

Astronomy 534: Radio Astronomy

Problem Set 10

Due 27 November, 2006

1. The recombination-line spectrum of the H II region W3 is shown for the frequency range containing the H91 α line in Figure 13.2 of the textbook. The H91 α line FWHM (full width between half-maximum points) is $\Delta\nu = 0.69$ MHz.
 - (a) What is the approximate rest frequency of the H91 α recombination line?
 - (b) What is the FWHM Doppler velocity width Δv (km s⁻¹) corresponding to the observed frequency width $\Delta\nu = 0.69$ MHz?
 - (c) What is the maximum temperature of this H II region consistent with the observed H91 α line width?
 - (d) What is the frequency offset of the ³He (the rare Helium isotope with only one neutron instead of the usual two) 91 α line relative to the H91 α line? Is any emission from the ³He line visible in Figure 13.2?
2. Using data in Table 14.2 of the textbook, estimate the rest frequency of the CO J = 5 – 4 transition.
3. What is the minimum gas temperature of a molecular cloud that produces strong CO J = 5 – 4 line emission?
4. The GBT has sensitive receivers covering the frequency ranges 18 to 26.5 GHz and 26 to 40 GHz. Show how this frequency coverage is sufficient to detect CO emission from galaxies at *any* redshift from $z \approx 1.9$ to at least $z \sim 10$, the estimated redshift at which stars first produced significant amounts of interstellar CO.