

Redshift / Blueshift HO

NAME _____

Station 1: Historic Galaxy Spectra

Read the article describing how to interpret the spectra images. Once you have done so, please use the spectra images to answer the questions below.

1. Explain what astronomers measure in each spectra to determine the direction and speed of the galaxy.

They measure the amount of redshift or blueshift by comparing the “Hydrogen” line that appears most clearly in many galaxies and stars. The more the line shifts the more velocity the object has.

2. Given your knowledge of the images, which colors of the rainbow must be on the left and right sides of the spectra?

The right side is the red side, and the left side is the blue side.

3. As galaxies have more and more redshift, how would you expect their velocities to change?

More and more redshift should increase their velocity given them a more and more positive velocity (or faster and faster AWAY from Earth)

4. The top galaxy spectrum is quite thick and they get progressively thinner as you go down the page. What do you think is the cause of the different galaxy spectra thicknesses?

This is a what do you think question, but the top one is quite thick because this galaxy is quite bright, while the spectra get thinner because the galaxies get farther and farther away which makes them less and less bright.

Station 2: Calculating the Velocities of Galaxies

Use the spectra and instructions at the station handout to fill out the table below and calculate how fast these galaxies are moving **and** which direction they are moving.

Galaxy Spectral Shift Table				
Galaxy	Hydrogen Spectral Line Location (nm)	Wavelength Shift (nm)	Velocity (km/s)	Direction (Away or Closer)
Virgo A	658.8 nm	2.8 nm	1280 km/s	Away

M65 Spiral in Leo	657.8 nm	1.8 nm	823 km/s	Away
Andromeda	655.4 nm	- 0.6 nm	-274 km/s	Closer
Human Eye	1 nm	1 nm	457 km/s This is about 1 million mph	---

Station 3: Redshifting Galaxies from Universe Expansion

Galaxy	Redshift (km/s)	Distance (Mpc)	Distance in lightyears
A	2500	38.7 Mpc	126,162,000
B	13500	209.3 Mpc	682,318,000
C	3900	60.5 Mpc	197,230,000
D	7400	114.7 Mpc	373,922,000
E	9600	148.8 Mpc	485,088,000

Step 3: How far does an object need to be in order for Universal Expansion to be visible to the human eye?

$2280 / 64.5 = 35.3 \text{ Mpc}$ or $35.3 \times 3260000 = 115,000,000 \text{ light years}$ (so pretty darn far)

Step 4: Can we use telescopes to see stars affected by Universal Expansion?

Since the far limit of telescopes is 100,000,000 light years, we **cannot observe stars that are redshifting due to universe expansion**, but we can see galaxies (which are easier to see) redshifting from universe expansion.

Station 4: Finding Exo-planets through Redshift - Blueshift

After reading the article online, please work together as a small group to answer the questions below.

1. What causes the redshift and blueshift in the radial velocity method?

The motion of a star as it wobbles / orbits under the gravitational force from it's nearby planets. Motion towards Earth causes blueshift and motion away causes redshift.

2. What is an exoplanet?

A planet that is not in our solar system (so it most likely orbits a different star(s))

3. What are two advantages of the Radial Velocity Method?

It is one of the first and easiest to do methods for finding exoplanets. Telescopes do not need to constantly track a star and they can also be on Earth instead of in space (which some methods require).

4. Using the blue graph, what do you think is the Period of the 51 Pegasi exoplanet?

The period is 4.231 days, which means one "year" for this exoplanet is only 4.2 days, which is wild.

5. What are two disadvantages of the Radial Velocity Method?

- This doesn't find the mass of the planet, just it's minimum mass, which is better than nothing but leaves many unknowns.
- Only detects movement **DIRECTLY away or DIRECTLY towards** Earth, so systems that orbit perpendicular to ours will be invisible and most orbits are only partially in our direction so they will give estimates that are too small.
- Generally either locates small binary stars (so not planets) or "Hot Jupiters" which are massive gas giants right next to their stars which would be very inhospitable for life. Either way, we're not finding the next Earth to go visit.