Chart Testing on the night of 8/1/2022

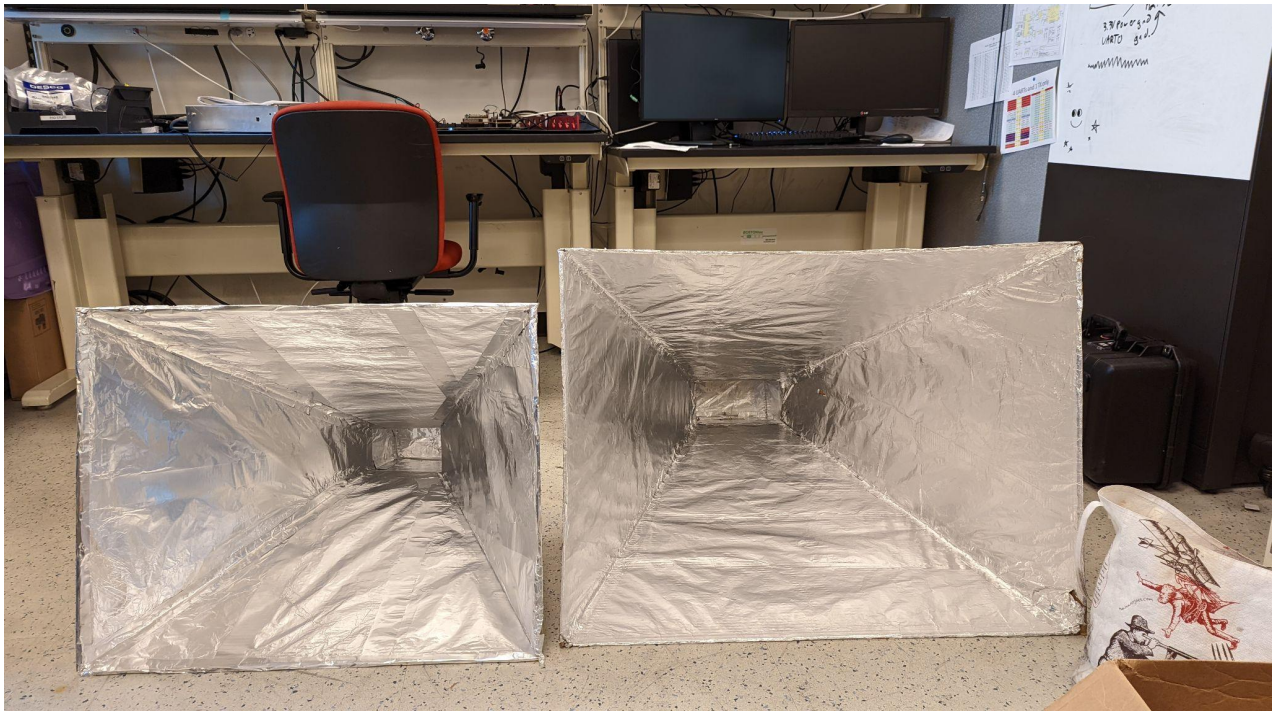
Location: Canyon Lake
Coordinates: 33.537740, -111.433172
Data taking time: 00:00-02:30
By: Arib Islam and Jonathan Davis

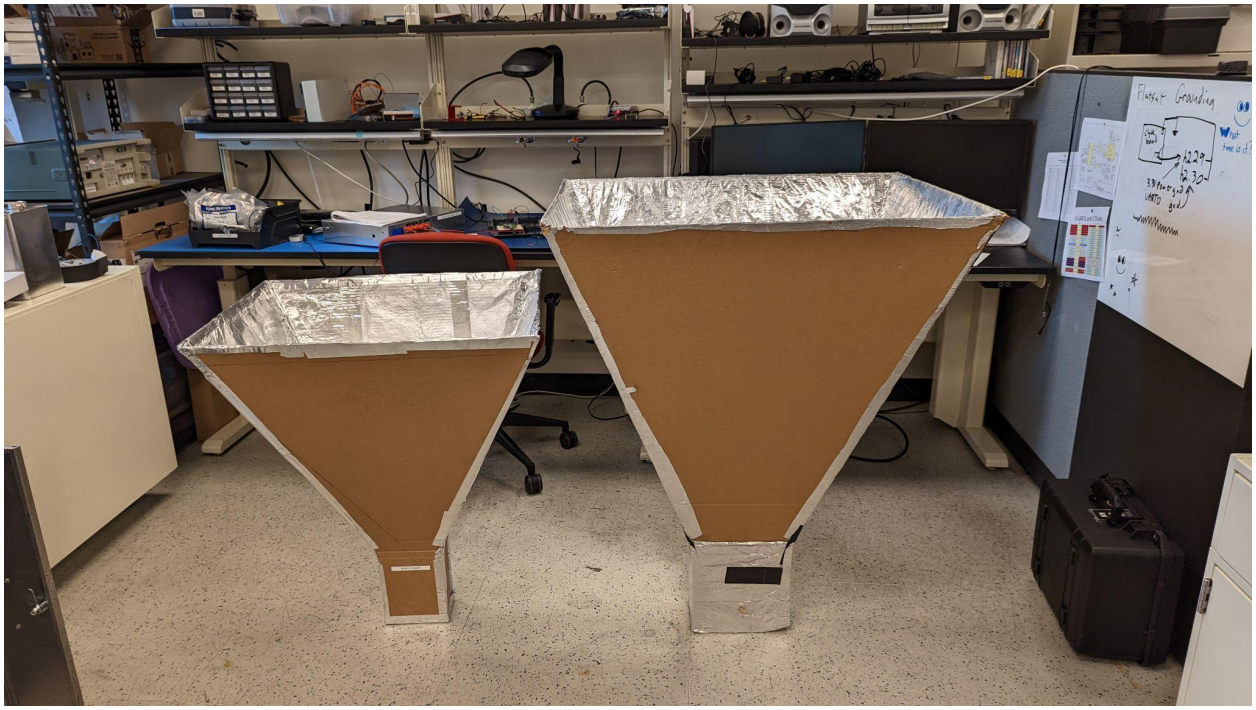
Introduction:

On August 2nd, 2022, Baby Chart and Chart were taken out to Canyon lake to see neutral hydrogen in the Milky Way galaxy. We looked to test the different sizes of horns. Testing the validity of data in a horn that uses fewer materials. The RTL-SDR was used in conjunction with the Nooelec sawbird+ H1 barebones filter.

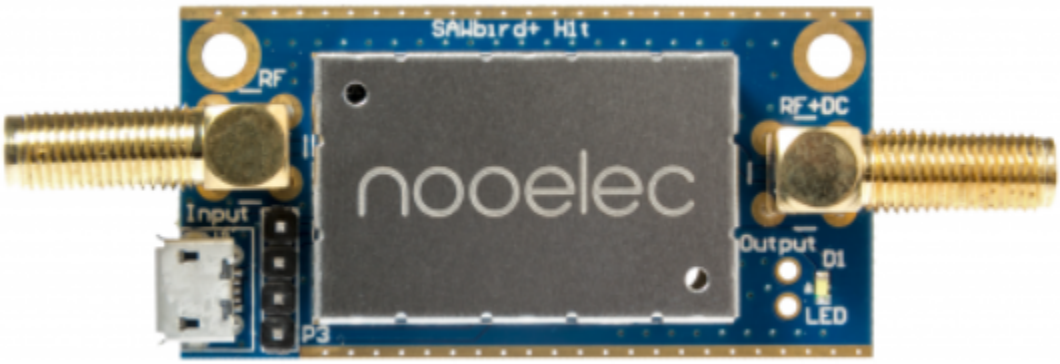
Hardware and Software:

Newly constructed smaller horn and previously built chart horn.





The RTL-SDR is the radio we used as per the Chart website. For the filter, the Nooelec sawbird+ H1 barebones was used. No amplifiers were used as the Nooelec has two built-in amplifiers and could be powered using the onboard bias-t of the RTL-SDR.



Data was collected using the installable package on the Chart Github Repository. The system was connected to a Raspberry Pi 3B running Raspberry Pi OS. A portable battery was able to power the system with no noticeable power issues. A compatible seven-inch screen was connected to the Pi to run the software and ensure everything was running properly. The system was housed in a wooden box to prevent interference from the system.

Data and Analysis:

The shape of the Nooelec filter was plotted using the Fieldfox

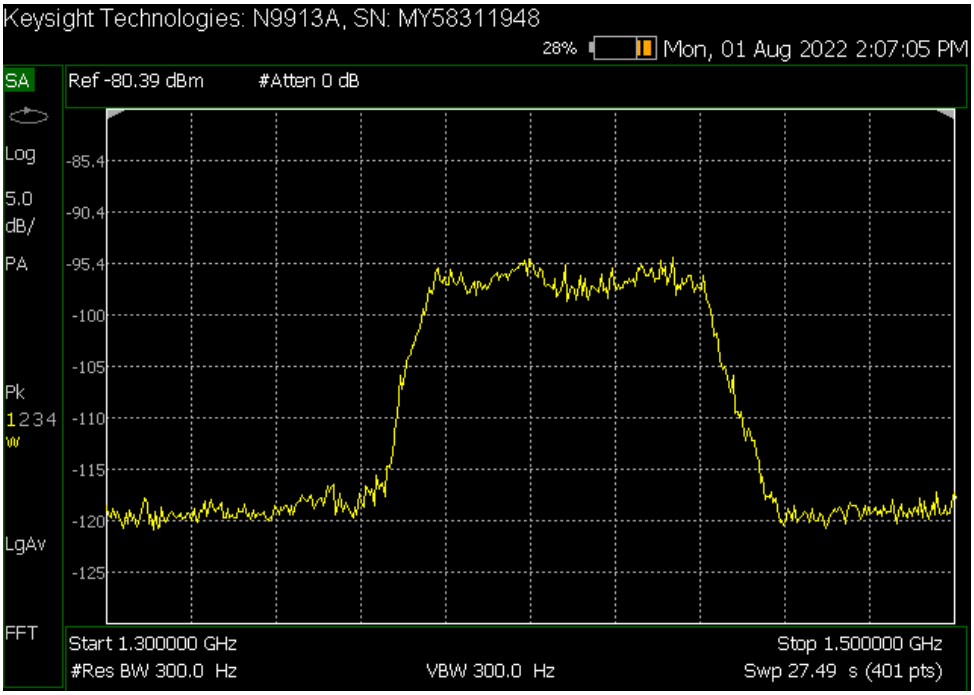


Figure 1: The plot gets to the highest intensity at around 1375 Mhz and starts dropping off around 1460 Mhz.

While out taking data, we came up with a formula to see how long each trial would take.(Thank you, Nivedita!)

(Number of Integrations * Integration time* (Final Frequency - Initial Frequency)) / 60 = Number of Minutes for each trial

Baby Chart: Unfortunately, there seems to be something wrong with Baby Chart. The check with the RF explorer in the lab went well, but any data taken in the field did not see anything. No matter how much the plot was zoomed into, the 1420 Mhz signal could not be seen.

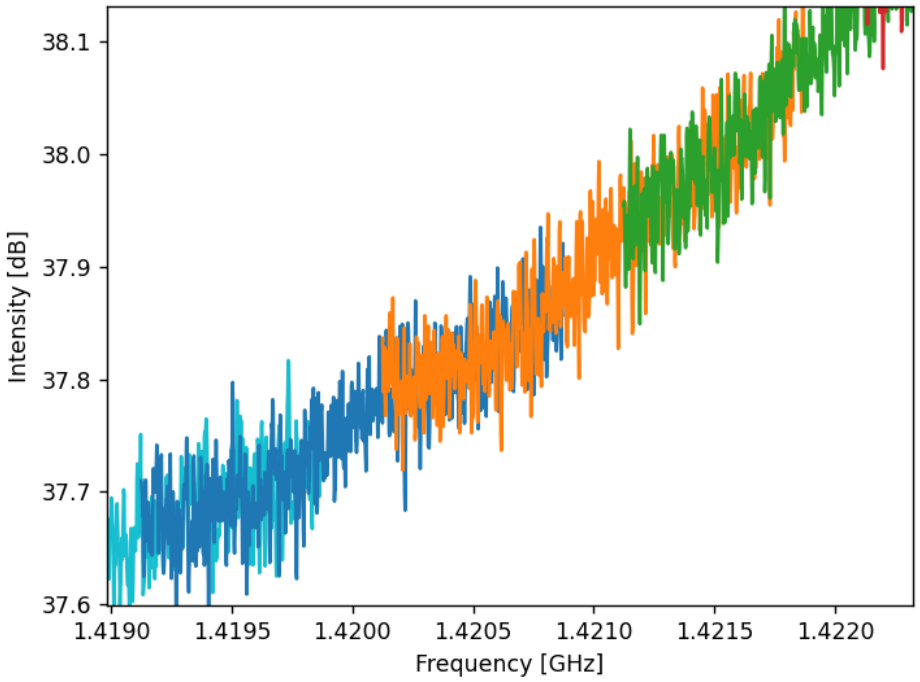


Figure 2

Chart: Using the normal chart yielded actual results. Three tests were run. One had the number of integrations set at 50. The other two had the same parameters. The parameters were:

- freq_i=1418 (Initial Frequency in Mhz)
- freq_f=1422 (Final Frequency in Mhz)
- nint=100 (Number of integrations) (50 for the first one)
- int_time=0.5 (integration time in seconds)
- biasT=True (Whether or not the onboard biasT on the RTL-SDR was active)

Everything else was set to default.

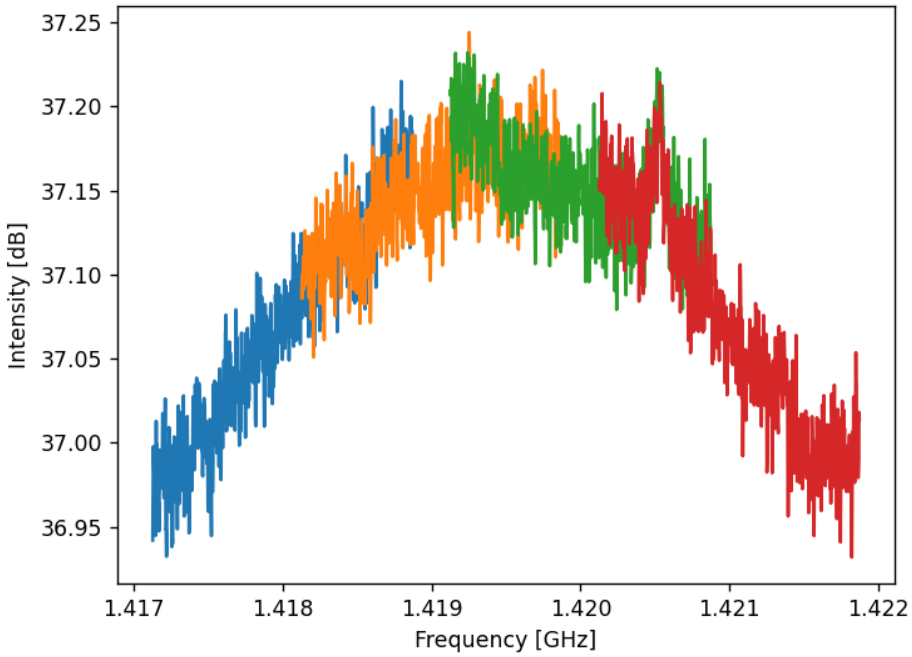


Figure 3: Chart was pointed straight up but with 50 integrations

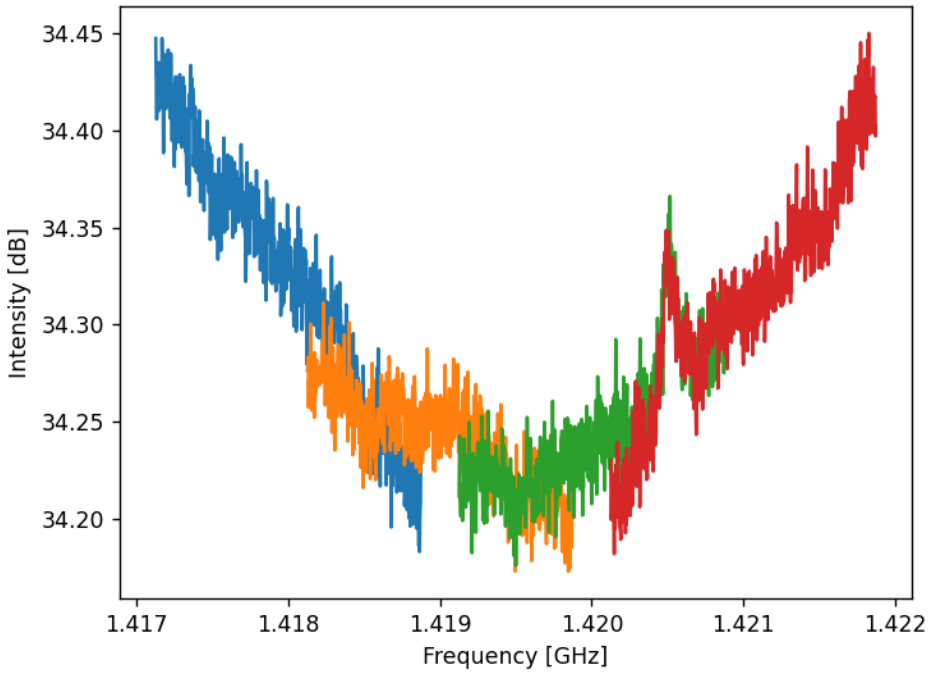


Figure 4: Chart was pointed straight up at the sky

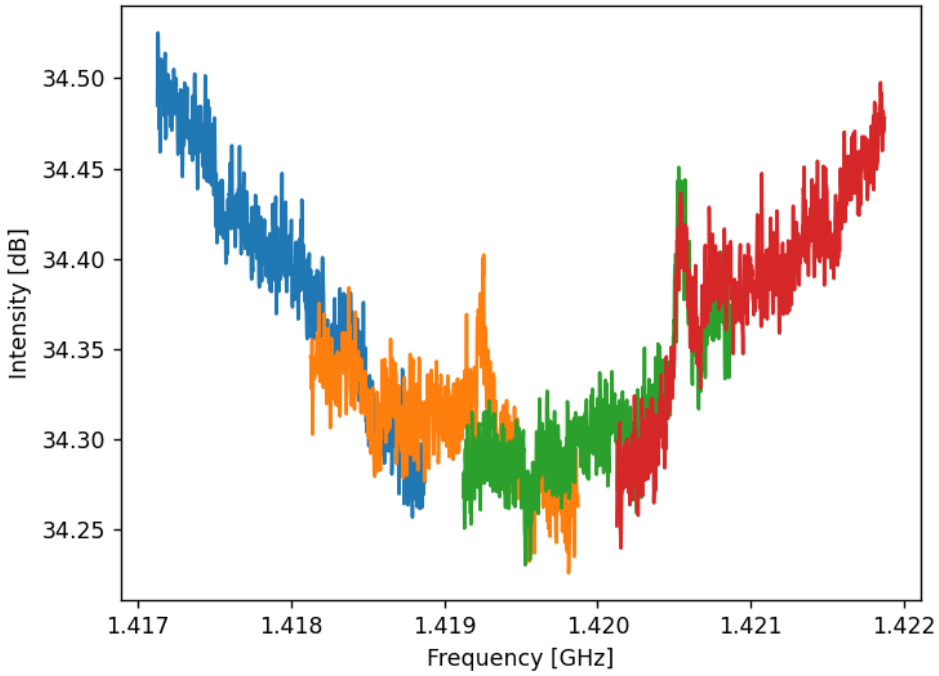


Figure 5: Chart was pointed at the northern part of the sky

For all three plots, it can clearly be seen that Chart was able to detect the 1420 Mhz signal. For figures 4 and 5, however, there is a slight blip around 1419. We are not exactly sure what that blip is from.

The difference in the size of the peaks leads me to believe that more integrations is better but more tests are needed to justify that completely.

When plotting the spectra of both graphs on top of each other, it can be seen that the crest of Figure 5 is shifted slightly to left of Figure 4

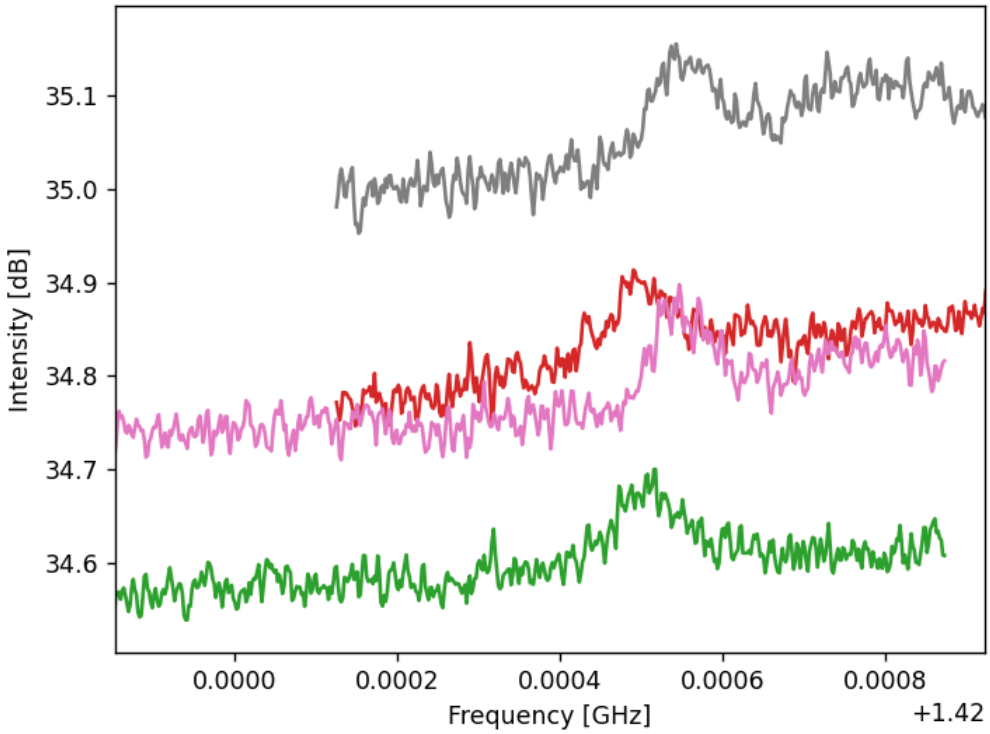


Figure 6: The green and red represent the horn pointing north and the grey and pink represent the horn pointing up

Another important observation of the data is the shape. Zooming into Figure one where the x axis is equal to 1420:

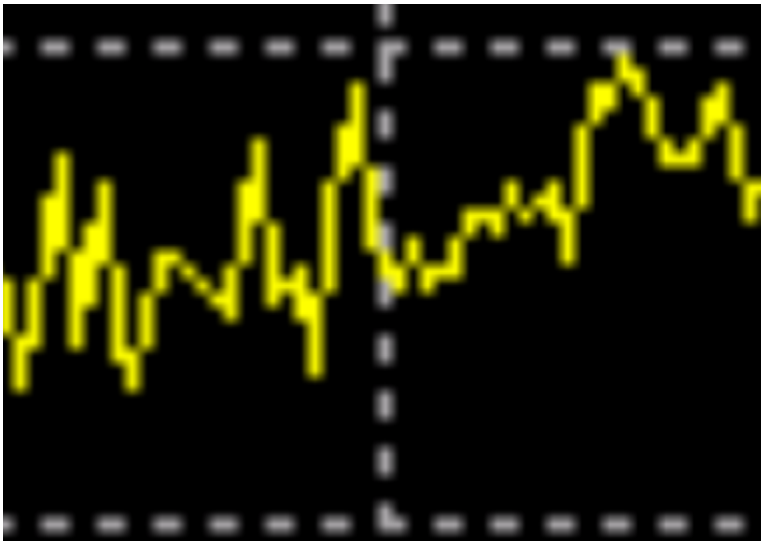


Figure 7

There is usually some sort of dip whenever a signal is amplified at 1420 Mhz. Most of the data and plots presented follow the Fieldfox's output so it can be concluded that the equipment was working properly and the data taken is correct.

Conclusion:

With this set up, everything ran mostly smoothly. It was a little disappointing that Baby Chart did not work, so we'll have to go over the documentation for it again to make sure the measurements are correct and the parts were built properly. The stand for Baby Chart worked as intended and was very helpful. Some concerns while testing was heat. After running a couple of tests, the RTL-SDR got so hot that it did not work. This could be because of the bias-T being constantly on or there not being enough ventilation inside the box. Future designs of the box holding the system might add a fan or two to keep the system cool since power consumption has not become an issue yet. Turning the bias-T off after each test without unplugging it is currently an issue on Github. With this report, we can conclude that the 1420 Mhz signal can be seen in a relatively radio quiet area. Future experiments might test if Chart can detect the signal in more urban and populated areas where schools are usually located and places where people are likely to deploy their horns.