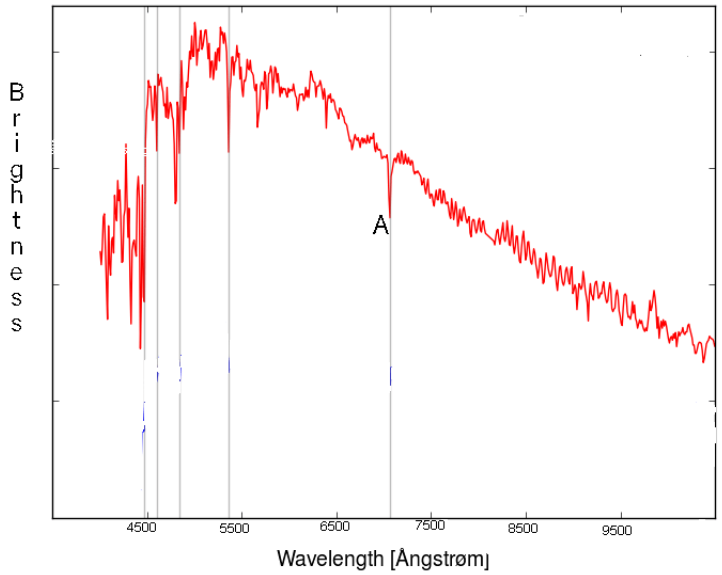
A star party

A group of aliens is throwing a massive party in the Andromeda Galaxy. One alien, realizing that they'd been invited just minutes before the event, speeds off as quickly as they can to make it on time. Of course, they drag along a customary gift: a solar-mass star. 2×10^6 years later, you receive the below data from that very star. Let's piece together some of the information we have.



(a) Notice the feature at **A**.[1] What is this feature called? Are all the photons of that wavelength absent? If not, what is the characteristic energy of one of these photons?

(b) One of your colleagues notes out that this line is somewhat offset from the H α line, which should be about 656 nm. If that's the case, is the star's light redshifted or blueshifted? How fast does this imply that the star is moving?

(c) From the alien's perspective, was the Sun's light redshifted, blueshifted, or unaffected? Why?

[1] Adapted from data used by the IceCube neutrino search team from the Las Cumbres Observatory. For the original paper, see: Multiwavelength Follow-up of a Rare IceCube Neutrino Multiplet.

(d) How hot is the star? Express this in Kelvin, Fahrenheit, and "Solar Temperatures." Note that the Sun's temperature is 5778 K.

(e) What is this star's energy flux output?

(f) Assume that this star is the same size as our Sun ($R_\odot = 7 \times 10^5$ km). What's the star's luminosity?

A difficult transition

(a) How are emission and absorption lines formed? Which are we seeing? Discuss with a partner.

(b) Draw an interpretation of this process inside the arc lamp. Explain your drawing to a partner.

(c) Sketch and label the spectra of mystery gases 1, 2, and 3. What elements could produce these emission lines?

(d) How would the spectra look if the arc lamp were flying away from you at $0.1c$? Toward you?

(e) How is this process applicable to astronomy?