Analysis of Constellation Photographs

Scale of the Photographs

It is important to know how much sky is in the photographs you have taken. The basic idea is that you find the separation between two known stars in *pixels* and compare this with the separation of the same two stars in *degrees*. The separation in pixels can be found from the images on the computer screen, while the separation in degrees are obtained from a star chart. The problem with this method is that the photographs are flat, while the real sky is curved. This is the same problem that arises with terrestrial maps - a curved surface mapped into a flat surface will inevitably result in some distortion. You can minimize this distortion by selecting a region near the equator for the scale measurement. For photographs taken in the early part of the fall semester the **Aquila** region is a good choice, while **Orion** is a good choice in the spring semester. For best results, the celestial equator should be parallel to the long axis of the photograph and the two stars selected should have, as nearly as possible, the same right ascension (i.e., lie along the *short axis* of the photograph).

I. Separation in pixels

Load the desired photograph into the Microsoft Paint program. In the tool section, select the "rubber band" (box outlined with dotted line). Note as the cursor is moved around, the pixel value of each point in the image is displayed in the lower left hand corner of the display.

Select two known stars:

Name of star A _______________

Name of star B _______________

Using the mouse to move the cursor, find the x, y coordinates of each star

Star A

X_A _____________

Y_A _____________

Star B

X_B _____________

Y_B______________

Separation in X

$\Delta X = X_A - X_B =$ ___________

Separation in Y

$\Delta Y = Y_A - Y_B =$ ___________

Total pixel separation

$\Delta P = \sqrt{(\Delta X^2 + \Delta Y^2)} =$ __________

II. Separation in Degrees

Find stars A and B on the SC001 constellation chart. Note that the 0, 6, 12 and 18 hour lines of right ascension have one degree interval tick marks. With a straight edge (a piece of paper will do), mark the distance between stars A and B, using the tick marks on the r.a. lines, determine the separation in degrees.

Separation S between stars A and B

S = _______________ degrees

III. Scale of the photographs

The scale of the photographs is simply the number of degrees per pixel. Thus,

Scale = S/P = ______________ degrees per pixel

The dimensions of each image you have are very nearly 800 x 600 pixels; you should check with the cursor to determine the image size exactly. With the size of the image in pixels known, determine the size of the image in degrees.

X dimension of photograph = 800 X Scale = _____________ degrees

Y dimension of photograph = 600 X Scale = _____________ degrees

The approximate area covered by the photographs is $X*Y$ = _______ degrees^2

The scale and the area should be the same for all photographs taken with the same lens. All of this will change if the focal length of the lens is changed.

Specifically for the equatorial photograph answer the following questions. (Non-equatorial photographs are more complicated)

Approximately how many hours of right ascension does the x-axis include. Remember, there are 4 minutes of right ascension per degree.

X dimension of photograph = _____ hours ____ min

Which specific hours of right ascension are covered in the photograph?

From _____hr ____min to ____ hr ____ min

Which lines of declination are covered in the photograph?

From ____° to ____°

Exploration of Individual Photographs

Colors in the Constellation Photographs

Your constellation pictures should be quite impressive, strewn with stars of various colors. Star colors are directly related to stellar surface temperatures and spectral classification. Thus, you can get an idea of the distribution of stellar types simply by examining the photographs. However, it is not possible to attain a high degree of precision for several reasons. First, the colors in the pictures are determined largely by the characteristics of the film and by the seeing conditions under which the images were taken. Also, color differences are visually subtle and subjective. Precision results require photometer measurements using filters to determine the color index or a diffraction grating to yield spectrographs. A final complication is that the brightest stars are usually over-exposed and tend to look white, regardless of spectral class.

Despite the problems described above, it is non-the-less possible to sort the stars into three broad categories using these photographs. A reasonable approach to sorting the stars by colors is given by the color scheme below:

Color	***Spectral Class***
Red/Orange	K, M
Off-White	G, F
Blue	A, B, O

Blue and red stars are easy to spot. The off-white colors are most difficult, because there is no distinctive color. This is due in part to the fact that most people take pictures in sunlight (light from a G2 V star), and the film is balanced to give a neutral color under this circumstance. In the exercises below, sort the stars K, M (red), A, B, O (blue) and G, F (off-white).

Non-Stellar Objects

In addition to individual stars, there may be other objects in the photograph that appear to be "fuzzy", and cover an extended area. Generally speaking, these objects can be sorted into three categories: (1) dense groupings of stars known as *clusters,* (2) external *galaxies*, and (3) clouds of gas known as *nebulae*. Although they are composed of stars, most clusters and galaxies are so far away that they appear to be smudges on images taken with simple equipment. With the unaided eye it is often difficult to distinguish between distant groups of stars and nebulae, but there are very obvious color differences. Nebulae always show up as pink or red blobs, while star clusters and galaxies are nearly always white smears.

Many of the brightest clusters, galaxies and nebulae have the designation ***M***, followed by a number. This refers to a list of "fuzzy", non-stellar objects made by the French astronomer Charles Messier in the 18^{th} century. For example, the Great Nebula in Orion was number 42 on the list, hence the designation M42. Messier was a comet hunter and his purpose for preparing the list was to identify permanent objects in the sky that might be confused with comets. Today we view these "Messier objects" as a list of celestial highlights: the brightest examples of deep sky wonders.

Proceed with the exercise by loading the specified constellation file into the Paint Brush program and answering the questions.

Orion

File Name: ___________________

Equatorial Coordinates (center of the image): R.A. _____ hr _____ min; Dec. _____°

<u>Stars</u>

1. What is your over all impression of the color of the stars in Orion (i.e., mostly blue, mostly red, or about an even split)?

2. From you knowledge of Orion's location with respect to the plane of the Milky Way, how would you explain your answer to question 1?

3. Estimate the colors of the following stars, using the accompanying map and the photograph.

Star	Coordinates	Color	Spectral Class
α (Betelgeuse)			
β (Rigel)			
γ (Bellatrix)			
κ (Saiph)			
ϕ_2			
δ (Mintaka)			
1			
2			
3			
4			

4. The absolute magnitude of Rigel is –7.1, while the absolute magnitude of Betelgeuse is –5.6. Given their relative brightness as seen in the photograph, which one do you think is the most distant? Why?

5. The star labeled 5 has a visual magnitude of 7.1. Can you see it in the photograph? Can you see stars that appear to be fainter?

Non-Stellar Objects

The "Great Nebula" in Orion, also known as M42, is the fuzzy patch in Orion's belt. It should be obvious that this is not a star simply from its shape and general color.

6. Describe the color of the nebula in Orion's belt and compare it to the color of Betelgeuse.

7. You have seen a glowing gas with a similar color in the laboratory. What is this gas?

8. M42 is an example of a diffuse nebula. Write paragraph describing the nature of diffuse nebulae, covering what they are, where they are located in the Milky Way, and what role they play in stellar evolution.

9. Can you see any of the other non-stellar objects shown on the map?

<u>Taurus</u>

File Name: ____________________

Equatorial Coordinates (center of the image): R.A. _____ hr _____ min; Dec. _____°

1. Estimate the colors of the following stars, using the accompanying map and the photograph.

Star	Coordinates	Color	Spectral Class
α (Aldebaran)			
γ (1)			
δ (2)			
ε (3)			
4			

Taurus consists of two open clusters, the ***Hyades*** that make up the "V" and the ***Pleiades*** (a.k.a. M45). These are physical associations, not simply line-of-sight groupings. The only exception is Aldebaran (α Tauri). Although it appears to be part of the pattern, Aldebaran is about 65 light years from the sun, whereas the cluster is approximately 150 light years away. Two things to note about these clusters: (1) Since for a given cluster the stars are gravitationally bound to each other, all the stars in that cluster are at about the same distance from us. (2) Both the Pleiades and the Hyades are roughly the same number of light years in diameter.

2. Compare and contrast the stars in the Hyades and the Pleiades. Do the brightest stars in the Hyades appear to have different color stars than the brightest stars in the Pleiades? What are these colors?

3. From the appearance of the two clusters, which one would you say is the most distant? Why?

4. From the color of the stars in these two clusters, which would you say is the oldest? Why?

5. Write a paragraph on open stars clusters, discussing the nature of these groupings, where they are located in the Milky Way and astronomers estimate the age of these clusters.

Canis Major

File Name: ____________________

Equatorial Coordinates (center of the image): R.A. _____ hr _____ min; Dec. _____°

1. Estimate the colors of the following stars, using the accompanying map and the photograph.

Star	Coordinates	Color	Spectral Class
α (Sirius)			
δ (1)			
σ (2)			
3			
4			
5			

2. Locate and find the screen coordinates of M41, M46, and M47.

M41 X: _______ Y_______

M46 X: _______ Y_______

M47 X: _______ Y_______

M93 X: _______ Y_______

3. What are these objects (open clusters, globular clusters, or galaxies)?

4. How would you compare their distances with the distances to the Pleiades and Hyades?

Cygnus

File Name: ____________________

Equatorial Coordinates (center of the image): R.A. _____ hr _____ min; Dec. _____°

Stars

4. What is your over all impression of the color of the stars in Cygnus (i.e., mostly blue, mostly red, or about an even split)?

5. From you knowledge of Cygnus' location with respect to the plane of the Milky Way, how would you explain your answer to question 1?

6. Estimate the colors of the following stars, using the accompanying map and the photograph.

Star	Coordinates	Color	Spectral Class
α (Deneb)			
β (Albireo)			
η			
δ			
1			
2			
3			

10. Although the three stars that make up the Summer Triangle (Altair, Deneb, and Vega) appear to be about the same brightness, they are located at very different distances. Deneb is 1800 light years away , Altair is 16 and Vega is 26. Assuming that each star appears equally bright (not exactly true, but O.K. for our purposes), list them in order of absolute luminosity, going from least luminous to most luminous.

11. The star labeled 4 has a visual magnitude of 7.1. Can you see it in the photograph? Can you see stars that appear to be fainter?

Non-Stellar Objects

The large red spot above and to the left of Deneb is the diffuse nebula NGC 7000, also known as the "North American Nebula". It should be obvious that this is not a star simply from its shape and general color.

12. Contrast the color of the nebula in with the color of the "red" stars in the constellation. Does the constellation have a different shade of red or do stars and nebula have about the same hue?

13. Glowing clouds in the Milky Way are composed mostly of what kind of gas?

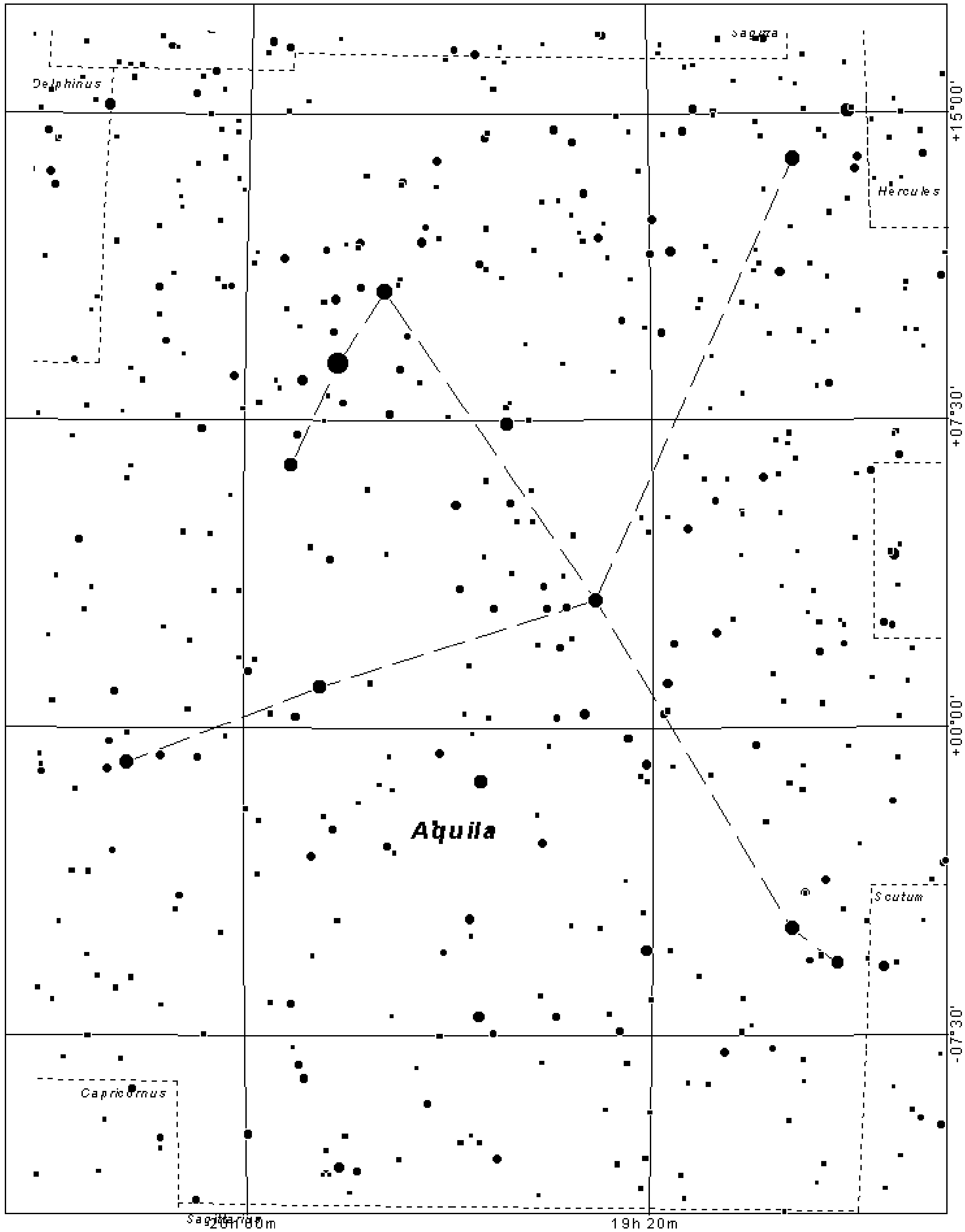
14. NGC is an example of a diffuse nebula. Write paragraph describing the nature of diffuse nebulae, covering what they are, where they are located in the Milky Way, and what role they play in stellar evolution.

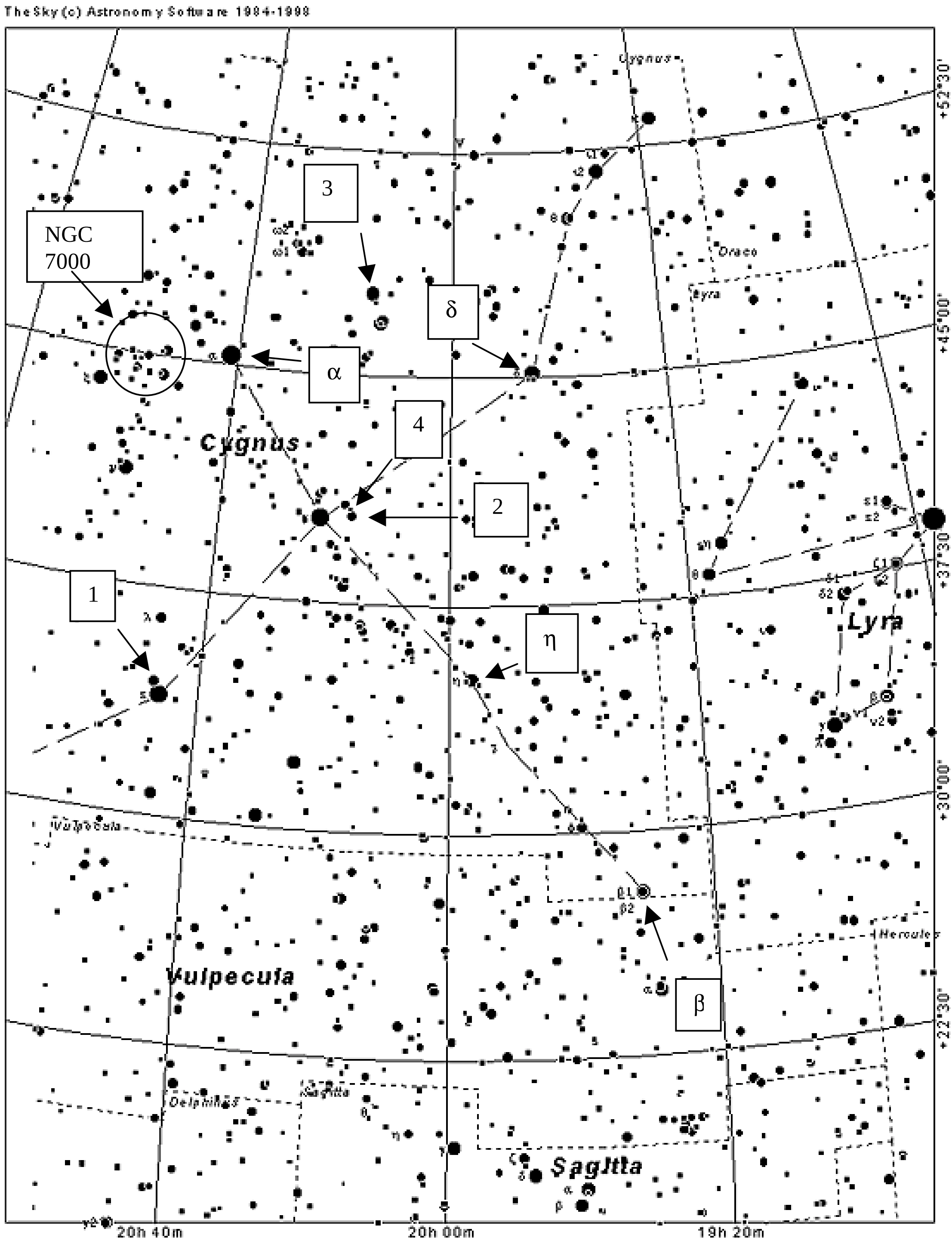
15. Look up the NGC 7000 on the SEDS website (http://www.seds.org/messier/xtra/ngc/n7000.html). Can you see why it is called the "North American" nebula? Draw a rough sketch.

16. Near the star η is the x-ray source Cygnus X-1. This is believed to be the location of a black hole. Briefly describe what a black hole is.

Internet Exercise

Students for the Exploration and Development of Space (SEDS), has an excellent web site for Messier and NGC objects. The URL is *http://www.seds.org/messier.* Download pictures and information for each of the Messier and NGC objects recorded in the photographs and write a short report on each. Include such information as the nature of the object, how far away, how big, how many stars (if appropriate), etc.


Sagitta
Delphinus
Hercules
Aquila
Scutum
Capricornus
Sagittarius
20h 00m
19h 20m
+15°00'
+07°30'
+00°00'
-07°30'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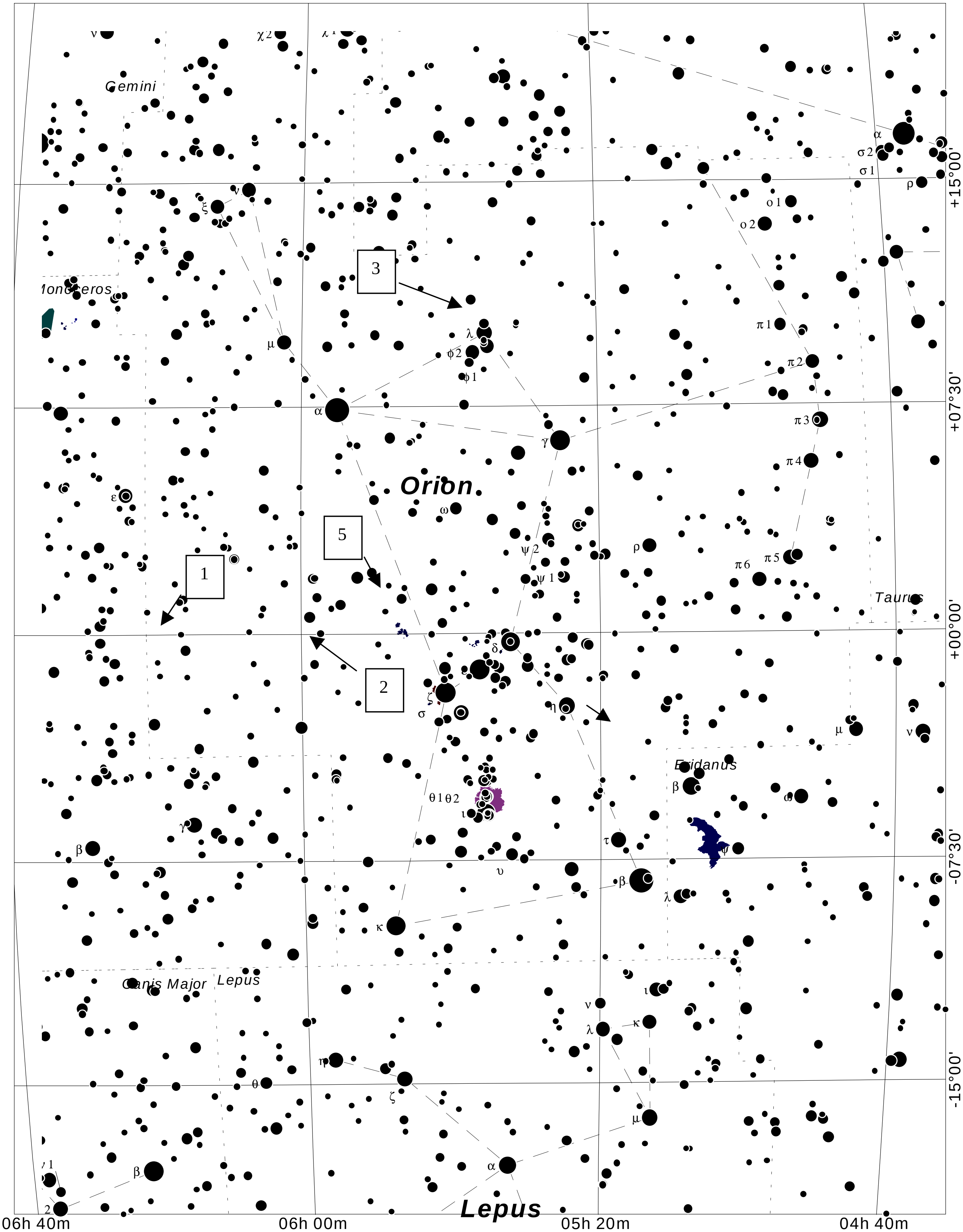
NGC 7000
3
δ
α
4
2
1
η
β
Cygnus
Lyra
Vulpecula
Sagitta
Draco
Hercules
Delphinus
20h 40m
20h 00m
19h 20m
+52°30'
+45°00'
+37°30'
+30°00'
+22°30'

TheSky (c) Astronomy Software 1984-1998



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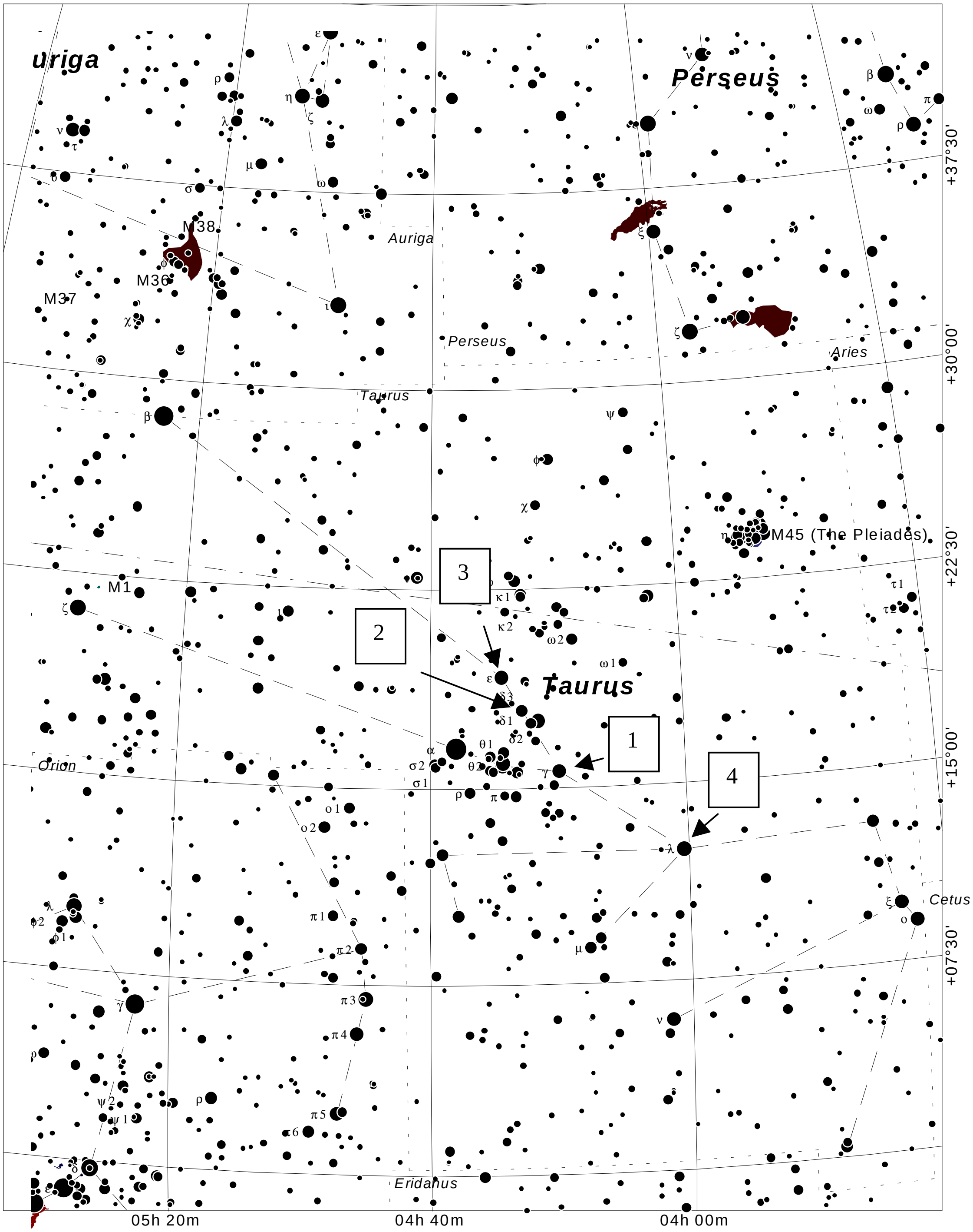

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