

Question 1:

a)

i.

Query : alpha Sco

submit id

Basic data :

*** alf Sco -- Red Supergiant**

Other object types: [?](#) * (*,CD,...),** (**,ADS,...),IR (E1a,IRAS,...),V* (V*,AAVSO),ISM (Ced,GN),s*r (1989ApJS),LP* (2009yCat),HII (LBN),RNe (DG),UV (TD1),NIR (2MASS),MIR (WISEA)

ICRS coord. ($ep=J2000$) : 16 29 24.45970 -26 25 55.2094 (Optical) [10.71 6.68 90] A 2007A&A...474..653V

FK4 coord. ($ep=B1950 eq=1950$) : 16 26 20.23122 -26 19 21.8433 [10.71 6.68 90]

Gal coord. ($ep=J2000$) : 351.94713737 +15.06432170 [10.71 6.68 90]

Proper motions mas/yr : -12.11 -23.30 [1.22 0.76 0] A 2007A&A...474..653V

Radial velocity / Redshift / cz : V(km/s) -3.50 [0.8] / z(-) -0.000012 [0.000003] / cz -3.50 [0.80] A 2006AstL...32..759G

Parallax (mas) : 5.89 [1.00] A 2007A&A...474..653V

Spectral type: M1.5Iab+B2Vn C 2021A&A...646A..11M

Fluxes (8) : U 4.08 [-] C 2002yCat.2237....0D
B 2.75 [-] C 2002yCat.2237....0D
V 0.91 [-] C 2002yCat.2237....0D
R -0.64 [-] C 2002yCat.2237....0D
I -1.87 [-] C 2002yCat.2237....0D
J -2.73 [-] C 2002yCat.2237....0D
H -3.49 [-] C 2002yCat.2237....0D
K -3.79 [-] C 2002yCat.2237....0D



Figure 1: Screenshot of the basic data of alpha Sco. Accessed 01/11/2024.

ii.

From the SIMBAD database for alf Sco, we have RA;

$$(\mu_{\alpha^*} = \mu_{\alpha} \cos \delta) : -12.11 \text{ mas yr}^{-1}$$

and proper motion in Dec;

$$\mu_{\delta} : -23.30 \text{ mas yr}^{-1}$$

Using equation 1.10:

$$\mu^2 = (\mu_{\alpha^*})^2 + (\mu_{\delta})^2 \quad (\text{eqn 1.10})$$

Substituting in our values:

$$\mu^2 = (-12.11)^2 + (-23.30)^2$$

$$\mu = \sqrt{(-12.11)^2 + (-23.30)^2}$$

$$\mu = \sqrt{146.6521 + 542.89}$$

$$\mu = \sqrt{689.54212}$$

$$\mu = 26.259\dots$$

$$\mu = 26.26$$

to 2 d.p

b)

i.

Results for object NGC 0001

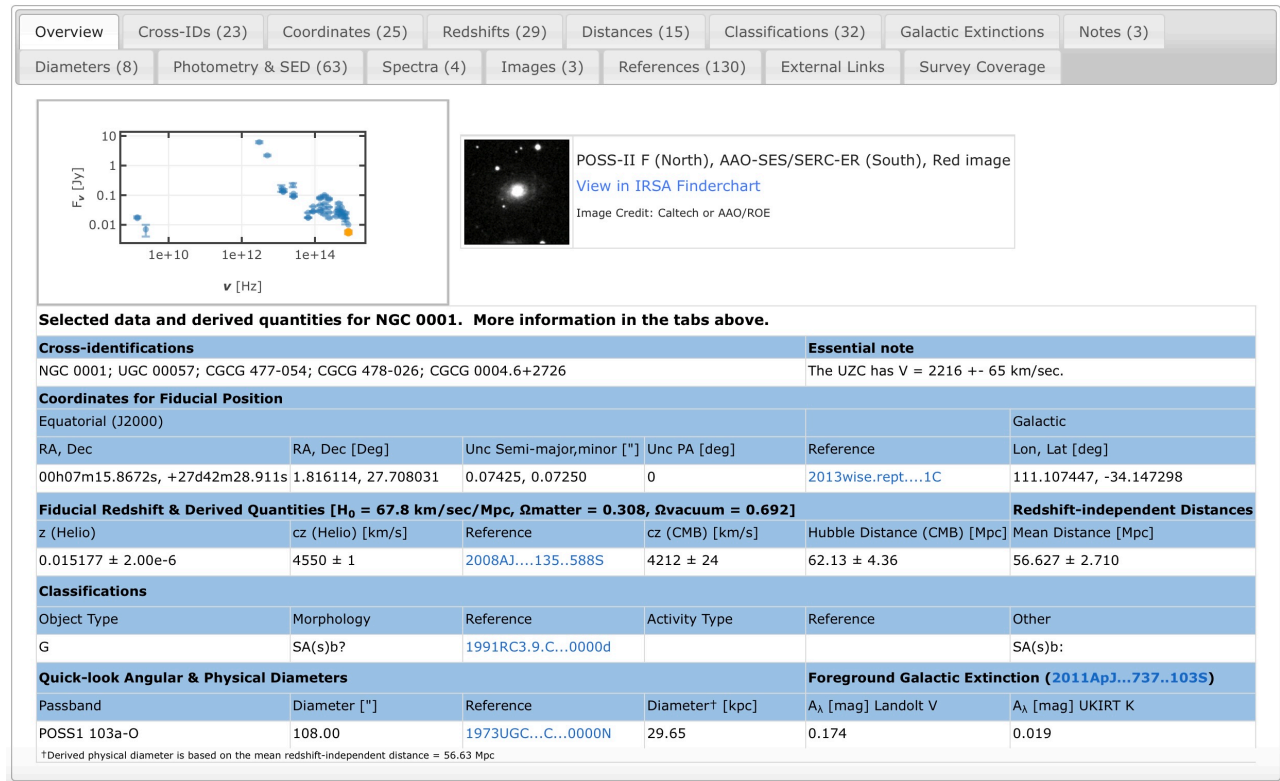


Figure 2: Screenshot of the basic data of NGC 0001. Accessed 01/11/2024.

ii.

From the NED database for NGC 0001, we have physical distance (D): 29.65 kpc and angular diameter (θ): 108.00".

Using equation 1.5:

$$\sin \theta = \frac{D}{d} \quad (\text{eqn 1.5})$$

$$\sin \theta = \frac{D}{d}$$

using approximation theory

$$\sin \theta \approx \theta \quad \text{when } \theta \text{ is in radians}$$

$$108.00'' \approx \left(\frac{108}{3600} \right)^\circ \times \left(\frac{2\pi}{360^\circ} \right)$$

So:

$$\theta \approx \frac{D}{d}$$

$$\approx 5.235 \times 10^{-4} \text{ rad}$$

$$D \approx d \div \theta$$

Substituting our values:

$$\approx 29.65 \div 5.235 \times 10^{-4}$$

$$\approx 56\,627.328\,75 \text{ pc}$$

$$\approx 56.63 \text{ Mpc} \quad \text{to 2 d.p}$$

Question 2:**a)****i.**

Plane plot of the distribution of the proper motions in the Alpha Persei cluster, proper motion in right ascension ($\text{pmra}/(\text{mas yr})$) versus the proper motion in declination ($\text{pmdec}/(\text{mas yr})$). With the co-moving group marked in blue.

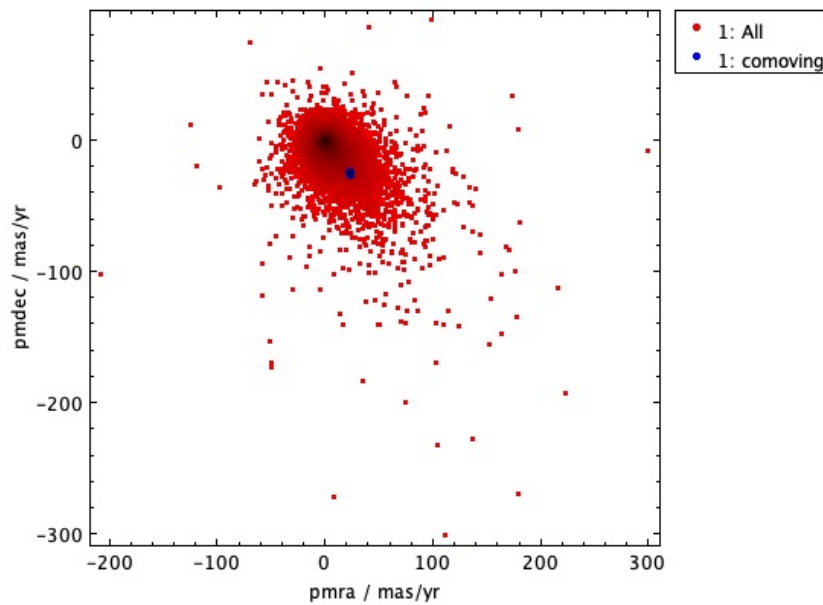


Figure 3: A plane plot to show proper motion in right ascension versus proper motion in declination. *Created 01/11/2024.*

An image of the same data but zoomed in so you can properly identify the area of stars that are co-moving.

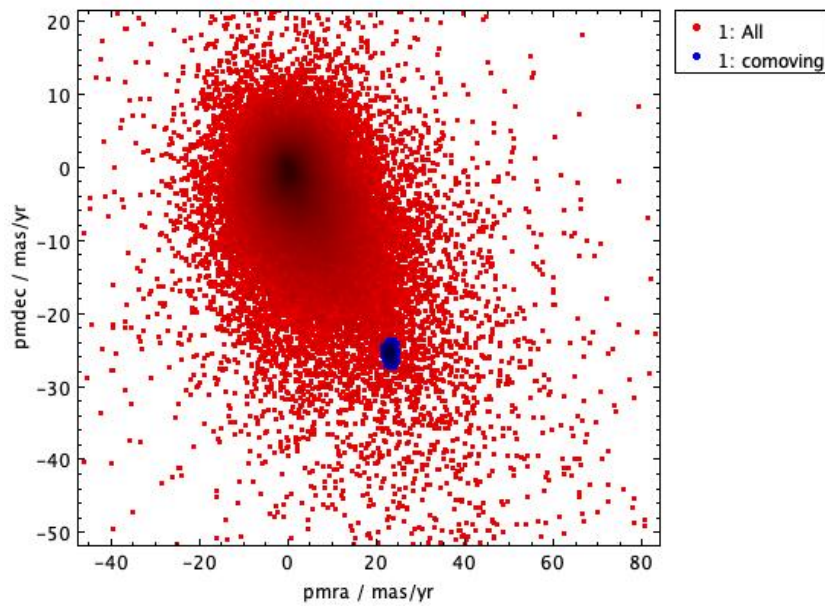


Figure 4: A plane plot to show proper motion in right ascension versus proper motion in declination, focused on the co-moving section of the cluster.. *Created 01/11/2024.*

ii.

A histogram of the parallax (parallax/mas) of the Alpha Perei cluster:

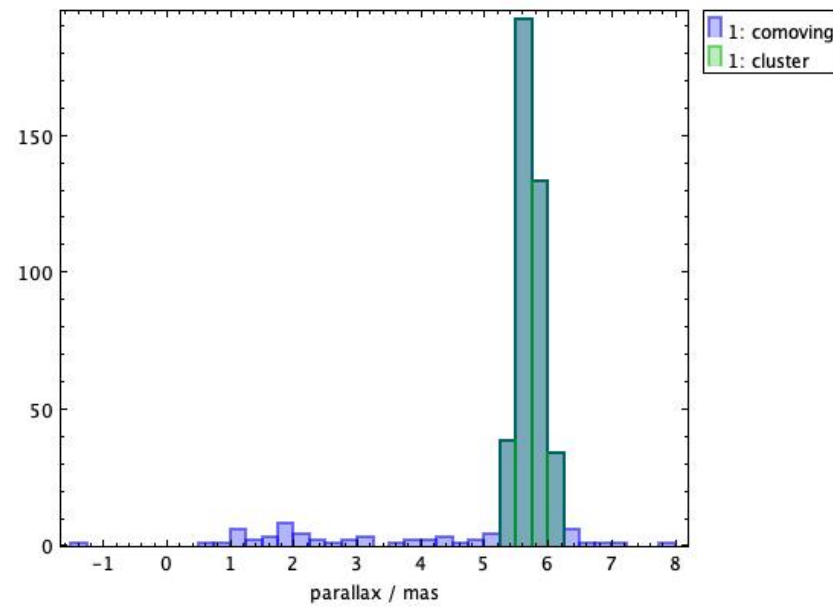


Figure 5: A histogram of the parallax of the cluster. Created 01/11/2024.

A histogram of the parallax (parallax/mas) of the co-moving subset, ie within the range $5.25 < \text{parallax/mas} < 6.25$ of the Alpha Perei cluster:

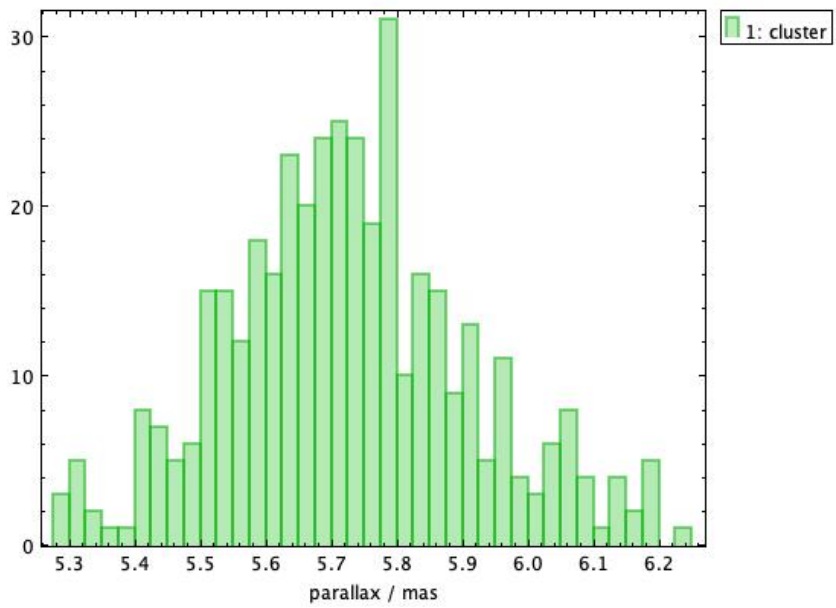


Figure 6: A histogram of the parallax of just the co-moving cluster.
Created 01/11/2024.

iii.

A plane plot of the CMD of the co-moving subset of the cluster, this is the 'blue-minus-red' ($\text{phot_g_mean_mag}/\text{mag}$) colour of each star versus the 'green' magnitude ($\text{bp_rp}/\text{mag}$), With the Y-axis flipped so that the magnitudes values increase downwards.

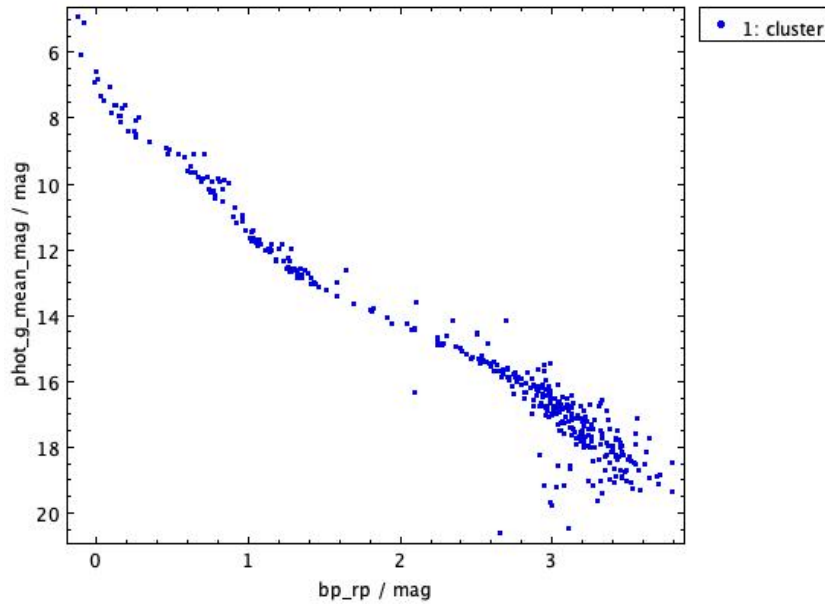


Figure 7:

A plane plot of the bp_rp versus phot_g_mean_mag
Created 01/11/2024.

b)

The mean parallax for this cluster in Alpha Persie is

$$5.724\,59\,\text{mas} = 5.724\,79 \times 10^{-3}''$$

with a standard deviation of

$$\pm 0.185\,625\,\text{mas} = 0.185\,625 \times 10^{-3}''$$

Using equation 3.1

$$(d\text{pc}) = \frac{1}{\varpi''} \quad (\text{eqn 3.1})$$

$$d = \frac{1}{\varpi''}$$

Substituting our values

$$= \frac{1}{5.724\,79 \times 10^{-3}''}$$

$$= 174.678 \dots \text{pc}$$

$$= 174.7\text{pc}$$

to 1 d.p

Using equation 3.2 to work out the error:

$$\Delta d = \frac{\Delta \varpi}{\varpi^2} \quad (\text{eqn 3.2})$$

$$\Delta d = \frac{\Delta \varpi}{\varpi^2} \text{pc}$$

Substituting our values

$$= \left(\frac{0.185\,625 \times 10^{-3}}{(5.724\,79 \times 10^{-3})^2} \right)$$

$$= 5.6639 \dots$$

$$= 5.7 \text{ pc}$$

To 1 D.P

Therefore the approximate distance to the star cluster is

$$d \approx 174.7 \pm 5.7 \text{ pc}$$