AIP
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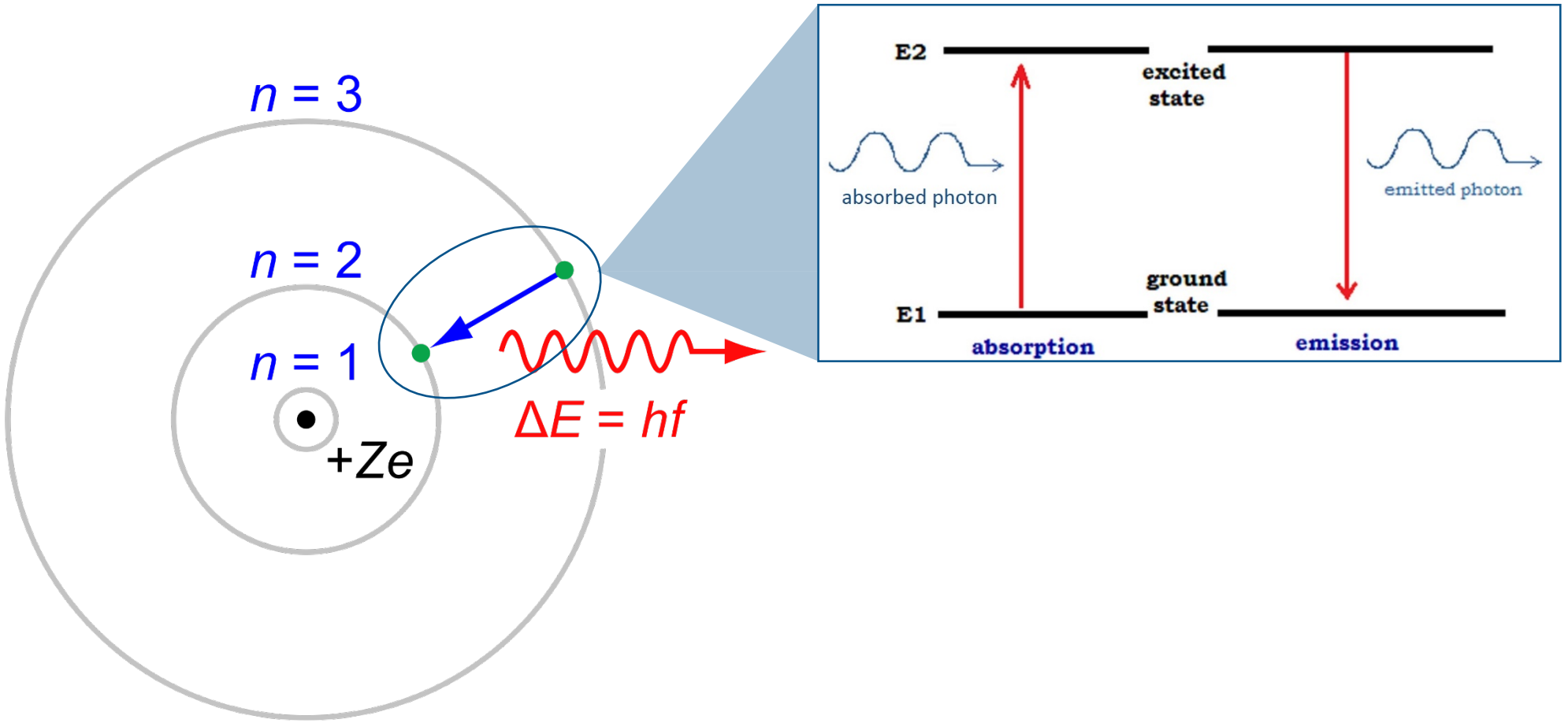
Spectra and Margaret Huggins

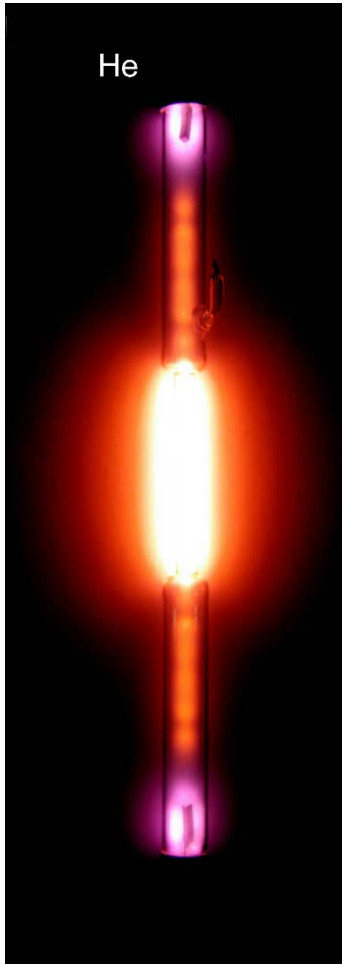
Prepared by the Center for the History of Physics at AIP

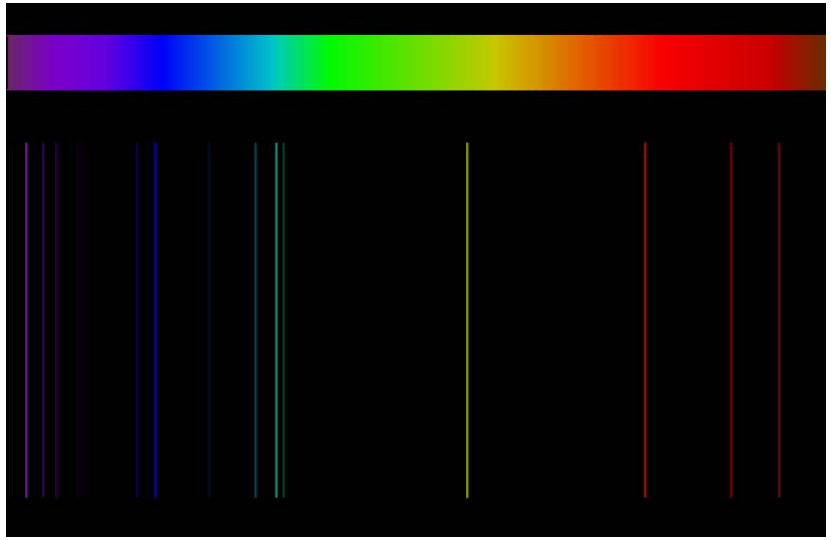
Atoms of Different Elements Absorb/Emit Light of Characteristic Frequencies



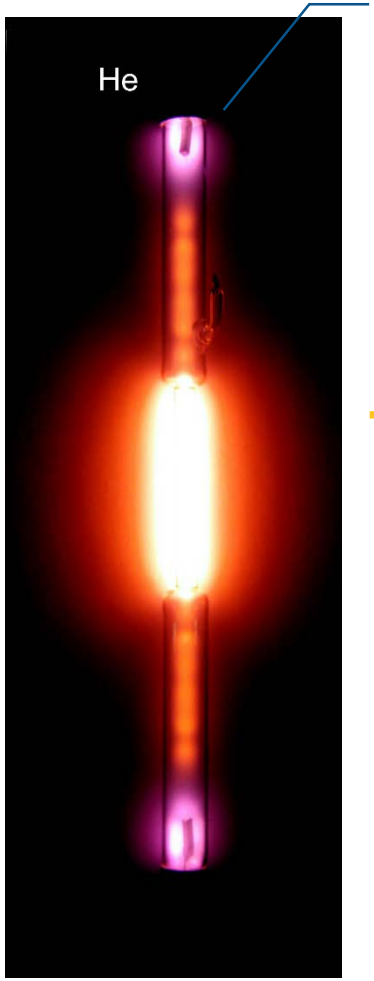
Images courtesy of Wikimedia Commons

Atoms and Energy are Needed to Produce a Spectrum, We Need to Split Up the Light to See It





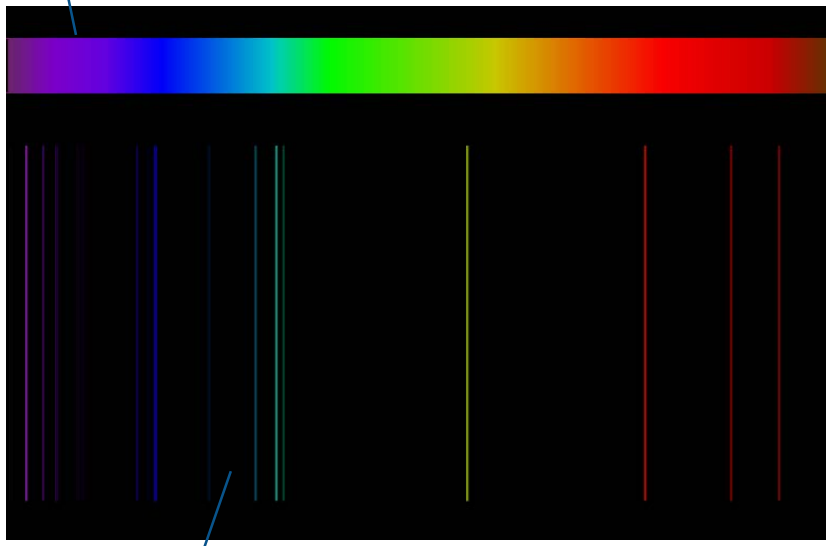
Viewing Spectra



Electricity is run through a glass tube containing Helium. The electricity excites the atoms of gas, which emit light as their electrons fall back to their ground states.

Glasses with diffraction gratings for lenses split up the light into its separate colors

Through a diffraction grating, white light looks like an entire rainbow.

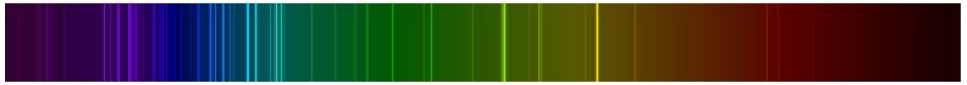


The excited gas emits light at specific wavelengths that we can see as lines of specific colors.

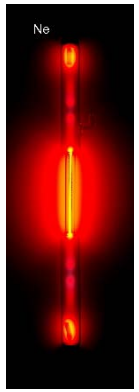
Different Elements Emit Light of Different Wavelength, Their Spectra Look Different

Xenon

Argon



Krypton

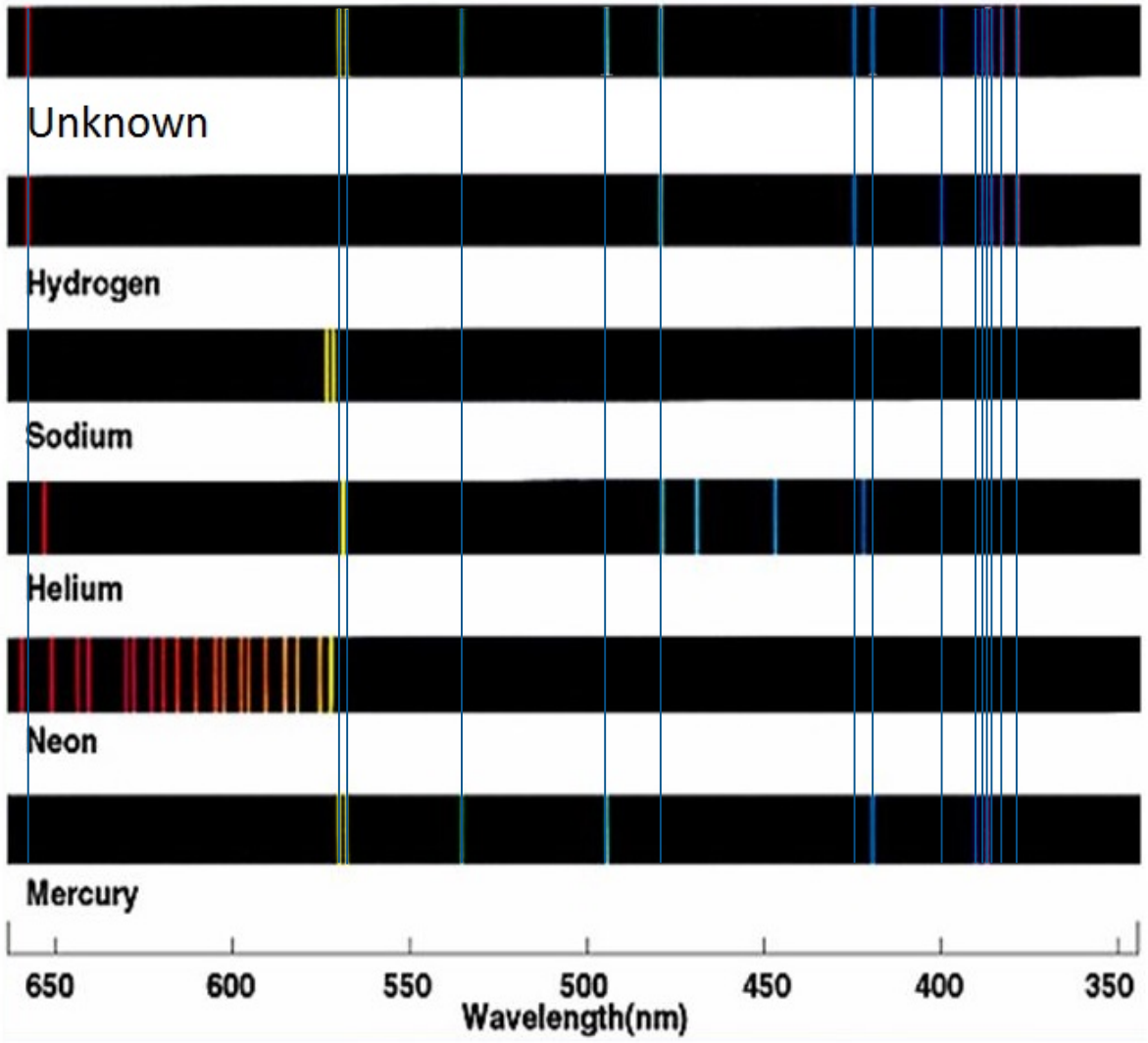


Neon

Comparing Spectral Lines

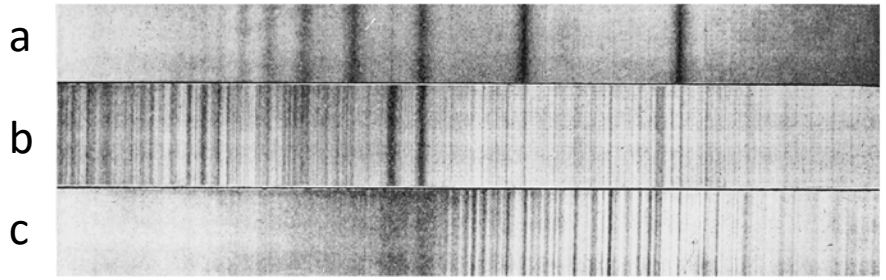
Which elements are likely present in the unknown object?

Hydrogen and Mercury



Margaret Huggins: Early Astronomer/Spectroscopist

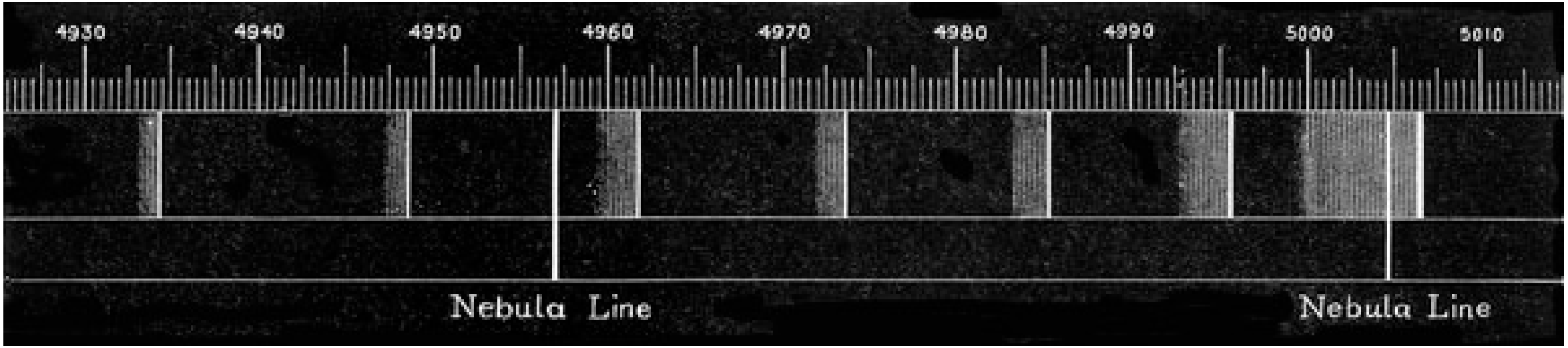
- Margaret Huggins was a late 19th century astronomer.
- She worked with her husband, William Huggins, in his private observatory in Tulse Hill, England.
- They were pioneers in the field of spectroscopy (the science of studying spectra).
- Used spectra to learn about the sun, other stars and nebulae.
- She used her background in photography to facilitate early spectroscopic photography.



Huggins's photographs of characteristic spectra of (a) white, (b) yellow, and (c) red stars.

Margaret Huggins

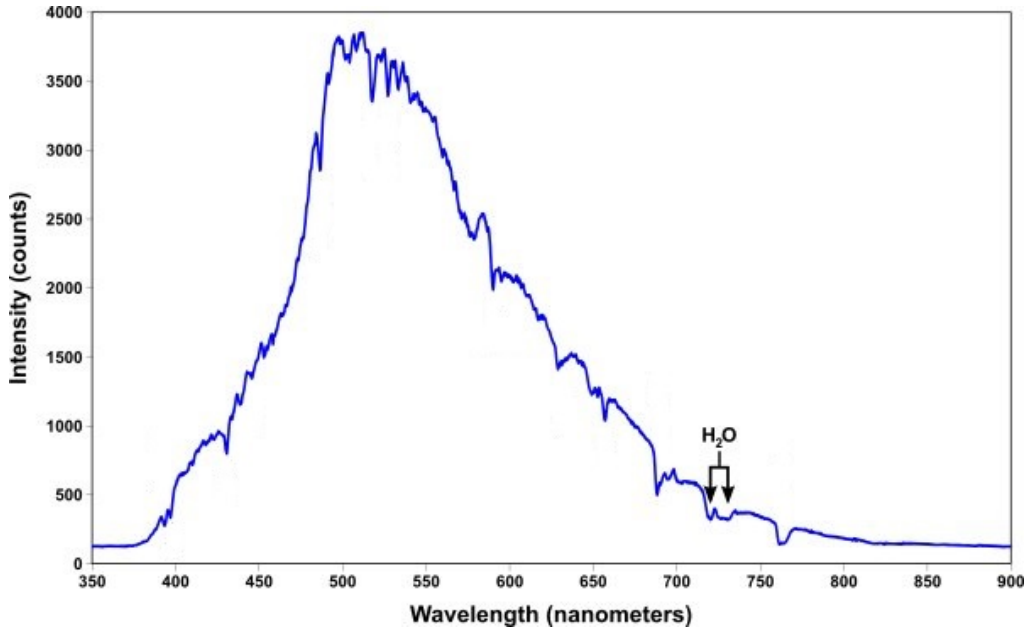
- Margaret and her husband used both photographs and drawings of spectra to study objects in space.
- Another astronomer, Joseph Norman Lockyer, claimed that nebular spectra contained magnesium lines. Margaret and her husband correctly disputed this claim, the nebula that they and Lockyer were observing did not contain magnesium.



The Hugginses' illustration comparing the visible magnesium spectrum with that of a nebula (1882).

Modern Spectra are Plotted on Graphs

- Spectra are usually plotted on graphs whose axes are wavelength and flux, which shows how much light of each color we are getting from an observed object.
- Emission/absorption lines are seen as dips or bumps on the spectrum



This is a spectrum of Earth's clear sky. The dips are absorption features, like the ones labeled H_2O .

Measuring Redshifts Tells Us About the Position and Motion of Objects in Space

- There are two types of redshift
- Doppler shift is the change in wavelength of light caused by the relative motion of the source toward or away from the observer. Astronomers can measure this shift and figure out how quickly an object is moving toward or away from the Earth
- Cosmological redshift is caused by the expansion of the universe. Light from distant galaxies is redshifted because space has expanded during the light's journey (causing the wavelength of the light to increase, making it appear more red). Cosmological redshift is dependent only on the distance between the observer and the object, so measuring this effect allows astronomers to calculate how far away an object is from Earth.

Two Types of Redshift

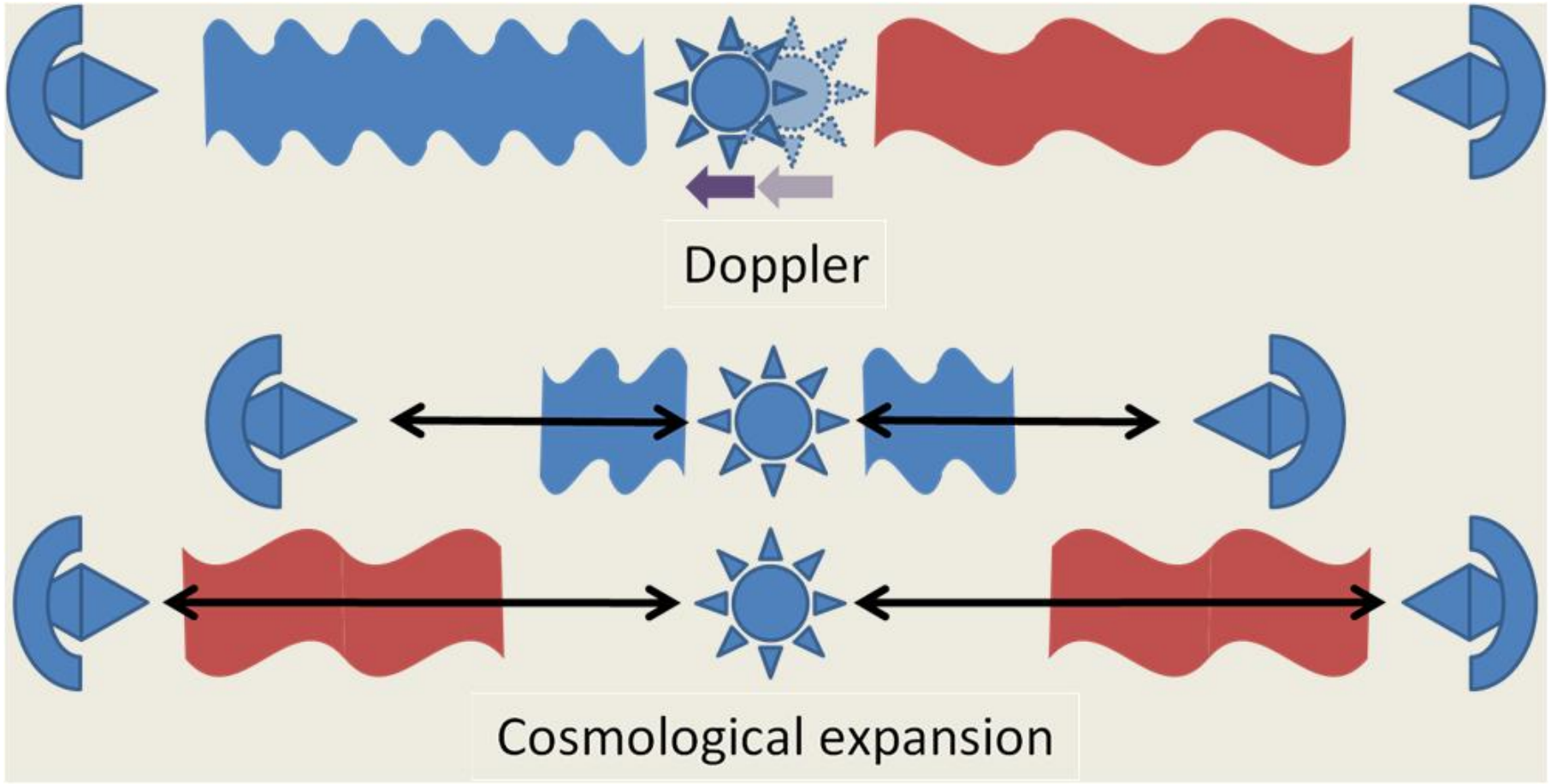


Image credit: Radu Mares