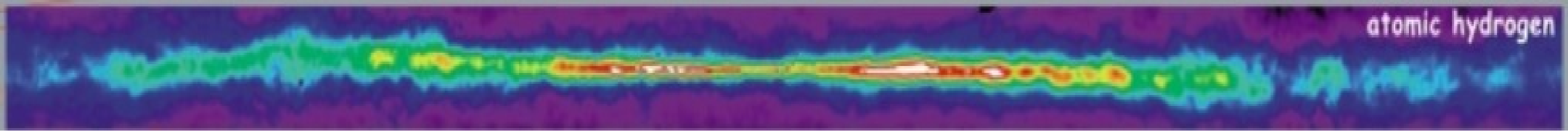


Leonardo Rossoni – 08/05/2024

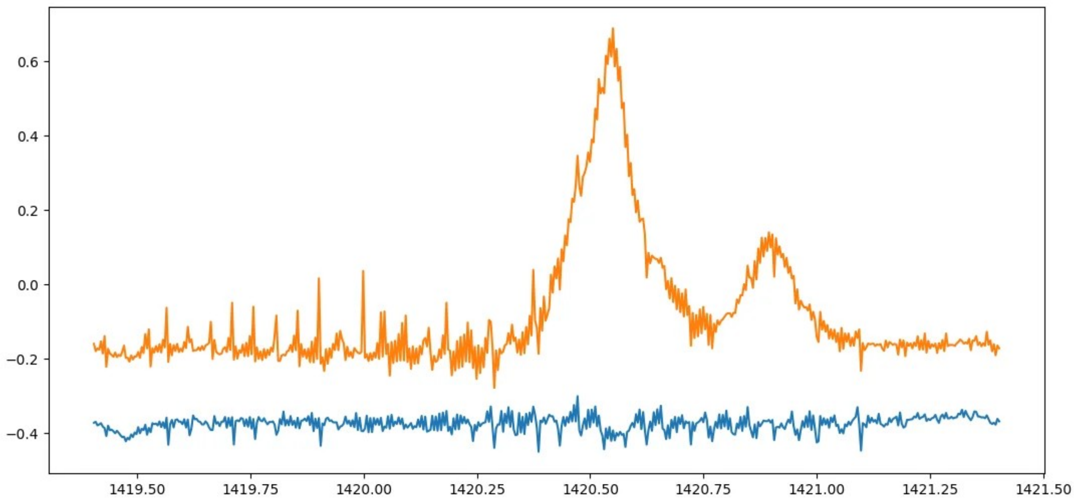
DEV - RADIOASTRONOMY

Report number 3: First results

News

In the past few days, I've had the opportunity to test and validate the functionality of my radio telescope. Thanks to a Python code based on the [rtl_power_fftw]() tool, I've been able to obtain some initial measurements that I find really interesting. After collecting the data, I initially attempted to interpret them with the help of the [r/radioastronomy]() community, who provided me with some truly useful advice.

The results



Taking a first look at this graph, we immediately notice two distinct traces. The first, in orange, represents the data collected while the radio telescope was pointing towards the Milky Way, specifically towards the constellation of Cygnus, while the second measurement, in blue, was taken in a "dark" area of the sky, far from the galaxy.

Figure 1: Pointing direction of the radiotelescope

Both measurements were preceded by an additional period of measurement, also in a dark area, to create baseline data for subtracting noise from the actual measurements.

Observing the orange measurement, we can easily spot two peaks at 1420.55MHz and 1420.80MHz. These radiations are emitted by atomic hydrogen, which constitutes about 70% of our galaxy.

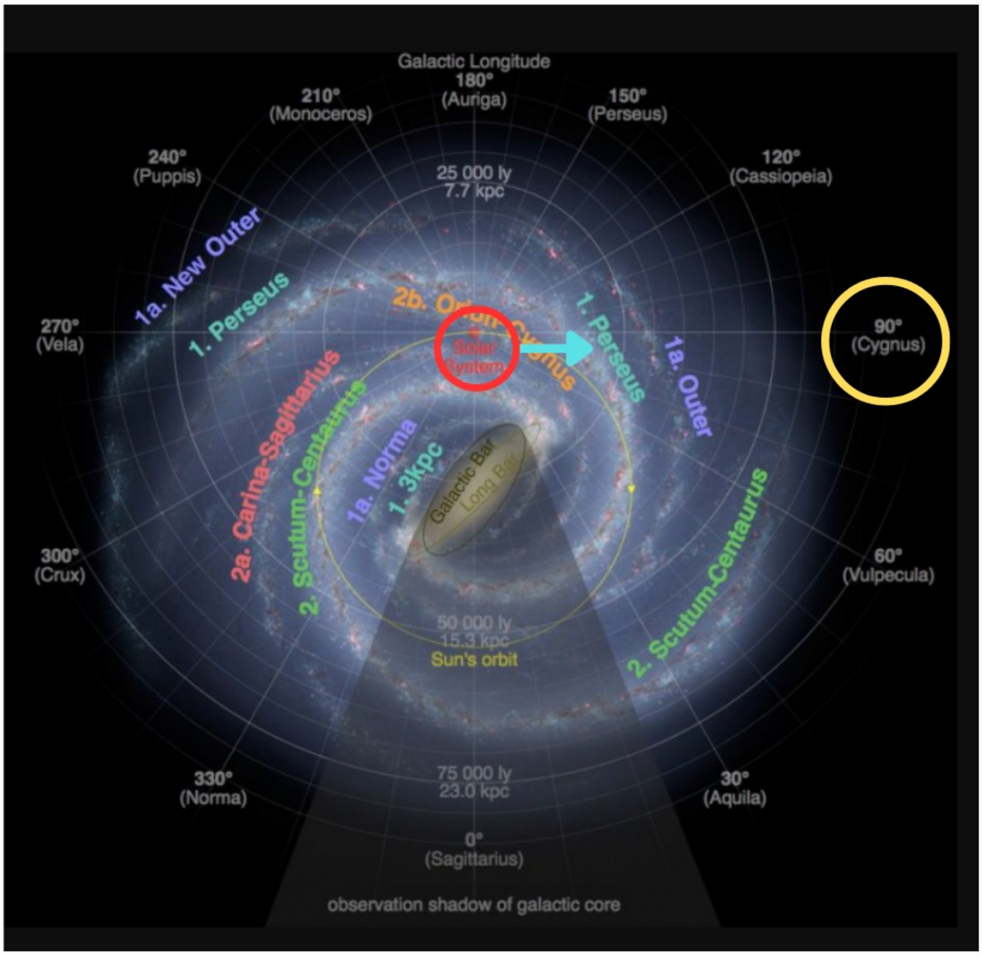
At this point, a spontaneous question arises: why are there two peaks of different frequencies when it's the same element emitting radiation?

The answer lies in the location of the hydrogen that emitted the measured radiation. Let's analyze the direction in which we pointed the radio telescope, towards the galactic plane, specifically towards the Perseus Arm, one of the arms of our spiral galaxy.

In the first peak, we see radiation emitted by gas present locally, around our entire galactic position, since we are "immersed" in these arms. This radiation essentially has the same frequency as one would expect from neutral hydrogen (1420.405 MHz).

The second peak, however, which also has lower energy, is shifted slightly to the right in the graph, with a frequency of approximately 1420.80MHz, slightly higher than the normal 1420.4MHz.

What causes this?



This phenomenon is known as "blue shift" and stems from a physical effect called the Doppler effect. Indeed, the radiation we observe comes from hydrogen present at a much farther point in the Perseus Arm compared to that observed in the first peak (*Earh and local hydrogen are in the red circle*).

Our solar system, along with all the local hydrogen around us, is moving around the centre of the galaxy as the Perseus Arm, and for this reason, our relative velocity to the second area where we observe atomic hydrogen is sufficiently high to cause an increase in the frequency of the radiations reaching my radio telescope.

Conclusions

As you can see, the study of the hydrogen line holds immense significance for understanding the structures and compositions of galaxies, as well as the dynamics of gas within them.
Through radio astronomy techniques like those employed in this investigation, researchers can discern valuable insights into the distribution and movement of atomic hydrogen across vast cosmic distances.
By analyzing the Doppler shifts in the hydrogen line emissions, astronomers can infer velocities and map out the intricate motions of gas clouds within galaxies.
This not only sheds light on the overall structure of galaxies but also provides crucial clues about their evolution, interactions, and the processes governing star formation.