International Year of Astronomy 2009 "You are Galileo!" Project

Let's Observe the Andromeda Nebula (M31)

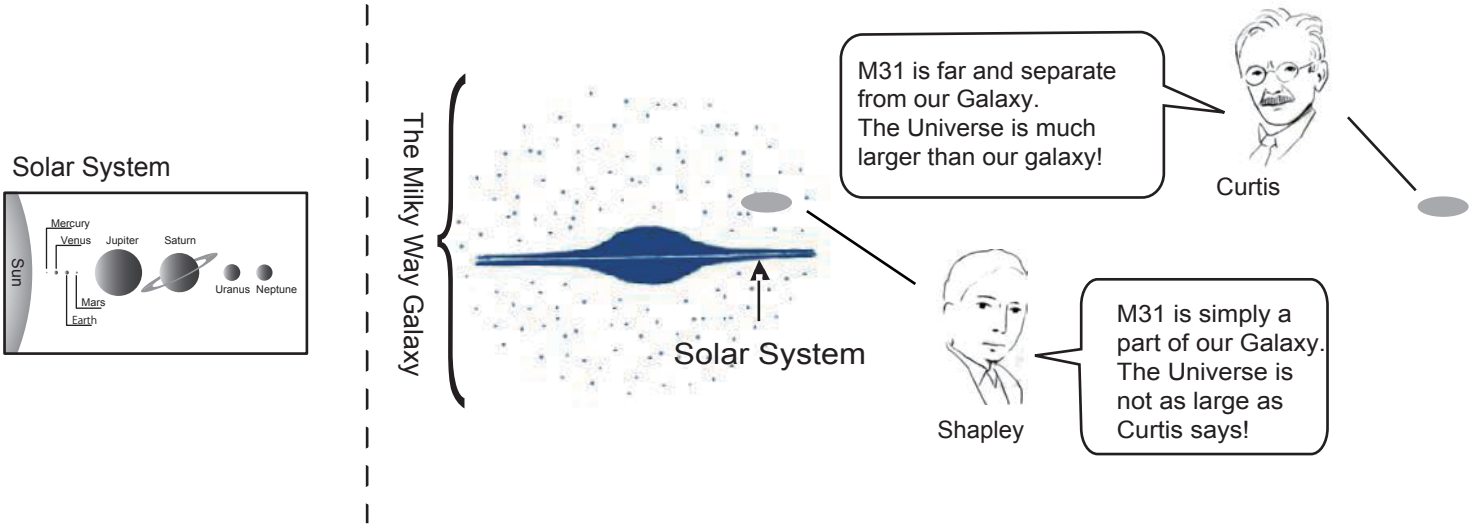
Pre Observation Study

Name _____

80 years ago, there was a great debate concerning the nature of M31. It took Edwin Hubble's observation to reveal the true nature of M31. This caused a breakthrough in our understanding of the Universe. What is M31? Let's see for ourselves using a telescope!

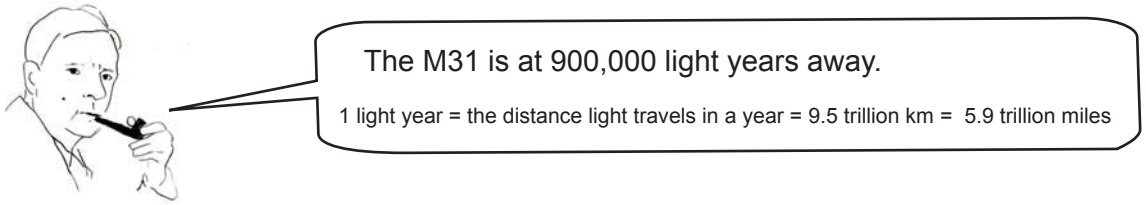
■About 80 years ago, we did not know what M31 was. The primary problem was whether M31 resided in our own Milky Way galaxy or whether it existed outside of the Milky-Way Galaxy independently. In 1920, the Great Debate over this problem was held between two American astronomers:

Harlow Shapley and Heber Curtis.



■ This Problem was later solved by another American astronomer Edwin Hubble.

Hubble identified and observed cepheid variable stars, which are used to estimate distance, in the M31.



■This was three times larger than the diameter (size) of our galaxy estimated at that time by Shapley: 300,000 light years.

Thus, ( ) was right! → The universe is far larger than our galaxy!

(In our current knowledge, the stellar disk of our galaxy is approximately 100,000 light-years in diameter, and M31 is 2.3 million light-years way from us.)

■What is the nature of this M31? What could it be?

Now let's observe the Andromeda Nebula and draw a sketch of it. Then, consider what it is.

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Let’s Observe the Andromeda Nebula (M31)

Observation & Sketch Worksheet

Name

Address

Age

■Let’s observe and make a sketch of M31

Observation Date : Month Date Diameter of Telescope cm

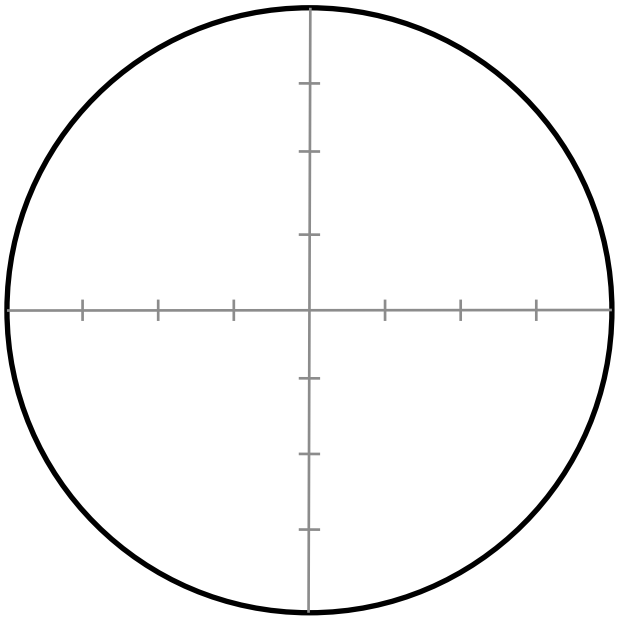
Place of Observation Power x Field of View °

* The power of the telescope can be determined by dividing the focal length of the telescope with the focal length of the eyepiece.

* The field of view depends on the telescope and eyepiece, so check the their manuals or the vendor’s web page.

Draw a large sketch and make it as detailed as possible.

Draw the size of M31 relative to the field of view of the telescope



■Write down what you noticed, and note anything you find in particular.

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Post Observation Study

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Let’s Observe the Andromeda Nebula (M31)!

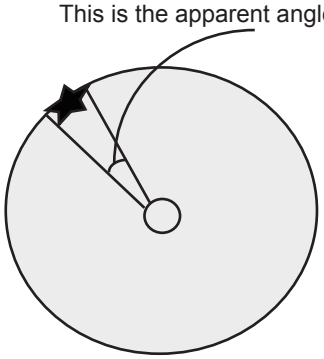
Name _____

■Since M31 is at so far away, it looks very small. How big is it actually?

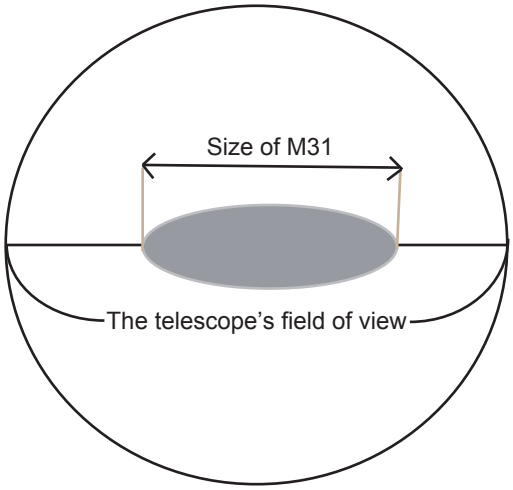
Let’s calculate using our sketches!

■First, let’s find the apparent size of M31 in angler degrees.

This is the apparent angle of the width of a celestial object projected on the celestial sphere.



■Calculate the apparent angle from the size of M31 relative to the telescope’s field of view.



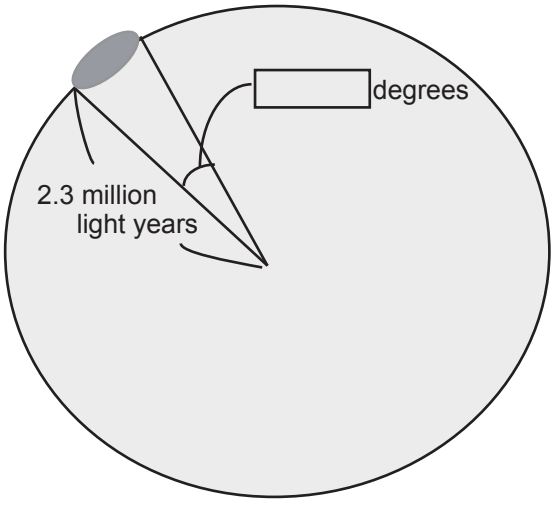
The apparent size of M31 (in angle units)

$$= \frac{\text{Size of M31 on your sketch (in cm)}}{\text{Telescope's field of view on your sketch (in cm)}} \times \text{Telescope's field of view (degree)}$$

$$= \frac{\square\ \text{cm}}{8\ \text{cm}} \times \text{Telescope's field of view (degree)}$$

$$= \square\ \text{degrees}$$

■Let’s calculate the actual size.



We want the length of circular arc of a circle with a radius of

2.3 million light years and an angle of ☐ degrees, so...

Apparent size of part of M31 you sketched = degrees

$$2.3 \text{ million light years} \times 2 \times 3.14 \times \frac{\square}{360}$$

$$= \square\ \text{light years}$$

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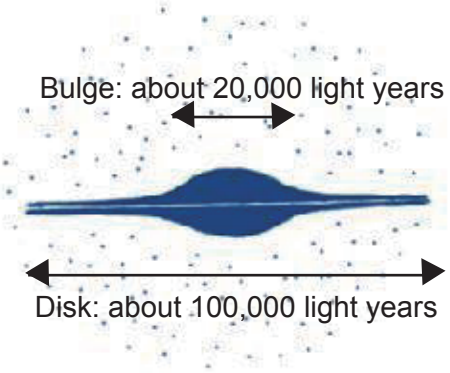
■The size of the M31 we saw in the telescope was [ ] light years.

Then, how large is M31 compared to our galaxy?
In our observation, did we see the whole M31?
What might M31 be?
→ Let us compare M31 and our Milky way Galaxy.

↓ Our Galaxy (a model of the view from the side)



The size of the disk of our Galaxy is about 100,000 light years. The bright part in the center is called the bulge. The diameter of the bulge is about 20,000 light years.

↓ M31 taken with a telescope with a diameter of 7.6 cm and long exposure time.

Unlike when you observe it with a 4 cm telescope, you can see that the center of M31 is very bright. A 7.6 cm telescope can gather more light, so you can observe lights that you could not see with a 4 cm telescope. With the 4 cm telescope, you were only looking at the bright section in the center.

→ Write down your own thoughts.

■Write down what you’ve learned today and what you would like to learn more about.

M31 is separate galaxy outside of our galaxy. We were looking at the bright bulge in the center of M31.

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