

# Distance to a Spiral Galaxy

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## 1 Background

Knowing the distance to other galaxies is quite important to astronomers. This is because all measurements of each galaxy, such as mass and luminosity, are based on the distance to that galaxy. If the distance measurement is wrong, then the measured mass and luminosity are also incorrect.

It turns out that there is a very simple method to determine the distance to close spiral galaxies, such as Andromeda and Bode's Galaxy (M81). When looking through a small telescope or binoculars, you cannot see the entire galaxy, you only see the core. If we assume that the core is 15,000 lightyears across, then through geometry we can calculate the distance to Andromeda or Bode's Galaxy

## 2 Materials

Small telescope or binoculars

Medium power eyepiece

Finder chart

Paper

Pencil

Stopwatch

Calclater

### 3 Procedure

1. First, you must obtain a finder chart for you galaxy. You may use the Sky and Telescope website, planetarium software, or planesphere.
2. Go outside to a place with little light pollution. Using your finder chart, find the galaxy.
3. Line up your telescope or binoculars so that the galaxy is in the center of your field of view. Note that you will not see arm structure.
4. If you are using a telescope, turn off the tracking.
5. Notice which direction the galaxy will drift.
6. Line up the galaxy in the center of your field of view again.
7. Let the galaxy drift. Once the edge of the galaxy has reached the edge of your field of view, begin your stop watch.
8. Stop your stop watch once the galaxy is no longer visible. Write this time in Table 1.
9. Repeat two more times, recording your results in Table 1.

### 4 Analysis

Table 1: Galaxy Distance Data

Time (min:sec)	Time Elapses (sec)	Number of galaxies/circle	Circumference (lightyears)	Distance (lightyears)

Convert the time in Column 1 into seconds. Write this value in Column 2.

1. How many hours:min:sec are around the Celestial Sphere?
2. How many seconds are around the Celestial Sphere?
3. Divide the seconds around the Celestial Sphere by the value of Column 2. Write your answers in Column 3.
4. Calculate the circumference of the circle defined by the galaxy with the Earth at the center. Make the assumption that the core of the galaxy observed is 15,000 lightyears across. Write this value in Table 1.
5. You have the circumference of the circle defined by the galaxy. We want the distance to that galaxy. This means we need to calculate the radius of the circle defined by the galaxy. This is the distance to that galaxy. The formula that relates the circumference of a circle to the radius is

$$C = 2\pi R \tag{1}$$

Solving for the radius, we get

$$R = C/2\pi \tag{2}$$

Write your answers in Table 1.

## 4.1 Results

1. What is the average distance you measured to the galaxy?
2. The actual distance to Andromeda is 2.2 million lightyears and the distance to Bode's Galaxy is 12 million lightyears. Using the your calculated average distance and the actual distance, calculate your percent error using

$$Err = (actual - observed)/actual * 100\% \quad (3)$$

3. What are the sources of error?