Seeing the Universe through X-ray Eyes

XMM-Newton studies the universe through three golden X-ray eyes. These eyes are mirrors composed of 58 nested, gold plated cylinders which focus incoming X-rays onto detectors. Part of these X-rays is used for spectroscopy. Part is used for images created by CCD (charge coupled device) X-ray cameras, similar to those found in video cameras. The pattern formed in the CCD in turn is data used to produce our image of the universe.

X-rays are far more energetic than visible light. When we look at X-rays in the cosmos we see things in a different way. The higher energy X-rays reveal hotter more explosive events that tell us about the evolution of galaxies and stellar objects like black holes.

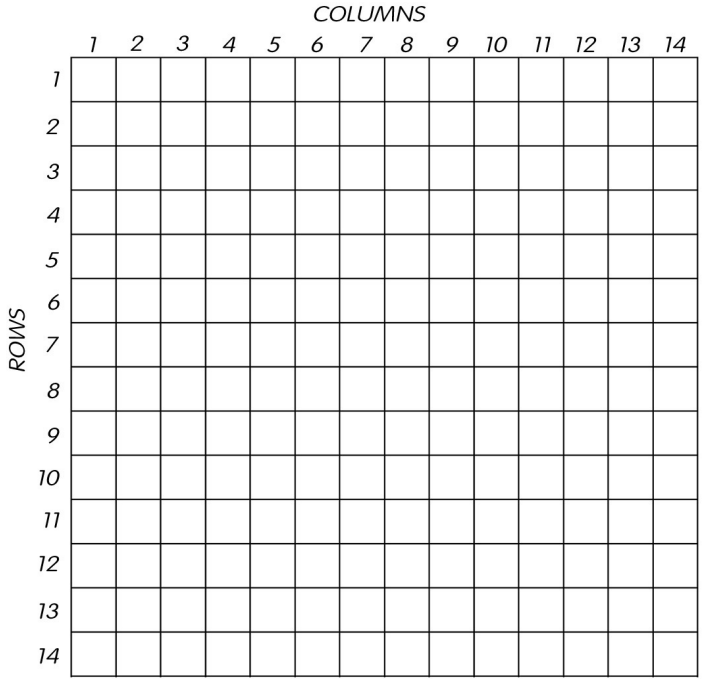
In this activity you will create an image of the Andromeda Galaxy (also known as M31) using approximated X-ray data. XMM-Newton's X-ray mirrors focusing onto a CCD device produced the observation. Using data from the accompanying table, plot the intensity of counts on the grid provided. Actual images from XMM-Newton have more than 500 rows and columns.

You will need yellow, orange, red, and black colored pencils.

Code:
H = High count rate, color the square yellow
M = Medium count rate, color the square orange
L = Low count rate, color the square red
Blank = No counts observed, color the square black

Data Table

R1 C2 = M	R7 C5 = L	R9 C5 = L
R1 C7 = L	R7 C6 = M	R9 C6 = H
R2 C9 = L	R7 C7 = H	R9 C7 = L
R3 C10 = L	R7 C8 = M	R9 C8 = M
R3 C11 = L	R7 C9 = M	R9 C9 = L
R4 C3 = H	R7 C10 = H	R10 C7 = L
R4 C5 = H	R8 C2 = L	R10 C8 = L
R4 C8 = L	R8 C3 = M	R10 C13 = L
R4 C14 = L	R8 C4 = L	R10 C14 = M
R5 C2 = M	R8 C5 = H	R11 C8 = L
R5 C6 = M	R8 C6 = M	R11 C10 = H
R5 C9 = H	R8 C7 = M	R11 C12 = L
R6 C5 = L	R8 C8 = H	R12 C2 = L
R6 C6 = L	R8 C9 = M	R12 C11 = H
R6 C7 = M	R8 C10 = L	R12 C13 = M
R6 C8 = L	R8 C12 = H	R13 C7 = M
R6 C9 = L	R9 C1 = H	R14 C4 = M
R6 C14 = M	R9 C3 = M	
R7 C14 = L	R9 C4 = L	



Questions:

1) What does your X-ray map look like?
2) Is there a pattern to intensities of the X-rays?
3) What do you suppose the highest intensity areas compare to?
4) Compare your work to the image produced by XMM-Newton's project scientists at:
http://outreach.ucsb.edu/xmm/images/27159.jpg
http://heasarc.gsfc.nasa.gov/docs/xmm_lc/edu/fun/activity/image1.jpg
5) Check out an optical image of the Andromeda Galaxy and see the comparison made with the XMM-Newton image . What do you notice?
http://outreach.ucsb.edu/xmm/news/archive/2000/12_15.html
http://heasarc.gsfc.nasa.gov/docs/xmm_lc/edu/fun/activity/image2.gif

Answers

1) A map that has colors representing x-ray intensity. 2) Higher intensity appears in the center roughly surrounded by medium and lower intensity with scattered other points. 3) This is an area of concentration of objects like x-ray binary stars which are black holes or neutron stars associated with a companion star emitting X-rays . There is also a body of hot gas left over from supernova explosions surrounding the objects. 4) The image produced by XMM-Newton scientists has much higher resolution. 5) The two images are very different! This is why astronomers study the Universe in different wavelengths. The area of your map corresponds roughly to the center of Andromeda. This galaxy is considered to be similar to our Milky Way galaxy.

Mission

The XMM-Newton satellite named for its X-ray Multi-Mirror design and after Isaac Newton, investigates the violent processes of the universe by taking images and spectrographic measurements of very hot celestial objects. The resulting elemental makeup of these objects informs theory about the processes of stellar and galactic evolution.

XMM-Newton is an ESA (European Space Agency) mission with NASA instrumentation and support. Launched from Kourou, French Guiana on December 10, 1999, the satellite is returning impressive scientific results. XMM-Newton observed the farthest quasar ever detected, uncovered mysteries in the vicinity of massive black holes, and revealed the detail of supernova remnant X-ray emission.

XMM-Newton about the size of a schoolbus, carries instruments to observe a multiwavelength universe including optical, ultraviolet, and X-ray telescopes. Its 48 hour elliptical orbit allows scientists to make very long and uninterrupted observations.

Education and Public Outreach

This program is designed to inform the public and the education community about XMM-Newton discoveries. Program elements include:

- educational materials aimed at secondary science classrooms
- educator workshops at regional and national science teacher meetings
- a website, aimed at the non-scientist and educator, containing information about X-ray astronomy, the mission, and XMM-Newton discoveries
- an extended educator workshop held during the summer
  classroom visits from XMM-Newton team members

The XMM-Newton website can be found at: http://outreach.ucsb.edu/xmm and at http://heasarc.gsfc.nasa.gov/docs/xmm_lc/