

HW 6

#2

The XRISM X-ray satellite measured the spectrum of a peculiar star system. One line in the spectrum is marked "SXVI Ly α (b)"

- element is "S" = "sulfur"

- ionization indicator is "XVI", which is Roman numeral for 16, meaning (16-1) electrons have been removed. That leaves just 1 electron

When an atom has only 1 electron, its spectrum is similar to that of hydrogen - but shifted to higher energies.

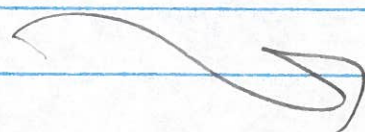
$$E_n = (-13.6 \text{ eV}) * Z^2 * \frac{1}{n^2}$$

$\nwarrow$ # of protons in ion

- the term "Ly α ", short for "Lyman α ", means a transition from $n=2 \rightarrow n=1$.

So we expect an energy of

$$\begin{aligned} E_1 &= (-13.6 \text{ eV})(16^2)\left(\frac{1}{1^2}\right) = -3482 \text{ eV} \\ E_2 &= (-13.6 \text{ eV})(16^2)\left(\frac{1}{2^2}\right) = -870 \text{ eV} \\ \hline \Delta E &= 2611 \text{ eV} \end{aligned}$$



#2, continued

The observed energy of the line is higher, about $E_{\text{obs}} = 2700 \text{ eV}$. The energy is higher because a Doppler shift increases its frequency. How fast must the gas move toward us?

$$\frac{\Delta \nu}{\nu_0} = \frac{\Delta E}{E_0} = \frac{v}{c}$$

$$\text{So } \frac{2700 \text{ eV} - 2611 \text{ eV}}{2611 \text{ eV}} = \frac{v}{c}$$

$$\rightarrow v = 0.034 c = 1.02 \times 10^7 \text{ m/s}$$