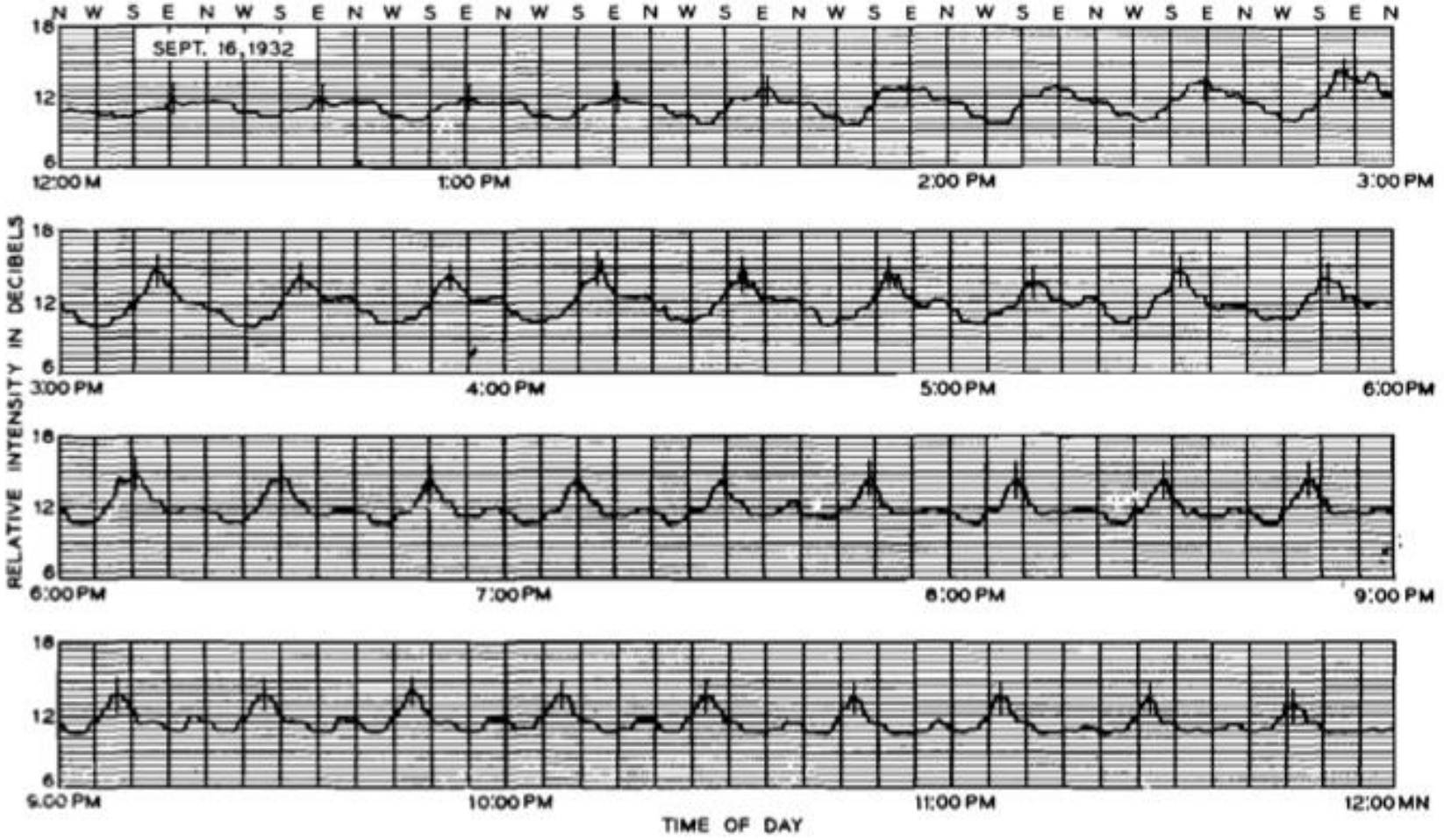
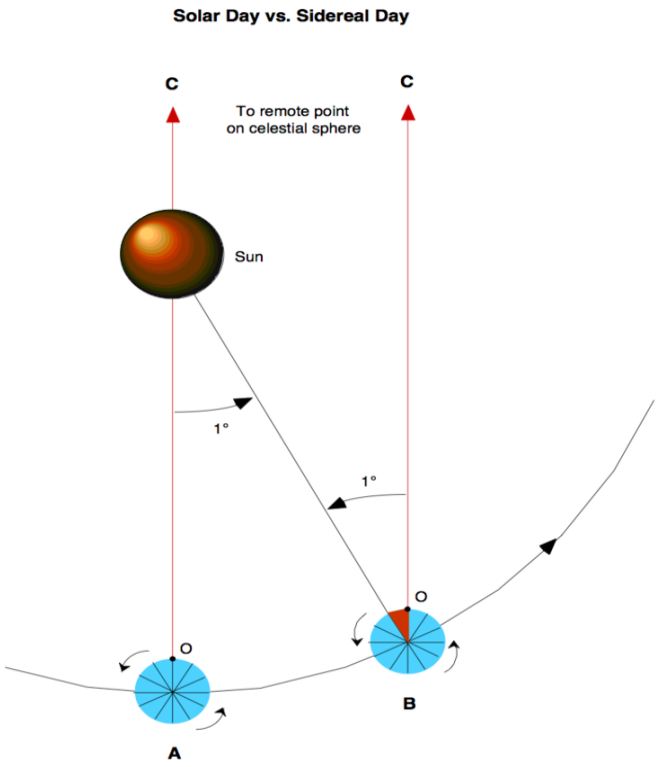


Fig. 5. Typical autumn record of waves of extraterrestrial origin. As the antenna was rotated through its 20-minute cycle, peaks appeared in the low-level noise that was then prevailing.

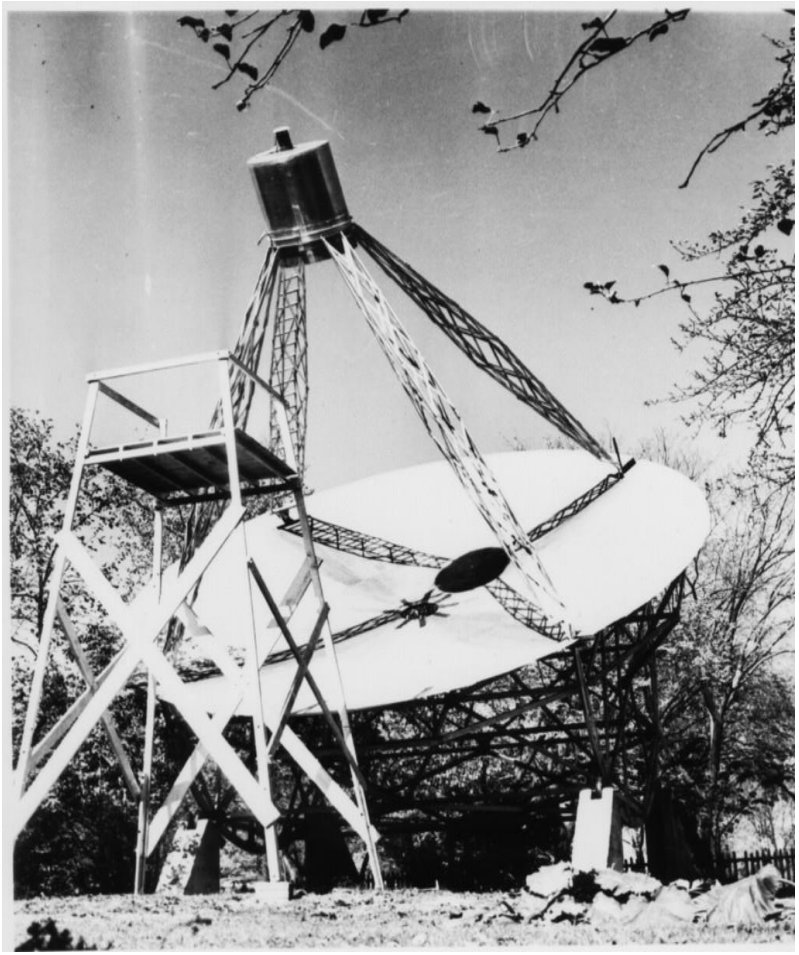
- Hiss rose and fell through day
- Repeated every 23 hours 56 minutes

What Jansky Found

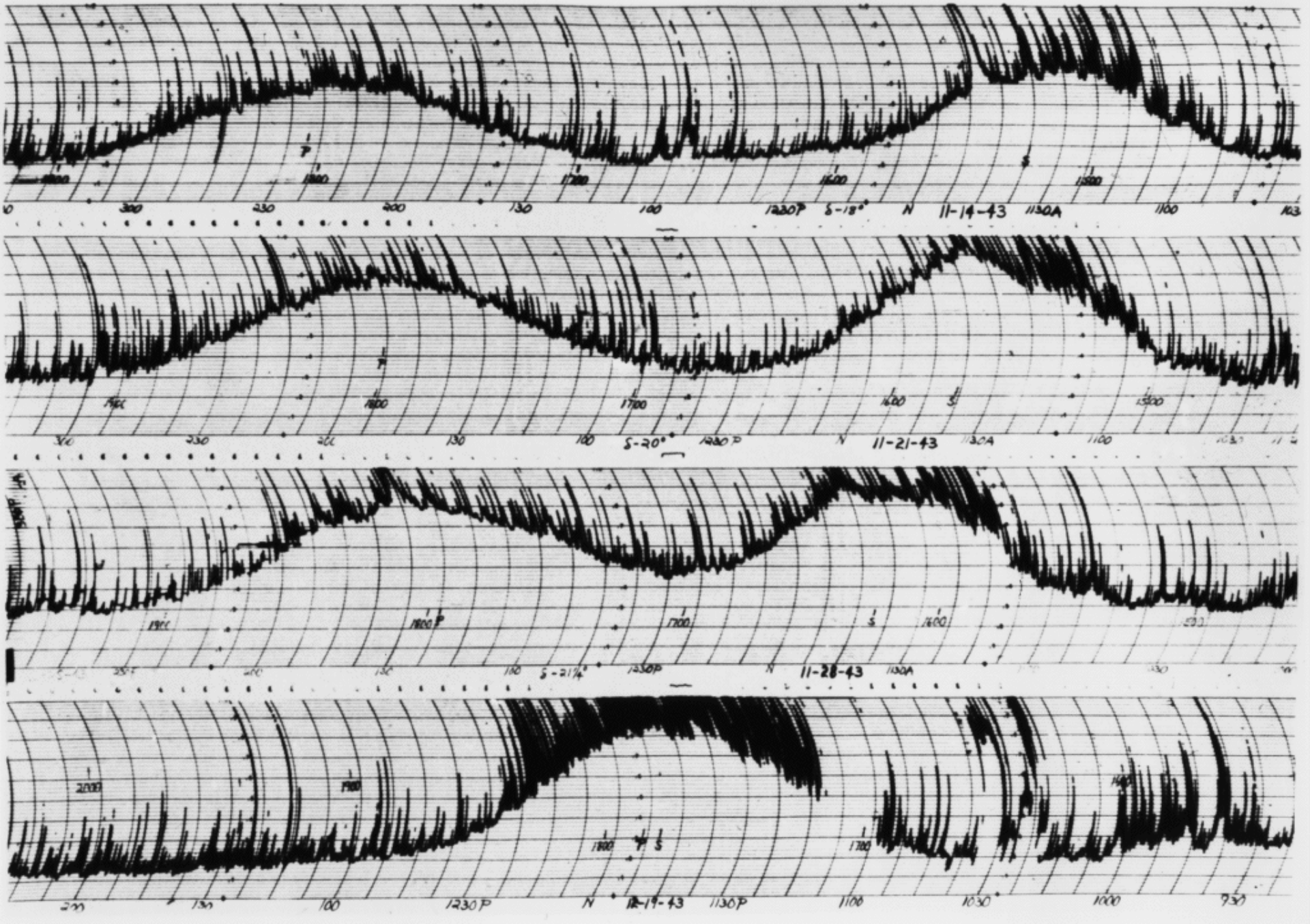


- Timing of the peak showed the source could not be the sun
- Discovery widely reported (eg. New York Times 5 May 1933)
- Jansky wanted to investigate further – proposed 100ft dish antenna
- Bell had the information it wanted – interference would not be a problem

Grote Reber W9GFZ
First radio astronomer



- Telescope built in 1937 in his yard
- 31’ diameter, 20’ focal length
- Built by Reber and 2 friends over 4 months
- Recorded signals at night to avoid interference from auto ignition
    - 1 year observations at 9cm no signal
    - 1938 – revisions, tried 33cm no success
    - 1939 1.87m – first detection
- Identified signals from center of universe and several constellations
- Paper submitted to astrophysical Journal published without review June 1940
    - “The astronomers couldn't understand the radio engineering and the radio engineers couldn't understand the astronomy”
- For nearly a decade worked alone in his back yard – the world’s only radio astronomer
    - 1943 found radio signals from sun
    - 1945 published first radio map of our galaxy


S-18°
N 11-14-43 1130A
S-20°
11-21-43
S-21¼°
11-28-43
12-19-43

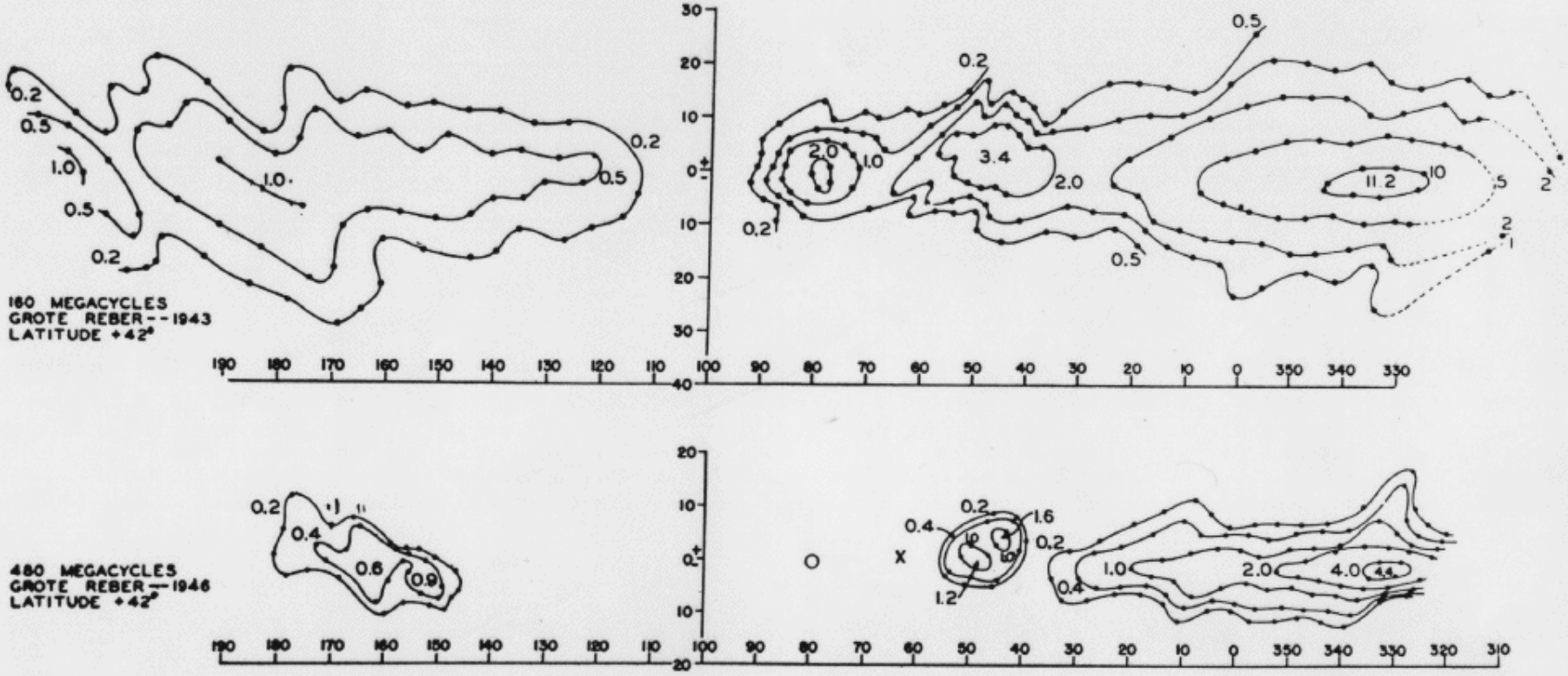
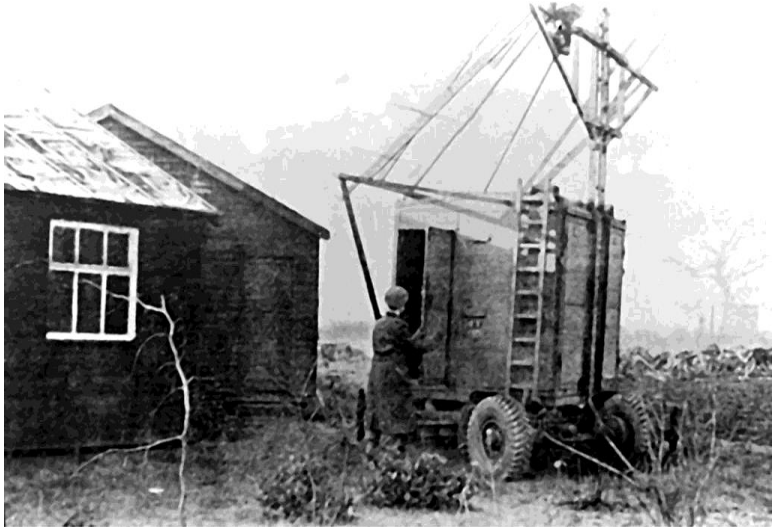


FIG. 7—Contours of constant intensity at 160 MHz and 480 MHz, taken at Wheaton, Illinois.

The Post War Expansion



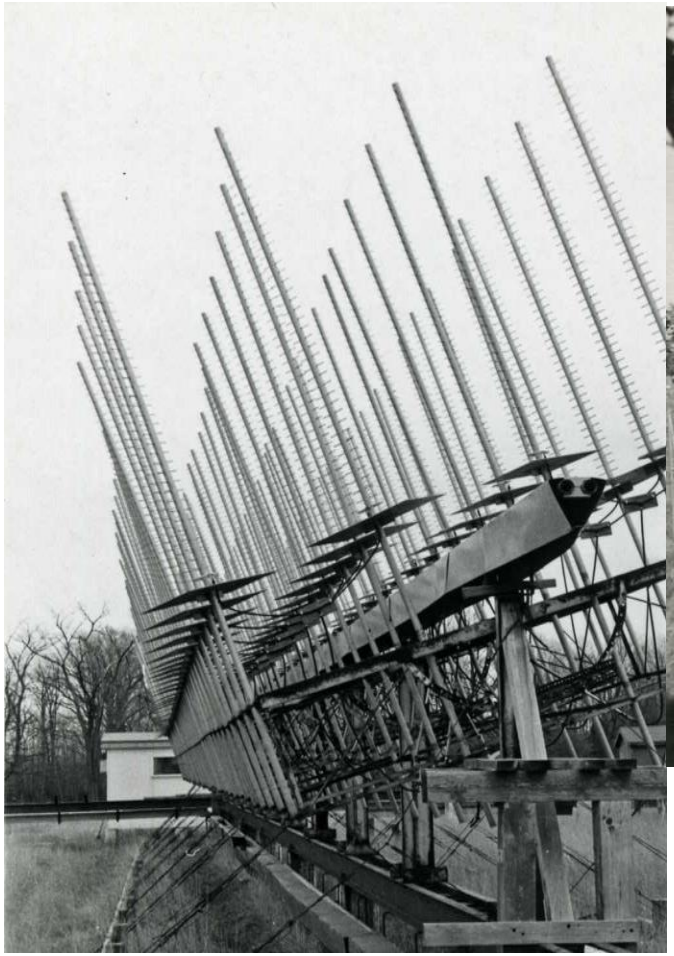
Jodrell Hut 1945

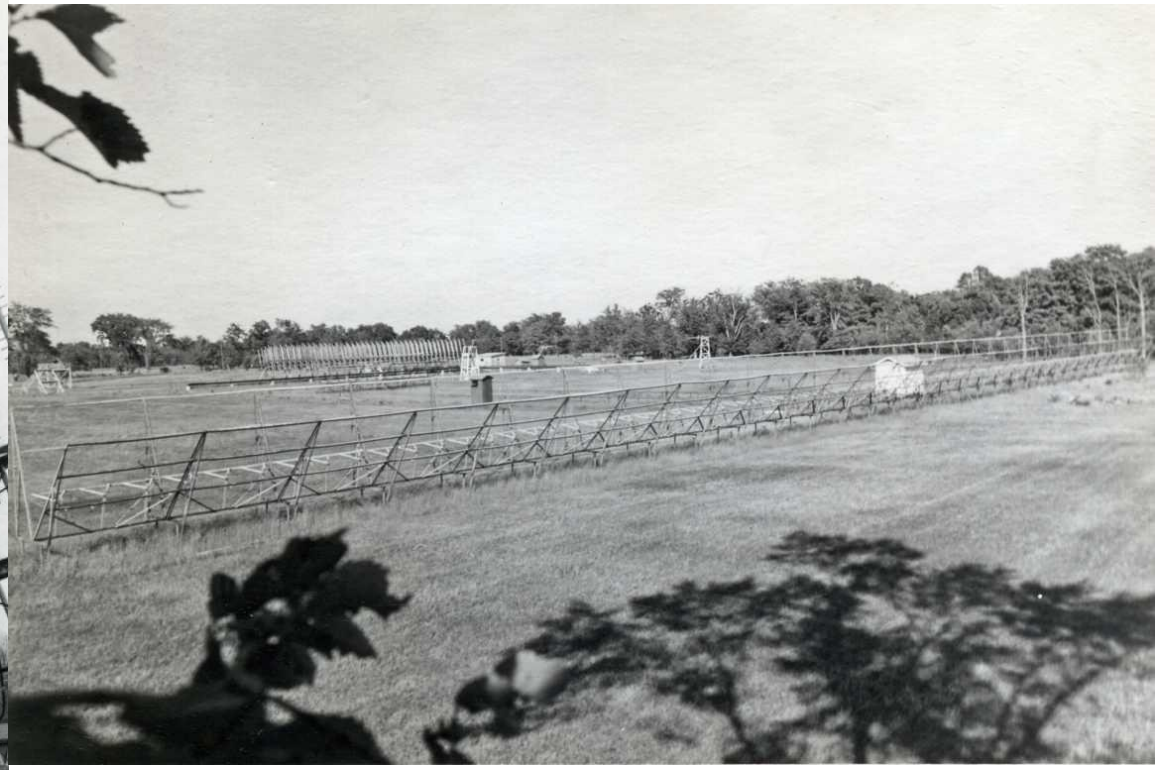
- First Jodrell Bank telescope
- Completed 1957
- 250’ diameter

NRAO 300’ dish

Began service October 1962
Originally designed as an interim facility, used until it collapsed in 1988

Radio Astronomy at Queen's mid 60s



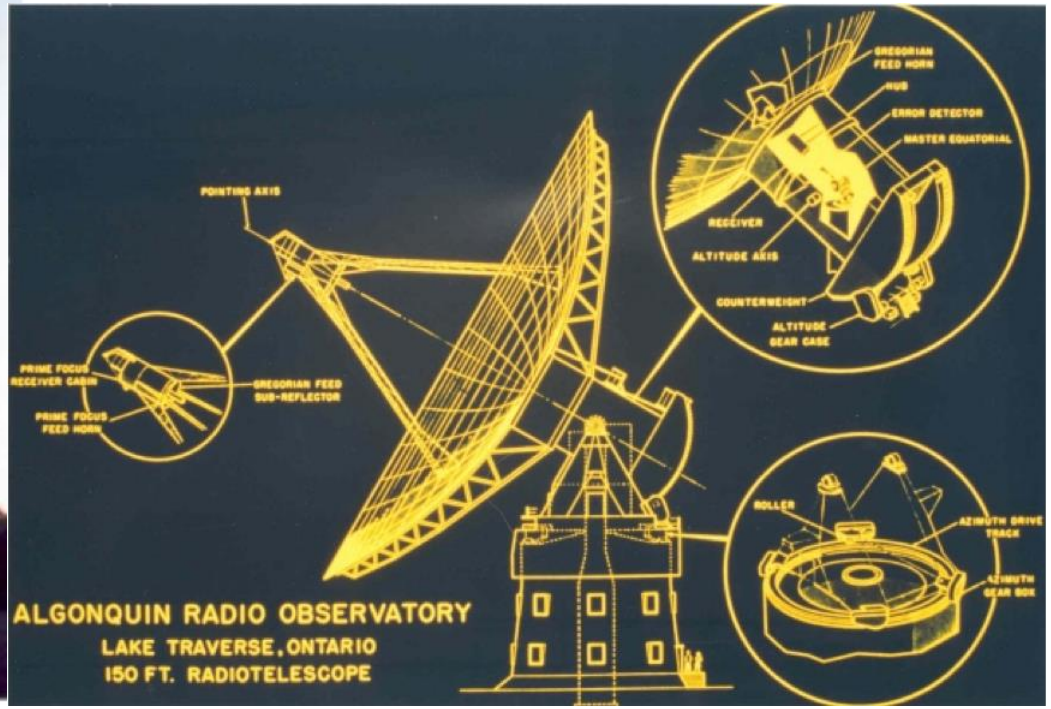


All that remains (with those who built it)

Observing at ARO 1967

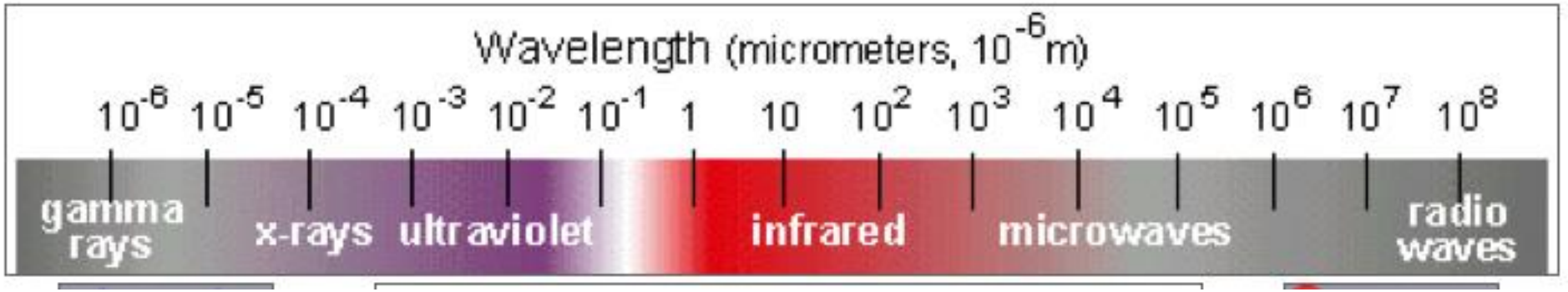
Algonquin Radio Observatory

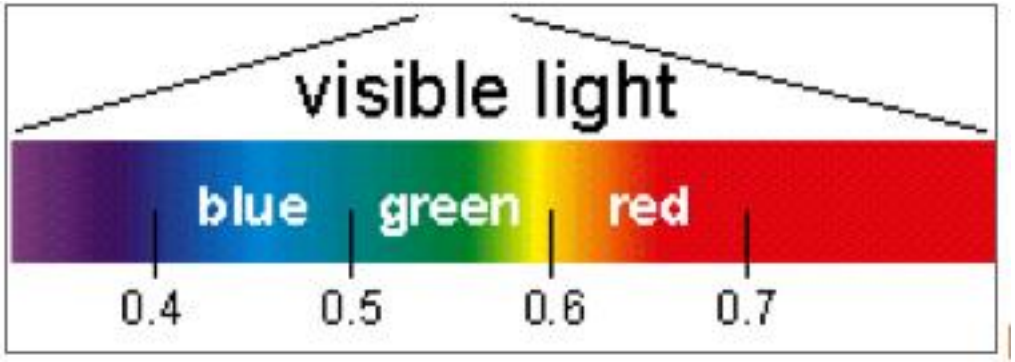
150’ Paraboloid
Operating Frequencies 2.8-10GHz
Commissioned in 1965
Present receivers at X and S band,
closed cycle helium cooling (sys temp~55-60K)



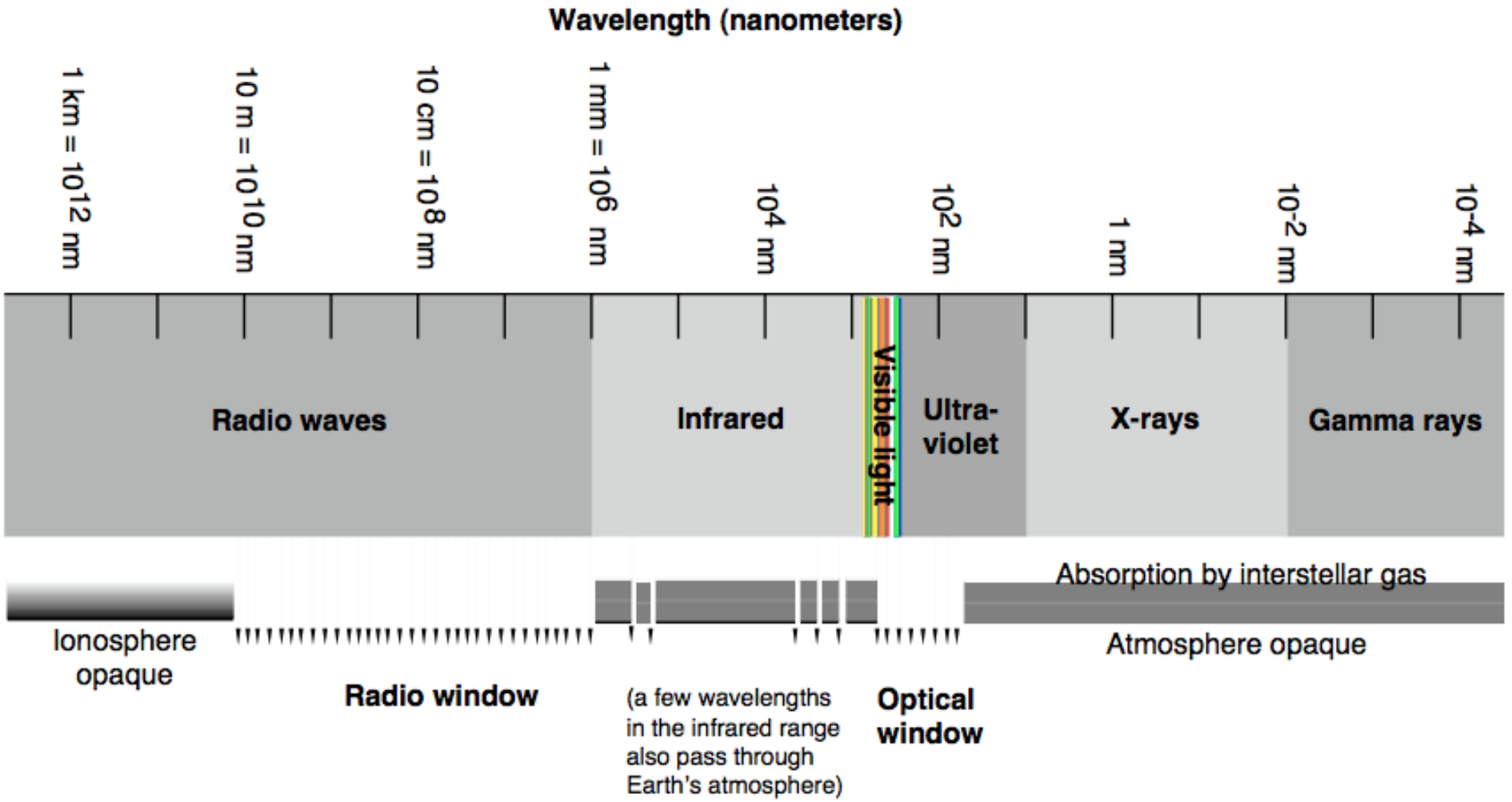
ARO from Operator's console

Why **Radio** Astronomy?





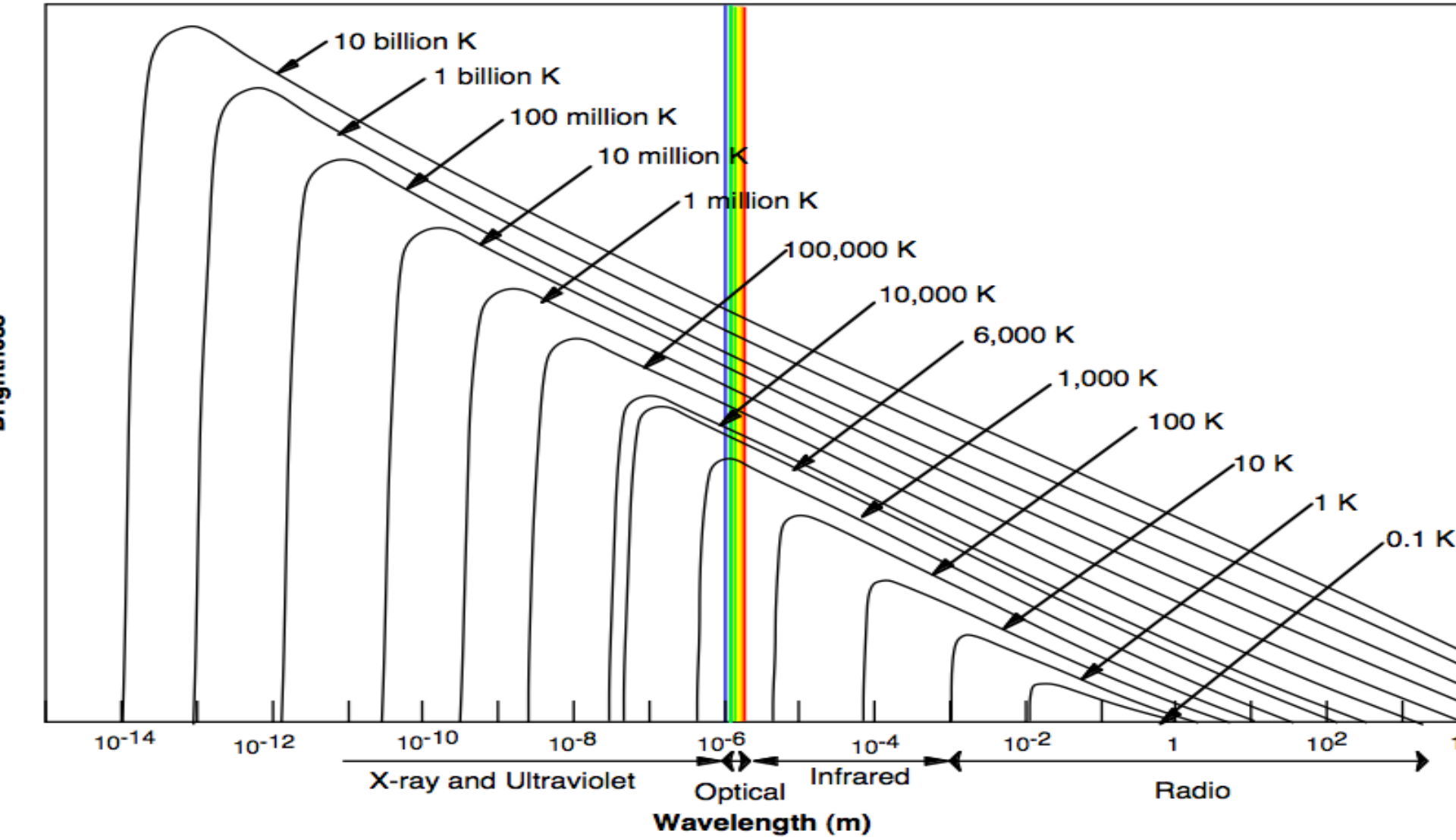
Atmospheric Windows to Electromagnetic Radiation



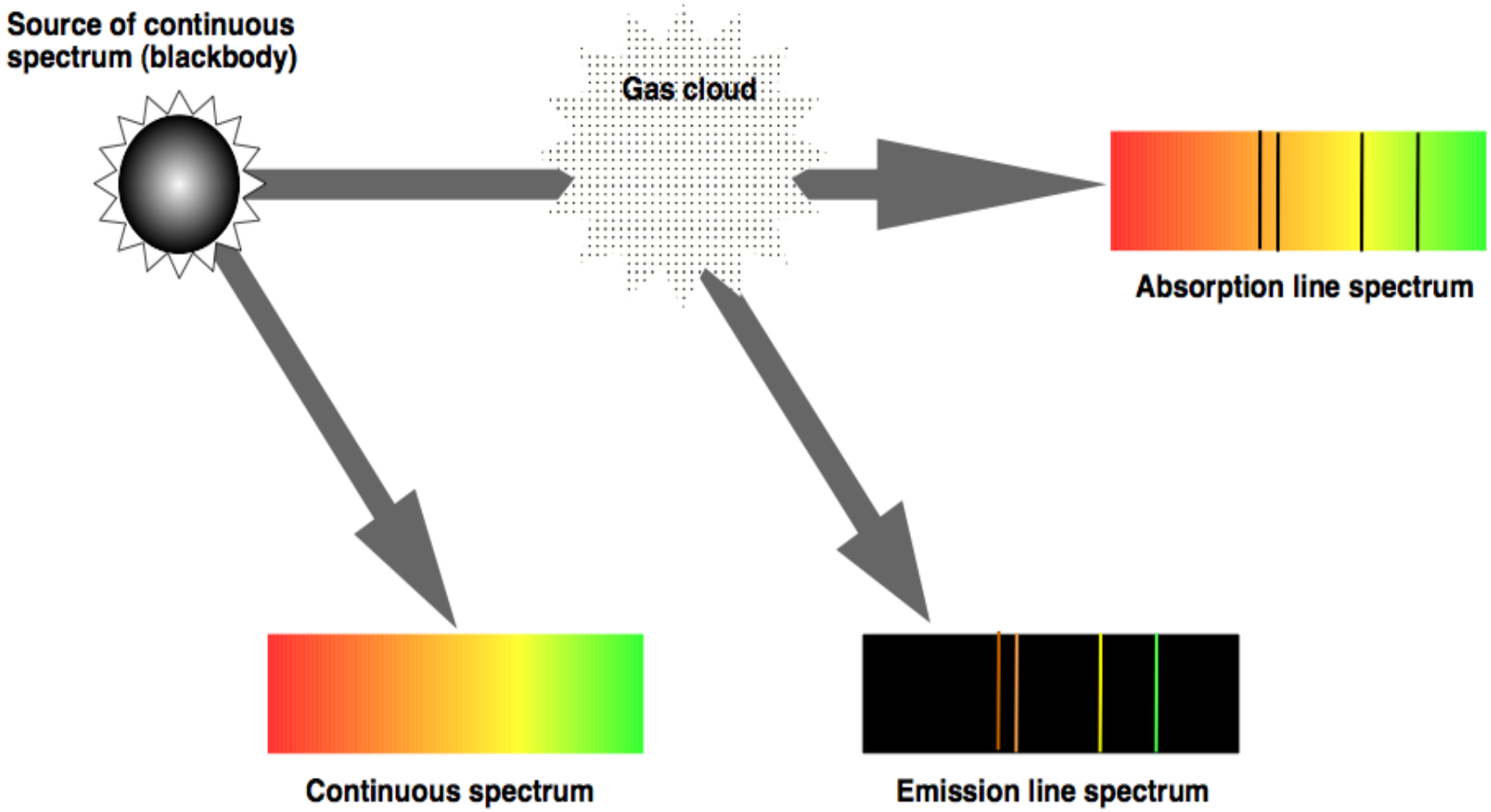
Radiation Mechanisms

- Thermal (intensity depends on temperature)
  - Blackbody
  - Bremstrahlung (thermal from plasma)
  - Emission lines
- Non thermal (other factors – magnetic field strength, electron velocity…)
  - Synchrotron
  - Stimulated emission (Masers)
  - Pulsars

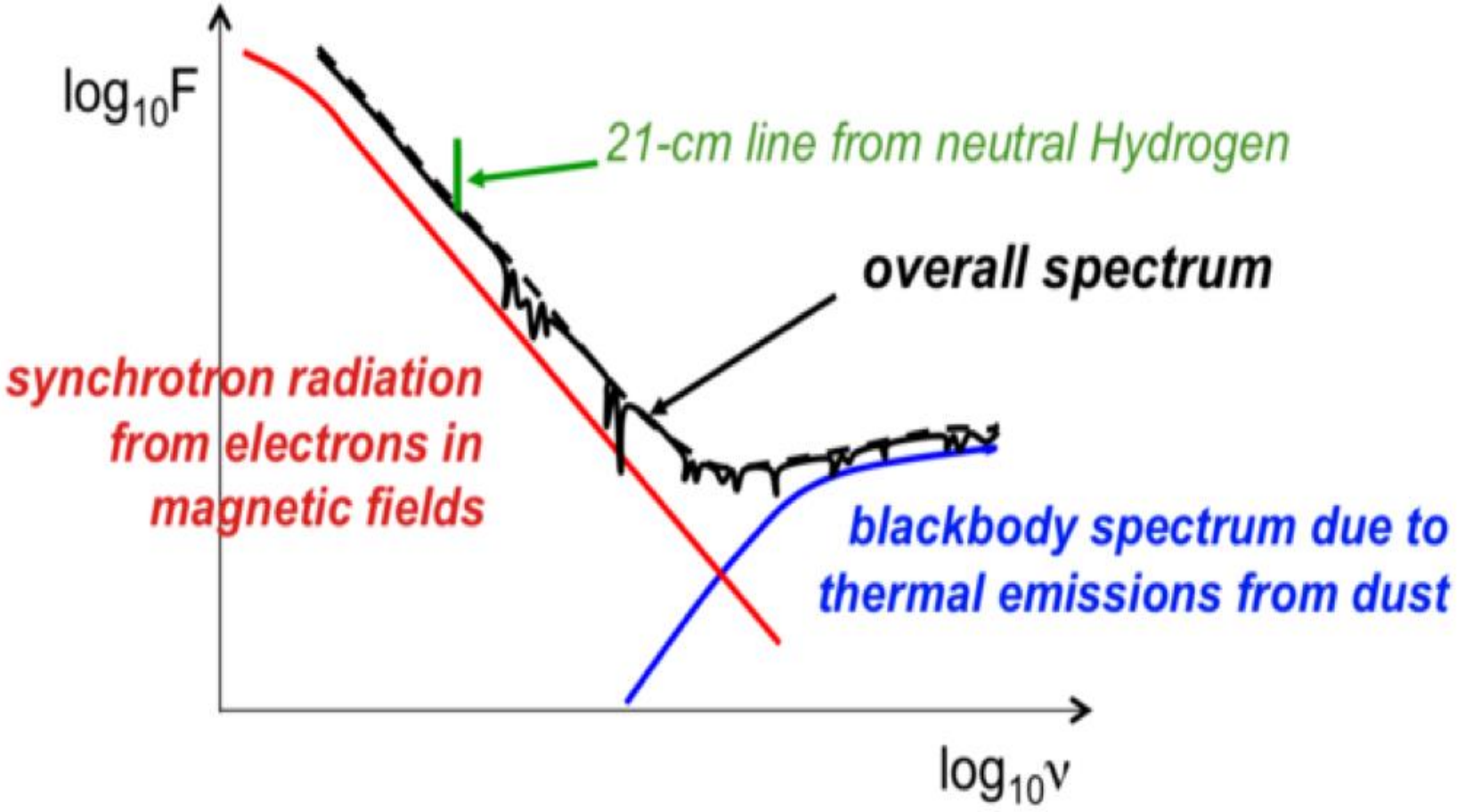
Blackbody Radiation



Factors affecting received spectrum



Typical Galaxy Spectrum



The Sun at 20cm (1.4GHZ)

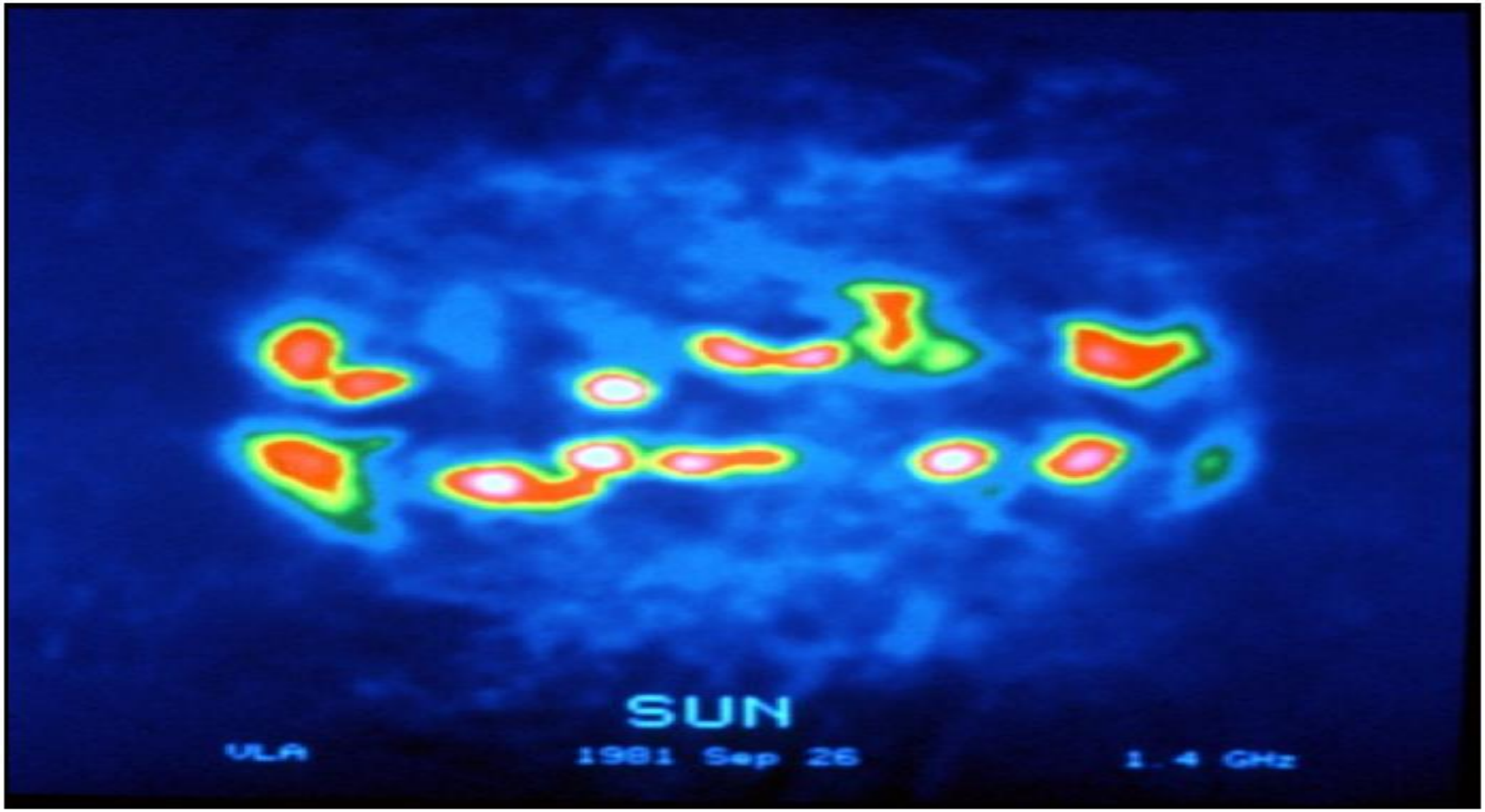


Image courtesy of NRAO/AUI

27 antennas maximum separation 1km gathering data for 10 hours
each antenna – 25m (82’) parabolic dish weighing 230 tons

NRAO Very Large Array (VLA)

Amateur Radio Astronomy

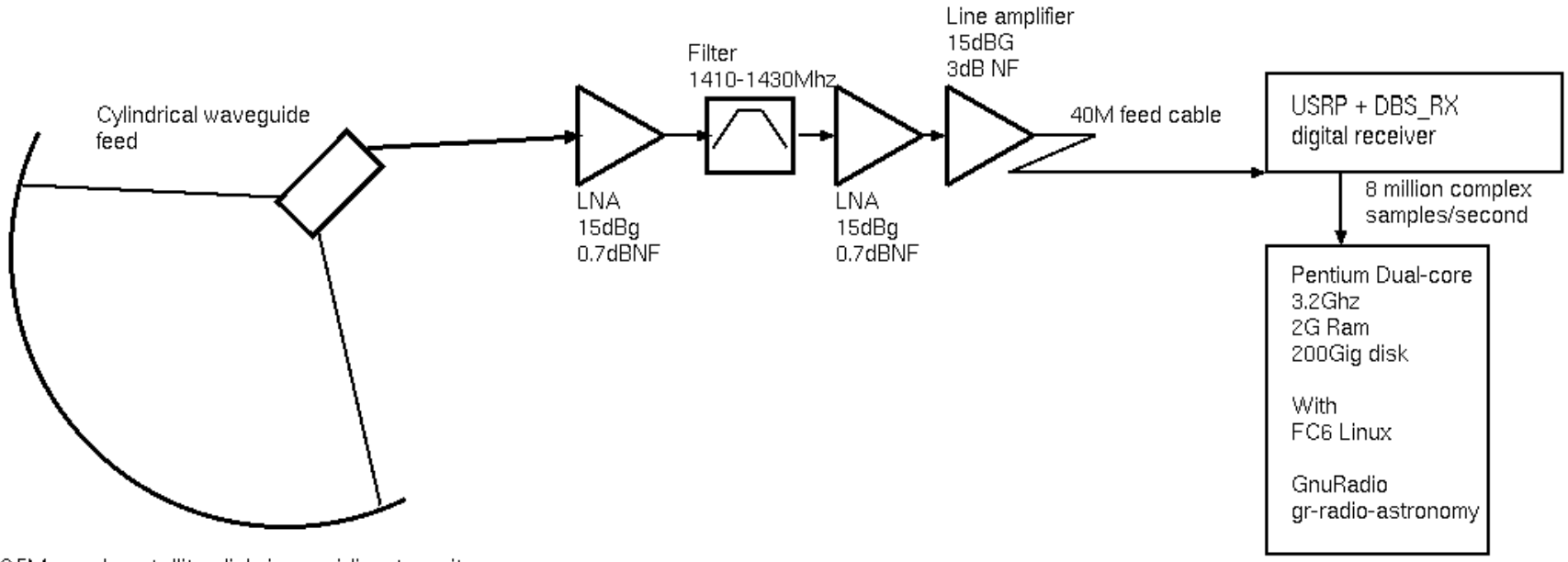
- Society of Amateur radio Astronomers
  - http://www.radio-astronomy.org/
  - Annual conferences
  - Booth at Dayton Hamfest
- Other Information / equipment sources
  - http://www.radiosky.com/

Amateur Radio Astronomy Projects

- Study Jupiter's noise storms.
- Record flares and predict geomagnetic activity.
- Detect a pulsar using DSP (digital signal processing).
- Detect stronger radio sources.
- Look for HEPs (high energy pulses} from the galactic center.
- Search for radio correlations to gamma ray bursts.
- Study ionospheric scintillation and refraction.
- Detect meteors invisible to the eye.
- Develop a long base line interferometer.

An Amaeur Radio Telescope: Marcus Leech VE3MDL

Electronics for radio telescope



3.85M mesh satellite dish in meridian-transit configuration. Declination range: -30 to +70Deg

Shirley's Bay Radio Astronomy Consortium

- 18M dish at Shirleys Bay
  - Needs lots of work
- SBRAC consortium formed to renovate/operate for amateur RA and SETI
- Was used in Alouette, ISIS, and early Anik program
- Dish surface in good shape
- Mechanicals unknown
- Still in early stages of getting approval

SBRAC needs:

- People to help out
  - Mechanical and power systems
  - RF/Microwave people
  - Antenna “monkeys”
  - Funding coordination/creation of not-for-profit
  - General labour (painting, antenna maint, etc)

For more info:

http://www.sbrac.org/

Thank You