

Astronomical Observing Techniques 2019:
Exercises on Radio
(Due on 25 March 2019 at 11:00)

March 19, 2019

1 Rayleigh-Jeans Approximation

Derive the Rayleigh-Jeans approximation for the brightness $B_{RJ}(\nu, T)$ from the Planck formula:

$$B_{\nu,T} = \frac{2h\nu^3}{c^2} \frac{1}{e^{h\nu/kT} - 1} \quad (1)$$

2 Atmospheric Transmission

a) Which molecule in the atmosphere is responsible for the transmission curve shown below?

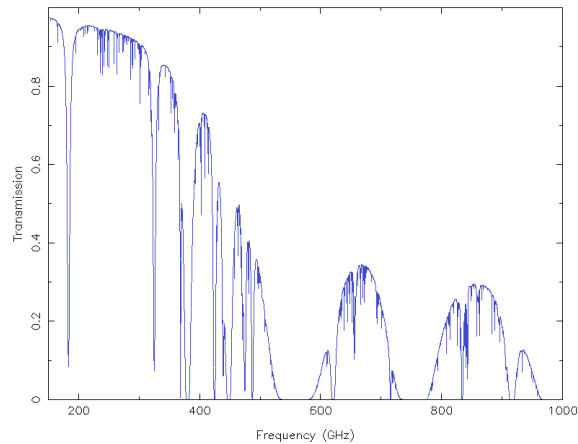


Figure 1: Atmospheric transparency

b) How do astronomers minimize this issue of absorption bands when building telescopes?

c) For a certain type of objects in the sky, we are still able to observe this molecule by making use of the velocity of the object. What type of object is this?

3 Solar Radio Observations

The quiet sun has a brightness temperature $T_b \sim 11000$ K at 10 GHz and an angular diameter of 32 arcminutes.

- a) What is the flux density we receive from the sun?
- b) We observe the sun with a radio telescope of 25 meter diameter. What is its beam size at 10 GHz?
- c) What flux density will this telescope measure at the center of the sun?

4 Heterodyne Receiver

Determine a suitable local oscillator frequency (LOF) for the WSRT radio telescope operating a 1.4 GHz, where we would like to down-convert the signal to a 50 MHz (carrier) signal.