If SETI does nothing but change the perspective of humans on this planet, then it will be one of the most profound endeavors in history.

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The Waterhole

HI AST 111. In this last module we'll explore how we search for extraterrestrial signals.

We've seen the huge difficulties in trying to move a mass - a spaceship, a robot, whatever - at faster and faster speeds. On the other hand, photons have no mass. They always move at the speed of light. In fact, if you have no mass, you have to move at the speed of light. If you have mass, you can never move at the speed of light.

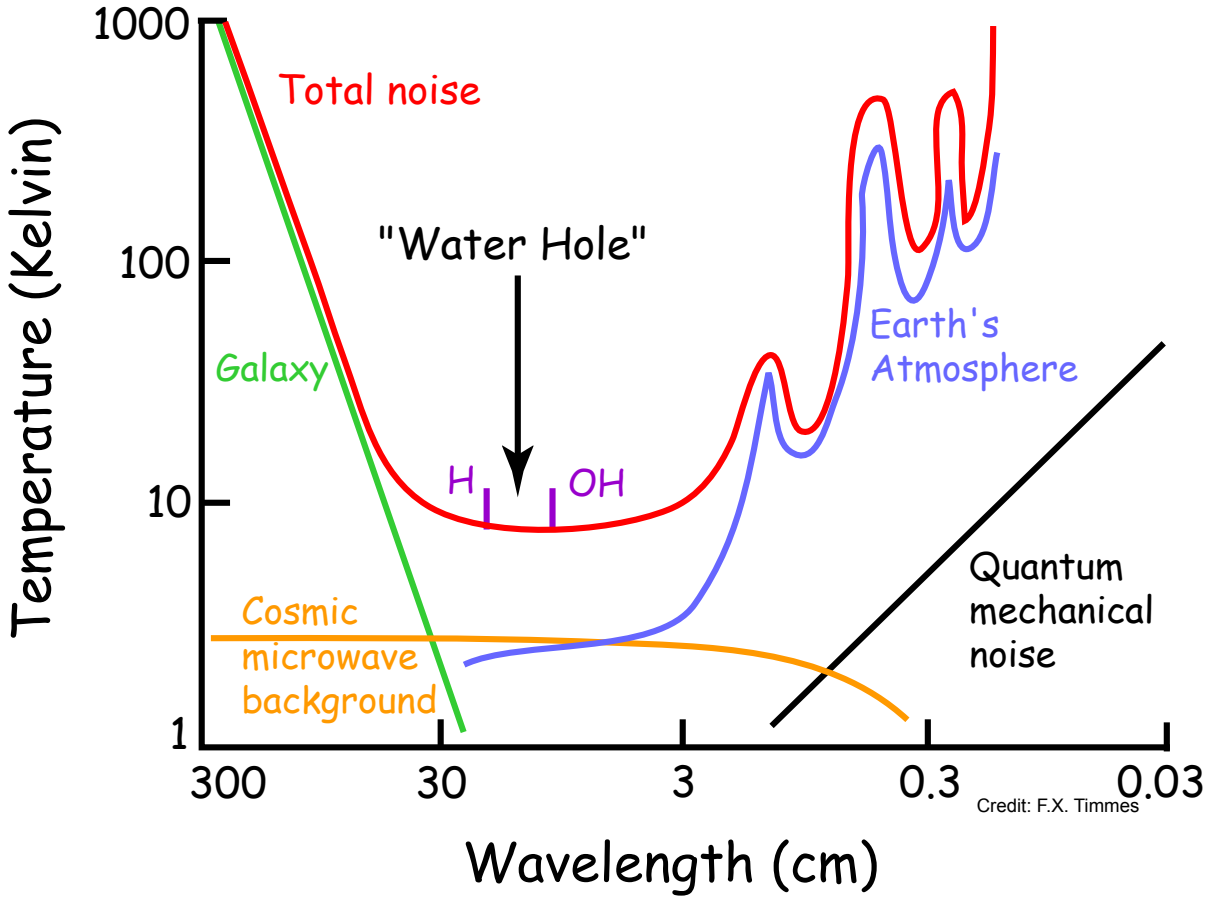
Credit: Philip Wilson, Creative Commons

Not only that, photons are inexpensive. Even for the distances we deal with on Earth, photons have come to dominate over matter for sending messages. It wasn't too long ago everybody had landlines. That's how you communicated on a telephone. Today many people have wireless mobile devices. They use photons to communicate. Considering the much larger distances that exists between stars, photons make a lot more sense to communicate than trying to move a piece of mass amongst the stars. Photons are our spaceships.

While we can't travel at the speed of light, we can send information at the speed of light by using radio waves, lasers, and other forms of radiation. If we can think of sending such signals, other civilizations can think of it too.

If we point our telescopes and we listen at just the right wavelength, we might hear other intelligent beings calling out to each other across the galaxy. But at what wavelength?? There's an infinite number of wavelengths! Consider the illustration below, which shows the antenna temperature as a function of wavelength. You can think of the “temperature” as “noise”. The higher the temperature, the noisier it is. If you want to have a conversation, you want it to be quiet.

Now, radio waves can penetrate interstellar gas and dust fairly easily because they have a long wavelength. This would kind of be a natural region to look in first. But radio is still much too big a region to search.



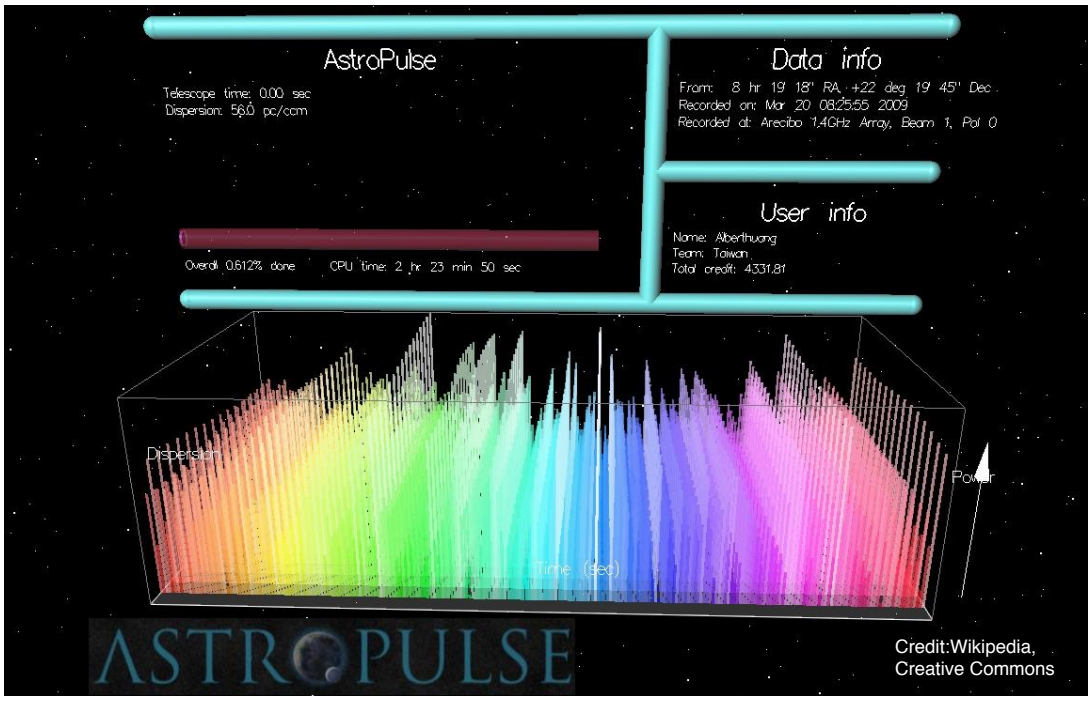
Wavelengths longer than about 30 centimeters are lost to background noise in our Milky Way galaxy, as the illustration above show. It's too dang noisy to have a conversation with wavelengths longer than 30 cm. So rule that region out.

Wavelengths shorter than about 3 centimeters are lost to absorption within atmospheres. So its too noisy to communicate there too. Scratch that region out.

It's only between 3 and 30 centimeters where it's quiet enough if to have a conversation. That's a lot better but still too wide to search effectively.

Nature may have narrowed the search for us. There's two very special spectral lines within this quieter region. One is from atomic hydrogen at 21 cm. The other is at 18 cm from the hydroxyl, OH, molecule Between these two lines is as quiet as it gets. If you want to have a conversation, and you listen carefully, you can communicate in this region of the radio spectrum with a minimal amount of background noise.

H and OH make H2O. Hence this region of the radio spectrum is called the "Water Hole". So the joke is: Where do civilizations go to communicate? They go to the water hole, where animals have always gone to drink and communicate!



You can search the Water Hole for ET, or help with other science projects, by downloading the BOINC software from http://boinc.berkeley.edu/. Above is a screenshot of the program in action. Its searching Water Hole data from the Arecibo radio telescope for wavelengths have an unusual amount of power. Maybe that power even fluctuates in way that is clearly not from a terrestrial or astronomical source!

I'm going to go search for other civilizations now.
Or maybe model a supernova explosion.
Or work on becoming an astronaut.

Thank you very much for taking this course. Bye bye!