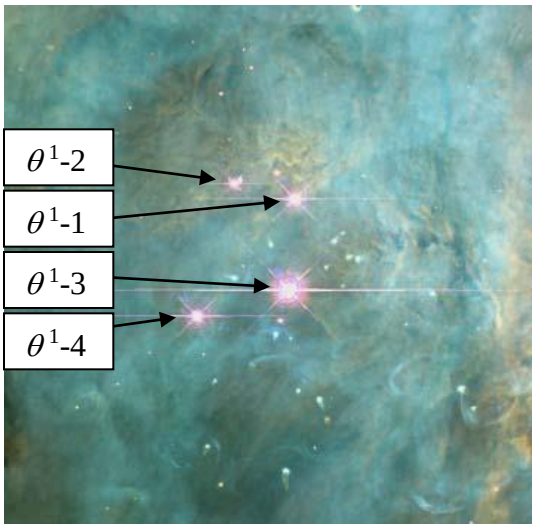
8.1 The Orion Nebula is a very large nearby molecular cloud. The central region is dominated by four rather bright stars called the Trapezium (the stars with the diffraction spikes in the Hubble Space Telescope image below). The first table below gives the star designation, the apparent magnitude, the observed color index *B*–*V*(obs), and the Spectral Type. The intrinsic values of color index, absolute magnitude and stellar mass for *O* and *B* spectral types is given in the second table. Note that spectral type *B0.5* is midway between spectral types *B0* and *B1*.



Star Name	m_V	*B*–*V*(obs)	*Spectral Type*
θ^1-1 *Ori*	6.73	+0.02	*B0.5V*
θ^1-2 *Ori*	7.96	+0.24	*B0V*
θ^1-3 *Ori*	5.13	+0.02	*O6V*
θ^1-4 *Ori*	6.70	+0.09	*B0.5V*

Spectral Type	*B*–*V*(int)	M_V	*Mass* (M/M_o)
O5V	-0.33	-5.7	60
O6V	-0.33	-5.5	37
O7V	-0.32	-5.2	
O8V	-0.32	-4.9	23
O9V	-0.31	-4.5	
B0V	-0.30	-4.0	17.5
B1V	-0.26	-3.2	

Use the information above to answer the following questions (refer to these equations if necessary):

$$m - n = 2.5 \log \frac{f_m}{f_n} \qquad m_V - M_V = 5 \log d - 5 \qquad m_V - M_V = 5 \log d - 5 + A_V$$

$$\textit{color-excess} = CE = (B-V)_{\text{obs}} - (B-V)_{\text{int}}$$

a) Using the observed apparent (m_V) and intrinsic absolute (M_V) magnitudes *without* correction for stellar extinction, what are the four distances you would derive for these stars? (2 pts)

b) The observed color indexes in the upper table are considerably larger than the intrinsic color indexes for the corresponding spectral type in the lower table. Does this mean that the stars appear *redder* than they should, or *bluer*? Which component of the molecular cloud, the *gas* or the *dust*, is the main reason for the color change? (2 pts)

c) What are the four values of color excess (*CE*)? For the Orion region, you can use the relation $A_V \sim 6\ CE$. Use this relation to give the corresponding extinction magnitudes, A_V. (3 pts)

d) Applying the correction for extinction, what are the distances you obtain for the four stars? Compare with the established distance to the Orion Nebula of 490 pc. (3 pts)

8.2 A cloud of neutral hydrogen is moving away from us at an angle of 30 degrees from the plane of the sky, with a velocity of 100 km/s. To what frequency should we tune our radio telescope in order to see the peak of the H I spectral line, if the rest frequency is 1420 MHz? (3 pts)