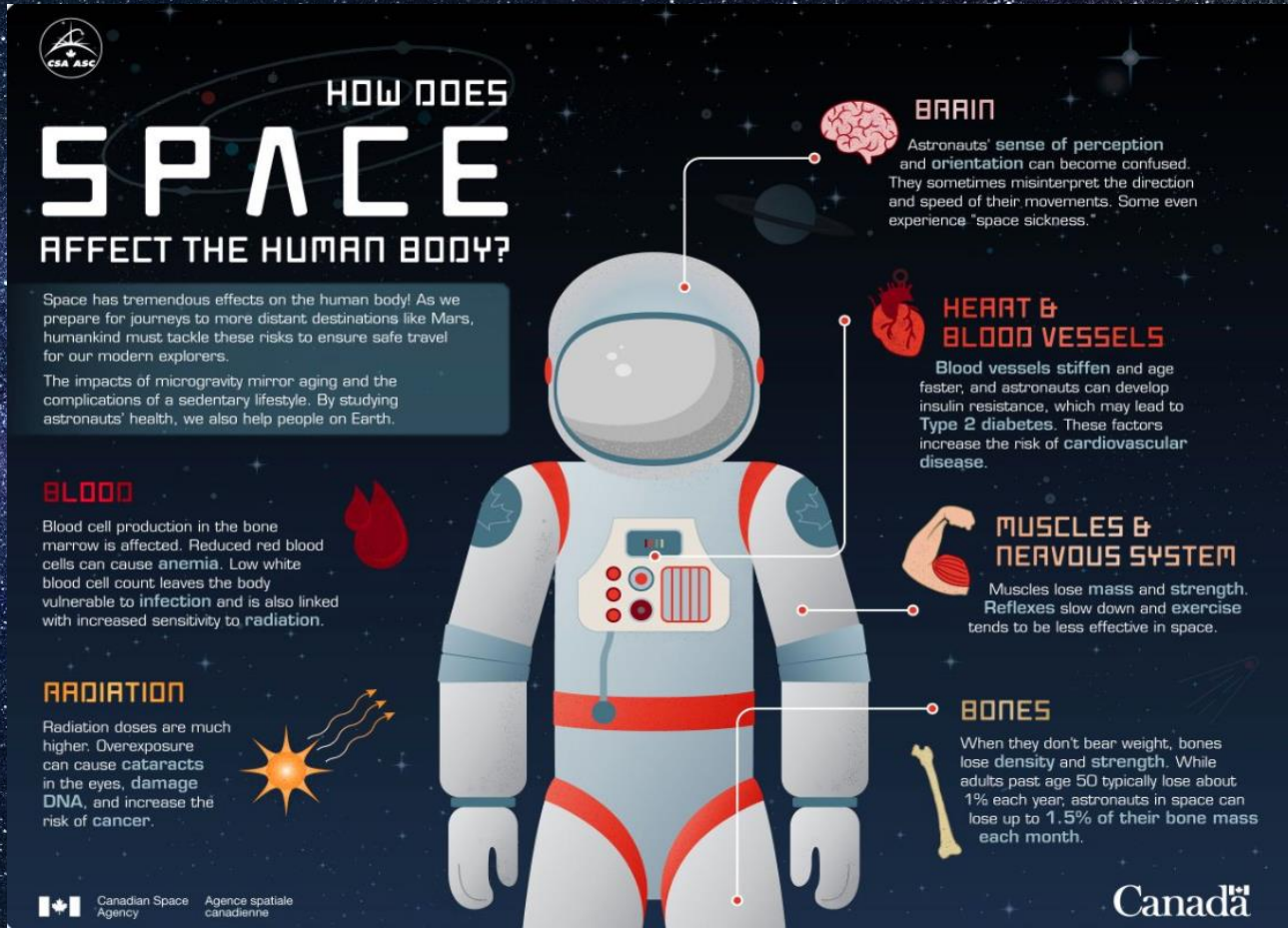
How do humans study space???

Studying Space

- Human Travel - People are bad at space travel...it's hard on the body..

*Twins and space study



Humans can’t go yet, so....

- Rovers - robotic vehicles that move across surfaces in space (moon, Mars)
- Probes - collect data in space and transmit it back to earth
- Electromagnetic Waves!!! - many objects in space give off EM waves that we can study through telescopes

The distance that an EM wave can travel in one year

5,878,499,810,000 miles

(A light year)

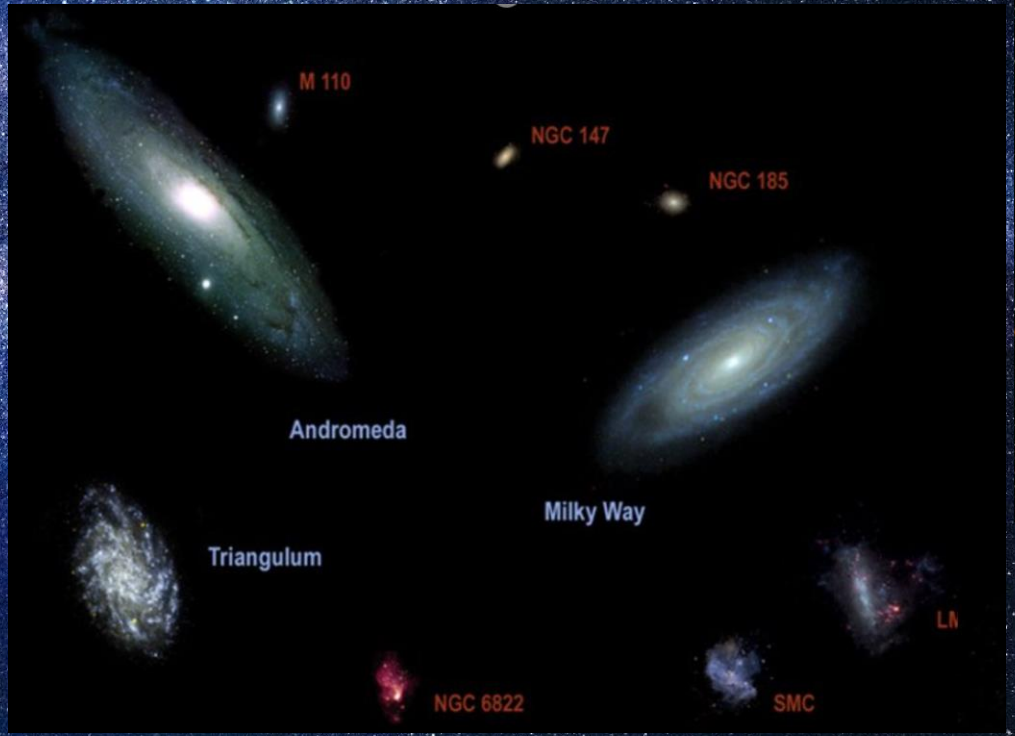
That equals:

129,329,760,000,000,000,000,000,000 years at current human travel speed!

129 septillion, 329 sextillion, 760 quadrillion years

Closest galaxy to Milky Way = 2,200,000 Light Years

Next Closest Major Galaxy = Andromeda



Images courtesy of http://mrdclassified.weebly.com/galaxies2.html (left) and Photo by Guillermo Ferla on Unsplash (left)

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Image courtesy of https://ecuip.lib.uchicago.edu/multiwavelength-astronomy/astrophysics/05.html

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Types of EM Telescopes

- Take note of what they have in common and what is different.

Radio Telescopes

Greenbank Radio Telescope, WV

Crab Nebula - Radio

Microwave Telescopes

Wilkinson Microwave Anisotropy Probe

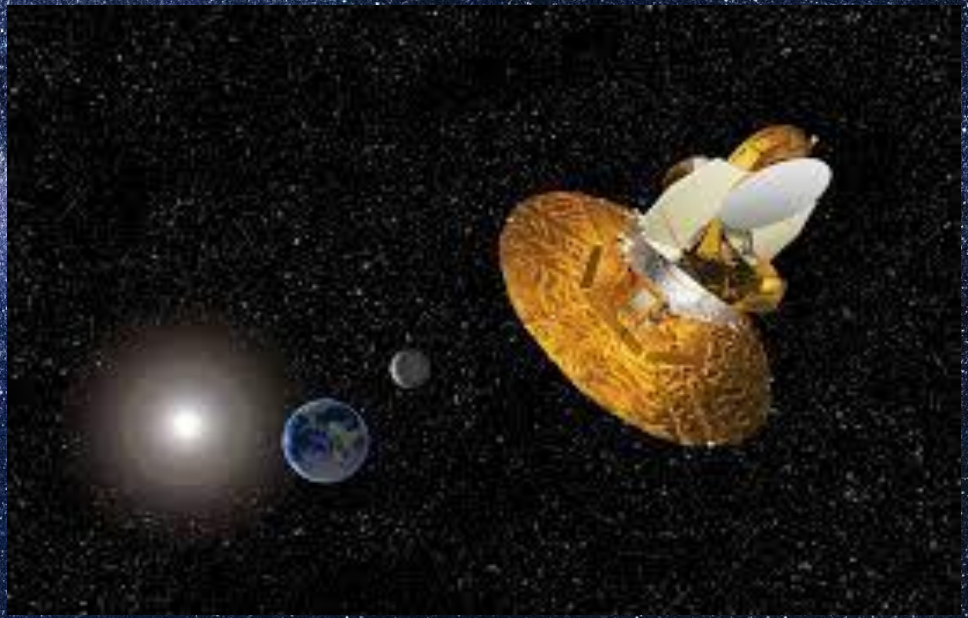

Image courtesy of NASA.gov

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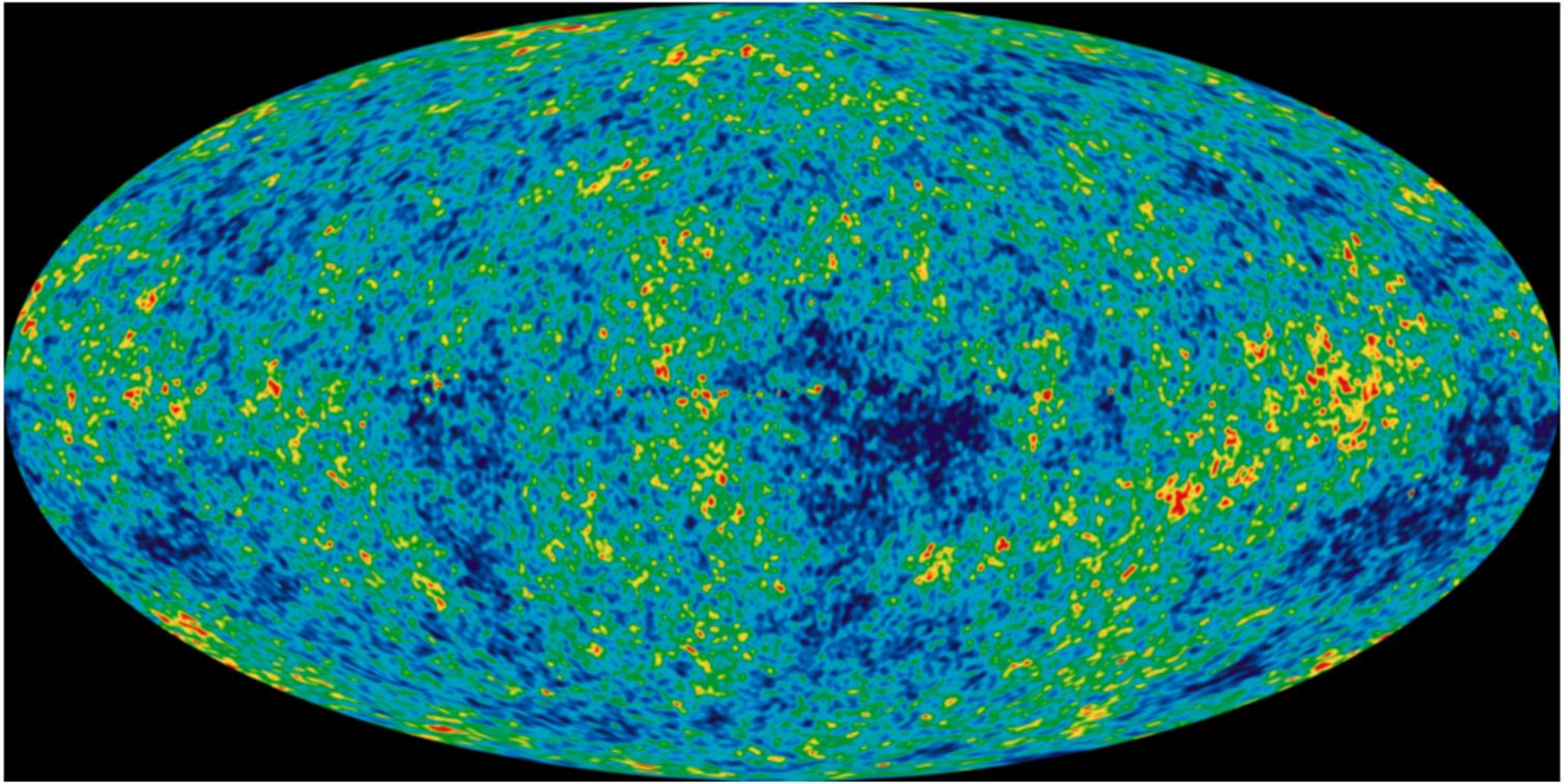

The full-sky image of the temperature fluctuations (shown as color differences) in the cosmic microwave background, made from nine years of WMAP observations. These are the seeds of galaxies, from a time when the universe was under 400,000 years old.

Credits: NASA

Infrared Telescopes

Spitzer Space Telescope

Image courtesy of NASA.gov

Infrared - Sombrero Galaxy

Image credit: NASA/JPL-Caltech/University of Arizona/STScI.

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Visible Light Telescopes

Great Canary Telescope

Credits: NASA, ESA and the Hubble Heritage (STScI/AURA)-ESA/Hubble Collaboration

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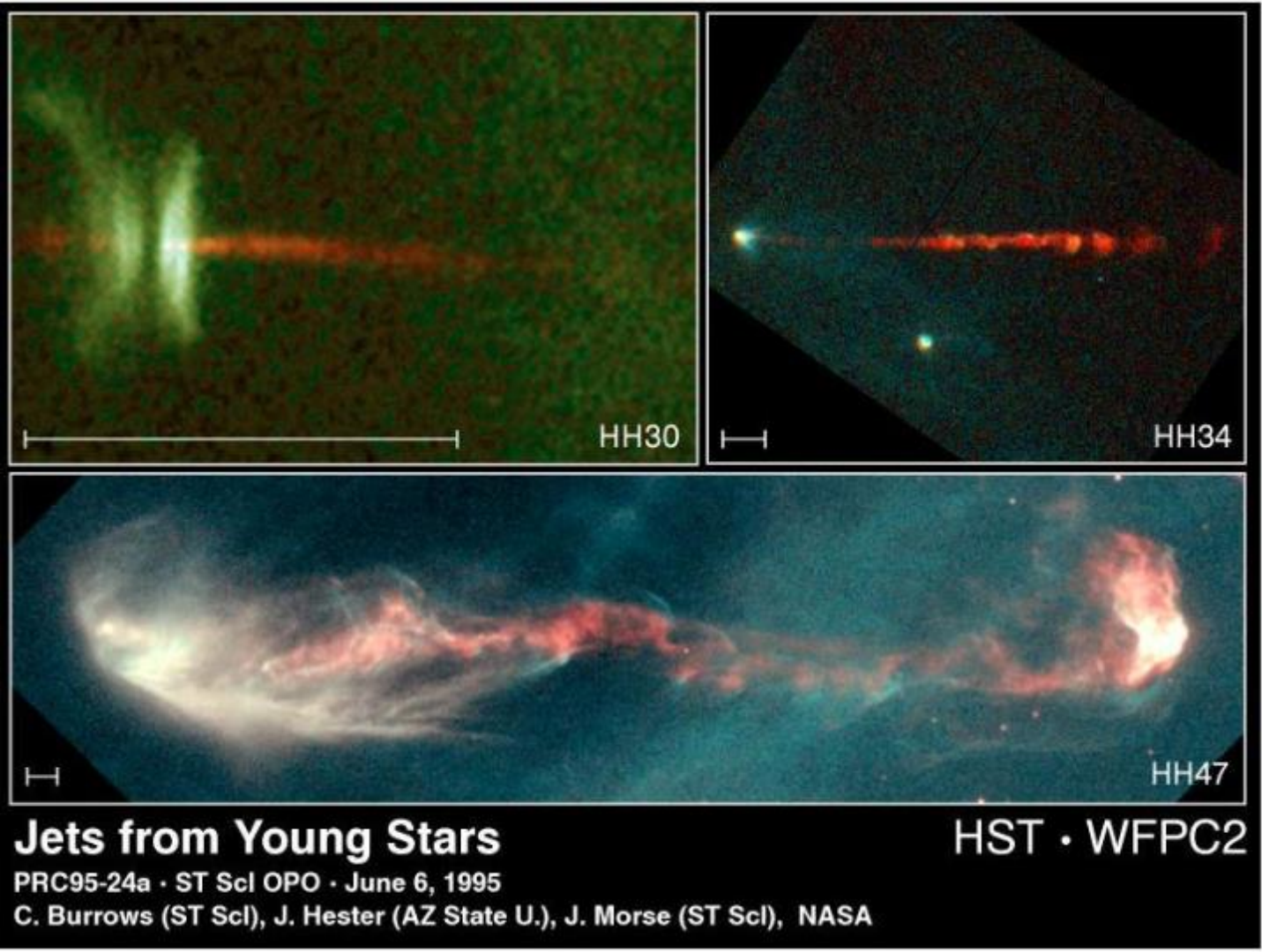
Ultraviolet Telescopes

The Hopkins Telescope

Image courtesy of NASA.gov

Ultraviolet Telescopes



X-Ray Telescopes

Chandra XRT Telescope - Coloring Our Universe:

[Part 1]

[Part 2]

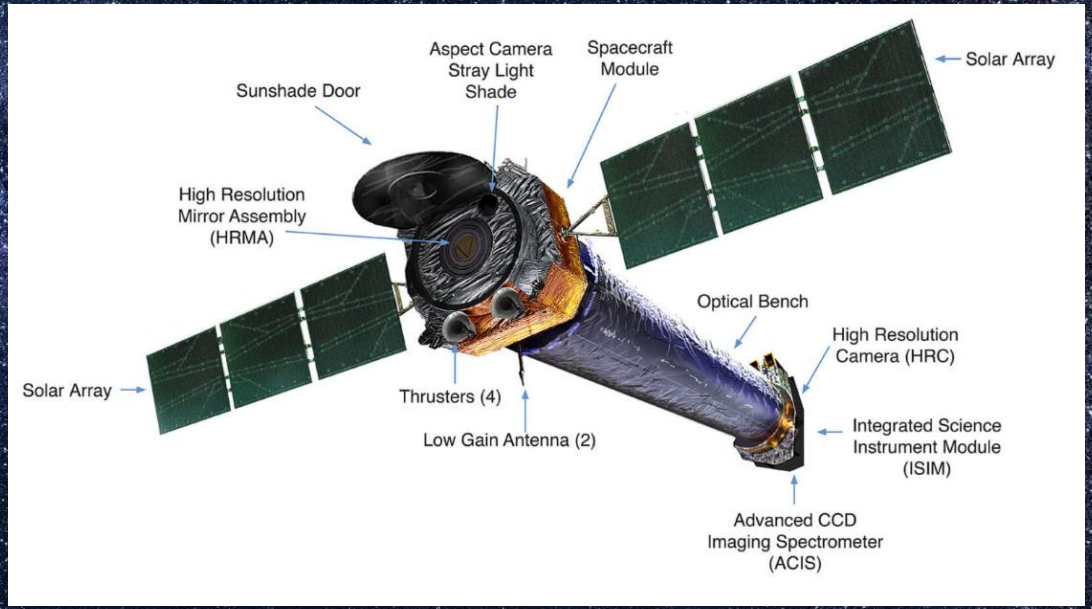


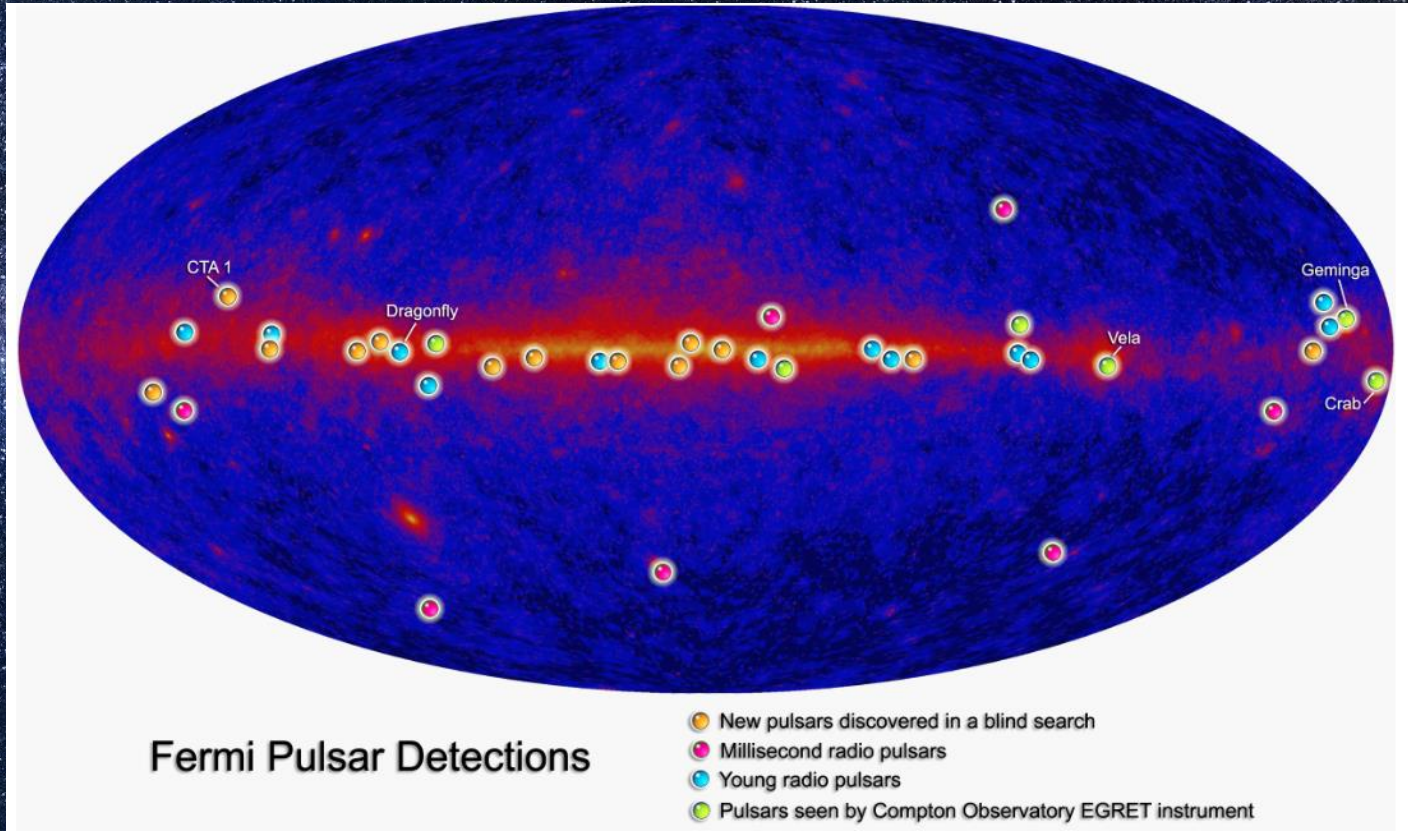
Image courtesy of NASA

Gamma Telescopes

Fermi Gamma Ray Telescope

Pulsars are **rotating neutron stars observed to have pulses of radiation at very regular intervals that typically range from milliseconds to seconds**. Pulsars have very strong magnetic fields which funnel jets of particles out along the two magnetic poles. These accelerated particles produce very powerful beams of light.

Image courtesy of NASA



Multi-Wave Moon

Types of EM Telescopes

- What did you notice? Did they have anything in common? Anything different?
- Radio Window

Can they go together? Cosmic Coloring

*If you want to learn more about the different types of telescope follow the NASA link.

The Radio Window

Remember Radio Waves???

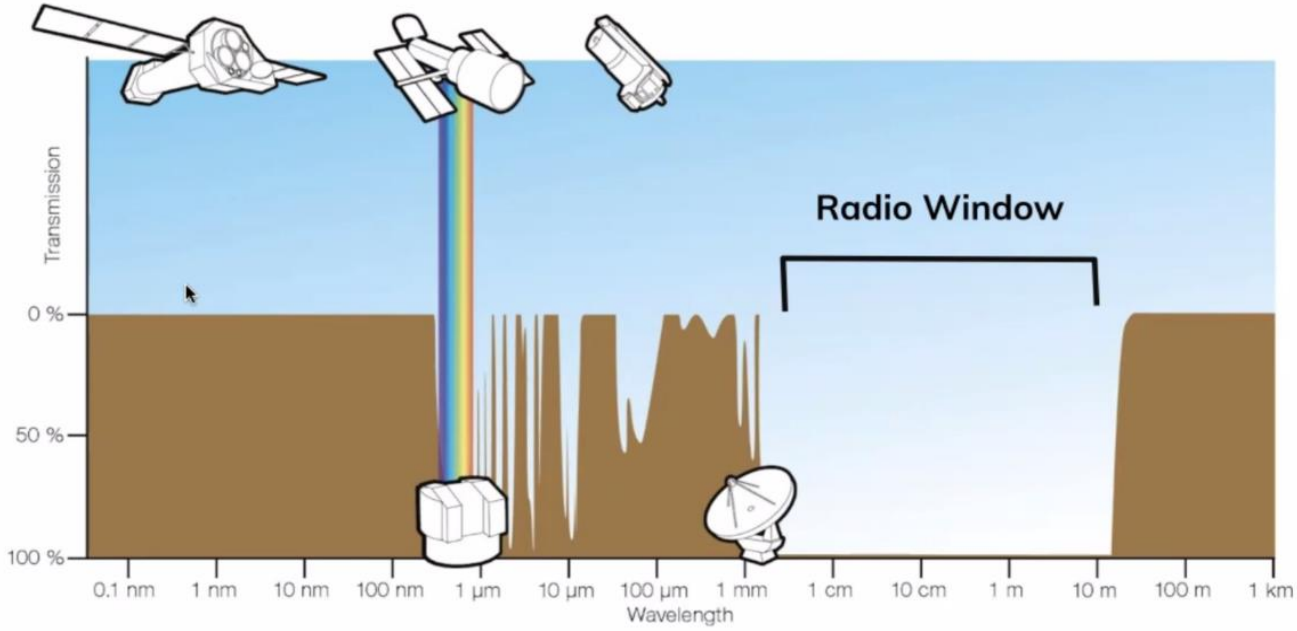


Image Credit: ESA/Hubble (F. Granato)

What is Radio Astronomy???

Video link

What's it like to be a radio telescope???

We will go outside for our activity.

*This is not a satellite dish.

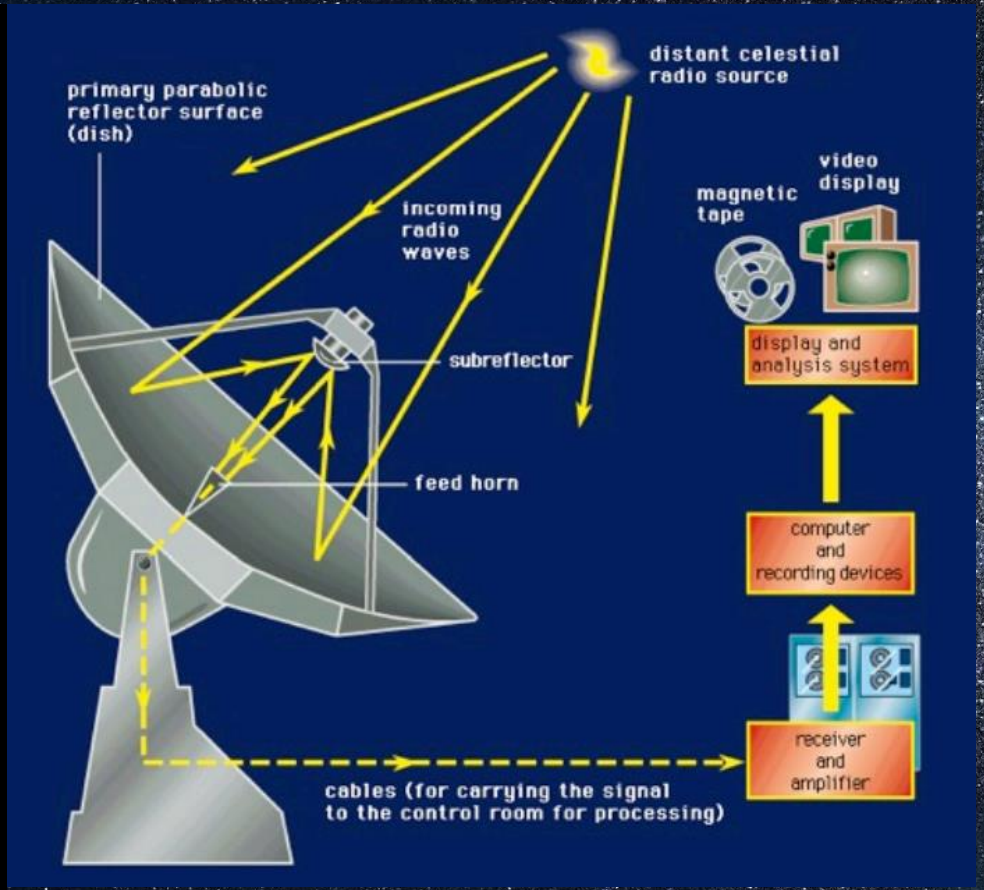


Image courtesy of http://scipp.ucsc.edu/~tesla/lecture15.pdf

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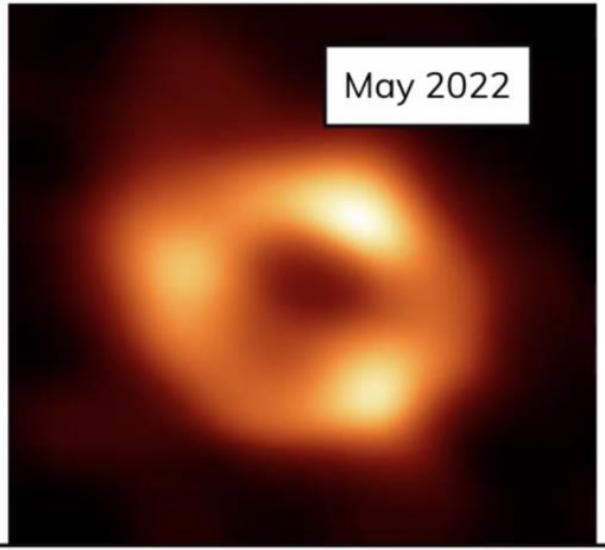
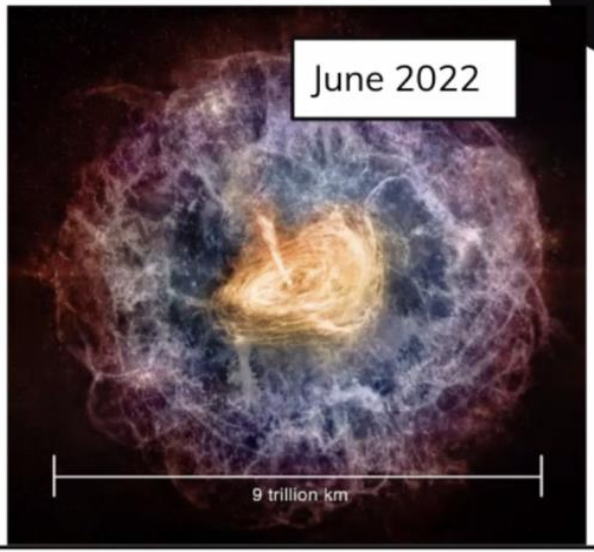
Present state of Radio Astronomy



Sgr A*, the black hole at the center of our galaxy, imaged by the Event Horizon Telescope- made up of 8 radio observatories across the globe!



Scientists found a new neutron star as young as 14 years old using the VLA through the pulsar signals

Image courtesy of NRAO

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Future - Next Generation Very Large Array

US states and territories with ngVLA antennas, based on Revision D of the array configuration.

Radio Facilities

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Radio Telescope Jigsaw

1. Five-hundred-meter Aperture Spherical radio Telescope
2. Greenbank Observatory
3. Very Large Array
4. Effelsberg
5. Parkes