

Scanning Across the Spectrum

Overview: We're going to use some software developed by the European Space Agency (ESA) to view data of distant galaxies. We'll be able to switch between different wavelengths to see different parts of the galaxy light up. At first your goal will be to explore two galaxies using different kinds of wavelengths and take notes and photos of what you find. In the second half of the assignment, you'll be tasked to summarize your findings as you describe the two galaxies, and then compare and contrast what makes the galaxies different. Part of the goal today is to deliberately practice your writing skills, so expect to put in effort to write a couple paragraphs today.

Part 1: We are going to use software made by the ESA to view different galaxies using photographs from a variety of types of telescopes. We will focus on two Galaxies today: M 31 (young galaxy) and M 87 (old galaxy) to see how the galaxies have different shapes, but also because of their age difference they have different types of stars spread throughout them. **For each galaxy you will use a variety of types of light to investigate what stars make up the galaxy and record this using a screenshot and a description.**

1. Open up this link here: <https://sky.esa.int/esasky/>
2. Then click **EXPLORER**
3. Use the table below to help you make sense of what you see in the photographs.

Types of Light and Objects that Produce Them		
Type of Light	Temperature (K)	Typical Sources
Gamma Rays	$> 10^8$ K	Matter falling into Black Holes
X-rays	$10^8 - 10^6$ K	Supernovas
Ultraviolet	$10^6 - 10^4$ K	Very Hot (and young) Stars
Visible	10000 - 1000 K	Cool (medium to old) Stars
Infrared	200 - 1000 K	Cool Dust and Stars Forming
Microwaves	10 - 200 K	Cosmic Microwave Background
Radio	< 10 K	Extremely Cold Dust

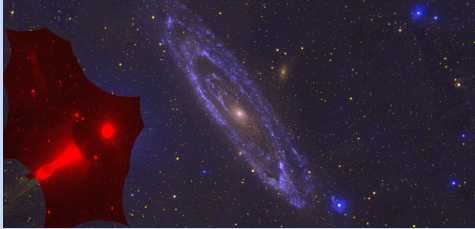
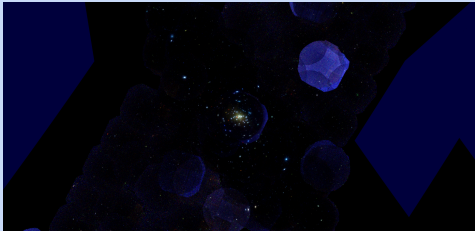
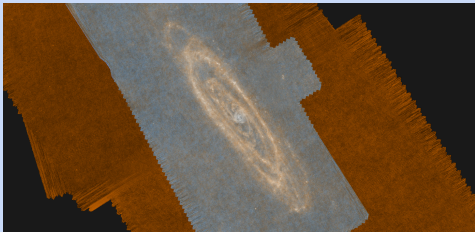
4. For Both galaxies use the software to view the galaxies using the following types of light. Switch between the types of light by clicking the icon in the top left corner which is three colored diamonds. Click the drop down menu on the left and select the light setting you are looking for.

Light Setting in Software	Part of EM Spectrum
Optical	Visible Light
Ultraviolet	Ultraviolet
Soft X-ray (M87 will need to zoom out)	X-rays (lower energy)
Far Infrared	Infrared (lower energy)

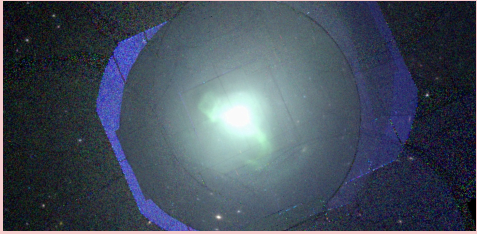
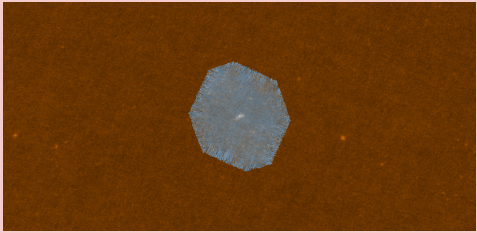
5. For each galaxy and type of light:

- Get a screenshot with the camera icon (like this ) in the top right corner. **And then upload it into this document.**
- Describe with your words where that type of light is showing up in the galaxy
- Describe with your words what type of objects are the likely source of the light (table above to help)
- **And in the visible light section**, describe the shape and overall look of the entire galaxy

M 31 - Spiral Galaxy - Younger galaxy		
Type of Light	Screenshot of the Galaxy	Description
Visible		Describe the Galaxy and where this light is coming from. The galaxies center is the light source/the light is coming from there. The outer side is light but darker then the inside. It looks like a dream. There are some visible/faint rings Describe what kinds of objects are a source for this light. The center, the black hole is the source of the light that is coming from the galaxy. From the stars that are medium to old.

Ultraviolet		Describe the Galaxy and where this light is coming from. The galaxy looks purple/violet there, those locations have gamma stars, new/jung stars. There are visible rings that are around the center. Describe what kinds of objects are a source for this light. The source of the light is the newborn gamma stars.
X-rays		Describe the Galaxy and where this light is coming from. The light is coming from supper novas, the light here is coming more from the center where the black hole is. Describe what kinds of objects are a source for this light. Supper novas are the source of light that we see from the x-ray
Infrared		Describe the Galaxy and where this light is coming from. The galaxy looks yellow and orange the light is coming from the center and the rings around it. Describe what kinds of objects are a source for this light. The light is coming from cool dust and stars forming

M 87 - Elliptical Galaxy - Older galaxy		
Type of Light	Screenshot of the Galaxy	Description

Visible		Describe the Galaxy and where this light is coming from. It looks like a really light/yellow/white ball of light Describe what kinds of objects are a source for this light. The light is coming from stars that are medium to old
Ultraviolet		Describe the Galaxy and where this light is coming from. There is a very faint but visible violet/purple light and there are two main stars in the middle that are making that light Describe what kinds of objects are a source for this light. There are two newborn gamma stars in the middle that are making that violet light
X-rays		Describe the Galaxy and where this light is coming from. It looks like a camera lens, there are these two clouds coming out like hands, the center is really bright Describe what kinds of objects are a source for this light. The light is coming from supper novas and they are mostly in the middle.
Infrared		Describe the Galaxy and where this light is coming from. It looks like a geometric shape where you have a garish color and around it there is orange Describe what kinds of objects are a source for this light. The light is coming from cool dust and stars forming

Part 2: In this section you will write about three paragraphs. I want you to summarize with your words what you found above about each galaxy. So one paragraph per galaxy. Then in your third and final paragraph compare and contrast what makes the two examples different. Try to show what appears to change as a young galaxy (M 31) ages

into an old galaxy (M 87). At this point you have all the data you need to start, you just have to summarize what you have found and explain what makes the galaxies different.

Galaxy M31 looks like it has rings and is so vibrant. In visible light the galaxy looks like a whitish yellow egg yoke in the middle and the flat ends like a frisby/pancake. There are some visible rings around the center and the outside part looks bluish. The light we see is coming from medium to old stars. Under ultra violet light the galaxy looks like only a few rings that are made out of newborn gamma stars. They have this violet/purple shade with a yellow dot in the middle where the black hole is. Under x-ray the galaxy's rings are no longer visible. The light that is seen comes from super novas. The image suggests that there are a few and they are not as bright as M87's. Infrared makes it look like there is gray around the where the galaxy is placed and around the galaxy there is an orange surrounding indicating the void. The rings are visible and they look orangy yellow. The light comes from cool dust and stars forming.

Galaxy M87 in visible light looks like a bright sphere/a bright yellow white ish ball of light. With a glow around it. The light is caused by medium to old stars. Under ultraviolet light the galaxy is made out of two violet dots. Those two dots are new born gamma stars that are the source of the violet light that shines from the galaxy. Looking through x-ray the galaxy looks like an explosion and vibrant. The galaxy looks like it would have a camera lens. One reason why it looks like an explosion and is so bright and huge is because the light comes from super novas that seem to be the brightest in the middle of the galaxy. Infrared makes it look like there is a grayish spot and around it there is an orange void. The light we see comes from cool dust and stars forming. The image doesn't show a lot of light, it looks like there is a dot in the middle that indicates the place of the cool dust clouds and forming stars.

The contrast between the two galaxies is not only visible in their size but also their source of light. Under visible light M31 has rings and it has more light in the center and less further out. Where M87 has the a ball of light that is in one place and not spread out. That means that M31 medium to old stars are more scattered around while M87 has them in one place and it makes it look like a ball of stars and light. M31 under ultraviolet light looks like rings and a bit of uv is also coming from the core. The galaxy has a lot of newborn gamma stars. Galaxy M87 has only two newborn gamma stars and it makes this dim violet glow from the center where the two stars are. Under x-ray light M31 looks like a few dots mostly in the center of the galaxy that indicates few super novas, and the rings are no longer visible. M87 looks like an explosion and there is a really bright light and colors coming from the center and coming out of it. From a distance it looks like a camera lens. Infrared shows us that M31 has cool dust and stars forming, the rings are visible and there is a orangy yellow glow around them. Indicating

that M31 has more cool dust clouds and stars forming than M87. Galaxy M87 has only a few in the center and not a lot of cool dust clouds and stars forming in the galaxy.