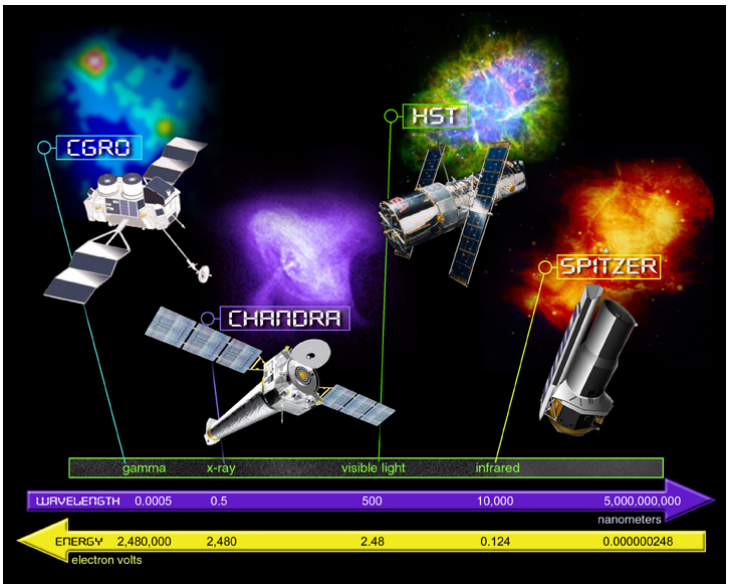
FROM EARTH TO THE Universe

# Activity: Multiwavelength Bingo

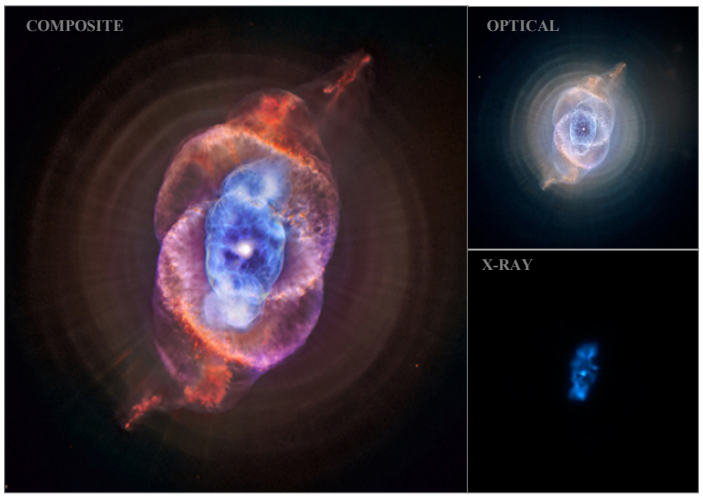
## Background:

Almost everything that we know about distant objects in the Universe comes from studying the light that is emitted or reflected by them. The entire range of energies of light is called the electromagnetic spectrum. Our eyes are sensitive only to a narrow band of electromagnetic radiation called visible light, but luckily NASA's great observatories allow us to look into the invisible!




From high energy, short wavelength to low energy, long wavelength, the electromagnetic spectrum is divided into gamma rays, x-rays, ultraviolet, optical (visible light), infrared, microwaves, and radio waves. The image to the right shows four of NASA's great observatories and the area of the electromagnetic spectrum in which they collect data. By taking a multiwavelength approach to viewing the cosmos, scientists gain a greater understanding of the workings of the Universe.

## What features can you see at different wavelengths of the electromagnetic spectrum?




Cat's Eye Nebula

**Credit: X-ray: NASA/CXC/SAO; Optical: NASA/STScI**

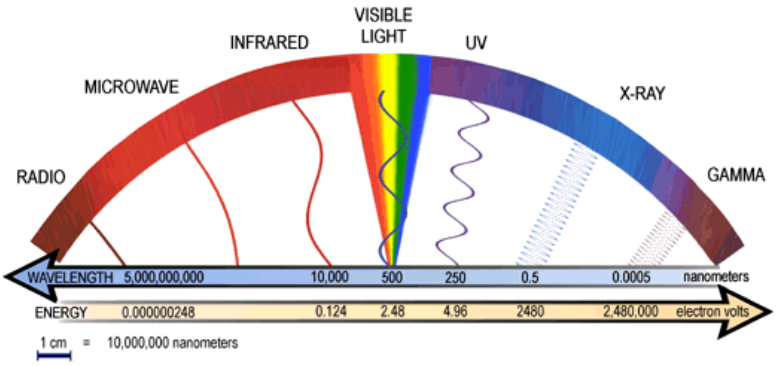
The Cat's Eye Nebula represents a phase of stellar evolution that the Sun should experience several billion years from now. This composite of data from NASA's Chandra X-ray Observatory and Hubble Space Telescope shows various features of this so-called planetary nebula. When a star like the Sun begins to run out of fuel, it becomes a red giant. In this phase, a star sheds some of its outer layers, eventually leaving behind a hot core that collapses to form a dense white dwarf star. A fast wind emanating from the hot core rams into the ejected atmosphere, pushes it outward, and creates the graceful filamentary structures seen in the optical data collected by Hubble. Chandra's X-ray data shows that its central star is surrounded by a cloud of multi-million-degree gas.

for more information on MULTIWAVELENGTH ASTRONOMY AND THE ELECTROMAGNETIC SPECTRUM, visit:

*The Multiwavelength Milky Way*
**http://mwmw.gsfc.nasa.gov/**

*Touch the Invisible Sky*
**http://chandra.harvard.edu/edu/touch/**

*Modeling the Electromagnetic Spectrum*

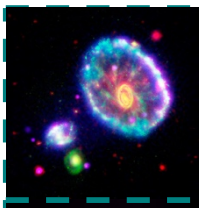
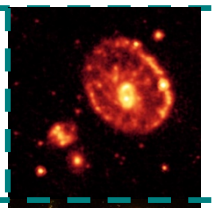
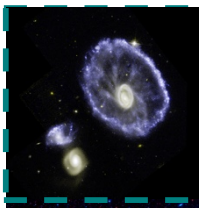
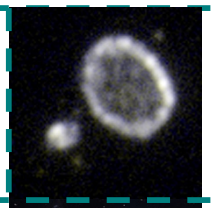
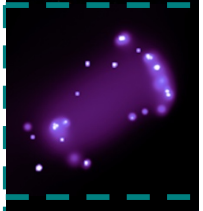
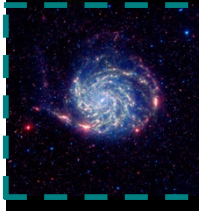
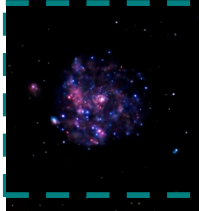
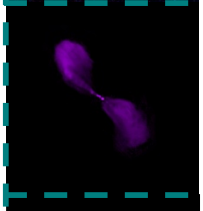
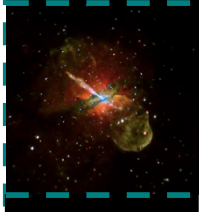
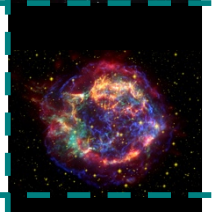
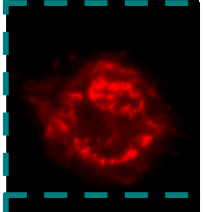
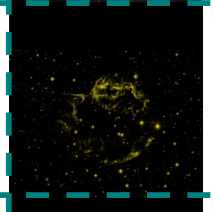
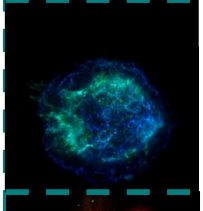
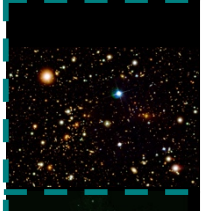
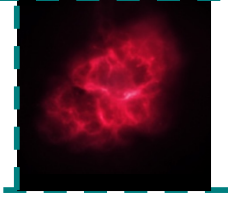
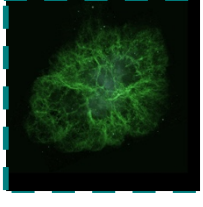
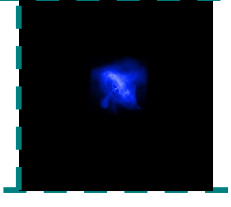



**http://chandra.harvard.edu/edu/formal/ems/**

## How to play multiwavelength bingo:

- ✓ Choose one person to be the "caller." Pass out a bingo board to all other players.
- ✓ Cut out the bingo calling cards along the dotted lines and put them into a container. The caller draws a card from the container, reads it out loud, and puts the card to the side.
- ✓ Players mark the corresponding image on his/her board with a bingo token using the flash cards as a guide.
- ✓ The caller continues drawing cards from the container, until a player has 5 marked images in a row (vertically, horizontally or diagonally) and yells "bingo!"
- ✓ If the caller verifies that the player indeed has bingo, that player wins. If not, incorrect tokens are removed and play continues until "bingo" is called again and verified.

# bingo calling cards

| | | | |
|---|---|---|---|
|  Cartwheel Galaxy composite |  Cartwheel Galaxy infrared |  Cartwheel Galaxy optical |  Cartwheel Galaxy ultraviolet |
|  Cartwheel Galaxy x-ray |  M101 composite |  M101 infrared |  M101 optical |
|  M101 x-ray |  Centauras A composite |  Centauras A radio |  Centauras A optical |
|  Centauras A x-ray |  Cassiopeia A composite |  Cassiopeia A infrared |  Cassiopeia A optical |
|  Cassiopeia A x-ray |  Bullet cluster composite |  Bullet cluster optical |  Bullet cluster x-ray/ lensing map |
|  Crab Nebula composite |  Crab Nebula infrared |  Crab Nebula optical |  Crab Nebula x-ray |