# The Expansion of Space

*This activity is designed to help students understand the nature of our expanding universe, and how galaxies that are farther from us appear to be moving faster than galaxies that are nearby.*

## Materials
- different-sized washers or paper clips (set of 10 per group)
- elastic bands of identical thickness and different lengths (15 per group)
- ruler or metre stick

## Procedure

### Part 1: Measurements

1. Create a "chain of galaxies" by attaching each galaxy—a washer or a paper clip—to elastic bands. Be sure to use different sizes of washers or paper clips and to vary the distances between the galaxies by using a variety of lengths of elastic bands. Loop the elastics around themselves when attaching them to the washers or paper clips.

2. Each group will determine the distance between galaxies using a different measurement unit, for example, centimetres, metres, floor tiles, inches, feet, or hand lengths.
Unit Choice: _____

3. In a large space, such as a hallway, place your galaxy chain on the floor, leaving it unstretched.

4. Choose your group's home galaxy from your chain, and record in Table 1. Measure the distance from your home galaxy to the other galaxies in your chain. Record your measurements in column 1 of Table 1.
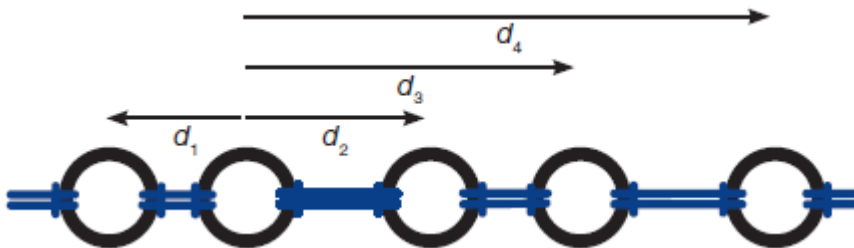
*Measure the distances ($d_1$, $d_2$, $d_3$, $d_4$ etc.) from your home galaxy to all the other galaxies.*

5. Now the universe needs to expand. A group member is positioned at each end of the galaxy chain, then they each pull their washers such that the universe doubles in size (from end to end). A third group member repeats Step 4 and measures the new distances to the galactic neighbours. Record your measurements in column 2 of Table 1.
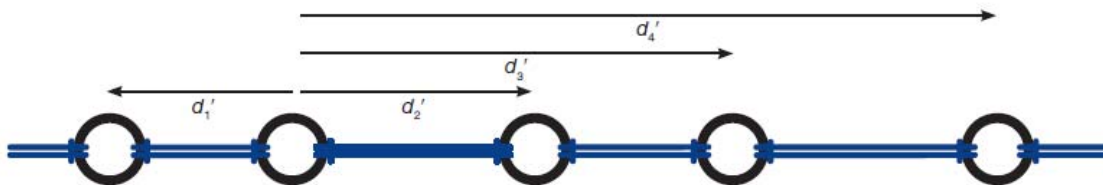
*Measure the stretched distances ($d_1'$, $d_2'$, $d_3'$, $d_4'$ etc.) from your home galaxy to all the other galaxies.*

## Part 2: Plotting and Comparison

6.  Complete column 3 of Table 1 by calculating the increase in distance between the two measurements in columns 1 and 2.

*Table 1* - Galaxy Distance Measurements

| Home Galaxy Number: _____ | Original Distance (unit) | New Distances (unit) | Increase in Distances (unit) |
|---|---|---|---|
| Galaxy _____ | | | |
| Galaxy _____ | | | |
| Galaxy _____ | | | |
| Galaxy _____ | | | |
| Galaxy _____ | | | |
| Galaxy _____ | | | |
| Galaxy _____ | | | |
| Galaxy _____ | | | |
| Galaxy _____ | | | |

1.  Graph the data from Table 1, with the original distance (column 1) on the horizontal axis and the increase in distance (column 3) on the vertical axis. Be sure to label both axes and include your chosen measurement units. Draw a line of best fit, and calculate the slope. Be sure to include all units.
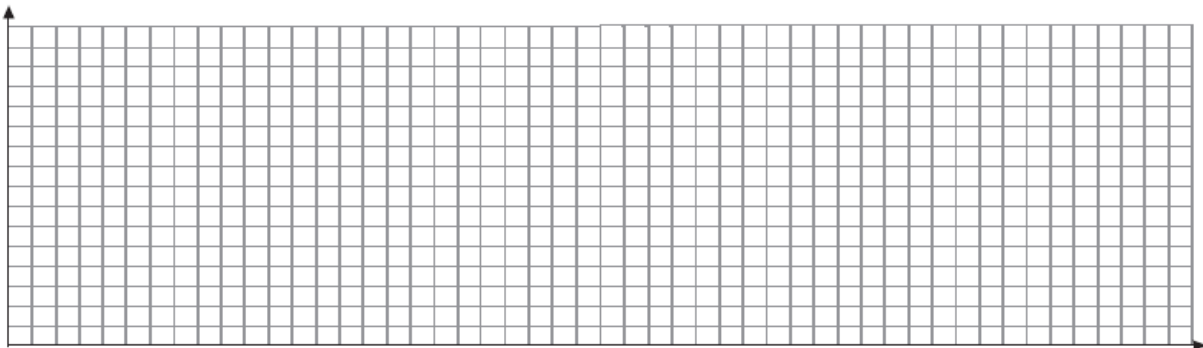


**Inquiry**

1.  Describe how the positions of the distant galaxies changed compared to the positions of the nearby galaxies.

2.  How would the chain look if the slope value were higher? Lower? How would you describe the universe if the slope were higher? Lower?

3.  If the universe is expanding, why don't the sizes of the galaxies expand as well?