

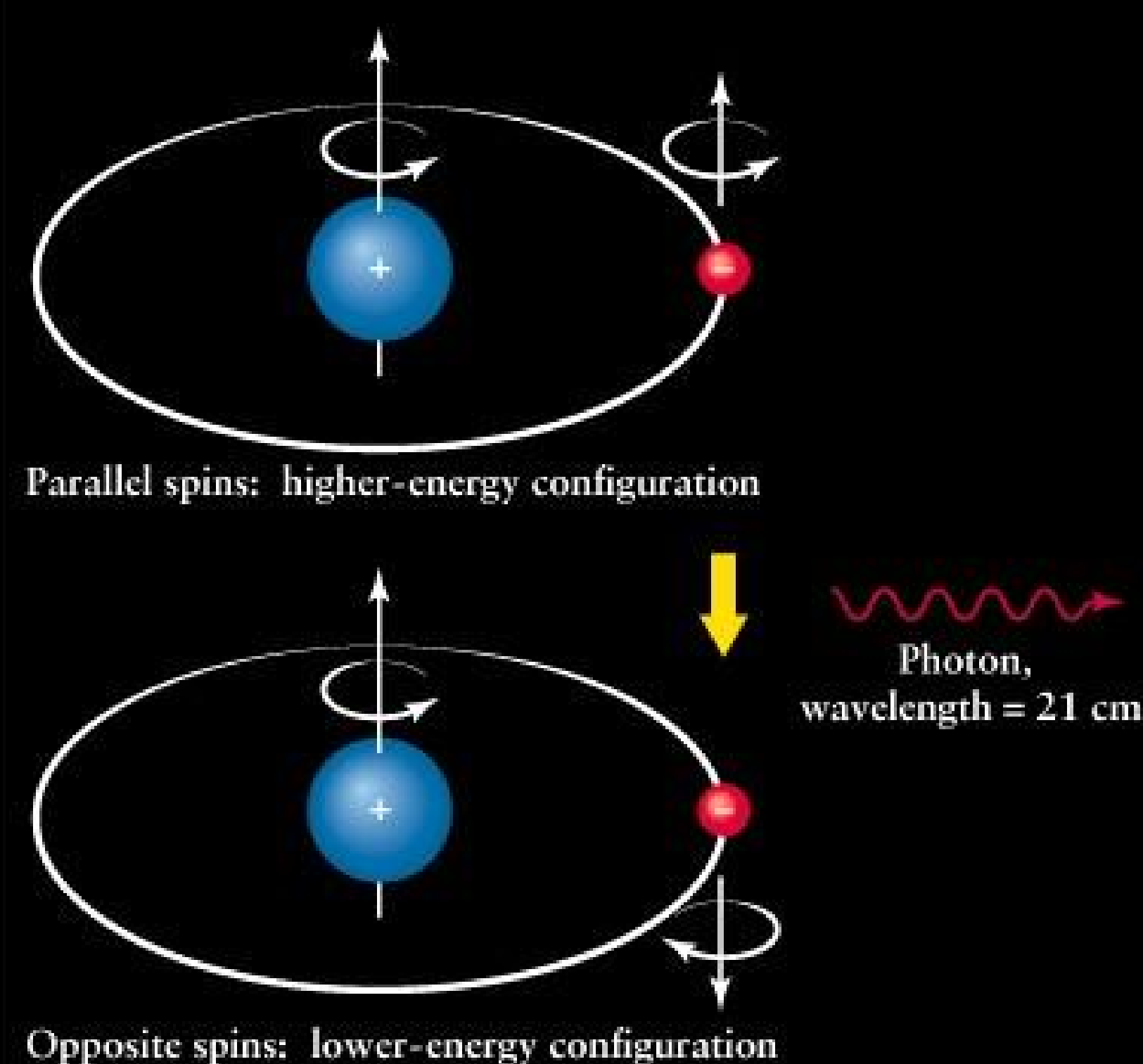
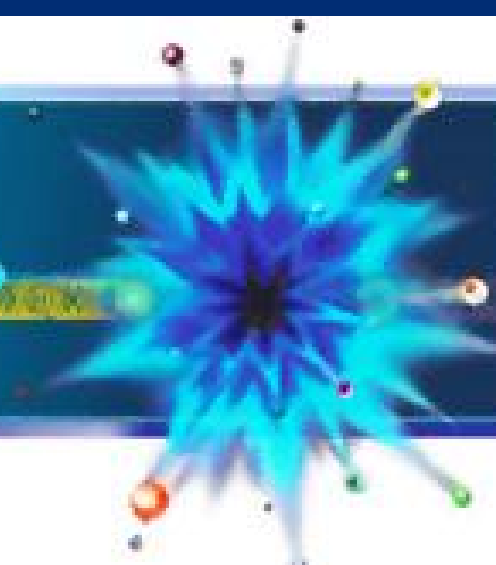


Radio Astronomy and The 21 cm Hydrogen Line

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QuarkNet



In neutral hydrogen, the hyperfine transition between the two spin states of its valence electron corresponds to a photon of wavelength 21cm.



When attempting to receive radio waves, the antenna's length plays a very large factor in the quality of the signal at the specific frequencies you are looking for. In the case of the 21cm line, $\frac{1}{4}$ of the wavelength (5 $\frac{1}{4}$ cm) is preferred.



The SDR Dongle is what really makes this product affordable. The radio waves that the antenna picks up are analog. In order to analyze this signal takes a lot of expensive parts, one being a specialized crystal oscillator. This SDR dongle circumvents many of these analog parts and instead acts as a 20\$ bridge to get the signal into software where it can effectively be analyzed for free.

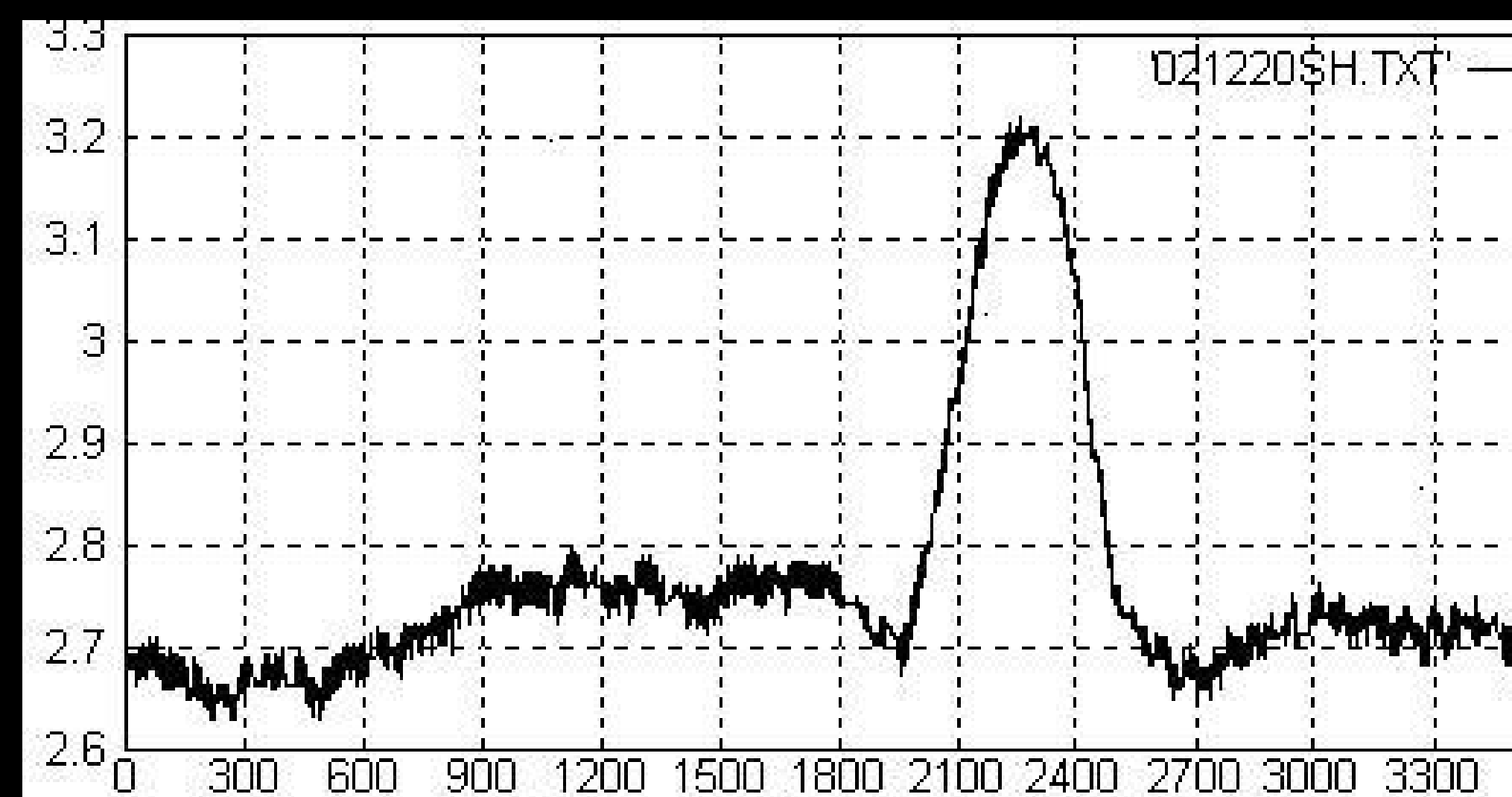
Abstract:

During my Research, I designed and built a radio telescope for about 200\$ before the dish and base. I did this by developing an understanding of how Radio Telescopes work (both data analyzation and hardware). Previously, building a small radio telescope would cost upwards of 6000\$, discluding the base and dish. But, I found out about a way to build a low budget RT using SDR USB Dongles. This is a very advantageous development because now it is viable for anyone with a budget of about 200\$ and access to a dish to build a radio telescope capable of observing objects within the Milky Way Galaxy.

Introduction:

By now, the importance of this information should be apparent. It provides a viable way for anyone to get a foot into the world of Radio Astronomy. It also provides material that could be possibly used as teaching materials for getting students involved and interested in the field. Radio Telescopes have been around since 1937 and their use includes, but is not limited to, observation of the 21cm hydrogen line.

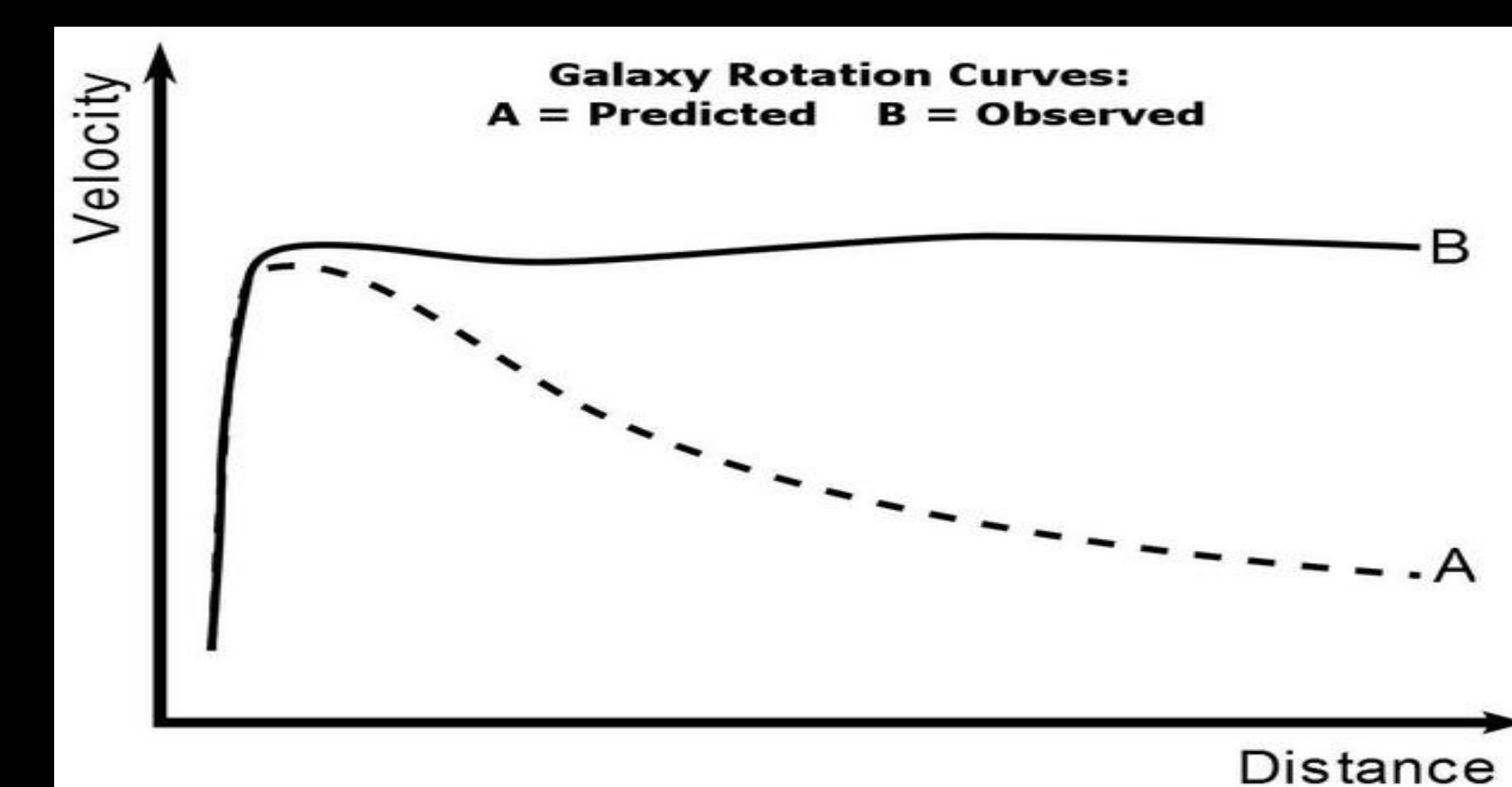
Once the signal is in the software, there exists a plethora of ways to analyze the data. It is very simple to record the raw data into text files using the SDR dongle, and from there the only limit is your imagination. For example, the graph on the right shows data points vs. intensity. With a graph like this red/blue shift can be calculated. Even without programming knowledge, if you can use excel, you are in business.



X Axis: Frequency Y Axis: Intensity
The red / blue shift can be calculated with the difference between the peak on the graph and the standing frequency of 1420 Mhz

Experiments:

In the 1930's Jan Oort used a radio telescope to gather data on galactic rotation. The thought at the time was that the further from the center of the spiral galaxy, the slower the rotation. But, it was actually found that the distance had little to no effect. This birthed the question of the missing mass and eventually lead to the theory of Dark Matter.



Dashed Line: Expected velocity of galactic points.
Solid Line: Measured with radio telescope



If you plan on reproducing this project, a very important factor to consider is the diameter of your dish. The dish I used is about 1.3 meters across. The bigger the dish the better, but your dish should be at least this size. Also you have choices regarding dish material. The wavelength of the 21 cm line is large enough that you can use a mesh dish instead of a solid metal and still guide the waves. Also, mesh dishes are more lightweight and wind resistant.

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Specific Information regarding the build can be found at [http:// www.rahatarefy.wordpress.com](http://www.rahatarefy.wordpress.com)