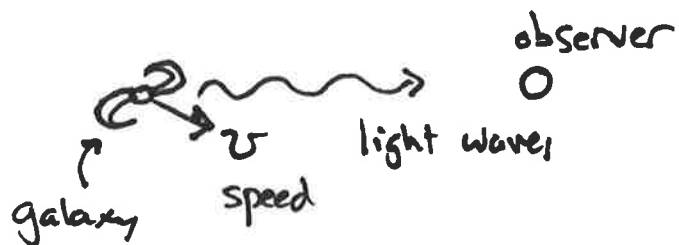


ASQv1 Ex 21.1 (Galaxy rotation)



When a galaxy emits light waves of wavelength λ , the wavelength observed by someone who is in motion at speed v relative to the galaxy is shifted by an amount $\Delta\lambda$. The amount is given by the formula

$$\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$$

In our problem, the average doppler shift of M51 is

$$\frac{0.22\mu\text{m} + 0.43\mu\text{m}}{2} = 0.325\mu\text{m} = \Delta\lambda$$

This means that

$$\frac{v}{c} = \frac{0.325\mu\text{m}}{21\text{cm}} = 1.5 \times 10^{-6}$$

where we have used the fact that the wavelength of the H-1 line (hydrogen) is $\lambda = 21\text{cm}$.

The galaxy is thus moving at $v = (1.5 \times 10^{-6})(3 \times 10^8 \text{ m/s})$

$$\boxed{v = 460 \text{ m/s}}$$

and it is rotating.