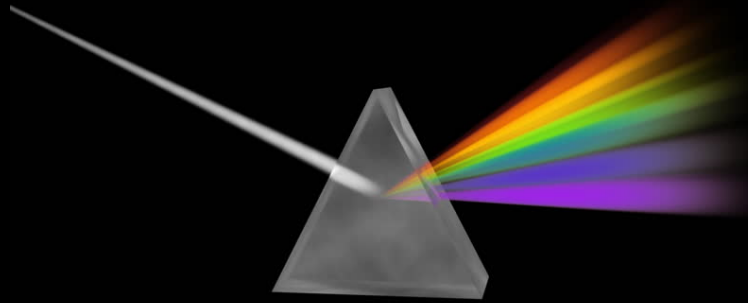


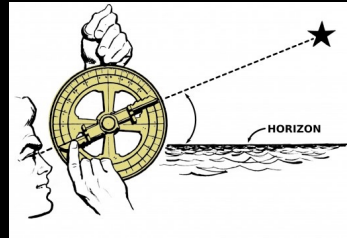
Electromagnetic Spectrum



Peterborough Astronomical Association
Novice Astronomy Class # 9
December 2, 2022
Brett Hardy

Visible Light

- Sundial
- Astrolabe
- Armillary Sphere
- Sextant



Visible Light

- A Momentous Event
- Netherlands 1608
- Hans Lippershey
- 3 X



Visible Light

- Italy 1609
- Galileo Galilei
- 30 X



Visible Light

- England 1668
- Sir Isaac Newton
- 35 X



Visible Light

- Sir Isaac Newton 1666 – 1672
- Red, Orange, Yellow, Green, Blue, Indigo, Violet
- ROY G BIV
- Wavelength: 400 – 700 nm
- Size: virus
- Filters



M42/M43 Orion Nebula Brett Hardy

Visible Light
Hubble Space Telescope



NASA

Visible Light
Keck I & II, Hawaii



Keck Observatory

Visual Light

Gemini (South), Chili

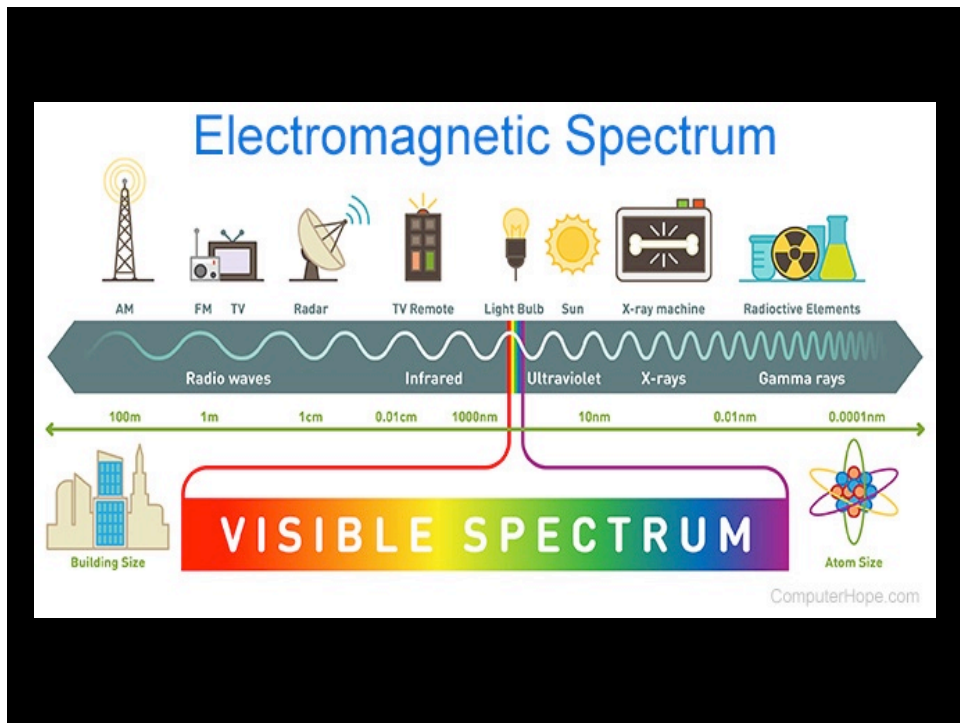
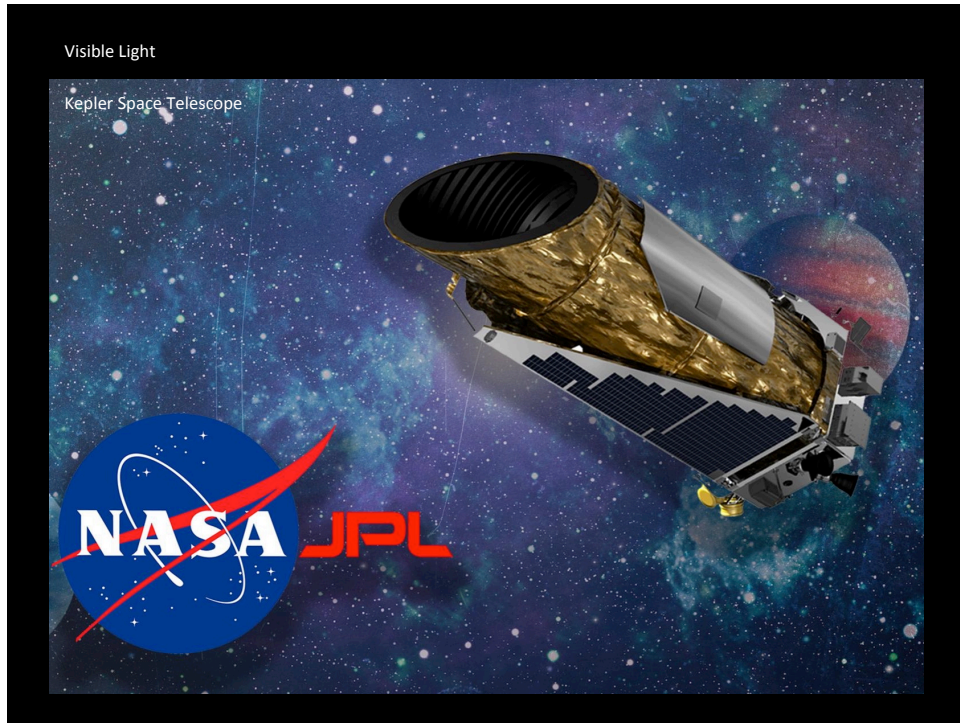


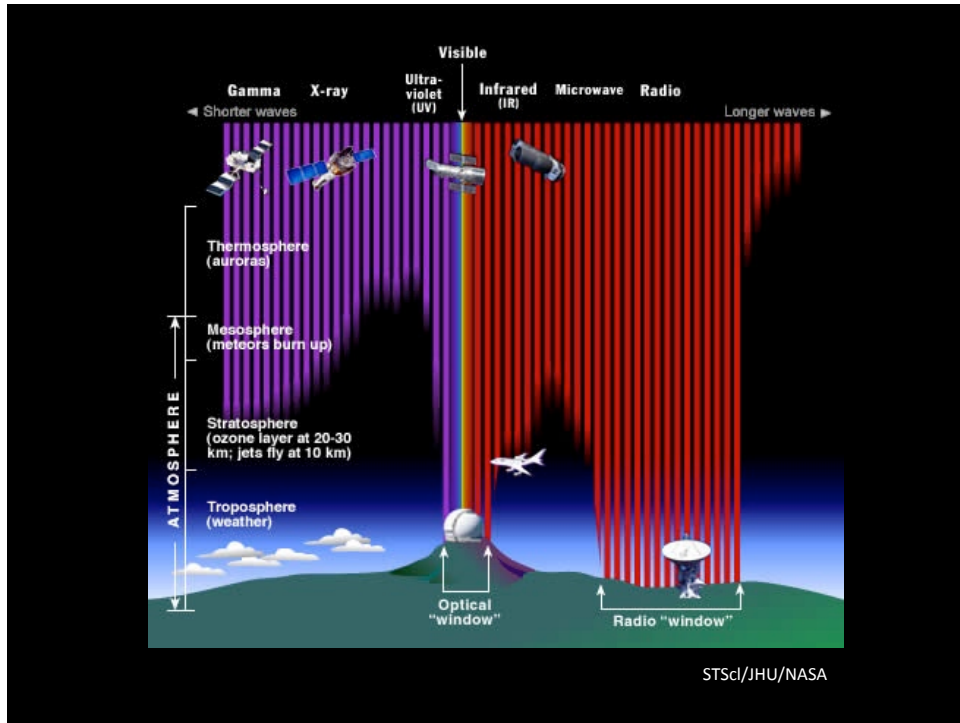
Visible Light

SALT: Southern African Large
Telescope (South Africa)
Largest in southern hemisphere



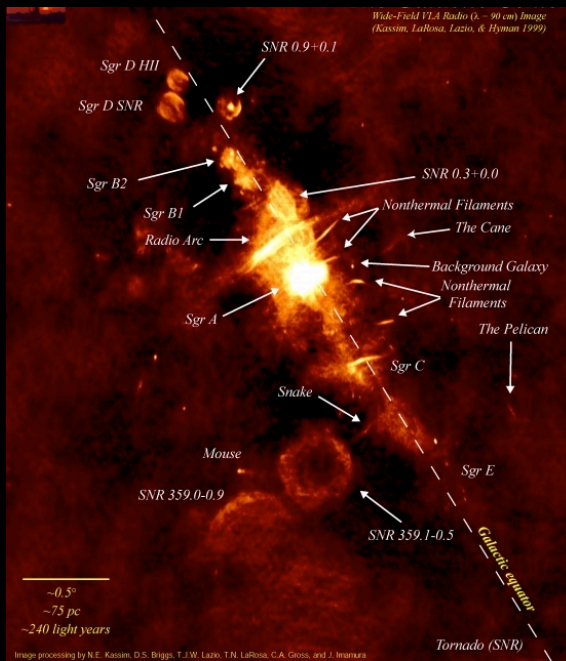
Adele De Witte/Fotolia

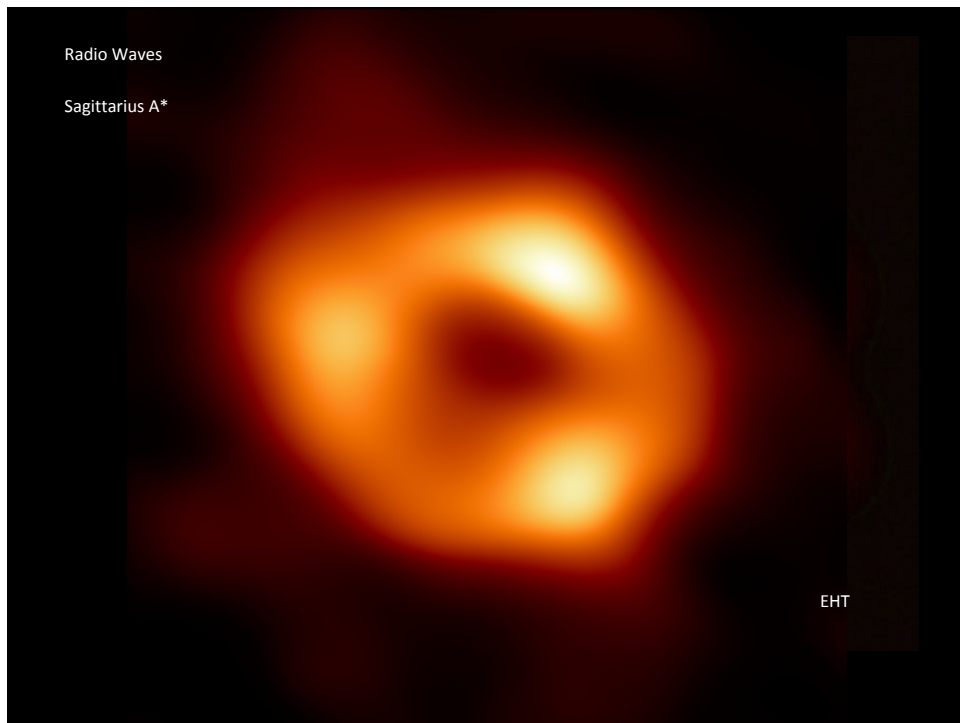
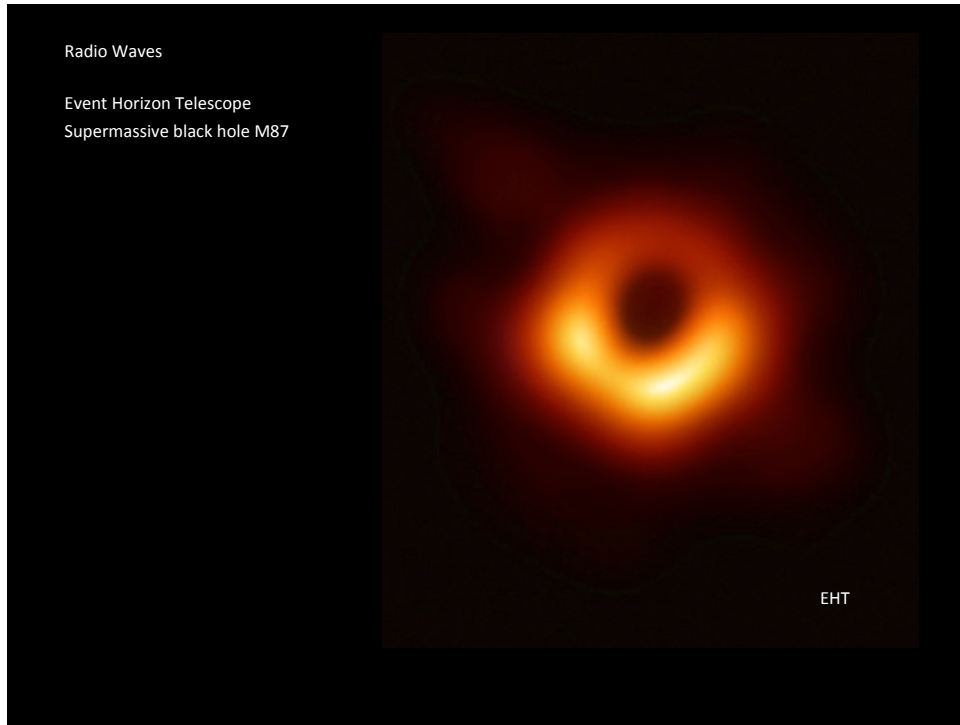




Radio Waves

- James Clark Maxwell 1867
- Heinrich Hertz 1886
- Karl Jansky (Bell Labs) first radio telescope 1932
- The longest wavelength of light > 10 m - 10 cm
- Size: large buildings >
- Lowest energy
- Used to look inside dense interstellar clouds and observe the motion of cold, dark gas
- Able to map the structure of our galaxy





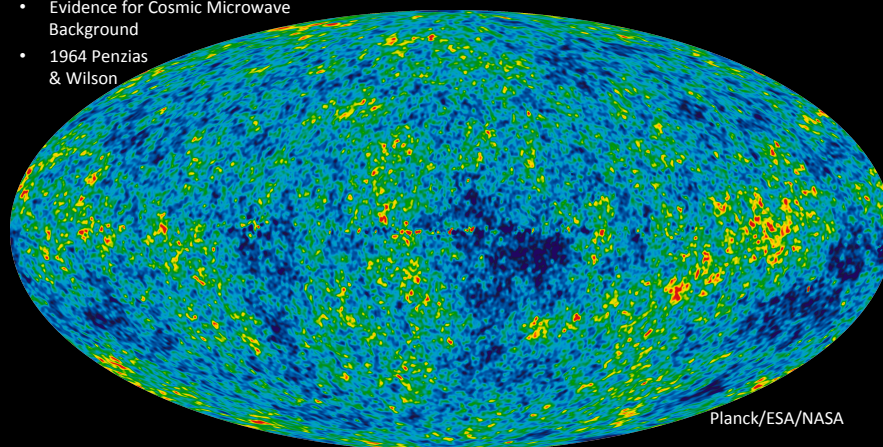
Radio Waves

Jodrell Bank , UK



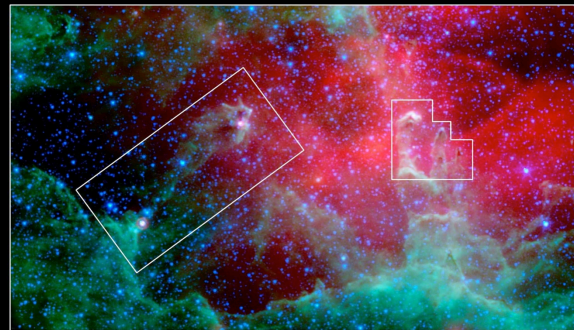
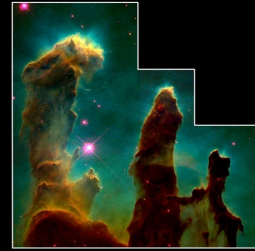
Microwave Radiation

- Percy Spencer 1945
- First telescope late 1960s
- Wavelength: 10 cm – 1 mm
- Size: butterfly
- Can see inside cool, dense interstellar clouds
- Evidence for Cosmic Microwave Background
- 1964 Penzias & Wilson



Infrared Waves

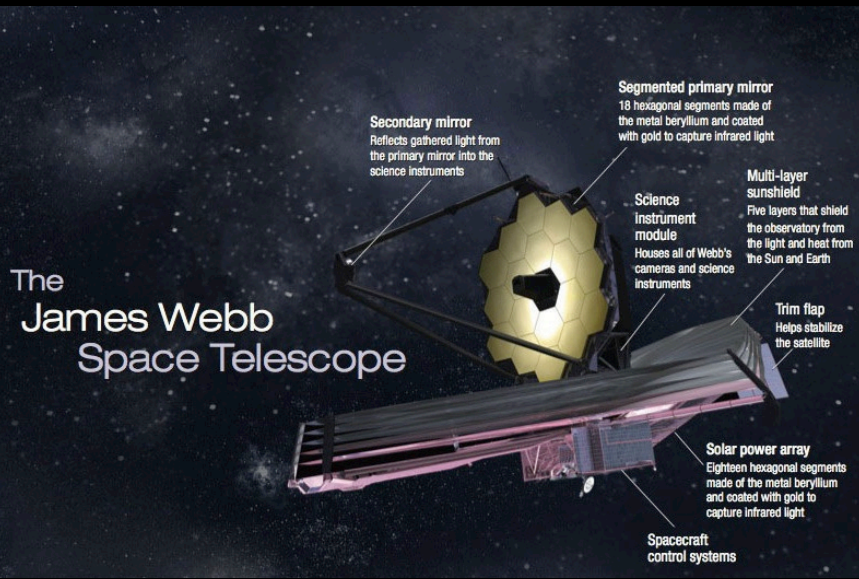
- William Herschel 1800
- Wavelength: 1 mm – 700 nm
- Size: Eye of a needle
- Most absorbed by atmosphere
- Useful for observing the formation and development of young stars
- Locate and measure the temperatures of exoplanets



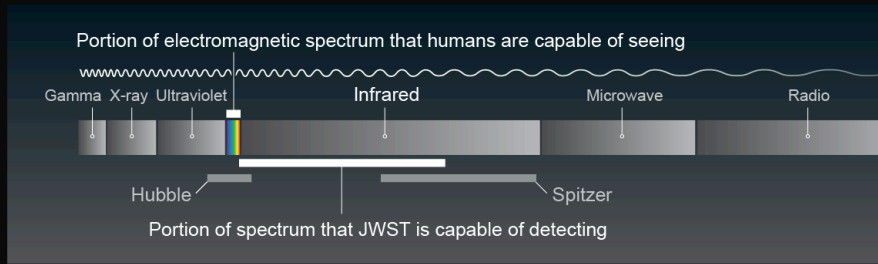
Spitzer Space Telescope & HST: Eagle Nebula

Infrared Waves

Launched December 25, 2021



Ultraviolet Waves



Ultraviolet Waves



NASA/ESA/CSA

Ultraviolet Waves

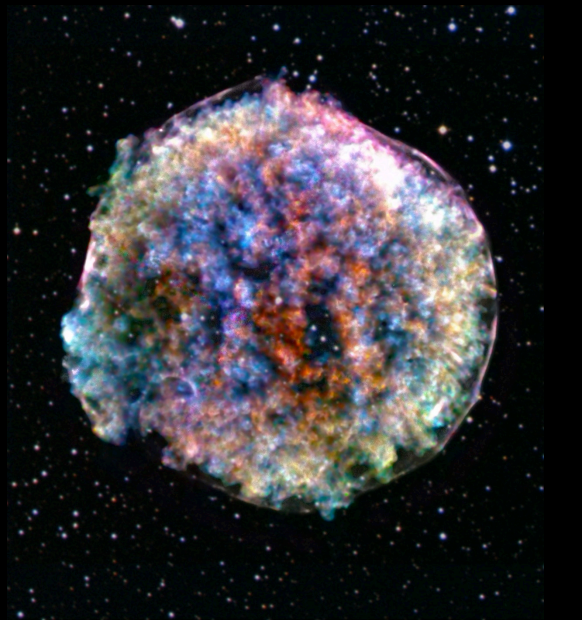
- Johann Wilhelm Ritter 1801
- Wavelength: 400 – 10 nm
- Size: molecules
- Responsible for sunburns
- Highest energy UV is ionizing
- Used for finding the most energetic stars, areas of star formation and black holes
- Most of the stars and gas disappear revealing hot young stars



GALEX: M33

X-Rays

- Wilhelm Conrad Roentgen 1895
- High energy ionizing light
- Wavelength: 10^{-10} m
- Size: atoms
- Absorbed by Earth's atmosphere
- Used to study neutron stars, high temperature gas and dust, black holes



Chandra Space Telescope: Tycho Supernova

Gamma Rays

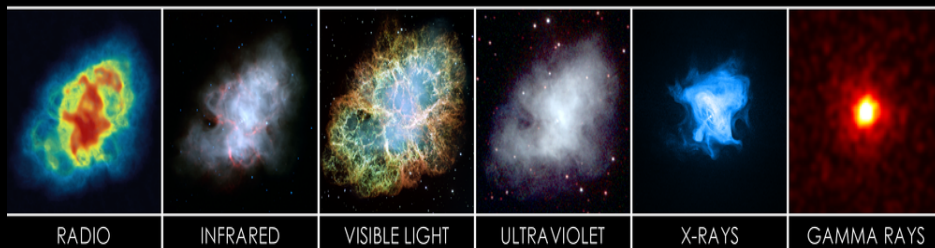
- Paul Villard 1900
- Highest energy ionizing light
- Shortest wavelength
- 10^{-12} m >
- Size: nucleus
- Blocked by Earth's atmosphere
- Deadly to life
- Used to study supernovae, cosmic radioactive decay and the annihilation of antimatter
- Gamma Ray Bursts 1967



Swift: Cassiopeia A Supernova Remnant

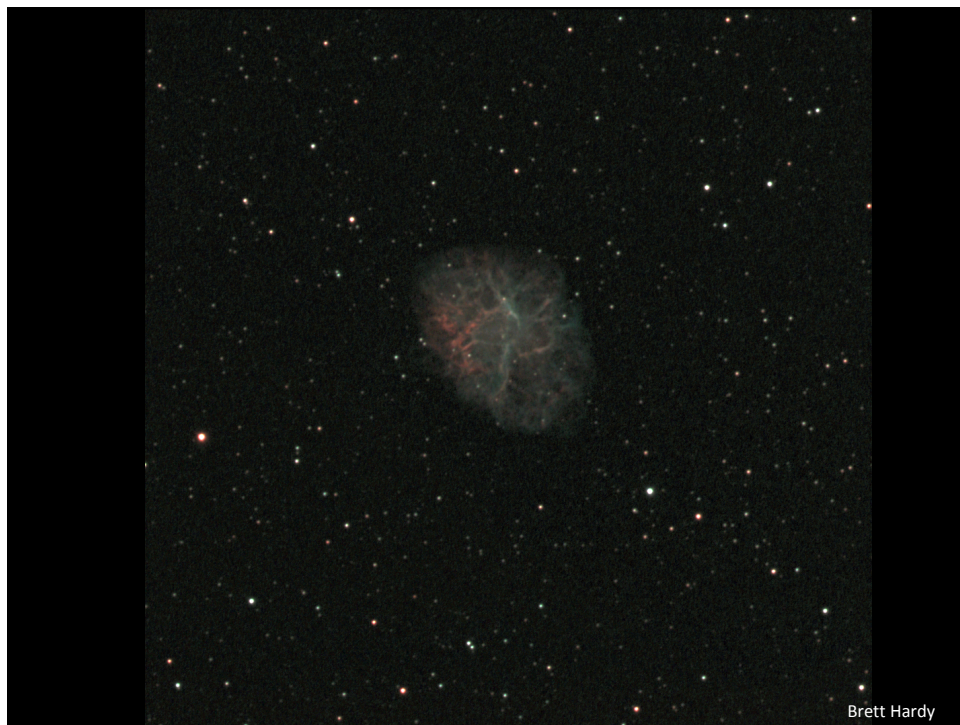
The Entire Electromagnetic Spectrum

CRAB NEBULA



The crab nebula in radio, infrared, visible, ultraviolet, x-ray and gamma-ray wavelengths.

Sources: Radio: NRAO/AUI and M. Bietenholz, J.M. Uson, T.J. Cornwell; Infrared: NASA/JPL-Caltech/R. Gehrz (University of Minnesota); Visible: NASA, ESA, J. Hester and A.Loll (Arizona State University); Ultraviolet: NASA/Swift/E. Hoversten, PSU, X-ray: NASA/CXC/SAO/F. Seward et al.; Gamma: NASA/DOE/Fermi LAT/R. Buehler



Novice Astronomy Class # 10
Deep Sky Objects Part 1
January 6, 2023

