How to Make a Radio Telescope From Household Materials

by nschreiber0813

So a while ago I was having a huge problem with my astronomy setup. It wasn't very practical to use it during the day for the only thing you can really look at during the day is the sun but my solar filter wasn't allowing me to see the details I would have liked to have seen.

A radio telescope would have given me the ability to see things during the day and even when there are clouds in the sky but what is a radio telescope? Optical telescopes use light to observe far away objects where radio telescopes use things of a greater wavelength than light typically. Like radio waves and microwaves.

Radio waves are everywhere even in the known universe. Not only that due to the fact radio waves have a much greater wavelength than light they can often times travel right through objects with very little issues. Of course they can't do this all the time because eventually they will get blocked by something but they are much better about this than light is.

The frequency this telescope will be picking up is 1420 megahertz. That is the exact frequency that hydrogen is known to emit. Due to the fact there is 1 electron and 1 proton in a hydrogen atom when the electron comes closer to the proton or farther away it emits a very specific frequency of 1420 megahertz. You don't really need to understand this a whole lot because I most certainly don't but this should give you a general idea if curious .

Pros to radio telescopes over optical

1. They can be used during the day and night no matter the weather conditions for the most part.
2. They can see things that are not visible with light such as hydrogen in space.
3. They don't need light to see things so they can see things that are in deep space not near any stars.
4. Hydrogen is the building blocks of life and stars so being able to know where hydrogen is in the known universe is important.

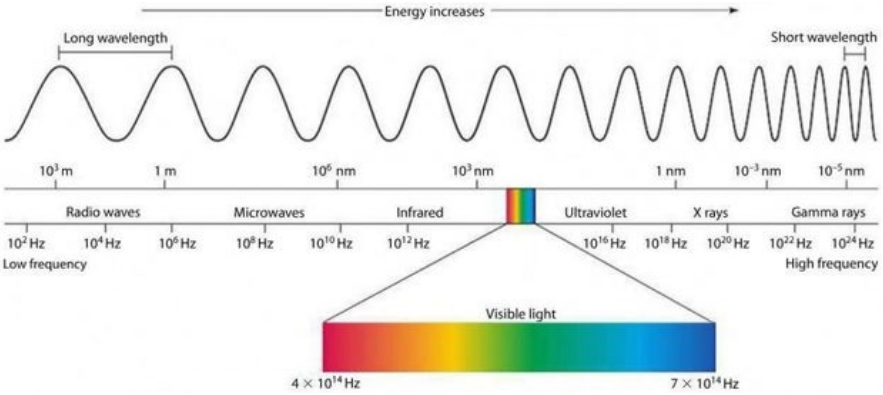
Cons to radio telescopes over optical

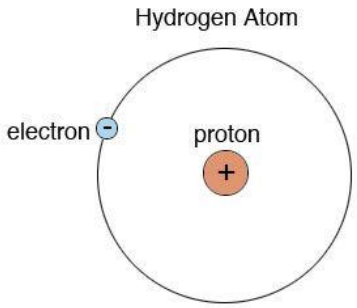
1. No pictures of space due to the fact these telescope just hear radio waves but don't actual see them or take pictures of any sort.
2. This type of antenna for the telescope we are going to make today is very oddly shaped and rather difficult to aim for the most part at objects.
3. It can be difficult to understand what you are observing since you are listening to sounds and spectral lines versus taking pictures or looking through an eyepiece with an optical telescope.

Supplies:

1. 4 * sheets of dollar tree foam board.
2. 1 * 18650 battery cell holder and one 18650 battery.

3. 1 * power switch
4. 1 * box of tin foil
5. 1 * roll of packing tape or thick blue tape
6. A lot of hot glue sticks
7. Hot glue gun
8. A utility knife
9. 1 * LNA amplifier
10. 1 * SDR dongle
11. 1 * 1/4 inch insert nut
12. 1 * small piece of wood
13. 2 * soda cans
14. A ton of sma cables. Some large some small.

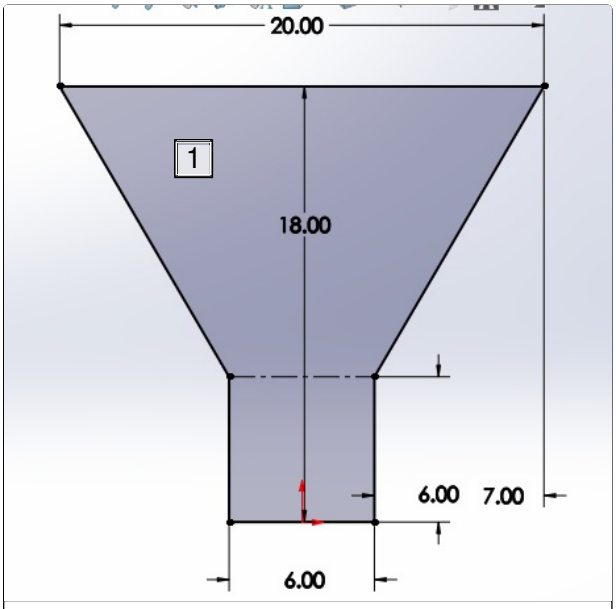




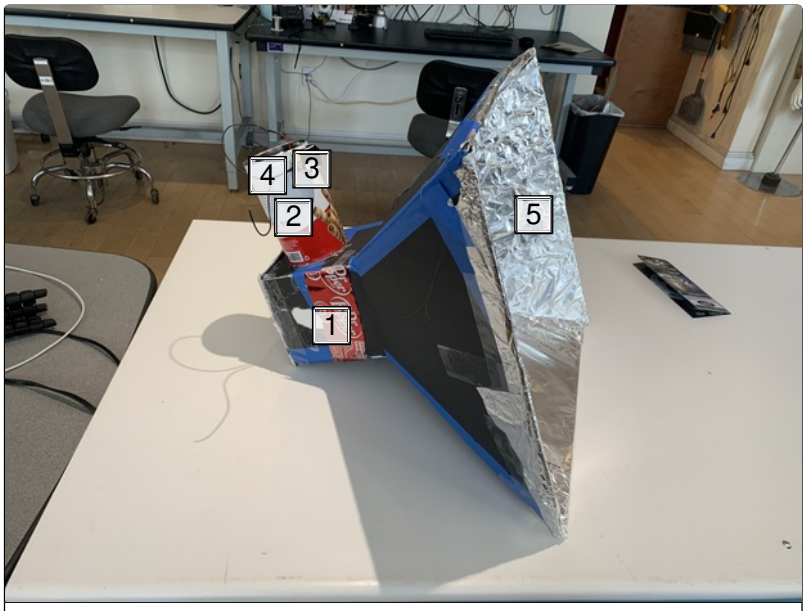
Step 1: Making of the Horn

1. To make the horn you are first to cut out of dollar tree foam board the horn sides 4 times. The dimensions of what you need to cut is listed in one of the images above.
2. You are then going to score the dotted line shown in the first image. You don't want to go very deep. Just deep enough you cut only the paper. Then you are going to fold where you just scored and the foam should form something like a hinge that is attached to the paper on the other side of the foam board you were scoring.
3. Then you are to tape the foam board together until you get something that looks similar to the second image.

4. You are then to cut a 6" square from one of the sheets of foam board.
5. Next you are going to hot glue the 6 inch square to the back of the horn.
6. After that you are going to hot glue the rest of the horn to make it stronger and more rigid against the other pieces of foam board that are taped together. After all they shouldn't just be taped together they need something stronger.
7. Lastly you are to tape tinfoil down to the inners of the horn. It's okay if there is a little bit of tin foil wrapped around the edges of the horn. Make sure the tinfoil overlaps each other so that the tin foil are all connected to one another electrically. You will find more of this out in the next step.



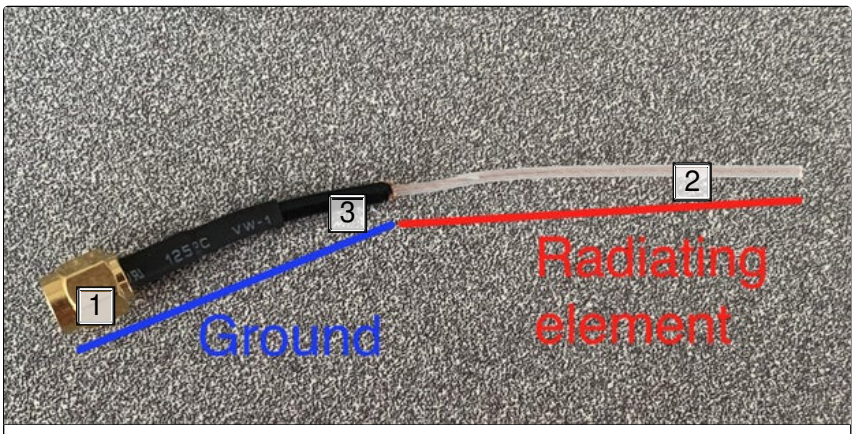
1. This is what you are going to cut out of foam board. Dimensions are in inches.



1. RF shield from soda can.
2. Another improvised rf shield
3. PSU switch.
4. 18650 battery cell inside this can.
5. Tin foil.

Step 2: Finishing Up the Horn Antenna!

1. Grab a sma cable and cut it at the 100mm mark.
2. From the tip of the cable you just cut mark 52.5mm.
3. Strip the wire from that mark and cut of the coax shielding that is surrounding that radiating element.
4. Drill a 6mm or 1/4" hole into the back compartment of the horn as shown in the second image above.
5. Glue the outside of the sma connector and shove it in so that radiating element is inside the horn.
6. Grab a square inch of tin foil and wrap it around the grounding element and tape it so that it is touching sma connector and is directly touching the tinfoil around it.
7. To test and make sure you did a good job with this step grab a multimeter and measure the electrical resistance between the outside of the sma connector and the tip of the horn. If you are able to measure a resistance you succeeded in making the horn.



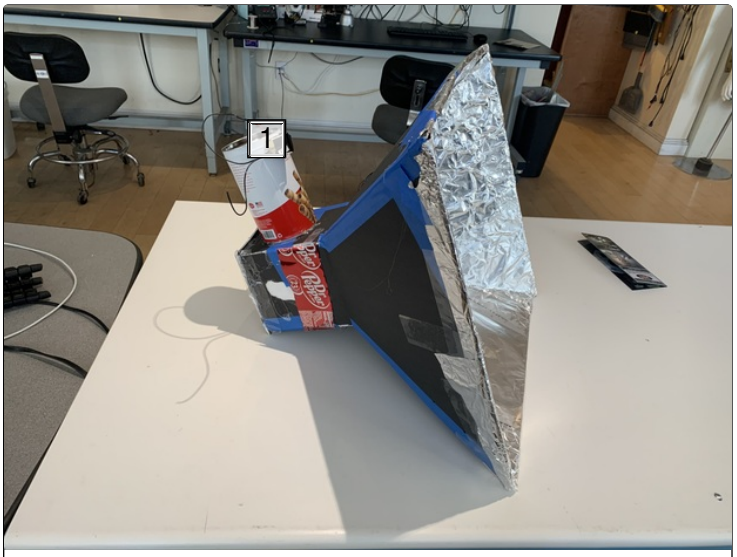
1. SMA connector male.
2. Plastic shielding with radiating element.
3. Ground wire.

1. Antenna you will make is located right here.

Step 3: RF Shielding and Electronics

There are several electronic pieces that will be used for this telescope. There is the LNA amp which amplifies the signal so you can read it from the sky. There's the battery and power switch for powering the LNA. And lastly there is the antenna from the previous step that actually receives the signal. These devices are all capable of causing noise inside the antenna so we are going to need to shield them so there is no interference inside the antenna.

1. Cut the top and bottom off of two soda cans so that you are stuck with a wide strip of aluminum sheet metal. A utility knife works best with this.
2. Glue down the aluminum sheet metal to one of the adjacent sides to the side with the antenna poking through it and then the opposite side of the antenna. (FYI I did not glue the sheet metal to the opposite side of the can for I literally used a steel can instead to hold the battery and the psu switch. You can do either. Both will work fine.)
3. Then solder 18650 cell holder to the switch that will be flicked on and off with the antenna. Then solder ground to ground on the LNA amp. Then solder power to the on and off switch so you can flick the switch to turn it on or off.
4. Glue the LNA amp to one of the pieces of foam board and cut it to roughly the size of it. Then glue that foam board piece to one of the sheets of aluminum.
5. Glue the rest of the electronics to one of the sheets of aluminum.
6. Connect a sma cable to the input of the LNA. The other connector on the sma cable is the output to your SDR dongle.



1. Battery goes inside and psu switch goes outside. Or just glue them both down to a soda can sheet metal. Either works best.

Step 4: Adapting It to a Tripod

I figured out an easy way to mount this to a regular camera tripod. To mount it you must do the following.

1. Grab a small scrap piece of wood and a 1/4 inch rivet and drill a small slightly smaller than the rivet.
2. Then use an Allen key and screw in the rivet into the wood.
3. Hot glue the piece of wood to the back of the telescope.

Step 5: Installing GNU Radio and Ubuntu

SDR is short for Software Defined Radio. It interfaces your radio to your PC. To use this telescope you need a SDR dongle for interfacing the telescope to your pc. In order to use your SDR you are going to need GNU radio to analyze what you are listenitng to. It is one of many software that interfaces your SDR dongle on your pc. You can learn how to download it here.

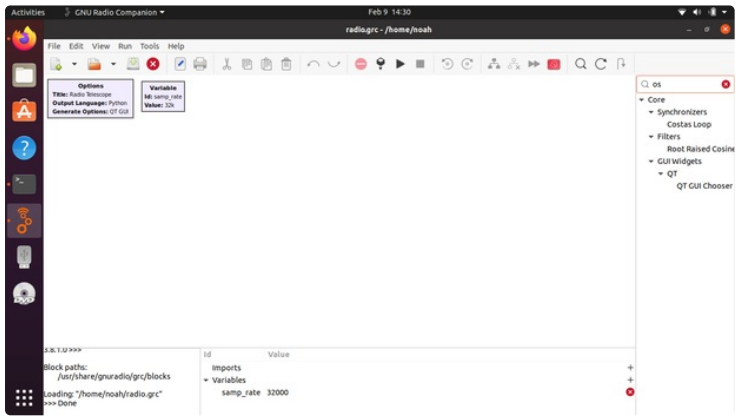
Ubuntu can be downloaded here.

https://ubuntu.com/download/desktop

Ubuntu can be installed with etcher onto a live usb.

https://www.balena.io/etcher/

https://wiki.gnuradio.org/index.php/UbuntuInstall



Step 6: in Conclusion

To be honest it is very difficult to tell how well this project went besides the fact that it clearly worked. I didn't want to go over GNU Radio due to the fact I am still a noob with it and there's a lot to it. GNU radio is really a tutorial in itself and that would make this instructable probably way too long. But at least it definitely worked. I managed to do a few tests on it and it was able to pick up 1420 mhz but I wasn't able to analyze it because I was unable to average my data along with a few other things.

This was a lot of fun building. You can use this horn even for things that aren't astronomy related. You could probably use it as a ham radio antenna for this would be perfect for it.

I hope you enjoyed this instructable! Feel free to comment or question below. Feedback is always important. Thanks!