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Final Class - Example Problem:

- Determine if a (recently exploded) star will escape the MW given:
  - ↳ $R_{star} = 8.3$ kpc
  - ↳ ~~Galactic Longitude = 180°~~
  - ↳ Fe XXVI spectral peak @ $\lambda = 0.1804$ nm
    - ↳ Lyα

Part 1: Determine V_{esc} for star:

from 12/2: $\frac{1}{2}MV_{esc}^2 - \frac{GM_{encM}}{R} = 0$, solved: $V_{esc} = \sqrt{\frac{2GM_{enc}}{R}}$

need M_{enc}:

$$R = 8.3\,kpc = (8.3\,kpc)\left(\frac{1000\,pc}{1\,kpc}\right)\left(\frac{3.08\times10^{16}\,m}{1\,pc}\right) = 2.56\times10^{20}\,m$$

$$V^2 = \frac{M_{enc}G}{R}, \text{ so } M_{enc} = \frac{V^2R}{G} = \frac{(235000\,m/s)^2(2.56\times10^{20}\,m)}{6.67\times10^{-11}\,\frac{Nm^2}{kg^2}} \approx 2.12\times10^{41}\,kg$$

↑ for an ordinary star in a circular orbit, I assume $v \approx 235$ km/s

$$V_{esc} = \sqrt{\frac{2(6.67\times10^{-11}\,\frac{Nm^2}{kg^2})(2.12\times10^{41}\,kg)}{(2.56\times10^{20}\,m)}} = 332.4\ km/s$$

Part 2: Determine V_{star}

λ_0 for Fe XXVI, Lyα: $\Delta E = z^2(-13.6\,eV)\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$, $z_{Fe} = 26$

$$\Delta E_0 = (26^2)(-13.6\,eV)\left(\frac{1}{2^2} - \frac{1}{1^2}\right) = 6.895\,keV$$

$$\lambda_0 = 1240\,eVnm / (6.895\times10^3\,eV) = 0.1798\ nm$$

Doppler Shift: $\Delta V = C\left(\frac{\lambda - \lambda_0}{\lambda_0}\right)$

$$\Delta V_{,star} = (3\times10^8\,m/s)\left(\frac{0.1804\,nm - 0.1798\,nm}{0.1798\,nm}\right)$$

$$\Delta V_{,star} = 1,001\ km/s$$

1,001 km/s > 332.4 km/s, escapes!