Question 1:

a)

i.

Query : alpha Sco submit id

Basic data :

*** alf Sco** -- Red Supergiant

Other object types:	* (*,CD,...),** (**,ADS,...),IR (Elia,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**
Parallaxes *(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**

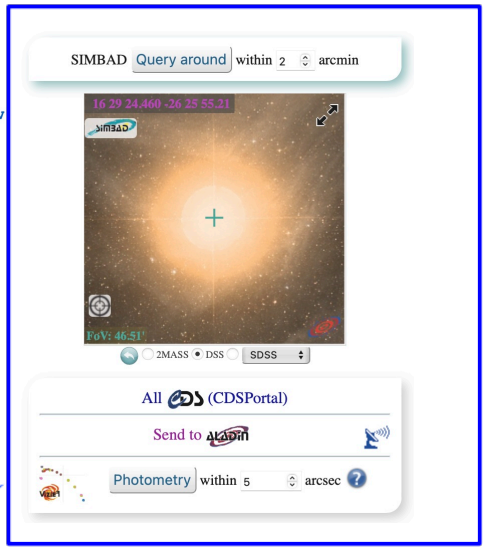


Figure 1: Screenshot of the basic data of alpha Sco. *Accessed 01/11/2024.*

Good - you can crop this out and just leave the data, then enlarge it for ease of reading.

2

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;

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

Start by defining variables and stating equation - this is good practice, well done!

Using equation 1.10:

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

Substituting in our values:

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

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

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

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

$$\mu = 26.259...$$

$$\mu = 26.26 \quad \text{masy}^{-1}$$

to 2 d.p

Correct, well done, but you need the units to score full marks here,

1

Better to state precision to s.f. rather than d.p. - though in this case the answer would be the same (4sf)

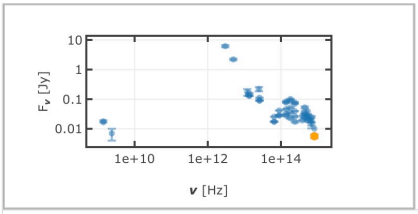
3/4

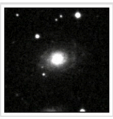
b)

i.

Results for object NGC 0001

Overview | Cross-IDs (23) | Coordinates (25) | Redshifts (29) | Distances (15) | Classifications (32) | Galactic Extinctions | Notes (3)
Diameters (8) | Photometry & SED (63) | Spectra (4) | Images (3) | References (130) | External Links | Survey Coverage





POSS-II F (North), AAO-SES/SERC-ER (South), Red image
View in IRSA Finderchart
Image Credit: Caltech or AAO/ROE

Selected data and derived quantities for NGC 0001. More information in the tabs above.

Cross-identifications				**Essential note**	
NGC 0001; UGC 00057; CGCG 477-054; CGCG 478-026; CGCG 0004.6+2726				The UZC has V = 2216 +- 65 km/sec.	
Coordinates for Fiducial Position					
Equatorial (J2000)					Galactic
RA, Dec	RA, Dec [Deg]	Unc Semi-major,minor ["]	Unc PA [deg]	Reference	Lon, Lat [deg]
00h07m15.8672s, +27d42m28.911s	1.816114, 27.708031	0.07425, 0.07250	0	2013wise.rept....1C	111.107447, -34.147298
Fiducial Redshift & Derived Quantities [H_0 = 67.8 km/sec/Mpc, Ωmatter = 0.308, Ωvacuum = 0.692]					**Redshift-independent Distances**
z (Helio)	cz (Helio) [km/s]	Reference	cz (CMB) [km/s]	Hubble Distance (CMB) [Mpc]	Mean Distance [Mpc]
0.015177 ± 2.00e-6	4550 ± 1	2008AJ....135..588S	4212 ± 24	62.13 ± 4.36	56.627 ± 2.710
Classifications					
Object Type	Morphology	Reference	Activity Type	Reference	Other
G	SA(s)b?	1991RC3.9.C...0000d			SA(s)b:
Quick-look Angular & Physical Diameters				**Foreground Galactic Extinction (2011ApJ...737..103S)**	
Passband	Diameter ["]	Reference	Diameter† [kpc]	A_λ [mag] Landolt V	A_λ [mag] UKIRT K
POSS1 103a-O	108.00	1973UGC...C...0000N	29.65	0.174	0.019

†Derived physical diameter is based on the mean redshift-independent distance = 56.63 Mpc

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

Good

2

ii.

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

Using equation 1.5:

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

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

small angle approximation - it isn't a theory

using approximation theorey

$$\sin\theta \approx \theta \qquad \textit{when } \theta \textit{ is in radians}$$

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

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

Good

So:

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

should be $d = \frac{D}{\theta}$

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

Substituting our values:

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

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

$$\approx 56.63\,\text{Mpc} \qquad \textit{to 2 d.p}$$

You've used the right calculation though and got the correct answer, well done.

2

4/4

Total for question 2: 7/8

Question 2:

a)

i.

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

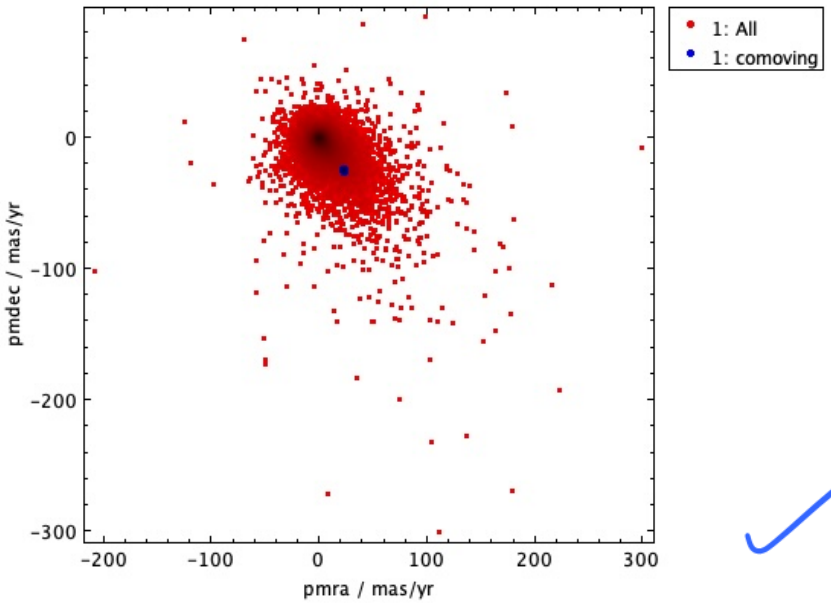


Figure 3: A plane plot to show proper motion in right ascension versus proper motion in declination. *Created 01/11/2024.*

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

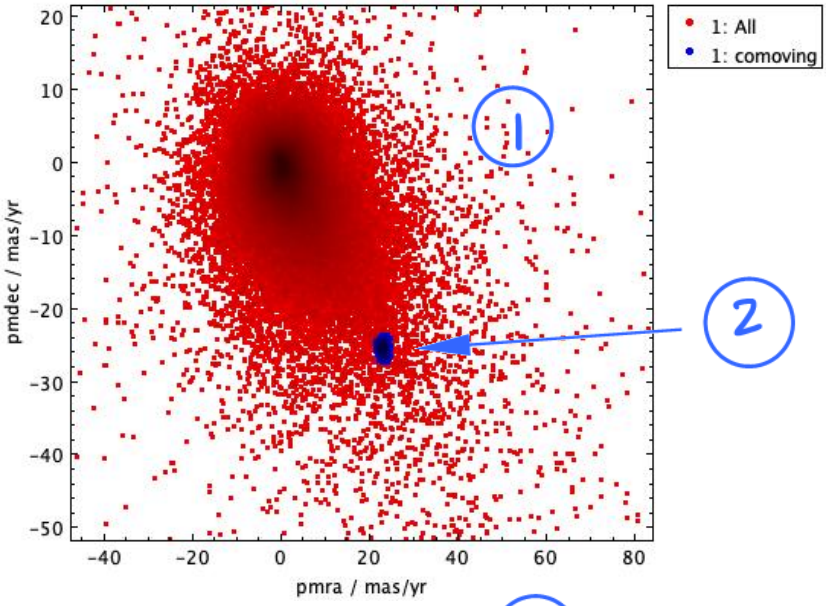


Figure 4: A plane plot to show proper motion in right ascension versus proper motion in declination, focused on the co-moving section of the cluster.. *Created 01/11/2024.*

6/6

Well done - But if you are asked to submit a screenshot in answer to a question, it's important that you submit only one image, otherwise I won't know which one to mark. On this occasion, I'll choose the best image to mark (highlighted cluster more visible).

ii.

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

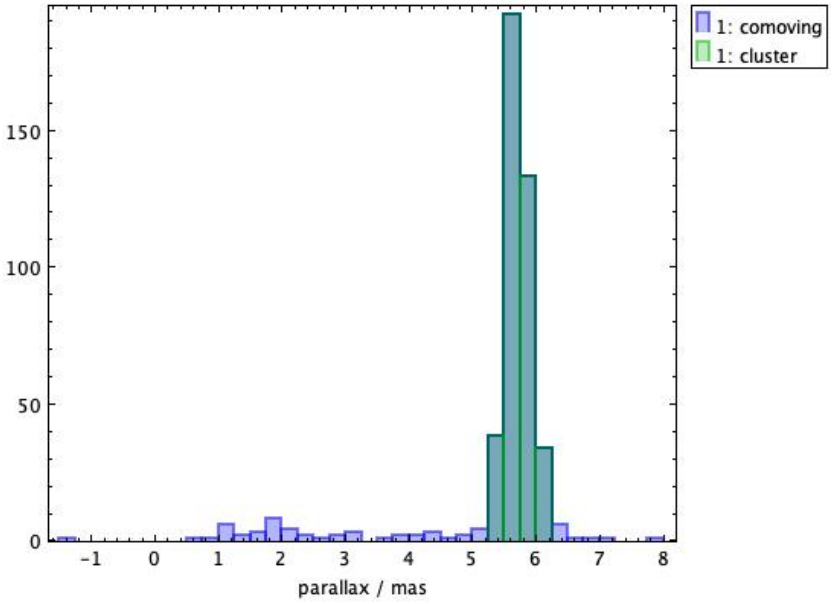


Figure 5: A histogram of the parallax of the cluster. *Created 01/11/2024.*

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

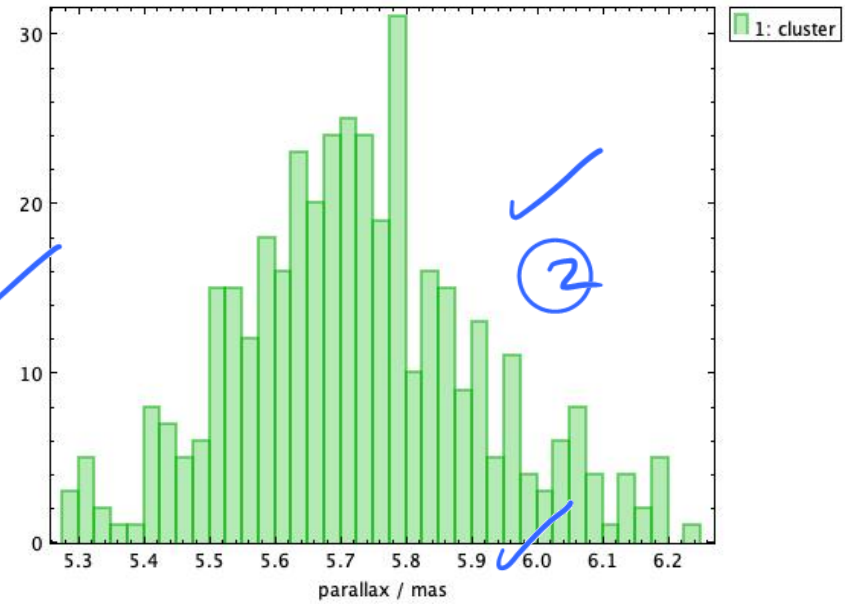


Figure 6: A histogram of the parallax of just the co-moving cluster. *Created 01/11/2024.*

Good, though see my comment above about offering more than one screenshot.

iii.

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

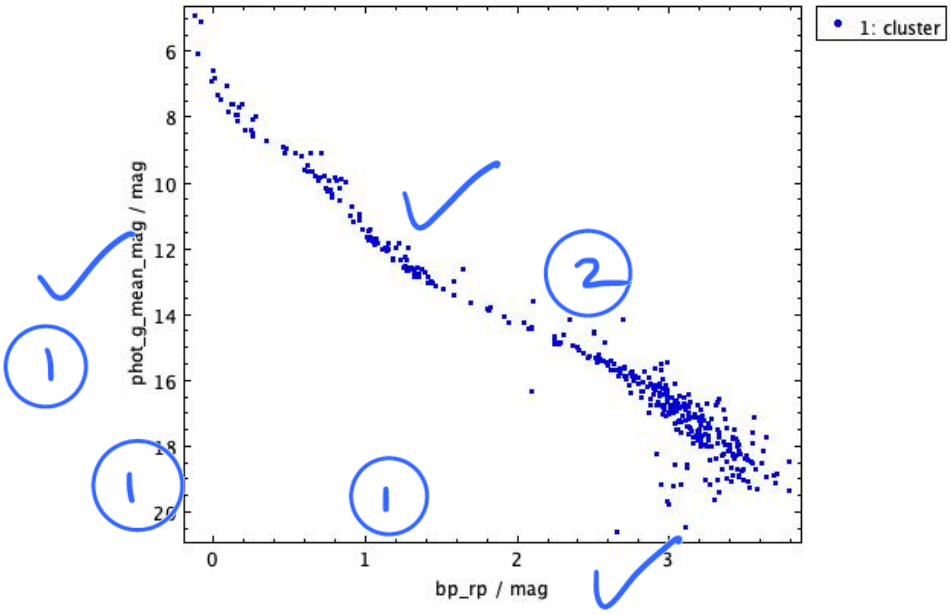


Figure 7:
A plane plot of the bp_rp versus phot_g_mean_ma
Created 01/11/2024.

6/6

Great, well done!

b)

The mean parallax for this cluster in Alpha Persie is

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

with a standard deviation of

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

Using equation 3.1

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

Start with equation - good.

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

Substituting our values

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

$$= 174.678\ldots\,\text{pc}$$

$$= 174.7\text{pc}$$

to 1 d.p

Well done.

Using equation 3.2 to work out the error:

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

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

Substituting our values

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

$$= 5.6639\ldots$$

$$= 5.7\,\text{pc}$$

3

Yes, good.

To 1 D.P

6/6

You don't need to say this as you're offering an uncertainty with your answer.

Therefore the approximate distance to the star cluster is

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

Great, well done!

Total for question 2: 24/24

Grand Total: 31/32