Introductory Astronomy

Week 4: Stars

Clip 12: Spectroscopic Binaries

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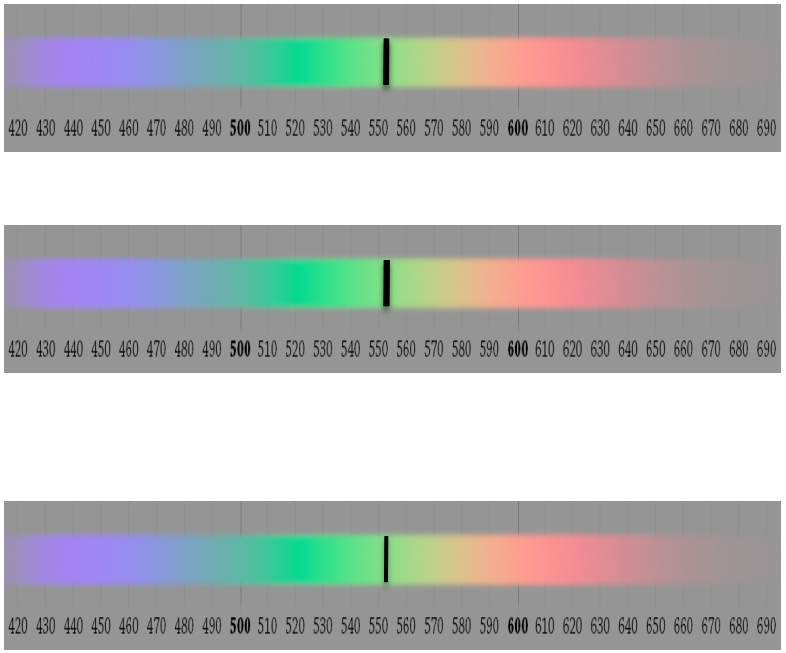
Spectroscopic Binaries

- If stars too close to resolve can distinguish periodic Doppler shift: Spectroscopic Binary
- If we can see both stars: double-line binary
- Often see only one



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Learning from Spectrum

- Measure: v_1, v_2, P $\quad v = c(1 - \lambda/\lambda_0)$

$$R_{1,2} = \frac{v_{1,2} P}{2\pi} \qquad M_1 R_1 = M_2 R_2 \quad M_1 v_1 = M_2 v_2$$

$$M = M_1 + M_2 = M_1(1 + v_1/v_2) = M_1(v_2 + v_1)v_2$$

$$R = R_1 + R_2 = \frac{P v_1}{2\pi} + \frac{P v_1}{2\pi} = (v_1 + v_2)\frac{P}{2\pi}$$

Finding Masses

$$P^2 = \frac{4\pi^2}{GM}R^3 \quad R = \frac{P}{2\pi}(v_1 + v_2) \qquad M = (v_1 + v_2)M_1/v_2$$

$$M = \frac{4\pi^2 R^3}{GP^2} = \frac{4\pi^2 P^3}{(2\pi)^3 GP^2}(v_1 + v_2)^3 \quad M_1 = \frac{v_2 P}{2\pi G}(v_1 + v_2)^2$$

- We can find masses! $M_1 = \frac{P}{1\,\mathrm{y}} \frac{v_2(v_1 + v_2)^2}{(29.78\mathrm{km/s})^3} M_\odot$
- Caveat: Orbit may tilt, we measure only v_r
- If we only see one star only know v_1

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Credits

- Rendered spectrum: Wikimedia/Spigget
  http://en.wikipedia.org/wiki/File:Rendered_Spectrum.png/