ASTR 101

Lab Report 1

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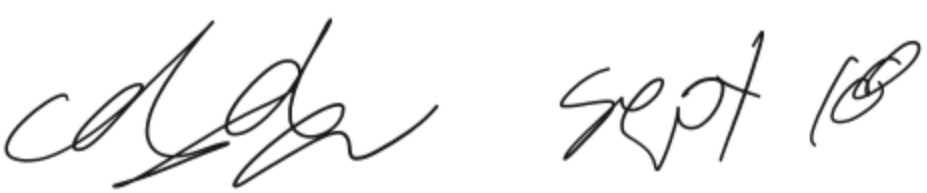
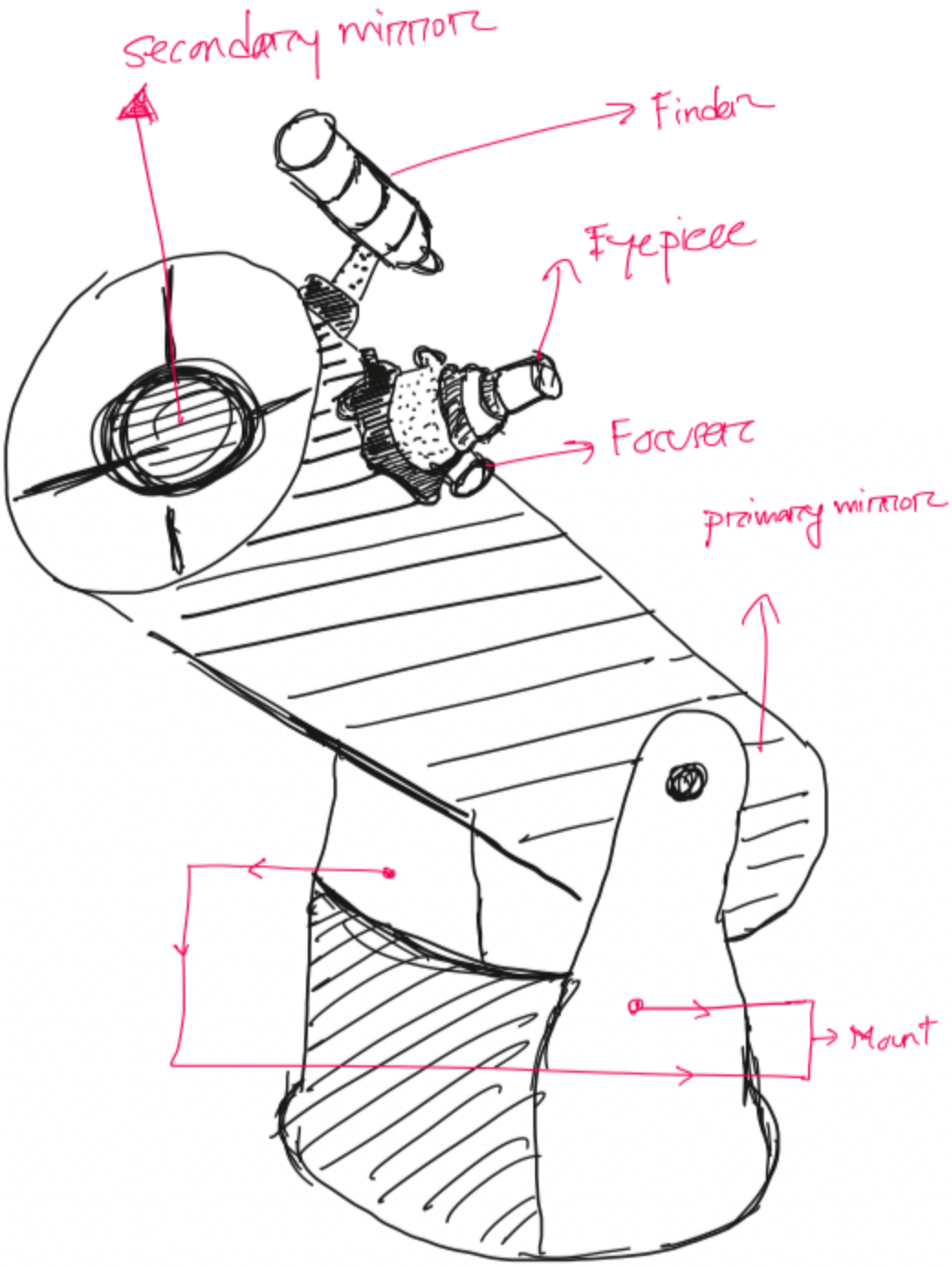
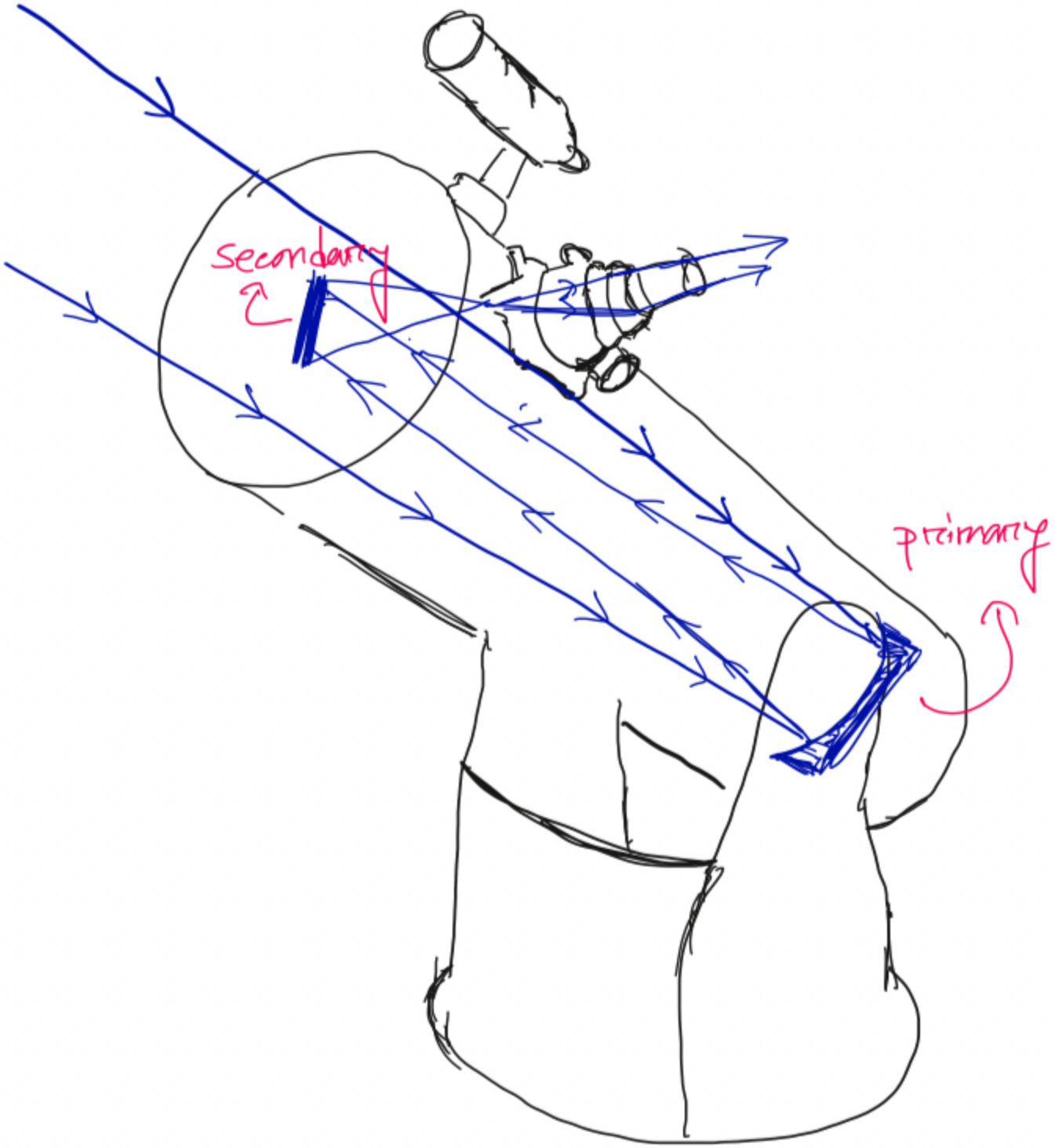


(1) Sketch a diagram of the telescope (use a full page), label each of the following parts:

- primary mirror
- secondary mirror
- eyepiece
- focuser
- mount
- finder



(2) Sketch the path of a light ray through the telescope.



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(3) In a sentence or two describe and explain the function of these parts.

(4) How much brighter will this Celestron telescope (primary mirror radius = 10cm) make the stars appear relative to your unaided eye?

(5) What is a *refractor* telescope?

(6) In the early days of observational astronomy (circa early 20^{th} century), most major telescopes were *refractor* telescopes. However, all modern-day, major telescopes are *reflector* types. Briefly explain the difference between these two types, and why this change to the reflector type may have happened?

Answer (3):

We use the **primary mirror**, which is the largest mirror in the telescope, to gather light from distant objects and reflect it to a focus point. The **secondary mirror**, a smaller mirror positioned in the optical path, redirects the focused light out of the side of the telescope to an eyepiece or a camera, allowing us to observe celestial objects. The **eyepiece**, the part through which we look, magnifies the image created by the primary and secondary mirrors, enabling us to view distant objects more clearly. The **focuser** is the mechanism that permits us to adjust the position of the eyepiece or camera, ensuring we can achieve proper focus and bring the image into sharp detail. The **mount**, serving as the support structure for the telescope, provides stability and allows us to point the telescope in different directions to track celestial objects as they move across the sky; there are two main types of mounts: equatorial and alt-azimuth. The **finder**, a smaller, lower-magnification telescope typically mounted on top of the main telescope, assists us in locating objects in the sky before viewing them through the main telescope, making it easier for us to find and track celestial objects.

Answer (4):

Using the formula for Relative Brightness Enhancement, and knowing that the human eye's pupil diameter in dark conditions is 0.5 cm (5 mm), we can calculate:

Relative Brightness Enhancement = (Telescope Aperture / Human Eye Aperture)^2
=> Relative Brightness Enhancement = (10 cm / 0.5 cm)^2 = (20)^2 = 400

Therefore, the Celestron telescope, with its primary mirror radius of 10 cm, will make stars appear approximately 400 times brighter than what we would perceive with our unaided eye under the same conditions.

Answer (5):

In a **refractor telescope**, we utilize lenses to bend and focus light, comprising an objective lens at the front to gather and refract incoming light, and an eyepiece lens at the back for image magnification. While reflecting telescopes employ mirrors to gather and reflect light, refracting telescopes use lenses to bend and focus light. Refracting telescopes are valued for their straightforward design and find common application in both terrestrial and astronomical observations.

Answer (6):

In the early days of observational astronomy, refractor telescopes were dominant, using lenses to bend and focus light. However, we shifted towards reflector telescopes, which employ mirrors to collect and reflect light. **One significant reason is the absence of color distortion**, where different colors of light bend unequally, leading to distorted images in larger refractor telescopes. Reflectors can be designed to minimize this issue, providing sharper images.

Another reason is the ability to build larger telescopes with reflectors. Mirrors can be made more cost-effectively than large lenses, and they don't face the same weight limitations. This *scalability* allowed for the construction of massive observatories, enhancing light-gathering capabilities for studying faint celestial objects.

Questions

(7) Sketch at least three (3) **new** constellations that you learned in this lab exercise. Note their approximate positions in the sky, and the time and date of the observations.

(8) Learn the names of at least three stars and mark them on your constellation sketches.

(9) What is the mythology associated with these constellations? Research and write about these stories. Instead of just Greco-Roman myths, find stories from other cultures such as Arabic, Chinese, Indian, etc., and at least one that the First Nations of North America associated with these constellations. Note that constellations between cultures are not identical. In such cases, find a story that shares at least the bright star you have labelled.

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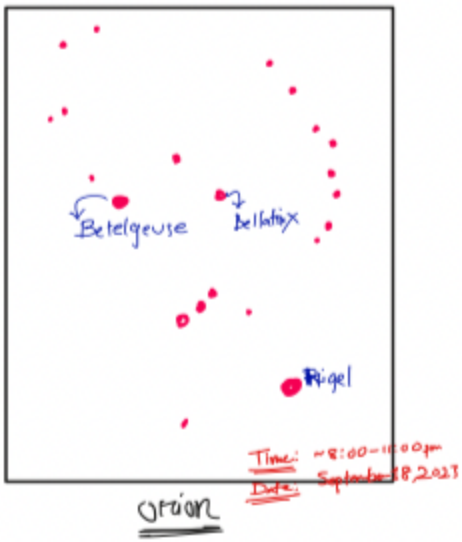
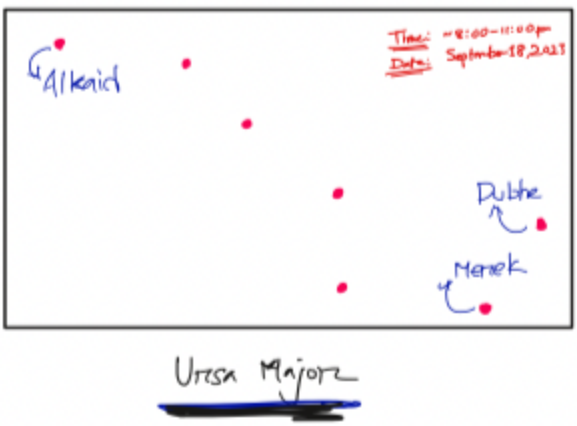
Answer (7), (8), (9):

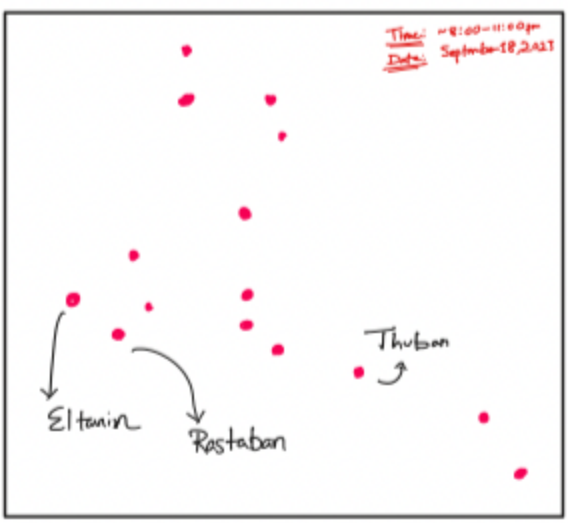


1 CONSTELLATION NAME: Orion
1A STARS: Betelgeuse, Rigel, and Bellatrix [1]
1B GRECO-ROMAN MYTHOLOGY: Orion was a great hunter in Greek mythology, but he was eventually killed and placed in the sky as a constellation by the gods.[1]
1C OTHER CULTURE: Other Culture: In Arab astronomy, Orion is known as "Al-Jabbar," the Giant, and in Chinese astronomy, it's associated with the legendary archer Houyi.[1]



2 CONSTELLATION NAME: Ursa Major
2A STARS: Stars: Dubhe, Merak, and Alkaid [2]
2B GRECO-ROMAN MYTHOLOGY: In Greek mythology, this constellation is associated with Callisto, who was turned into a bear by Zeus and placed in the sky as Ursa Major. [2]
2C OTHER CULTURE: The Iroquois people of North America have a story about the Great Bear representing the constellation, which is part of their creation mythology. [2]

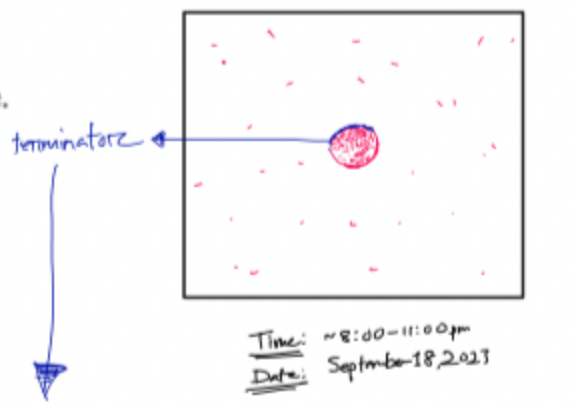
Draco



3 CONSTELLATION NAME: Draco
3A STARS: Thuban, Eltanin, and Rastaban [3]
3B GRECO-ROMAN MYTHOLOGY: Draco is a constellation representing the dragon slain by the hero Hercules as one of his labors. [3]
3C OTHER CULTURE: In Chinese astronomy, the stars of Draco were associated with the Celestial Emperor's throne, and it's often referred to as the "Celestial Emperor's Chair." [3]

(10) Sketch the moon as seen with your eye. Indicate the date and time of the observation.

(11) Sketch the moon as seen through the telescope.



(12) In a sentence or two, explain what the *terminator* is? Also indicate it on your sketch.

Answer (12): ***Terminator*** on the Moon marks the boundary between the illuminated side, bathed in sunlight, and the dark, shadowed night side. [4]

(13) Use the telescope to observe each visible planet. Note also the time and date of your observation.

- What colour is the planet?
- Can you see markings on its surface?
- Can you see its moons?
- Is the planet crescent-shape, round, or gibbous (nearly full)?

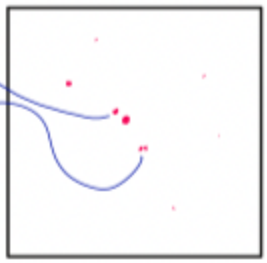
(14) Sketch each planet (and its moons, if any) as seen through the telescope.

(15) If the moons of any planet are visible, label them on your sketch.

Mercury
- yellowish?
- no
- N/A
- round

Venus
- yellow?
- yes... not sure
- wasn't visible
- crescent

Mars
- dark yellow
- no
- ~~yes~~ N/A
- round



Jupiter
- yellow & white
- yes
- yes
- round

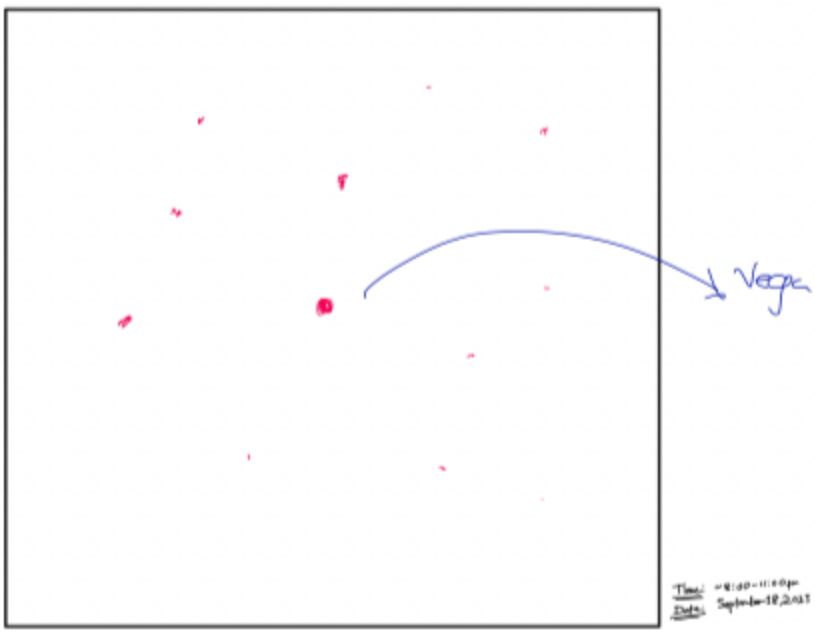
Neptune
- bluish white
- no
- no
- round

Saturn
- yellow white
- no
- no
- round w/ visible rings

Uranus
- yellowish white
- no
- no
- round

Time: ~8:00-11:00pm
Date: September 18, 2021

(16) Point your telescope at any bright star in the sky. In Fall, Vega, Deneb, or Altair are bright, easy targets. In Spring, Sirius, Betelgeuse and Arcturus are probably good choices. Note down what you observe, mainly the color and brightness of the star. Make a note of the date and time of observation.

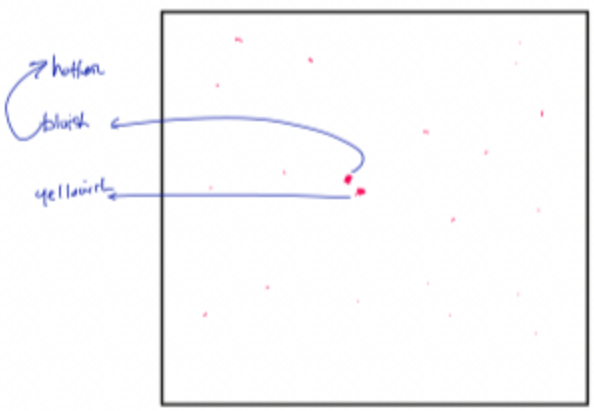


(17) Point your telescope at Albireo (Fall term) or ι-Cancri (Spring term).

(18) Sketch Albireo or ι-Cancri. Note the time and date of your observation.

(19) What is the colour of each star in the binary system you observed?

(20) Which star is the hotter of the two? Explain.



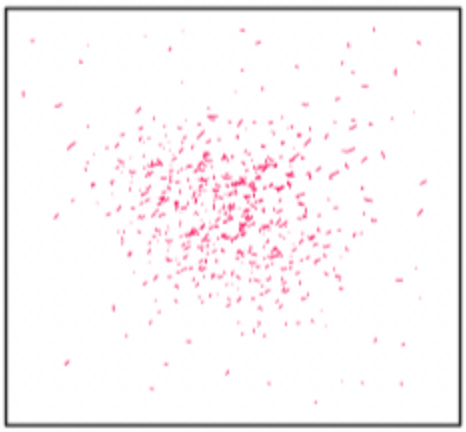
Albireo

Time: ~8:00-11:00pm
Date: September 18, 2023

(21) Observe and sketch one of each of these four types of objects; also note the time and date of your observations.

- Globular Cluster - Fall M13, M15 - Summer M3
- Open Cluster - Fall M11, NGC 869 - Summer M67
- Planetary Nebula - Fall NGC 7662, M57 - Summer M57
- Galaxy - Fall M31, M32 - Summer M82

(22) Describe each of the four objects given above. Explain the class of object, e.g., globular cluster, and then include pertinent details about the particular object, eg., distance, size, number of stars, age, etc. Refer to sources such as Wikipedia to obtain relevant information about each of them. **The descriptions should be written in your own words, no copying and pasting**. Remember to cite all your sources in your bibliography.



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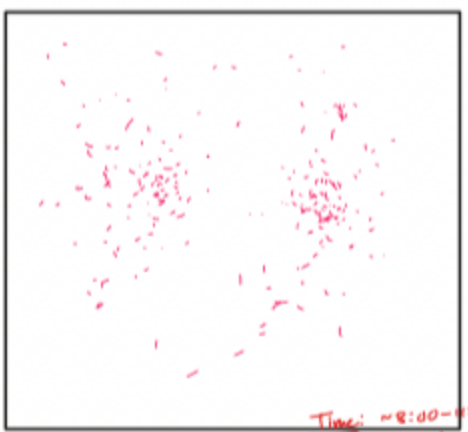
MESSIER 13 (Globular Cluster)

Distance: M13 is approximately 22,200 light-years away from Earth. [5]
Size: The cluster has a diameter of about 145 light-years. [5]
Number of Stars: M13 contains an estimated 300,000 to 500,000 stars tightly packed within its core. [5]
Age: The age of M13 is estimated to be around 11.65 billion years, making it one of the older globular clusters in the Milky Way galaxy. [5]

NGC 869 (Open Cluster)

Distance: NGC 869 is located at a distance of approximately 7,600 light-years from Earth. [6]
Size: The cluster is relatively large and spans about 29 light-years in diameter. [6]
Number of Stars: NGC 869 is composed of over 300 stars, making it one of the richer open star clusters in the night sky. [6]
Age: The age of M13 is estimated to be around 12.8 billion years. [6]



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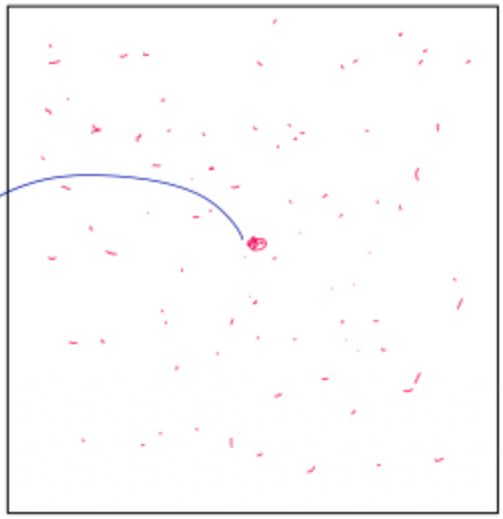

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M57 (Planetary Nebula)

Age: Estimated to be around 6,000 to 8,000 years old. This age represents the age of the star at the center of the nebula. [7]
Size: The Ring Nebula has a diameter of approximately 1 light-year. It is relatively small in size compared to many other astronomical objects. [7]
Number of Stars: Primarily composed of gas and dust. [7]
Distance: M57 is located at a distance of approximately 2,300 light-years from Earth. [7]

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M31 (Andromeda Galaxy)

Age: Approximately 10 billion years. [8]
Size: Diameter of about 220,000 light-years - one of the largest galaxies in our local group of galaxies. [8]
Number of Stars: Estimated to contain around 1 trillion stars. [8]
Distance: Located at a distance of approximately 2.537 million light-years from Earth. [8]

References:

1. https://en.wikipedia.org/wiki/Orion_(constellation)
2. https://en.wikipedia.org/wiki/Ursa_Major
3. https://en.wikipedia.org/wiki/Draco_(constellation)
4. https://en.wikipedia.org/wiki/Terminator_(solar)
5. https://en.wikipedia.org/wiki/Messier_13
6. https://en.wikipedia.org/wiki/NGC_869
7. https://en.wikipedia.org/wiki/Ring_Nebula
8. https://en.wikipedia.org/wiki/Andromeda_Galaxy