How to build a homemade radio telescope

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What is radio astronomy?

Radio astronomy is a major branch of astronomy that studies celestial objects at radio frequencies (3 kHz- 300 GHz) [1].

It is needed to get a full picture of distant objects. [2]

Radio telescopes are the instruments used to receive radio waves. [2]

Credit: Bettymaya Foott, NRAO/AUI/NSF

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Credit: Bettymaya Foott, NRAO/AUI/NSF

1. What are EM waves? [3]

Composed by oscillating electric and magnetic field, perpendicular to each other and time varying.

Produced by accelerating charged particles.

Travel at speed of light.

Non mechanical, transverse waves

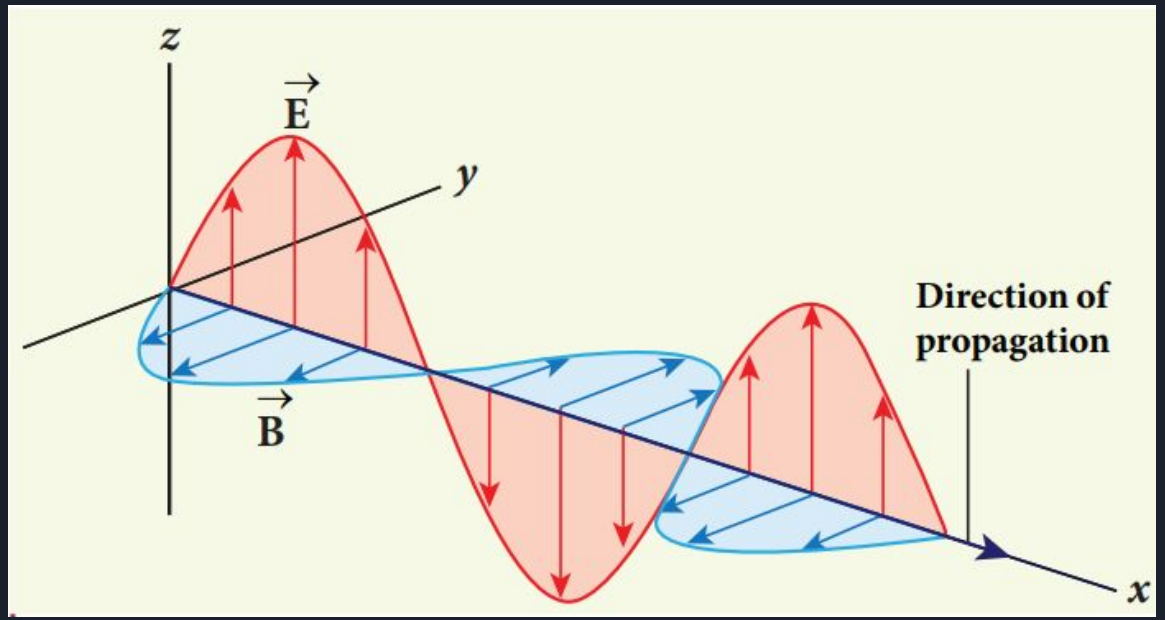
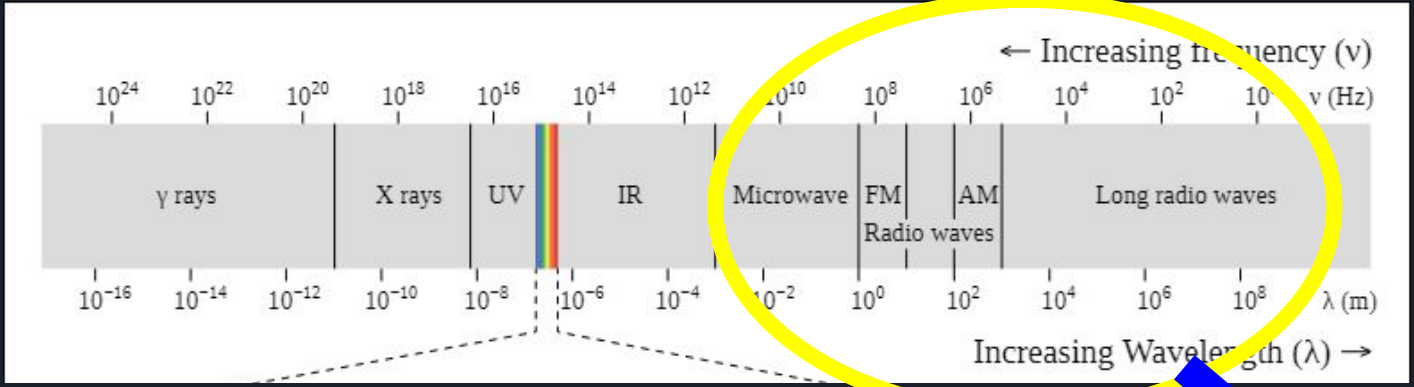


Figure 1. EM wave

Credit: extracted from [3]

1. EM Spectrum

Orderly distribution of electromagnetic waves in terms of wavelength and frequency [3]



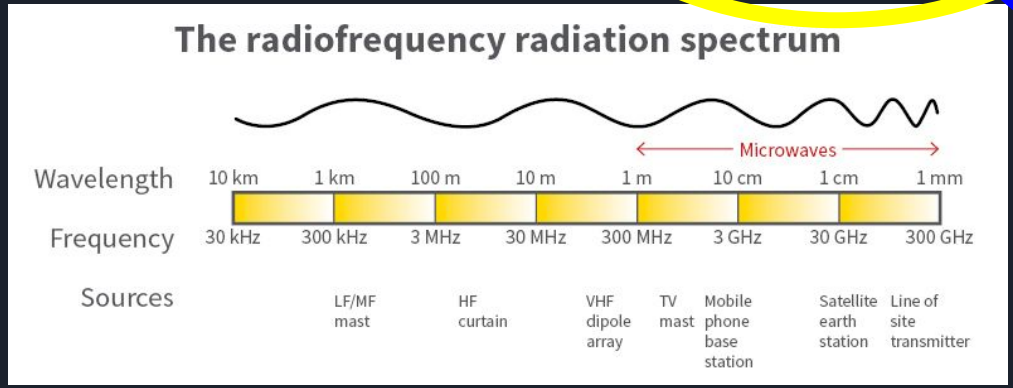


Figure 2.
EM (up) and radiofrequency (down) spectrum.

Credit to: Philip Ronan and ARPANSA

2. Materials

Figure 3. Radio Telescope assembled
Credit: myself

Mandatory

1. Parabolic antenna
2. LNB
3. Satellite finder
4. Battery
5. Coaxial cable and connectors

Recommended

1. Lighter/wire stripper
2. Stick
3. Base support

2. Materials- Parabolic antenna [4]

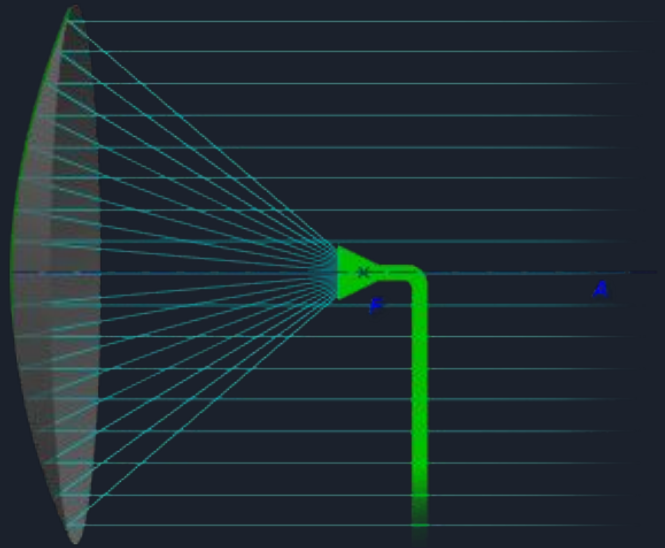


Figure 4. Principle of parabolic antennas.

Credit to: radartutorial

Parallel radio waves that incide are reflected and they all pass through a particular point - the focus.

These type of parabolic antennas are called primary antennas.

The LNB can cast a shadow over the dish

2. Materials- Parabolic antenna

Figure 5. Dish used.

Credit: myself again

Offset antennas are used to receive more signal. [4]

Dish has oval shape thus displacing the focus . [4]

Nonetheless, other type of antennas do exist (Cassegrain), where radio waves are reflected back to the middle of the dish and detected behind it. [1]

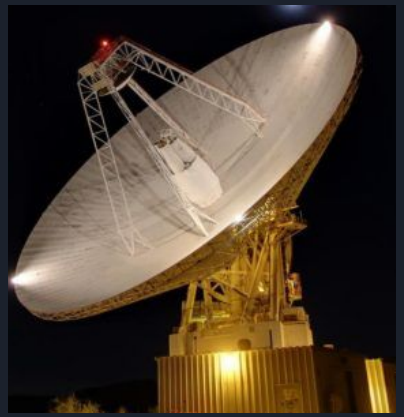


Figure 6. Cassegrain antena.

Credit to: NASA (public domain)

2. Materials - LNB

Figure 7. LNB used.
Credit: myself once more

The Low Noise Block downconverter (LNB) receives the EM radiation, amplifies it and reduces the frequency of the signal received (downconversion). [5]

Thanks to this process, the signal received can be carried with relatively cheap coaxial cable. [5]

Will only detect some frequencies. [6]

2. Materials - Satellite finder [7]

Figure 8. Satellite finder used

Credit: myself flipped

Tells how strong the signal received by the LNB is.

If a display is presented it is possible to measure the strength of the signal.

However measurement will only be comparative and will lack precision.

2. Materials - Battery

Figure 9. Battery holder used

Credit: myself once more
once more

-Needed for closing the electric circuit.

- Voltage and type of current needed depending on the Satellite tracker acquired. [7]

-Battery holders are advised.

2. Where can you find the materials?

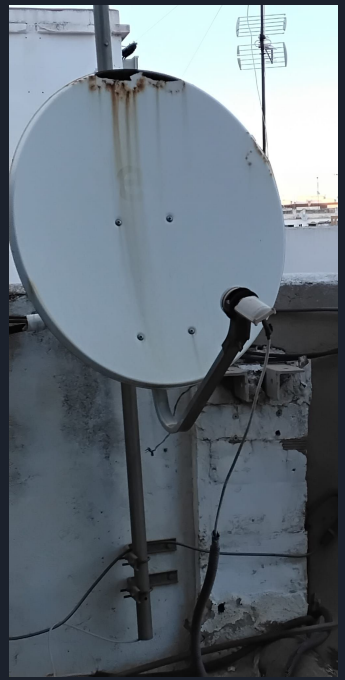


Figure 10. Possible providers of antennas and LNBs

Credit: myself

2. Where can you find the materials?

Figure 11. Possible providers of sat. finder and batteries

Credit: myself

2. Where can you find the materials?

Figure 12. Local shop where you may find the materials needed.

Credit to: Dassenman

3. Assembly [8]

Figure 13. Connections and dish mounted.

Credit to: Octavio M.

1. Mount the dish and lnb following the instructions which came with the antenna.

2. Attach the connectors to the coaxial cable.

3. Connect the LNB to the Satellite finder using the coaxial cable with its connectors.

3. Assembly [8]

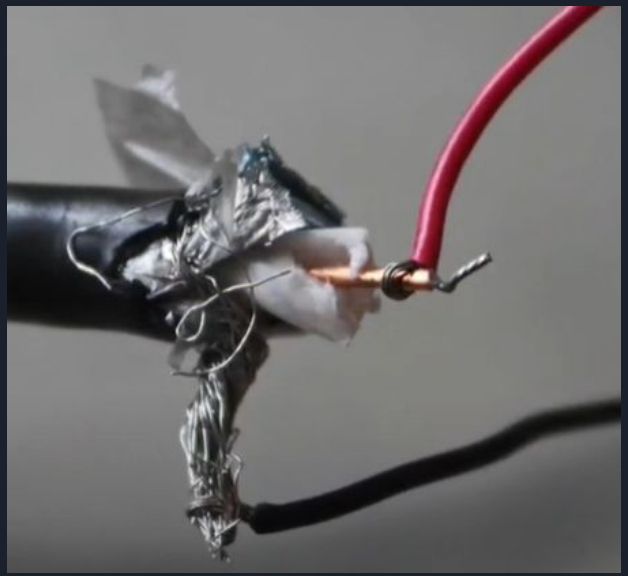


Figure 14. Connection of the battery.

Credit to: Physics peer

4. Cut the coaxial cable.

5. Connect the core of the coaxial cable to the battery's positive terminal and the copper shield to the negative.

4. Possible experiments

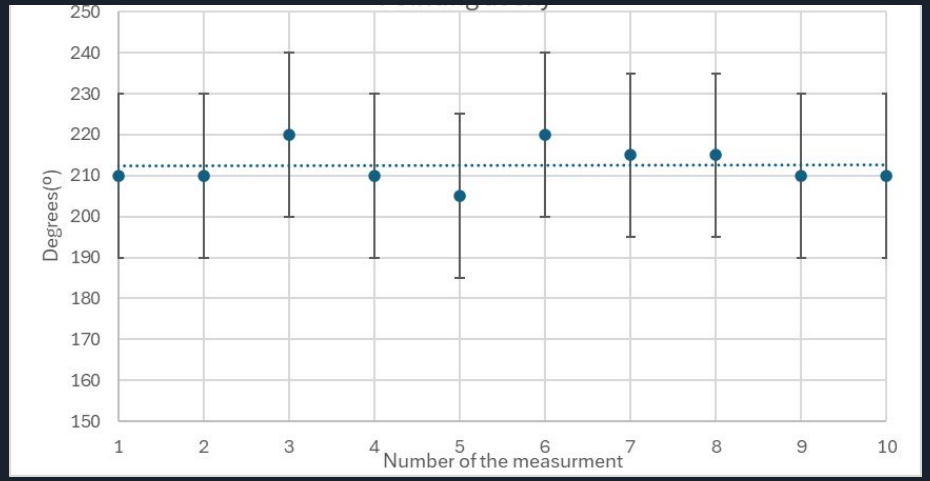
There are some possible experiments and measurements that can be done with this very basic radio telescope. Some of them are:

-Detection of solar EM waves.

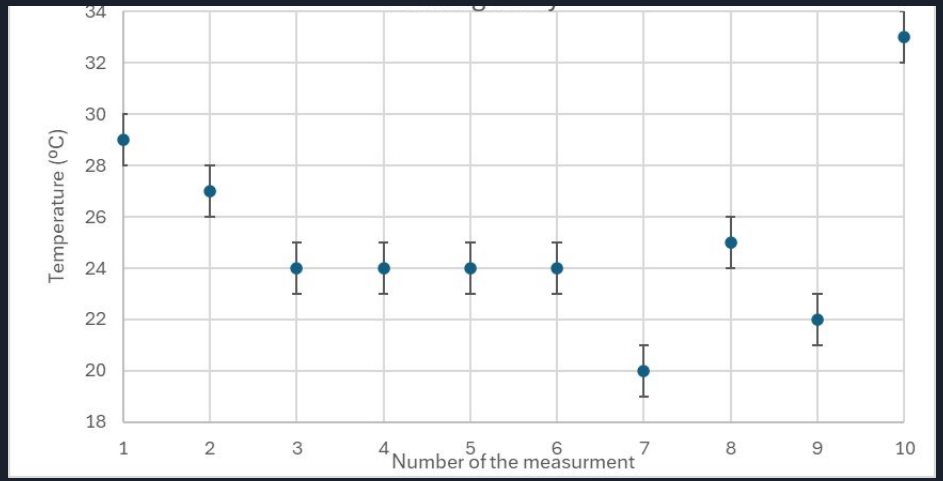
-Measurement of the background radiation.

-Emission and reflection of EM waves.

4. Possible experiments - Measurement of the background radiation



Graphic 1. Degrees measured while pointing at sky



Graphic 2. Temperature recorded for each measurement.

4. Possible experiments - Measurement of the background radiation

-Signal remained approximately constant, independently of temperature and climate variation.

-It is possible that it slightly changed with weather, as shorter radio wavelengths waves can be absorbed by water in the clouds. [1]

Figure 15. Responsable clouds.
Credit: myself

Conclusions: Worth it?

Pros:

-Cheap

-Materials are easy to find

-Easy assembly

Drawbacks:

-Not very precise

-Only some frequencies can be detected

-Background radiation

It really depends on what you are looking for

Bibliography

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