

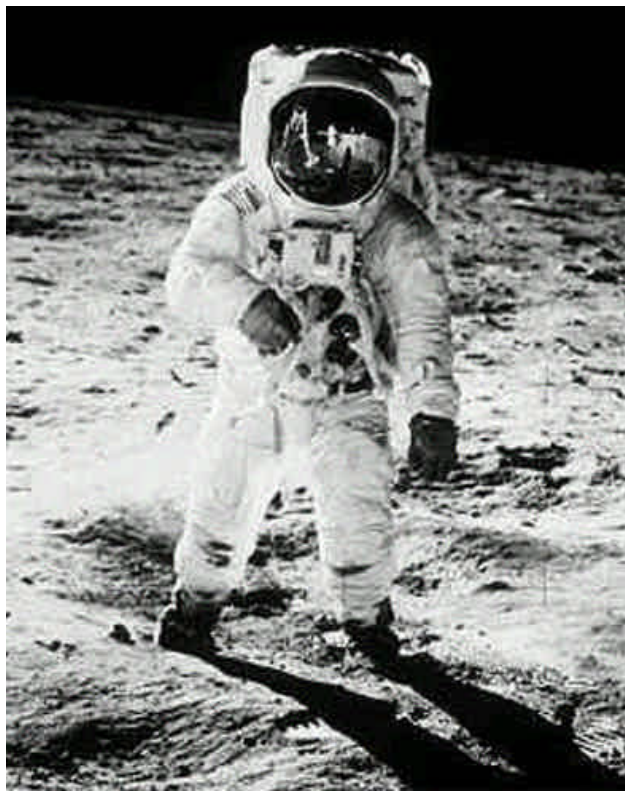
Mathematics Science Strand

Environmental Science

Module

E6

Earth in Space



Your love, Lord, reaches to heaven,
Your truth to the skies *Ps 35:6*

**Additional Student Support
Material - Reference Booklet**

Acknowledgements

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The Greek Alphabet

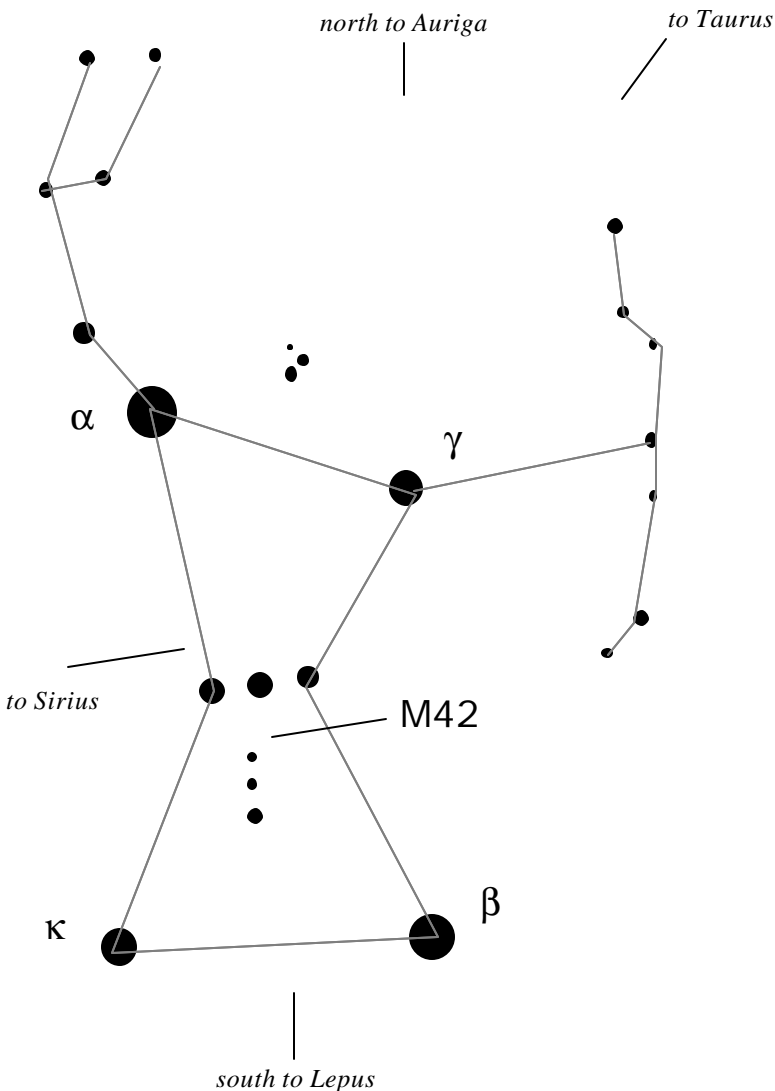
α alpha	η eta	ν nu	τ tau
β beta	θ theta	ξ xi	υ upsilon
γ gamma	ι iota	ο omicron	φ phi
δ delta	κ kappa	π pi	χ chi
ε epsilon	λ lambda	ρ rho	ψ psi
ζ zeta	μ mu	σ sigma	ω omega

Constellations

Abbreviations and Culmination (Highest Point) at 9pm

<i>Name</i>	<i>Genitive</i>	<i>Abr.</i>	<i>Description</i>	<i>Cul.</i>
Aquarius	Aquarii	Aqr	The Watercarrier	Oct 09
Aquila	Aquilae	Aql	The Eagle	Aug 30
Bootes	Bootis	Boo	Bootes, the Herdsman	Jun 16
Cancer	Cancri	Cnc	The Crab	Mar 16
Canis Major	Canis Majoris	CMa	The Big Dog	Feb 16
Canis Minor	Canis Minoris	CMi	The Little Dog	Feb 28
Carina	Carinae	Car	The Keel	Mar 17
Centaurus	Centauri	Cen	The Centaur	May 14
Corona Australis	Coronae Australis	CrA	The Southern Crown	Aug 14
Corona Borealis	Coronae Borealis	CrB	The Northern Crown	Jul 03
Corvus	Corvi	Crv	The Crow	May 12
Crux	Crucis	Cru	The Southern Cross	May 12
Delphinus	Delphini	Del	The Dolphin	Sep 14
Gemini	Geminorum	Gem	The Twins	Feb 19
Grus	Gruis	Gru	The Crane	Oct 12
Hydra	Hydri	Hyi	The Water Snake	Apr 29
Leo	Leonis	Leo	The lion	Apr 15
Lepus	Leporis	Lep	The Hare	Jan 28
Lyra	Lyrae	Lyr	The Lyre	Aug 18
Musca	Muscae	Mus	The Fly	May 14
Orion	Orionis	Ori	Orion the Hunter	Jan 27
Pegasus	Pegasi	Peg	Pegasus the Winged Horse	Oct 16
Sagitta	Sagittae	Sge	The Arrow	Aug 30
Sagittarius	Sagittarii	Sgr	The Archer	Aug 21
Scorpius	Scorpii	Sco	The Scorpion	Jul 18
Taurus	Tauri	Tau	The Bull	Jan 14
Triangulum Australe	Trianguli Australis	TrA	The Southern Triangle	Jul 07
Ursa Major	Ursae Majoris	UMa	The Great Bear	Apr 25

Orion, the Hunter Jan 27



α Betelgeuse
red supergiant
0.5; 650 ly;
dia x300-x400 Sun
name means "armpit of the central one"

β Rigel
0.12; blue-white (B8)
supergiant; 815ly
"Giant's leg";
the 7th brightest star;
Orion's lucida
Has a 7th mag. companion.

γ Bellatrix
1.6; pale yellow (B2)
name means 'female warrior'

M42 Great Nebula
Also called θ Orionis
One of the finest nebulae in the sky; visible to naked eye as a fuzzy patch; 1500ly; includes the Trapezium (multiple star)

α Orionis (Betelgeuse) forms a triangle with Sirius (α Canis Majoris) and Procyon (α Canis Minoris).

ly = light years (distance from us);

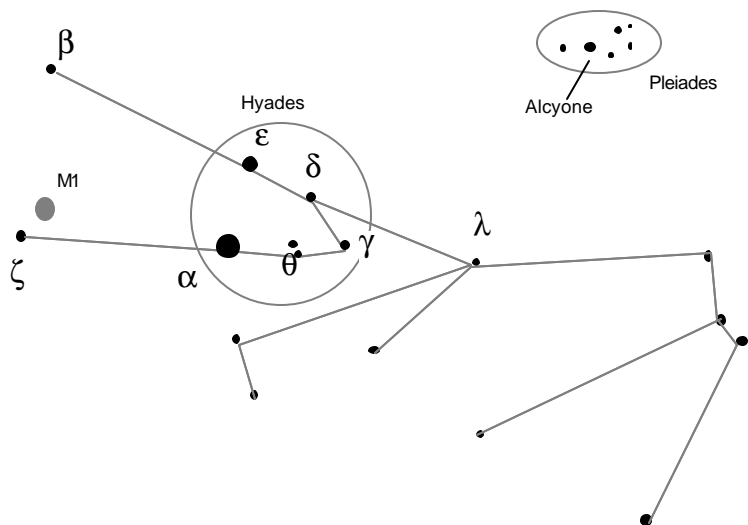
dia = diameter (e.g. x300 Sun = 300 times diameter of our Sun)

lucida = brightest star in the constellation (usually α , but not always)

"0.5" etc = magnitude (brightness)

(brightest stars are mag. 1 or less; faintest visible to the unaided eye are mag. 6)

Taurus, the Bull Jan 14



The two most famous open clusters, the Pleiades and the Hyades, are in Taurus. It is the second constellation of the Zodiac so it is approximately overhead from the Tropics when it culminates (9pm on Jan 14).

Zodiac =“circle of the animals”—the zodiac constellations form the background for the sun, moon and planets. There are 12 zodiac constellations. The sun spends about a month in each.

α Aldebaran

0.85, pale red; an irregular variable; 68ly; name means “the follower” because it follows either the Pleiades or more probably, the Hyades, rising just after they have risen or setting just after they have set.

The star was one of the four Royal stars or “watchers” of ancient Mesopotamia. The others are Regulus (α Leo), Antares (α Sco) and Fomalhaut (α Piscis Austrinus, the Southern Fish)

The Hyades—Open Cluster

The V shape in the head of Taurus the Bull

Aldebaran is not part of the cluster. 5° of the sky; 200 stars; 150ly. Brightest star: θ (3.4) name means “rainy ones” (herald of storms)

M45 The Pleiades

“The Seven Sisters”

Naked Eye Cluster

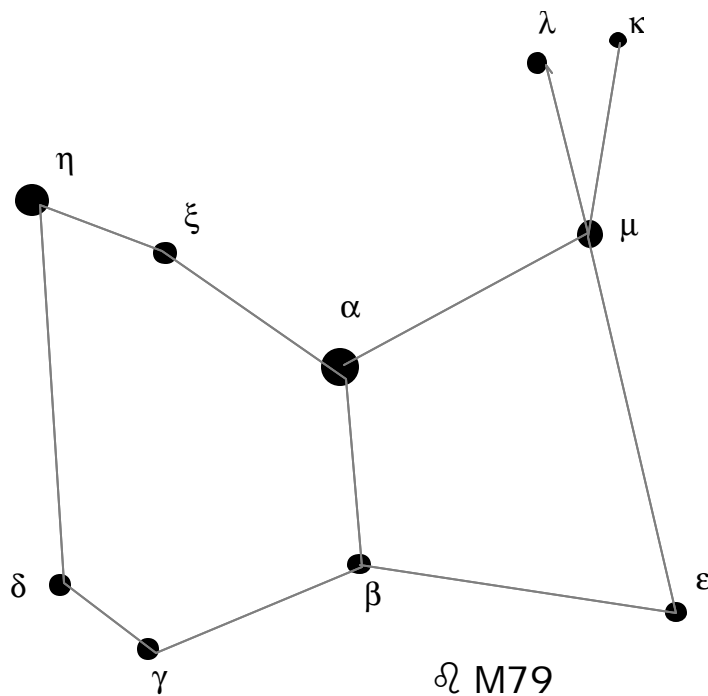
Most see 6 stars, so perhaps one (Sterope) lost brightness since ancient times.

Their names are (brightest to faintest): Alcyone (2.9), Atlas, Electra, Maia, Merope, Taygeta, Pleione, Celaeno and Sterope (5.8) 410ly; new stars (formed in the last 50 million years)

M1 The Crab Nebula

About 1° north west of zeta (ζ) (2 full-moon-diameters). It is the remnant of a famous supernova explosion observed in 1054 AD. Distance: 6,500 ly; Filaments of this nebula reminded astronomers of the legs of a crab, hence the name.

Lepus, the Hare Jan 28

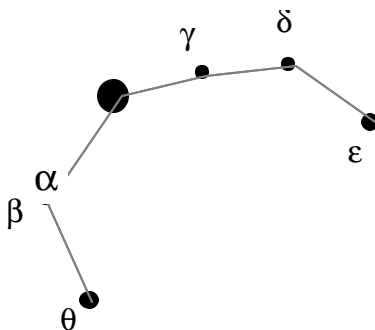


M79 Small Globular Cluster
7.9; diameter about 3 minutes of arc (1/10 of the Moon's diameter)



Located at the base of Orion the Hunter. The hunter's dog, Canis Major, lies immediately to the east, ready to leap on its prey.

As the Hare goes to ground in the West, you will see Corvus the Crow rising about 45° up in the East. Hares hate crows. Lepus only rises when Corvus has set.

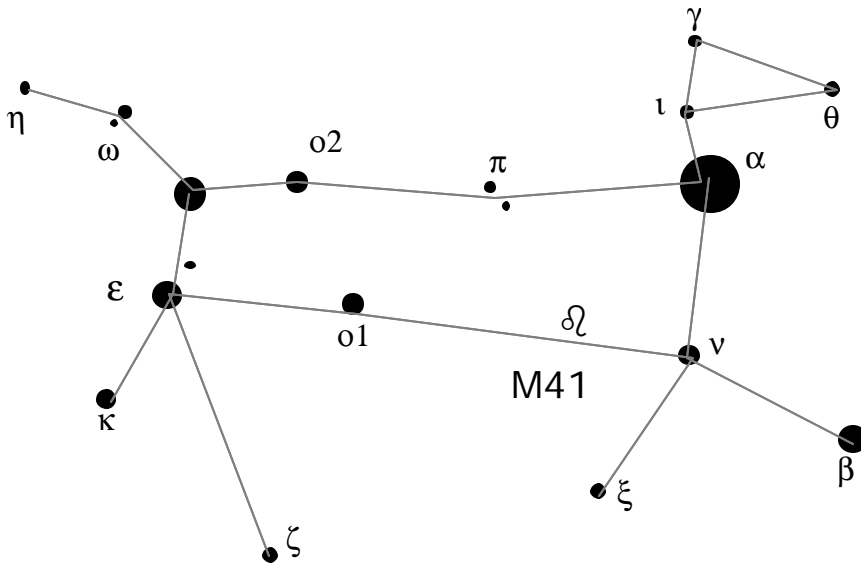


α Alphecca
2.2, blue-white, 'bright one of the dish', also known as Gemma, the unopened buds of a floral crown

τ the Blaze star
variable mag., pale yellow;
an unpredictable star which
can flare up from mag. 11
to mag. 2
Nova 1866

Corona Borealis lies between Boötes to the West and Hercules to the East.

Canis Major, the Big Dog Feb 16



α Sirius
A-type; 1.46, brilliant white, the name means 'scorching'. 8.7ly; brightest star in the sky; one of the Sun's closest neighbours.

β Mirzam
2.0, blue-white; name means 'announcer' (rises slightly ahead of Sirius)

δ Wezen
1.8; yellow; the name means 'weight' in Arabic (no one knows the reason)

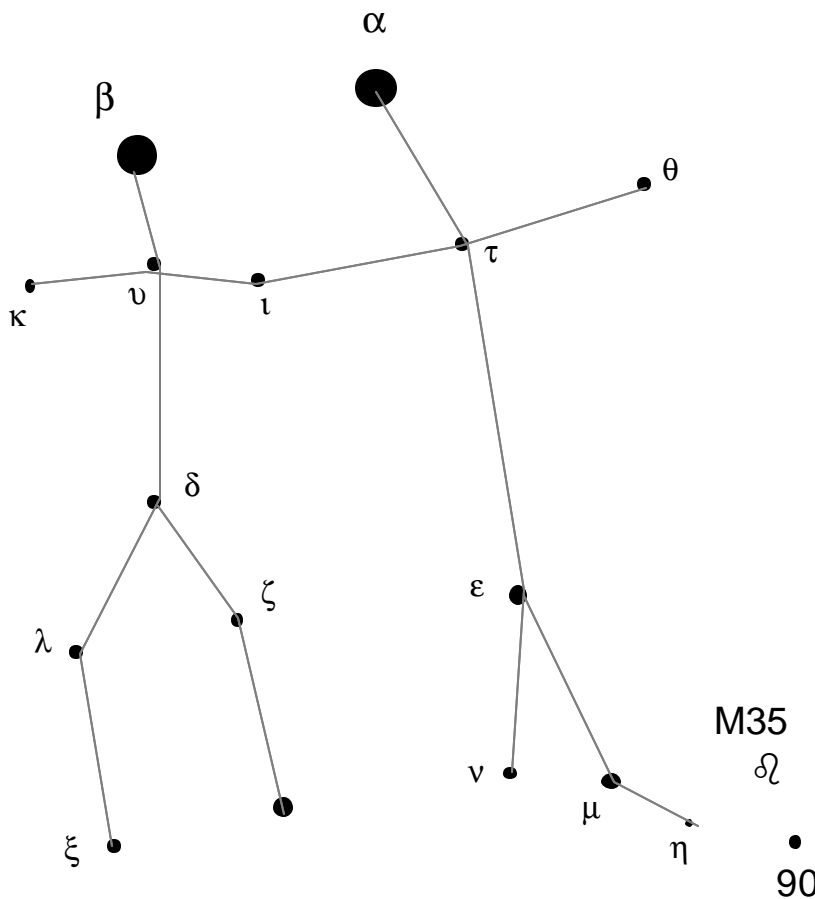
ϵ Adhara
1.5, blue, the name means 'virgins': from the Arabic legend of Canis Major and Canis Minor as being 2 sisters, one of whom eloped leaving her sad sister behind.

M41 —Open Cluster
80 stars; 7th mag. and fainter with 6.9 mag. red star near centre; overall mag. 4.5; about half a degree in diameter (full moon size); just visible to the unaided eye on a dark clear night.

Seems to be following Orion as his hunting dog. The Milky Way runs over the top of the Dog. It is seen high in the sky in the Tropics.

There is a controversial claim that the Dogon peoples of Mali in West Africa have traditionally given Sirius a companion-star, Po. This they termed the "heaviest star", and calculated their ritual time-periods on the basis of its 50-year, elliptical orbit. However, not until 1862 was it scientifically proven that Sirius was actually a binary (double star), its tiny companion Sirius B (magnitude 8.5) orbiting every 50 years. How the Dogon made this discovery hundreds of years earlier remains a mystery.

Gemini, The Twins Feb 19



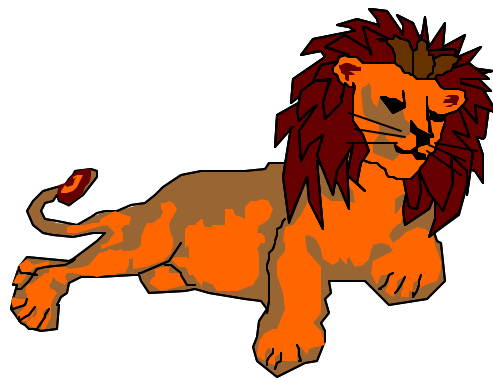
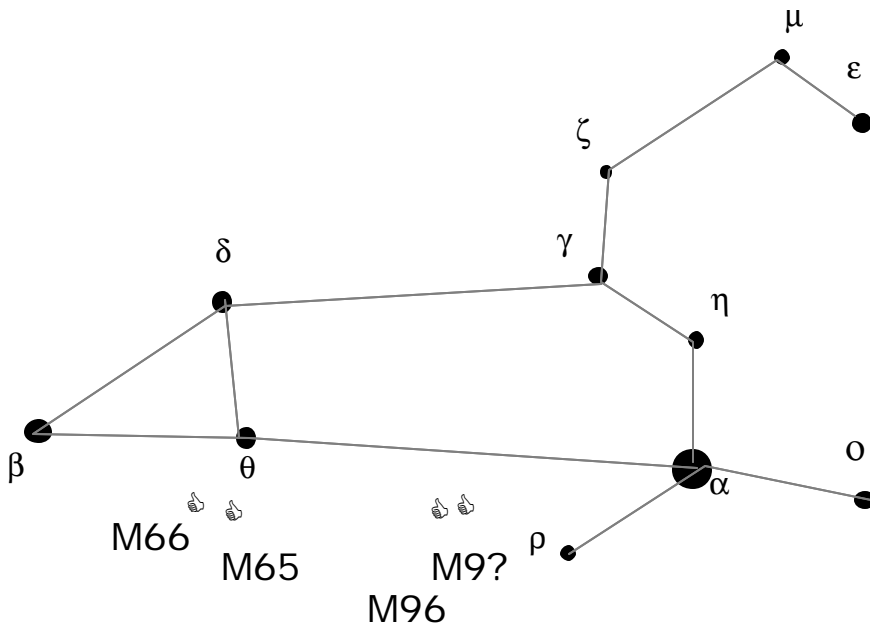
β Pollux
1.1, yellow (K); the brightest star in Gemini; name from Polydeuces, son of Zeus and Leda, queen of Sparta

α Castor
1.6; blue-white (A); a remarkable compound system of 6 stars, made up of 3 pairs of binaries. 47 ly; unable to separate in small telescope

M35 Open Cluster
 δ
200 stars, mag. 9-16; overall magnitude 5.3; 2800 ly; half a degree in diameter (the size of the full moon); a fine cluster, just visible to the naked eye.

3rd Zodiacal constellation; North-East of Orion. I first learned to recognise the Twins by the cross shape with the high cross-bar, with β at the right and α at the base. Its third brightest star Alhena (γ Gem) marks the feet of the twins, who paddle in the Milky Way.

Leo, The Lion April 15



α Regulus
1.4; blue-white B7;
also called *Cor Leonis*, the 'heart of the lion'. 'Regulus' means 'little king', and was the leader of the 4 Royal Stars or 'watchers' of the Mesopotamians

β Denebola
2.1; white; name means 'lion's tail'

M66 Spiral Gal axy
8.8

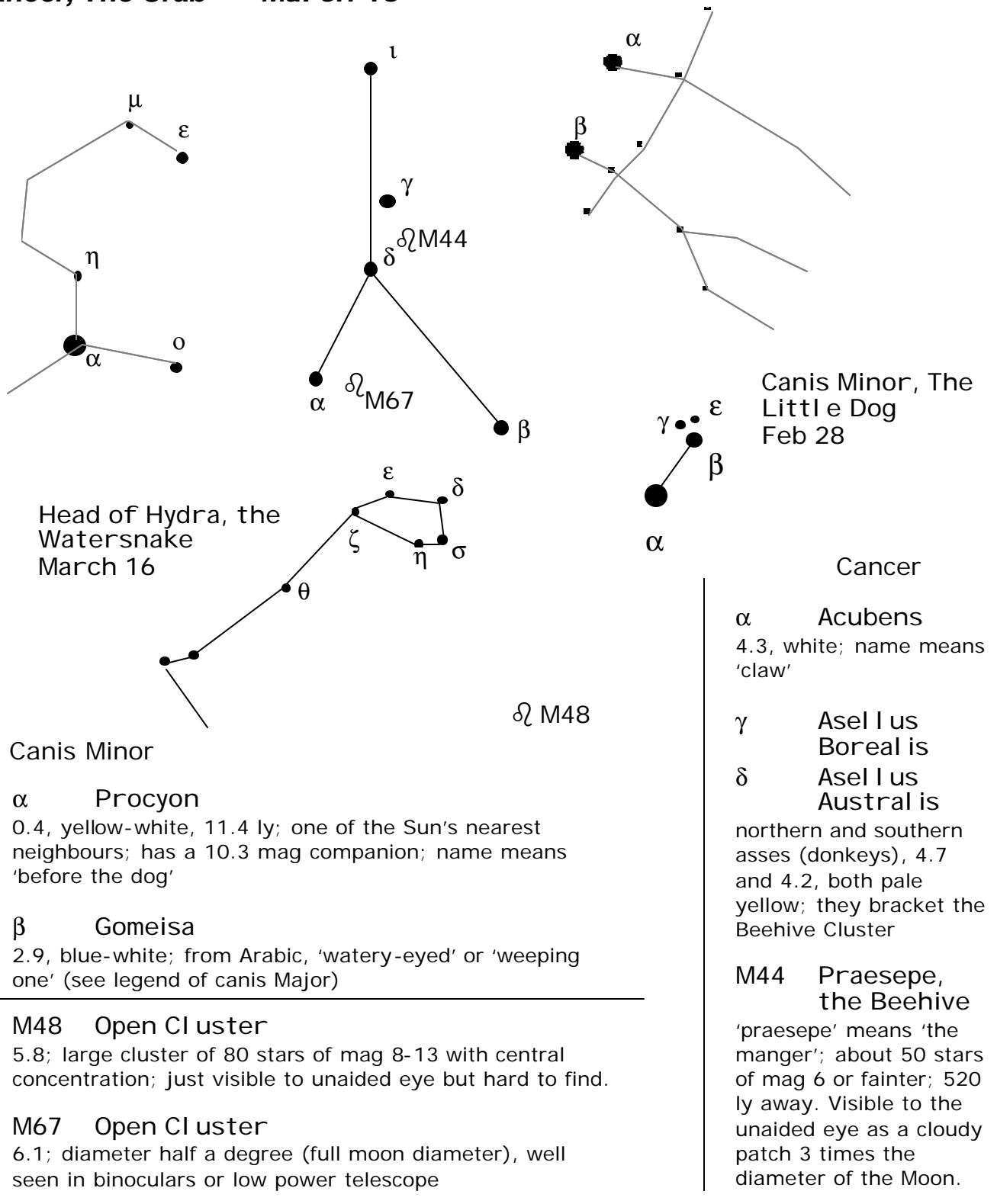
M65 Spiral Gal axy
9.5

M96 Spiral Gal axy
Mag. 9 (brighter than M95)

M95 Spiral Gal axy

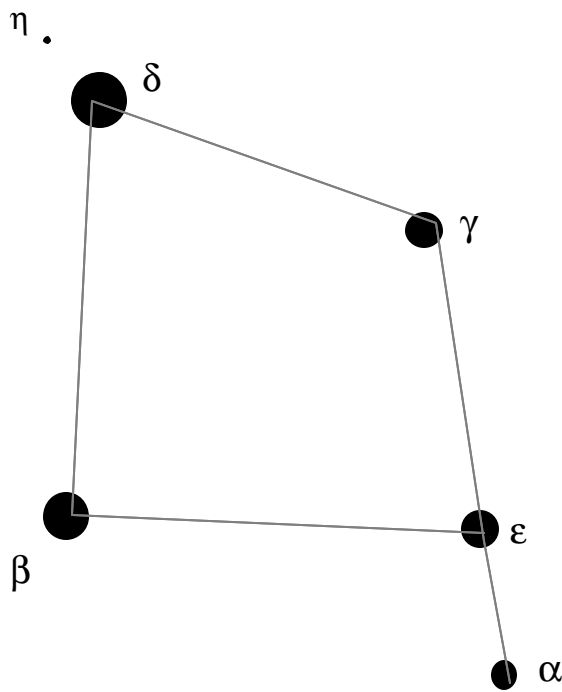
Leo is the 5th Zodiacal constellation: a crouching lion facing Westward. Its head and mane are marked by a sickle-shaped reverse question mark.

Cancer, The Crab March 16



Cancer is half-way between the head of Leo and the Gemini, the Twins. It is the hardest of the zodiacal constellations to pick out. No star is brighter than 4th magnitude. The body of Hydra winds back underneath Leo. It is the largest constellation.

Corvus, the Crow May 12



Al chiba
 te; name means
 Arabic; it may
 e been brighter

ρ Kraz
 3, yellow

δ Al gorab

γ Gienah
 3, blue-white

ε Minkar

α Dubhe
 'bear' (Arabic)
 1.8, yellow
 β Merak
 'flank'
 2.4, greenish-white
 γ Phecda
 'thigh'; 2.4, yellow-
 white

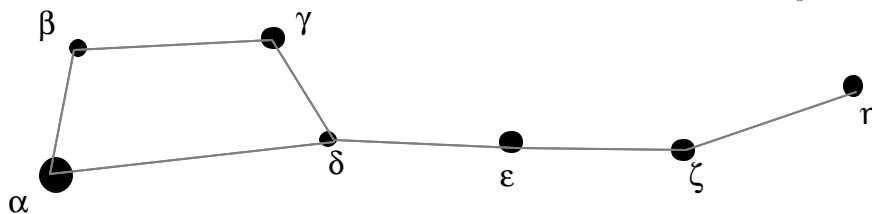
δ Megrez
 'root of the tail'
 3.4, white

ε Al ioth
 1.8, white

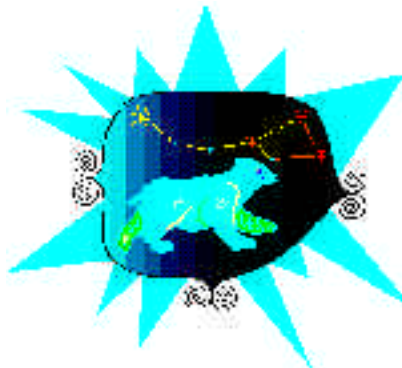
ζ Mizar
 2.4, white

η Al kaid or
 Benetnash
 1.9, brilliant white
 The 'principal mourner'
 (from the Arabic Ka'id
 Banat al Na'ash) of the
 children of Al Na'ash,
 who were murdered by
 the Pole Star, Al Jadi,
 according to Arabic
 myth. Every night as
 the stars of the Big
 Dipper they still crowd
 around in their
 circumpolar course,
 seeking revenge

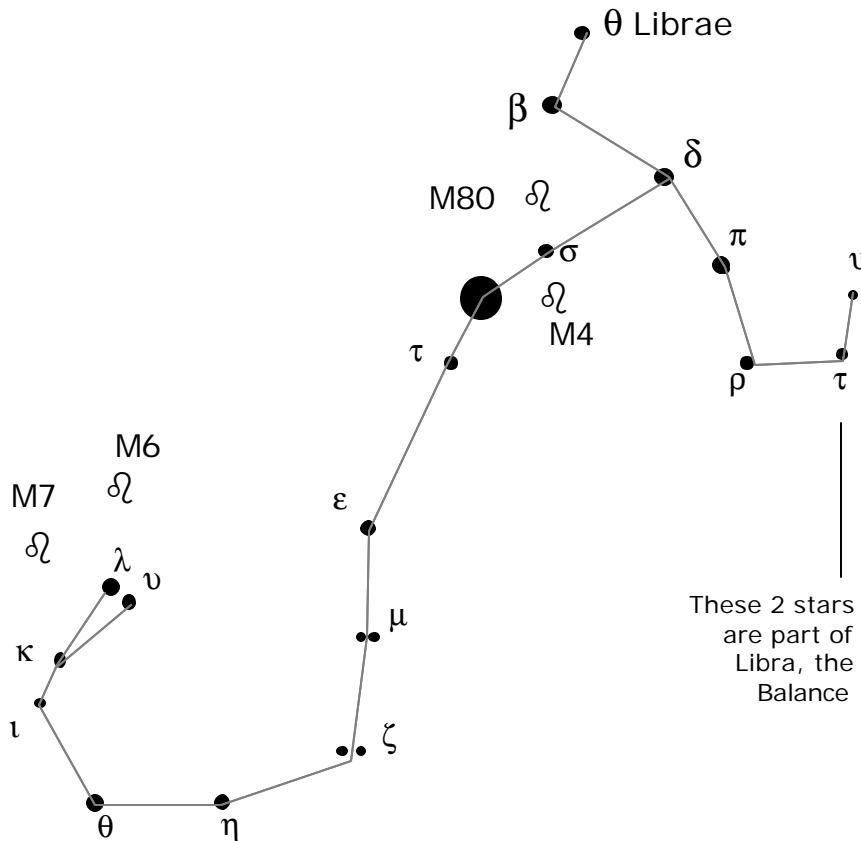
The Big Dipper (part of Ursa Major, the Great Bear) Apr 25



From PNG, the Big Dipper is low in the North and upside down, circling the North Celestial Pole.



Scorpius, the Scorpion July 18



α Antares
1.35, red supergiant
400 times diameter of
the Sun, 170ly,
brightness varies over
a 4.75 yr cycle; one
of the 'watchers' or
Royal Stars of
Mesopotamia; name
means 'rival to Ares
or 'equal to Ares',
Ares being the Greek
form of the Roman
Mars, the red planet.
Occasionally called
'*Cor Scorpii*', the
heart of the scorpion.

β Acrab or
Graffias
2.6, blue-white
'scorpion' and 'claws';
a double star

δ Dschubba
2.3, blue-white
'front' or 'forehead'

λ Shaula
1.6, blue-white
name means 'sting'

ν Lesath
from another word for
'sting', Al Las'ah

θ Sargas
1.9, yellow giant
190 ly; name is of
Mesopotamian origin

These 2 stars
are part of
Libra, the
Balance

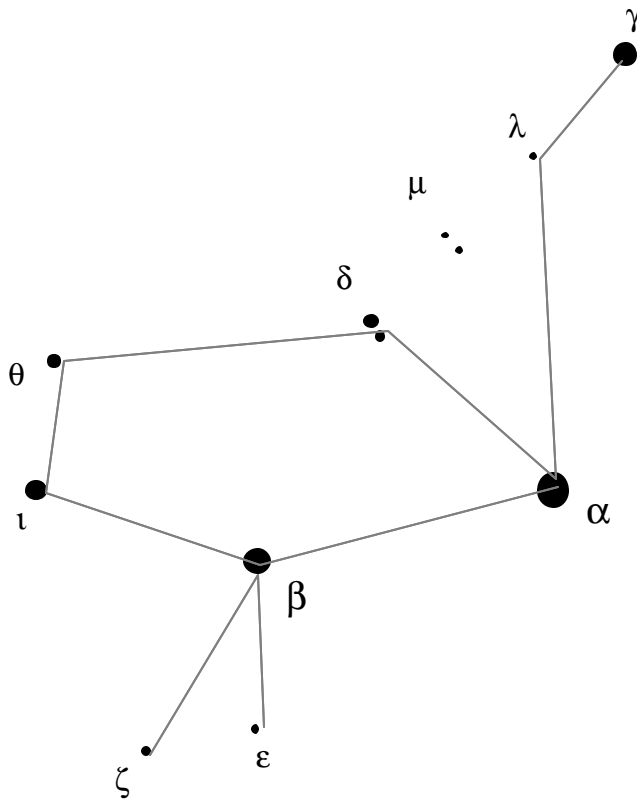
M6 Open Cluster
5.3, beautiful open cluster, 'like a butterfly
with wings'

M7 Open Cluster
mag 4, brilliant open cluster of bright stars,
visible with the unaided eye.

M80 Globular Cluster
7.7; condensed globular
between Antares and β

Sometimes known as *Scorpio*, Scorpius is the 8th zodiacal constellation.

Grus, the Crane Oct 12



α Al nair
name means 'bright
one', 1.74, blue-
white

β
red, variable star
2.0-2.3

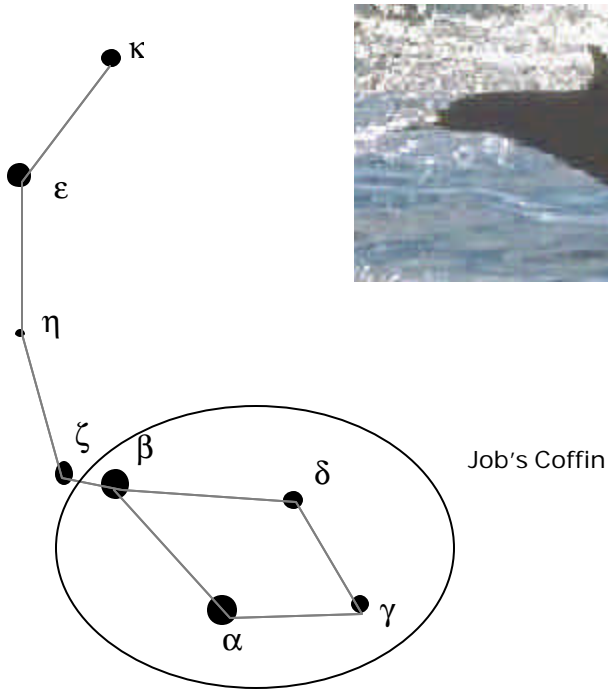


Grus was created in its present form in 1603 by the German astronomer Johann Bayer, best known for his Greek lettering of the stars.

Grus lies south of the bright star Fomalhaut (α Piscis Austrini, the brightest star in the Southern Fish, Piscis Austrinus).

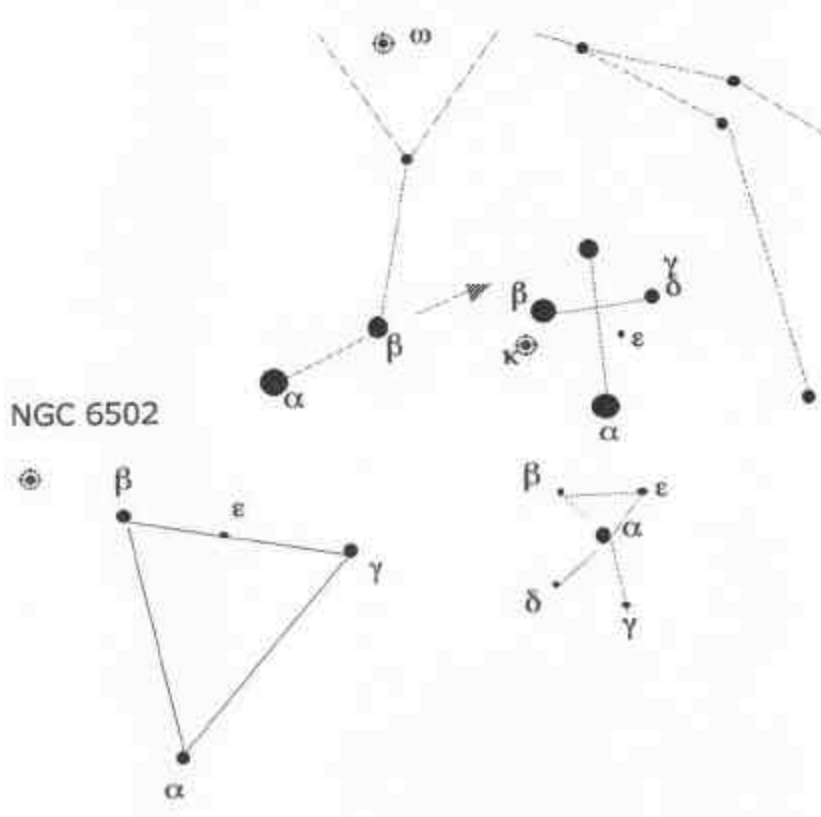
I first learned this constellation by recognising the straight line of stars with the two double-stars in it.

Delphinus, the Dolphin *Sept 14*



α Sualocin
 β Rotanev
 The names of α and β first appeared in the 1814 Palermo catalogue. Spelled backwards they form the name of Nicolaus Venator, assistant at the Palermo Observatory. 'Nicolaus Venator' was the Latinized name of Niccolo Cacciatore.

Delphinus swims east of the bright star Altair (α Aquilae). The parallelogram of four main stars is called 'Job's Coffin'.

Crux, The Southern Cross May 12***Musca, The Fly May 14******Triangulum Australis, the Southern Triangle******Dec 7*****Gl obular Cl uster**

Naked eye globular cluster, the finest example in the skies; thousands of mag 12-15 stars; half a degree in diameter (full Moon size)

NGC 6502**Open Cl uster**

5.1, 60 stars, large brightness range, slight central concentration

 α Cru Acrux

0.8, blue-white (B), 270 ly
name probably dates from 1800s, the American astronomer Elijah Burritt; from 'Alpha Cru'

 β Cru Mimosa (Becrux)

1.3, blue-white (B), 460ly This star is a Cepheid variable (changes brightness regularly)

 γ —Gacrux

1.6, red (M), 88ly

 κ Cru

'The Jewel Box'
Open Cl uster NGC 4755

More than 50 stars, large brightness range; 7600 ly; to the naked eye it appears as a single 4th mag. star.

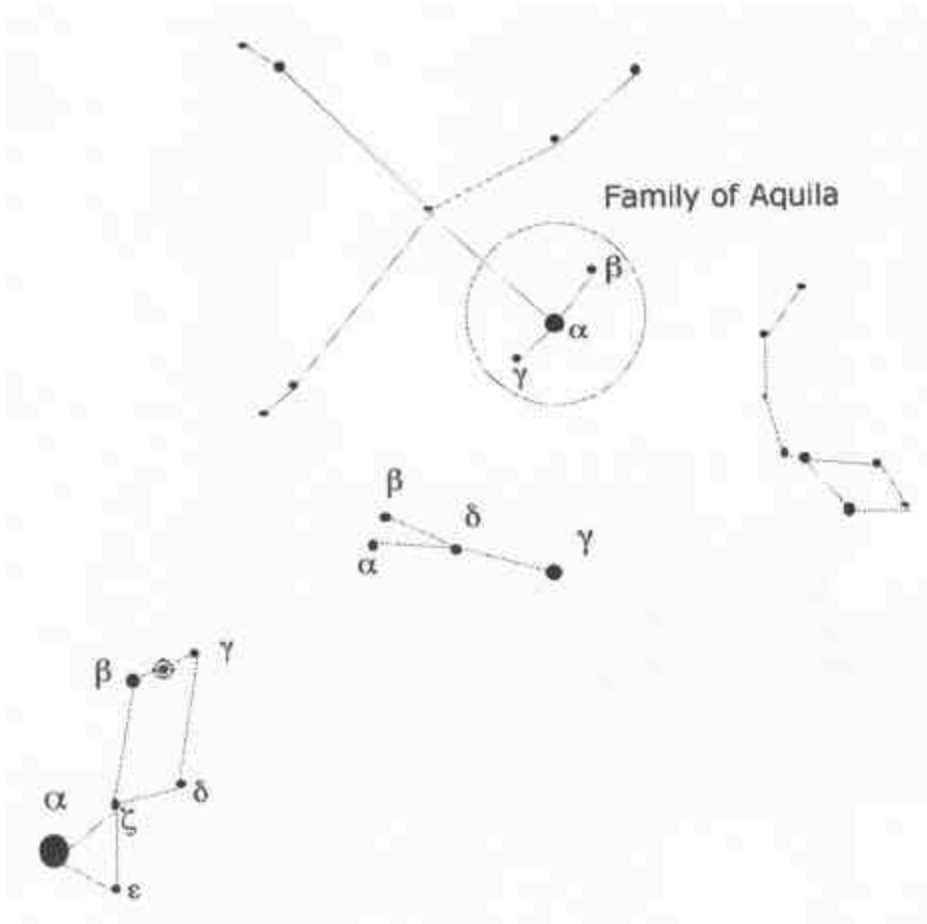
 ω Cen

The Cross can be used to locate South. Extend the line from γ to α $4\frac{1}{2}$ times and you arrive at the South Celestial Pole, which is always due South. If the Pointers (α Cen and β Cen) are visible, where the perpendicular bisector of the line joining them meets the extended line from γ to α Cru also gets you there.

Aquila, The Eagle Aug 30

Lyra, The Lyre Aug 18

Sagitta, The Arrow Aug 30



α Aql Al tair
0.77, white (A)
16ly; Arabic word for
'eagle'

β Aql Al shain
3.7, yellow
Persian for 'eagle'

γ Aql Tarazed
2.7, yellow

α & β Sagittae
4.37, yellow giants

γ Sagittae
3.47, orange, 175ly

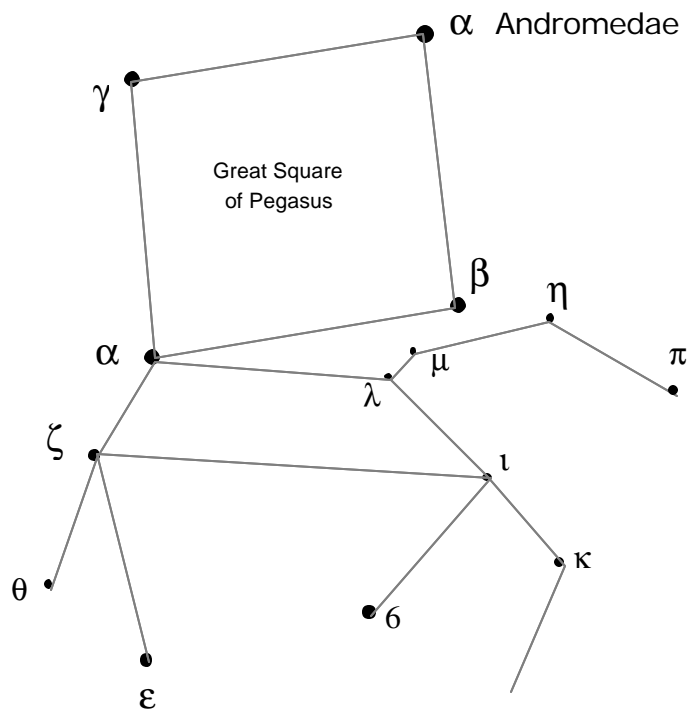
α Lyrae Vega
0.03, blue-white
5th brightest star in the
sky, 26ly, from Arabic,
'swooping vulture (or
eagle)'; to the Arabs Lyra
was a bird with half-
closed wings.

M57
The Ring Nebul a
appears as an elliptical
hazy disk through a
telescope, 2000 ly; a
planetary nebula, the
remains of a nova
explosion

Sagitta lies in the Milky Way, 10° North of the bright star Altair (α Aquilae). The two stars α and β are similar distances from earth: 610 and 640 ly respectively.

The Solar System is heading in the direction of Vega as it orbits the galactic centre.

Pegasus, The Winged Horse Oct 16



α Markab
2.5, blue-white, name means 'saddle'

β Scheat
av. 2.5, deep yellow

γ Al genib
2.8, blue-white, name means 'side'

ϵ Enif
2.4, yellow, a supergiant, name means 'nose'. Good binoculars should reveal a blue companion-star of mag. 8

η Matar
2.9, yellow
'fortunate rain'

ζ Homam
3.6, white, name from "Sa'd al Humam", "Lucky star of the Hero" (whoever could ride Pegasus)

α Andromedae
(Al pheratz)
2.1, blue-white

A good test of the eyes is how many stars you can count in the Great Square.

The Brightest Stars

Rank	Star	Constellation	Distance Light- years	Spectral Type	Magnitude	Visible Light Output (Sun=1)
0	Sun	-	0	G2 V	-26.74	1.0
1	Sirius	Canis Major	8.6	A1 V	-1.44	22.4
2	Canopus	Carina	310	F0 Ib	-0.62	14,000
3	Alpha Centauri	Centaurus	4.4	G2 V K1 V	-0.28	1.57
4	Arcturus	Boötes	37	K2 III	-0.05	113
5	Vega	Lyra	25	A0 V	+0.03	50
6	Capella	Auriga	42	G8 III G0 III	0.08	71
7	Rigel	Orion	800	B8 Ia	0.18	-6.8
8	Procyon	Canis Minor	11.4	F5 IV-V	0.40	7.2
9	Achernar	Eridanus	144	B3 V	0.45	1,100
10	Betelgeuse	Orion	430	M2 ib	0.45	7.2
11	Beta Centauri	Centaurus	530	B1 III	0.61	13,000
12	Altair	Aquila	16.8	A7 V	0.76	11
13	Alpha Crucis	Crux	320	B0.5 B1 V	0.77	2,300
14	Aldebaran	Taurus	65	K5 III	0.87	150
15	Spica	Virgo	260	B1 IV	0.98	2,000

The Nearest Stars

Rank	Star	Constellation	Distance Light-years	Spectral Type	Magnitude	Visible Light Output (Sun=1)
0	Sun	-	0	G2 V	-26.74	1.0
1	α Centauri A	Centaurus	4.40	G2 V	-0.01	1.57
2	α Centauri B		4.40	K1 V	+1.35	0.45
3	α Centauri C		4.40	M4.4 V	11.01	0.000057
4	Barnard's Star	Ophiuchus	5.94	M4 V	9.54	0.00043
5	Wolf 359	Leo	7.8	M6 V	13.45	0.00002

I supergiant **II** bright giant **III** giant **IV** subgiant **V** main-sequence star

O,B blue **A** white **F** pale yellow **G** yellow **K** orange **M** red