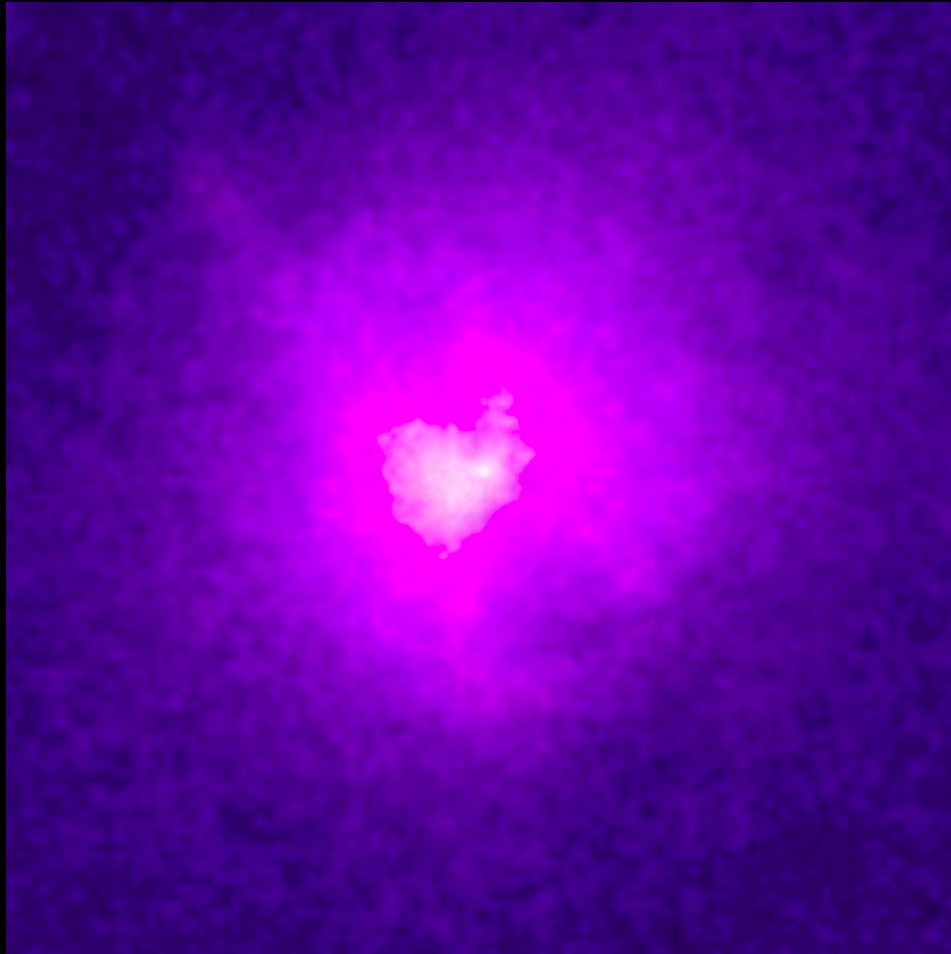
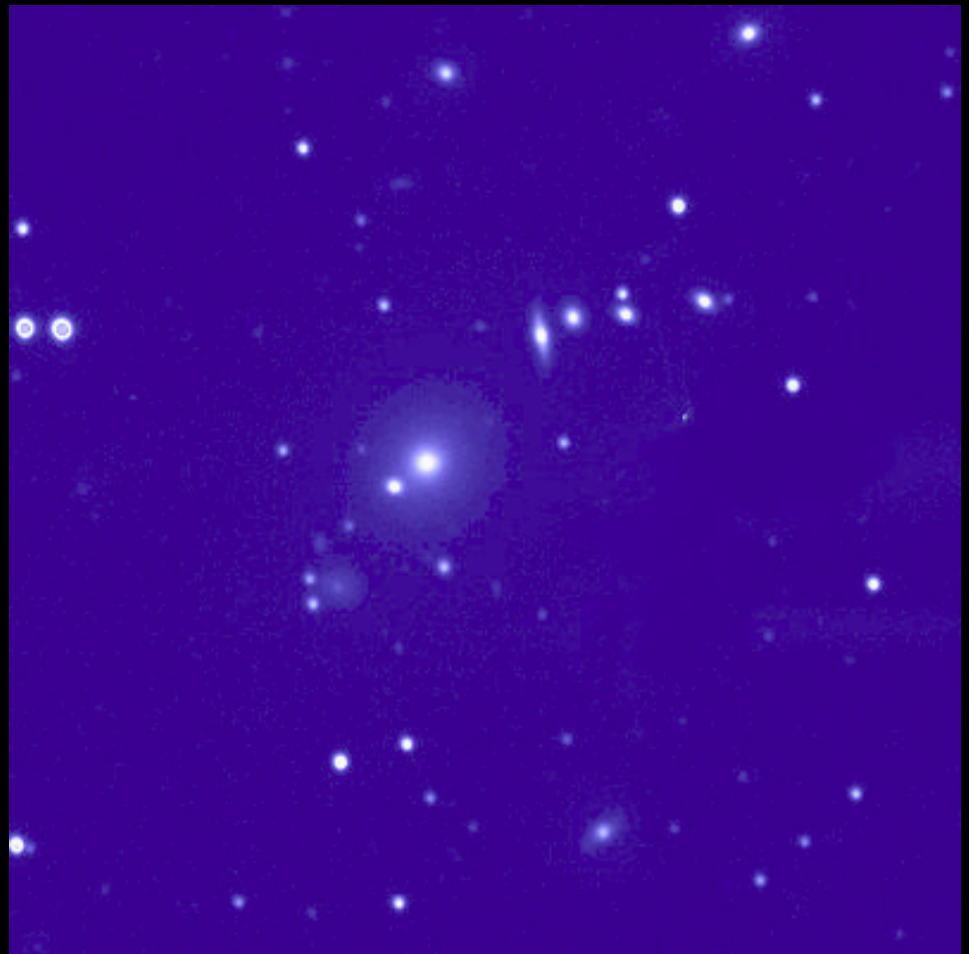


# GALAXY CLUSTER HYDRA A



X-RAY



OPTICAL

# GALAXY CLUSTER HYDRA A



**On the Front:** The galaxy cluster Hydra A is 840 million light years from Earth. The optical image on the right shows many individual galaxies radiating in the visible wavelength. The false color Chandra image on the left, made with the Advanced CCD Imaging Spectrometer (ACIS), shows X-ray emissions. The colors represent the brightness of the X-rays, with white being the brightest. The Chandra image shows the complex inner structure of the large cloud of multimillion degree gas. Long strands of 35 million degree gas are seen expanding away from the center of the cluster. They may be deflected by magnetic fields produced by explosions from the vicinity of a supermassive black hole at the core of the central galaxy. As the largest gravitationally bound objects in the Universe, galaxy clusters provide crucial clues for understanding the origin and fate of the Universe.

## What is the X-ray Universe?

The light produced by stars and clouds of gas in space comes in many forms, from low energy radio waves, through infrared and optical radiation, to high energy X-rays and gamma rays. The "X-ray Universe" refers to the Universe as observed with telescopes designed to detect X-rays. We could equally well speak of "the radio Universe" or "the optical Universe." These are not separate Universes. They are just different ways of observing the same Universe.

## Why observe the Universe with different types of telescopes?

Because many things cannot be seen by even the most powerful optical telescopes. Radio and infrared telescopes observe cool clouds of gas and dust that are a hundred or more degrees below zero. X-ray telescopes observe extremely hot matter with temperatures of millions of degrees. Without different types of telescopes, we would miss many very important discoveries about the Universe.

## Does an X-ray telescope take X-rays of the Universe?

No. The X-ray machine in a doctor's or dentist's office is a source of X-rays. An X-ray telescope is not a source of X-rays. The telescope collects and focuses X-radiation from cosmic X-ray sources onto X-ray detectors. The data from these detectors are then used to make an image of the cosmic X-ray source.

## For the Classroom

The picture on the left shows an optical photograph of the Hydra Cluster of galaxies which is about 800 million light years from Earth. The optical image shows many individual galaxies, but that is only part of the story. By coloring in the numbers on the grid on the right according to the following code: 6 = white, 5 = yellow, 4 = orange, 3 = Pink, 2 = Purple, 1 = Blue, 0 = Black you can make an X-ray image of the same region. The color code represents the brightness of the X-ray emissions due to the concentration of hot gas, from very bright (6) to none (0). The false-color X-ray image reveals the presence of vast clouds of hot gas which contain more mass than all the stars in the galaxies put together. This enormous cloud of hot gas is several million light years across. (One light year is equal to the distance light travels in a year - 6 trillion miles!)

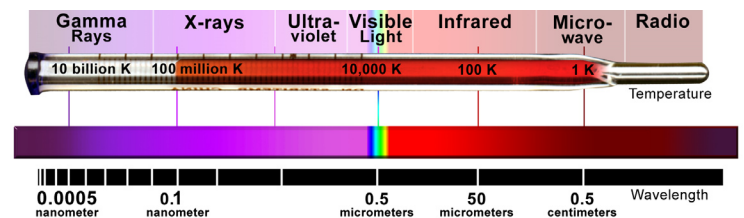


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0	1	1	1	1	1	2	2	2	1	1	1	1	1	0

From the illustration on the right, determine the relationship between the wavelength of radiation from an object and its temperature.

What kind of radiation do humans give off?

For clues, check out the X-ray Astronomy section of our web site at <http://chandra.harvard.edu>.



Relevant to NSES grades 9-12 content standards A (Science as Inquiry), B (Physical Science- Interactions of energy and matter) and C Earth and Space (Origin and Evolution of the Universe).