

TRAVELING THROUGH GALAXY THREE-DIMENSIONAL MODELS OF CONSTELLATIONS BASED ON NEW DATA FROM HIPPARCOS SATELLITE

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Abstract

To develop the skill of spatial perception and to understand that stars lie at the different distance from the Earth, groups of students make three-dimensional models of five different constellations. These models are based on accurate data from Hipparcos satellite and they are easy to construct. Models of constellations are compared and discussed. This activity can be carried out with the students of different age on two levels: basic and extended.

Concept

Stars are not situated on the surface of imaginable sphere; they lie at different distance from Earth.

Objectives

After completing this activity students will be able:

- to understand that distance to the stars is very different;
- to discover that the constellation pattern changes, if viewed from different points of space;
- to understand the relationship between apparent brightness of star and its size and distance.

Materials (for each group of students)

One copy of constellation worksheet
One piece of A5 size cardboard (15 × 20 cm approximately)
Seven cocktail tubes
Color pencils or felt-tipped pens
Scissors, glue, ruler, scotch
Compasses (for extended procedure only)

Age group

12 to 15 years (basic procedure).

Can be extended to age group 16 to 17 years (extended procedure).

Background information

The European Space Agency launched Hipparcos satellite in 1989. For several years it measured the position, brightness and parallax of 120 000 stars down to 12th magnitude (distance of star can be easily derived from parallax). Measurements were very accurate, for example distance of star up to 1600 light-years (ly) was measured with accuracy ± 1 ly or better. Final catalogue was published in 1997. Star data in this activity are taken from Hipparcos catalogue.

Basic procedure

- Cut out the constellation drawing and glue it on the cardboard.
- Write the names of students.
- Color and then cut out the circles of stars.
- Find the star with greatest distance and choose the scale of the model (1 cm = x ly), taking into account that the greatest distance in model must not exceed approximately 20 cm.
- Calculate the scaled distance of each star (in cm) and write it together with true distance (in ly) to the constellation drawing (or in the Table 1 for extended procedure).
- For each star cut the cocktail tube of appropriate length.
- Make small cuts at both ends of each tube (see Picture 1).
- Fix the star circle to one end of each tube (use scotch).
- Fix the other end each tube with scotch to the constellation drawing (see Picture 2). Constellation model is ready.

Extended procedure

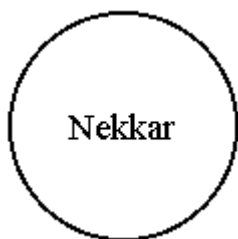
- For each group of students make a copy of constellation worksheet WITHOUT star circles and information on star size, color and distance.
- Make instead a copy of Table 1 "Star Data".
- Choose the scale of star size (1 cm = y Sun diameters) and write it to table, taking into account that the greatest size of star must not exceed approximately 10 cm (except Betelgeuse).
- Calculate for given constellation the scaled diameter of each star and write it to table.
- Find the color of star using Table 2 "Color and Temperature" and write it to Table 1.
- Using the compasses draw for each star the circle of appropriate size.
- Estimate for each star does it belongs to Sun-size stars, giants or supergiants.
- Then proceed with the basic procedure.

Discussion

Compare the completed models and discuss the following questions:

- How many times differs the greatest and smallest distance of stars in the constellation?
- If all models would have the same distance scale (say 1 cm = 10 ly), how they would look like?
- Which stars are the brightest when observed from the Earth? From what factors depends brightness of the star?
- If we look to the model from different sides, can we see the same star pattern as from above?
- Show the path of imaginary spaceship that goes from the biggest to the smallest star.
- Which stars are the hottest and which are the coolest ones? (For advanced procedure only).

Constellation BOOTES



Nekkar

yellow giant
219 light-years



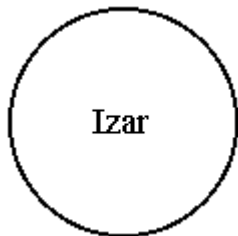
Delta Bootes

yellow giant
117 light-years



Seginus

white Sun-size
star
85 light-years



Izar

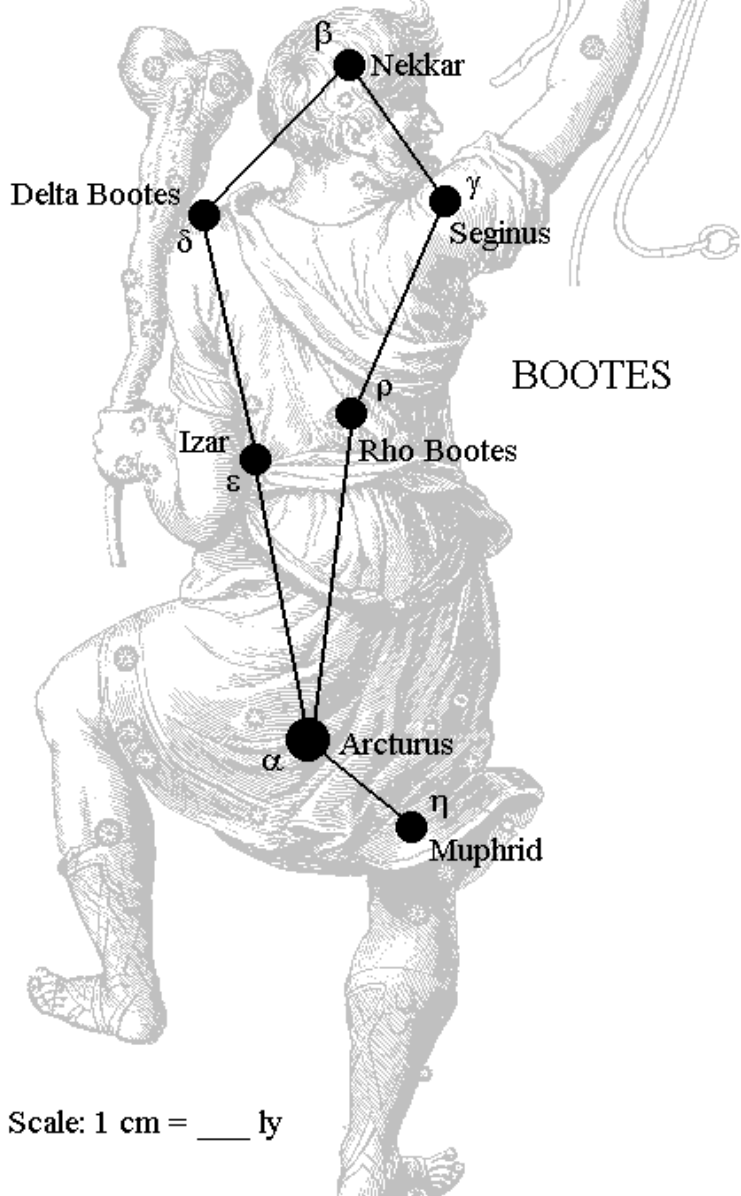
white giant
85 light-years



Rho Bootes

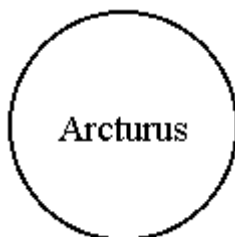
orange giant
149 light-years

Name _____



BOOTES

Scale: 1 cm = ___ ly



Arcturus

orange giant
37 light-years



Muphrid

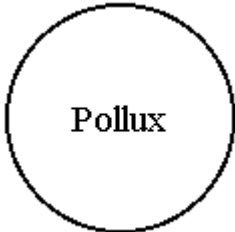
yellow Sun-size star
37 light-years

Constellation GEMINI



Castor

white Sun-size star
52 light-years



Pollux

orange giant
34 light-years



Wasat

white Sun-size star
59 light-years



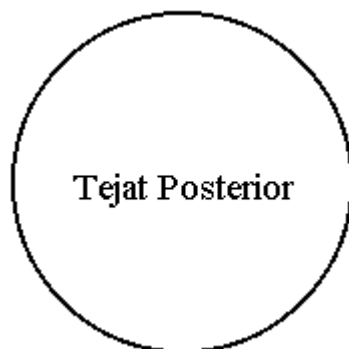
Mekbuda

yellow Sun-size star
57 light-years



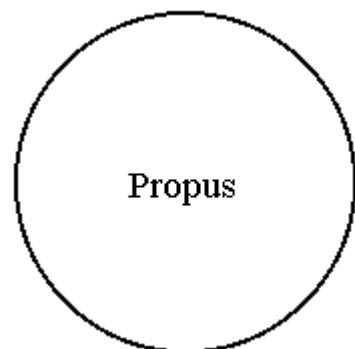
Alhena

white Sun-size star
105 light-years



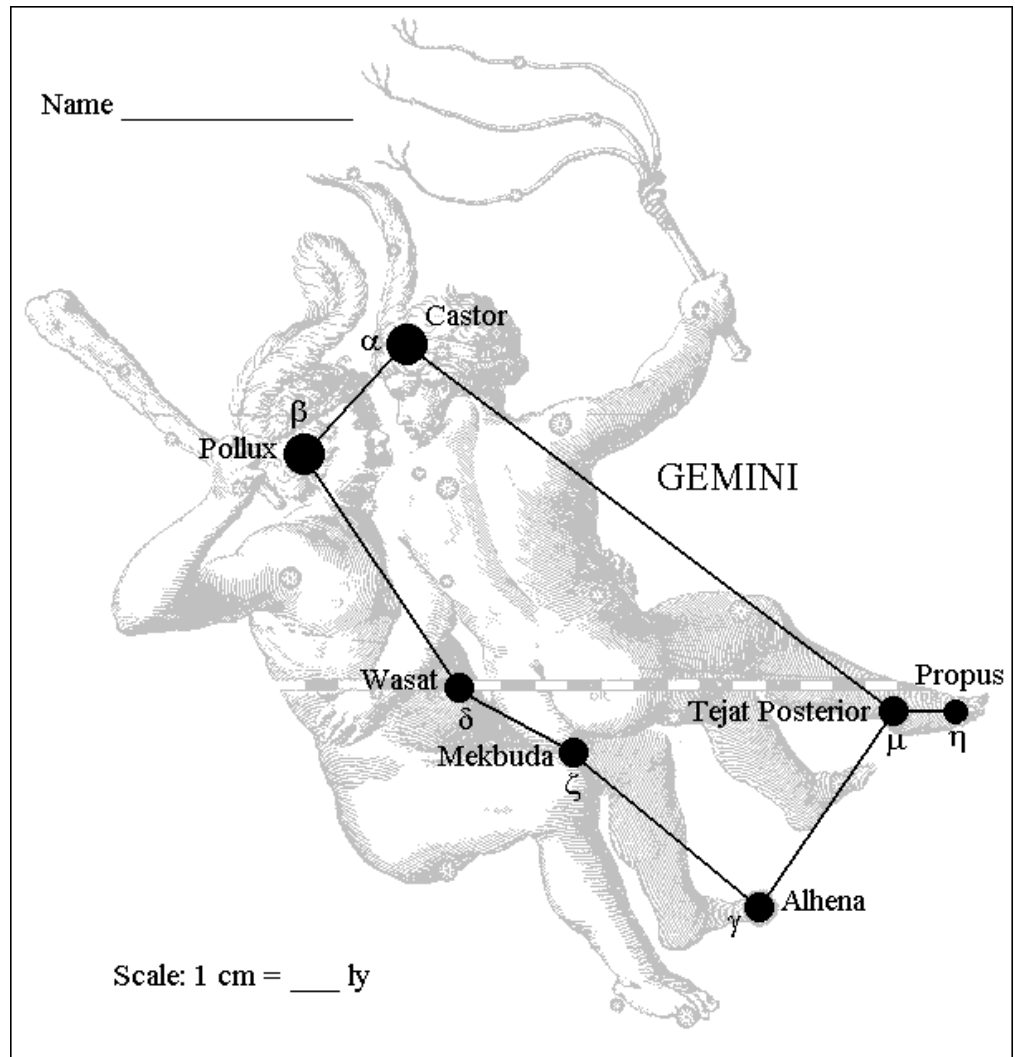
Tejat Posterior

red supergiant
232 light-years



Propus

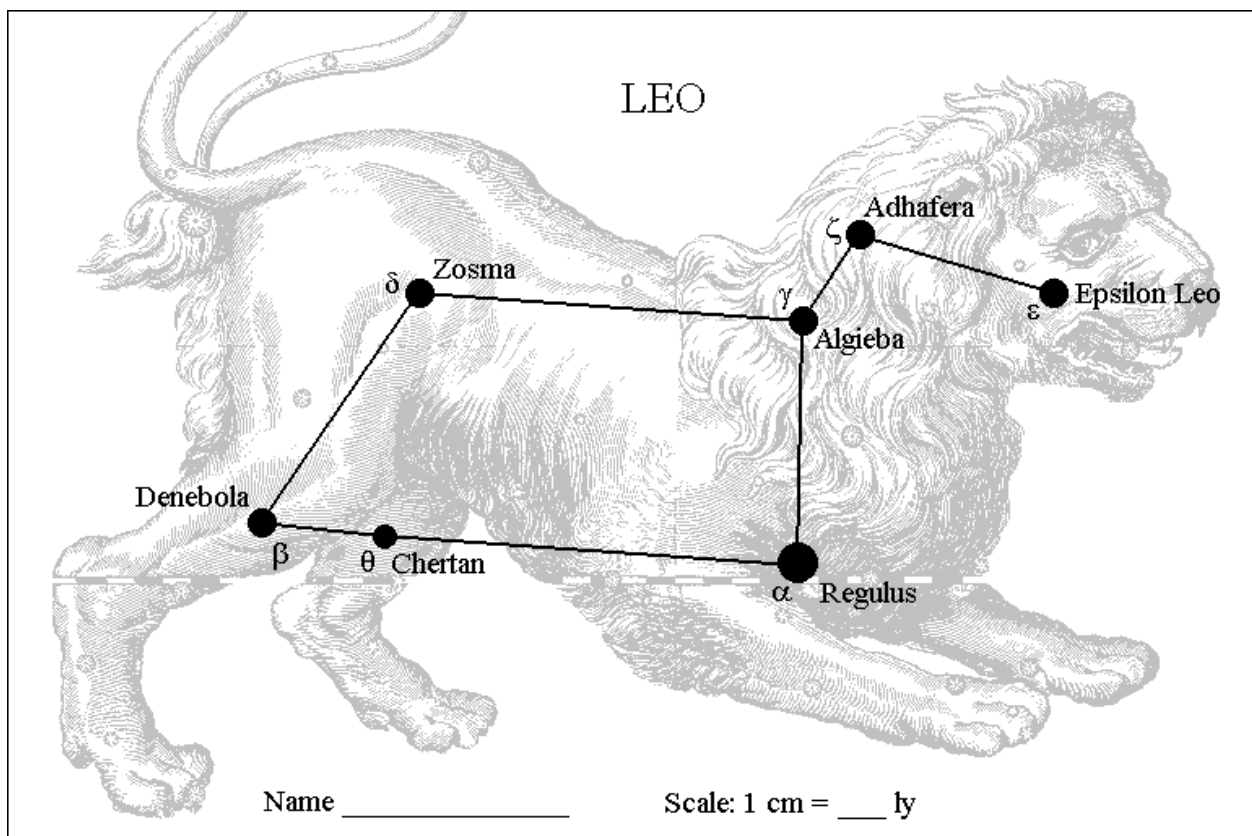
red supergiant
349 light-years



Name _____

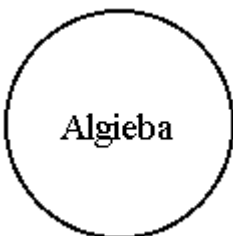
Scale: 1 cm = ___ ly

Constellation LEO



Adhafera

white giant
260 light-years



Algieba

orange giant
126 light-years



Epsilon Leo

yellow giant
251 light-years



Zosma

white Sun-size star
58 light-years



Denebola

white Sun-size star
36 light-years



Chertan

white Sun-size star
178 light-years



Regulus

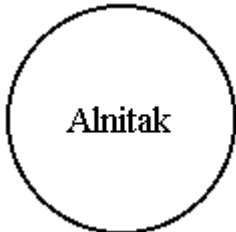
blue Sun-size star
78 light-years

Constellation ORION



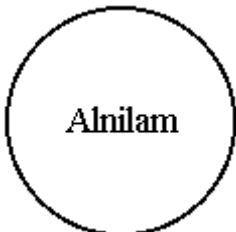
Bellatrix

blue Sun-size star
243 light-years



Alnitak

blue giant
817 light-years



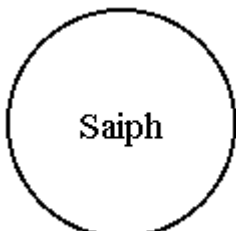
Alnilam

blue giant
1340 light-years



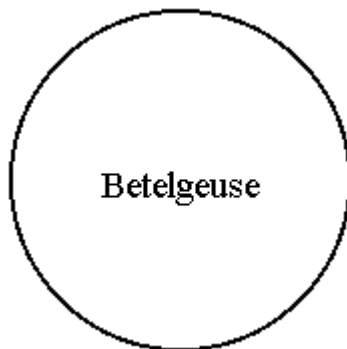
Mintaka

blue giant
916 light-years



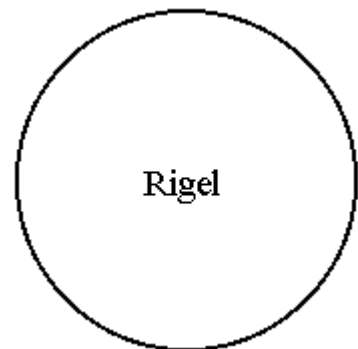
Saiph

blue giant
722 light-years



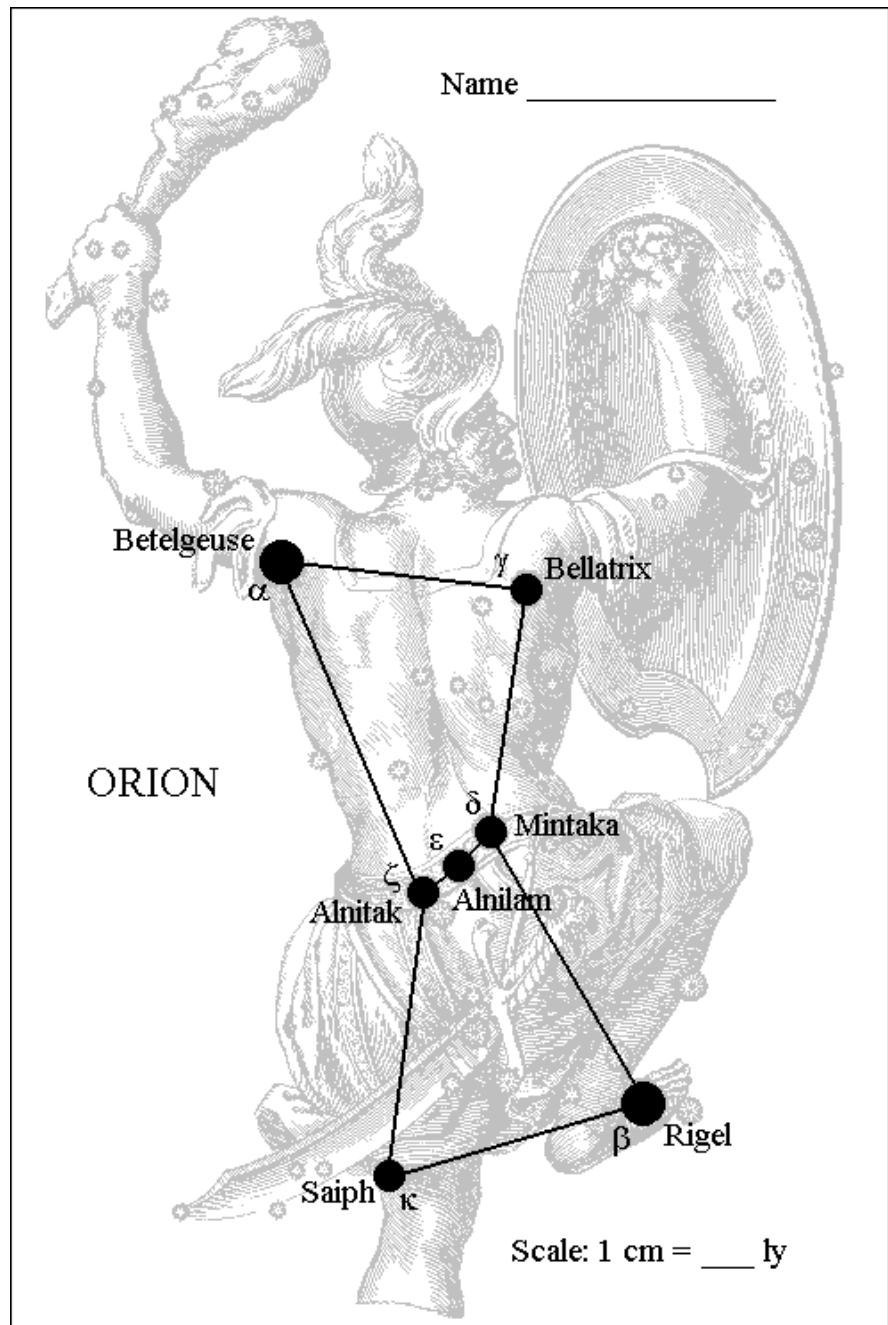
Betelgeuse

red supergiant
428 light-years

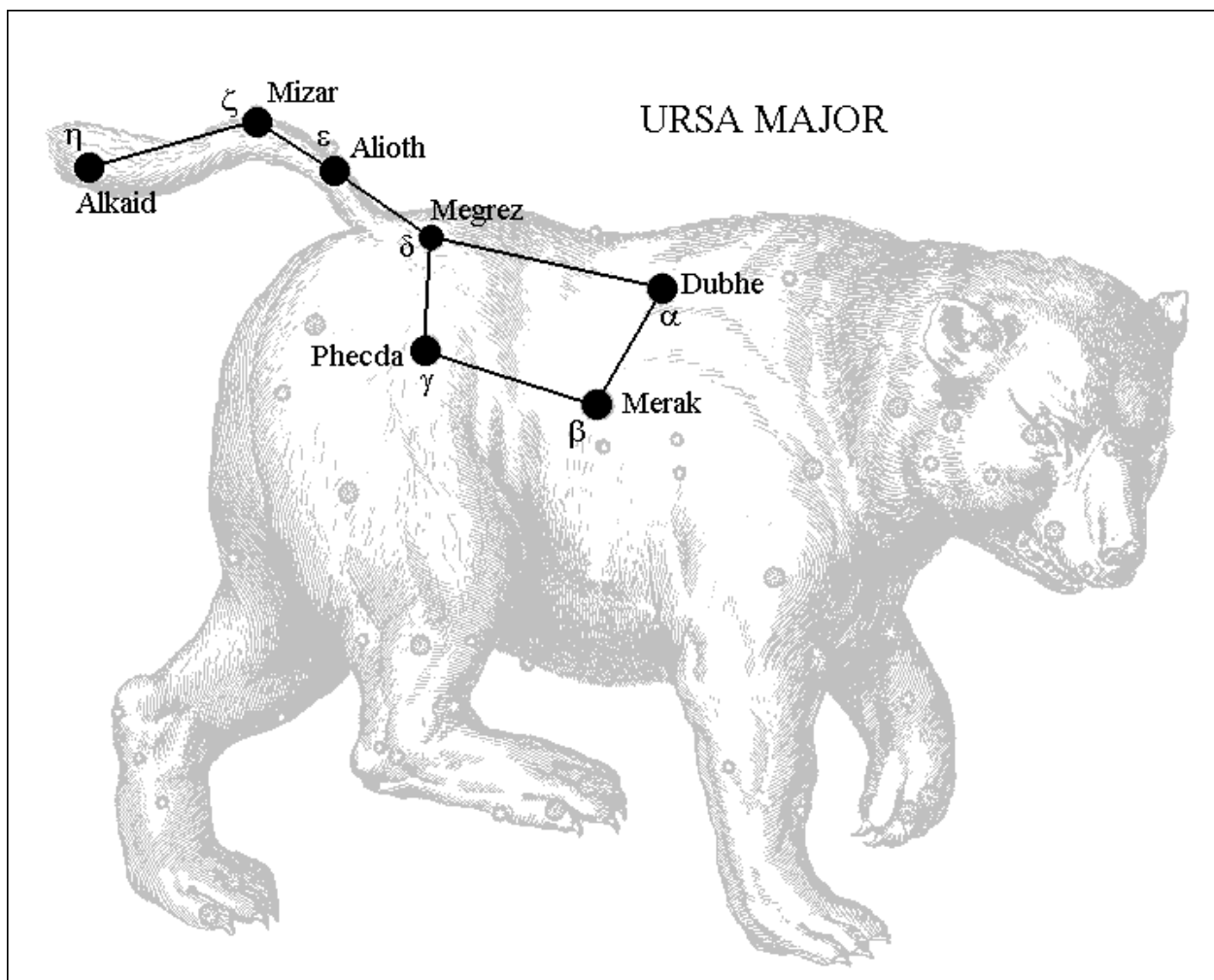


Rigel

blue supergiant
773 light-years



Constellation URSA MAJOR



Alkaid

blue Sun-size star
101 light-years



Mizar

white Sun-size star
78 light-years



Alioth

white Sun-size star
81 light-years



Megrez

white Sun-size star
81 light-years



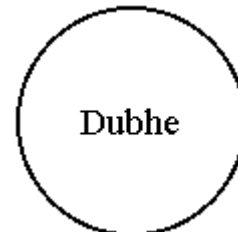
Phecda

white Sun-size star
84 light-years



Merak

white Sun-size star
79 light-years



Dubhe

yellow giant
124 light-years