

577.

Problem 42.9 (RHK)

We have to show that, for the 21.1-cm line so much used by radio astronomers, a Doppler frequency shift in kHz can be converted into a radial velocity in km s^{-1} by multiplying by 0.211 provided that $u \ll c$.

Solution:

Frequency of the 21.1 cm line is

$$\nu_0 = \frac{c}{21.1 \times 10^{-2}} \text{ Hz},$$

and the magnitude of the longitudinal Doppler frequency shift for a source moving with radial velocity $u \ll c$ will be

$$\Delta \nu = \frac{u}{c} \times \nu_0 = \frac{u}{c} \times \frac{c}{21.1 \times 10^{-2}} \text{ Hz} = \frac{u}{21.1 \times 10} \text{ kHz},$$

and

$$u = 211 \times (\Delta \nu \text{ kHz}) \text{ m s}^{-1} = 0.211 \times (\Delta \nu \text{ kHz}) \text{ km s}^{-1}.$$