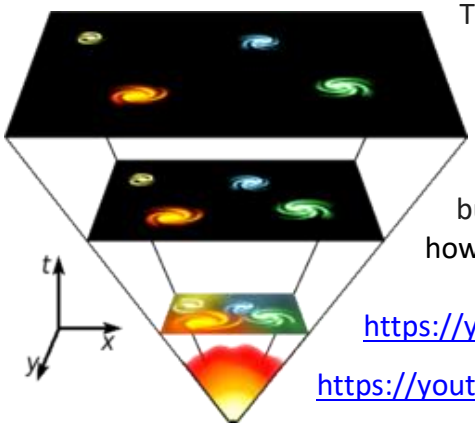
DoD STARBASE
A Department of Defense Youth Program

ASTRONOMY

The Expanding Universe

The universe began very hot, small, and dense, with no stars, atoms, form, or structure (called a "singularity"). Then about 14 billion years ago, space expanded very quickly (thus the name "Big Bang"). This started the formation of atoms, which eventually led to the formation of stars and galaxies. It was Georges Lemaître who first noted (in 1927) that an expanding universe could be traced back in time to an originating single point. The universe is still expanding today but getting colder as well. Click on the videos below to learn more about how our Universe Expands!



https://youtu.be/HZ7hwUduMoU

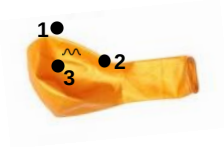
https://youtu.be/6PiyUjVxukI

MATERIALS:

- 12” round balloon
- Black marker
- Paper clip
- Measuring tape (centimeters side) or ruler (using centimeters side)
- Stopwatch (you can use an app on your phone for this)
- Data table SHEET

PROCEDURE:

BEFORE INFLATING THE BALLOON:



1. With the marker make three dots on the balloon (1-2-3). *Don’t put the dots on a straight line*. These will be the Galaxies.
2. Measure the distance of the dots in cm.
3. Then draw a wave ∿ this will represent the “*redshift*”.
4. Measure the wavelength from end to end.

INFLATING THE BALLOON:

1. Take the stopwatch or app before blowing slowly into the balloon; take the time lapse for every circumference as seen on data sheet.
2. Blow the balloon to a circumference of 40cm and make the measurements, blow to a 50cm circumference and make the measurements and last blow to a 60cm circumference and make the last measurements. Bend the end of the balloon down and paper clip it so that no air escapes.
    - Remember the measurements are both on the dots and the wave. See Data Sheet
3. To calculate the average speed of the galaxies take the last measurement of 60cm circumference (d_4) minus measurement before inflating the balloon (d_1) and divide by the total time (t).

$$\frac{d_4 - d_1}{t}$$

Expanding Universe Data Sheet

Distance between Galaxies	Measurement before inflating the balloon d_1	Measurement at 40 cm circumference	Measurement at 50 cm circumference	Measurement at 60 cm circumference d_4	Average Speed of Galaxies (d_4-d_1/t)
1-2	_____cm	_____cm	_____cm	_____cm	____cm/sec.
2-3	_____cm	_____cm	_____cm	_____cm	____cm/sec.
3-1	_____cm	_____cm	_____cm	_____cm	____cm/sec.
Wavelength	_____cm	_____cm	_____cm	_____cm	___cm/sec.
Time Lapse	_____sec. to 40cm	____sec. to 50cm	____sec. to 60cm		**Total Time** _____sec.

Answer the following questions:

1. If the dots represent galaxies, do they get larger as the balloon expands? Why do you think this is or is not?

   _____

   _____

   _____

2. What relationship exists between the speed of the galaxies moving apart and their initial distance from one another?

   _____

   _____

3. The wave represents the light emitted from the galaxies, what do you think is happening in this demonstration? Why? (Use videos as reference)

   _____

   _____

   _____

4. What happens to the wavelength when the distance of the galaxies increases?

   _____

   _____

   _____