One arc-second

Sigma Orionis (Part of a close group of four stars visible with a small telescope.)

Magnitudes: 4.0 and 6.0

Period: 170 years

Semi-major axis: 0.25 arc-seconds

Inclination: 165°

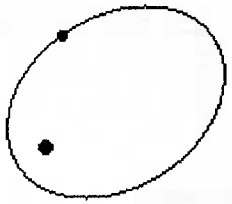
Epsilon^1 Lyrae

Magnitudes: 5.0 and 6.1

Period: 1166 years

Semi-major axis: 2.8 arc-seconds

Inclination: 138°



Epsilon^2 Lyrae

Magnitudes: 5.2 and 5.5

Period: 585 years

Semi-major axis: 3.0 arc-seconds

Inclination: 121°

One arc-second

Eta Cassiopeia

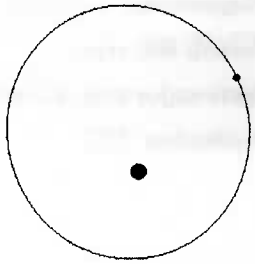
Magnitudes: 3.5 and 7.5

Period: 480 years

Semi-major axis: 12 arc-seconds

Inclination: 35°

(NB Scale is less than others, and magnitudes are exaggerated.)



Double Stars

by Geoff Falla

Geoff describes his favourite objects - binary and multiple star systems, and shows where to find some of the best examples, in familiar constellations. Finder charts are provided.

As we look up at the night sky, we do not realise that many of the stars which we see are double stars. However, many can be found with the telescope quite easily, as the primary star is visible to the naked eye.

Some of these double stars are optical doubles - two stars widely separated in space which just happen to be in the same line of sight. But most of the doubles are true binary stars revolving around a common centre of gravity. In many cases there are more than two stars in the system. Of all the stars we can see, it is estimated that about one-third are binaries or multiple systems.

There are in total some 25,000 known visual binary stars, all within our own Galaxy. Even on nights when the visibility is not quite good enough to observe fainter nebulae, or if moonlight is a problem, it is still possible to observe many interesting double stars. Often of different colours, they present a striking and beautiful contrast, and are a very satisfying way of testing the optical performance of a telescope, as well as the observer's ability to split the double using the best eyepiece.

In the case of binaries which can be observed with a telescope, the actual separation distance between the stars is considered to be equivalent to the distance between our Sun and one of the outer planets, while a typical orbital period is measured in hundreds of years. Only about one percent of binary star orbits have so far been measured accurately.

Some binary stars have companions so close that they are not within the visible grasp of even a powerful telescope, but can only be detected using a spectroscope. The spectroscopic binaries have orbits around the primary star comparable with those of our Solar System's inner planets. Orbital periods can be as short as a few hours but in a typical case can be measured in years.

The separation between binary or multiple stars as observed through a telescope is measured in arc-seconds. To put this into perspective, the apparent diameter of the Moon is around half a degree, or 30 minutes of arc. Each minute of arc is divided into 60 arc-seconds. The separation between a pair of close double stars is just a few arc-seconds, so the challenge for the telescope and for the observer can be appreciated. A 3-inch telescope is considered capable of dividing a double star with a separation of two or three arc-seconds, while an 8-inch has a resolving power down to about one arc-second.

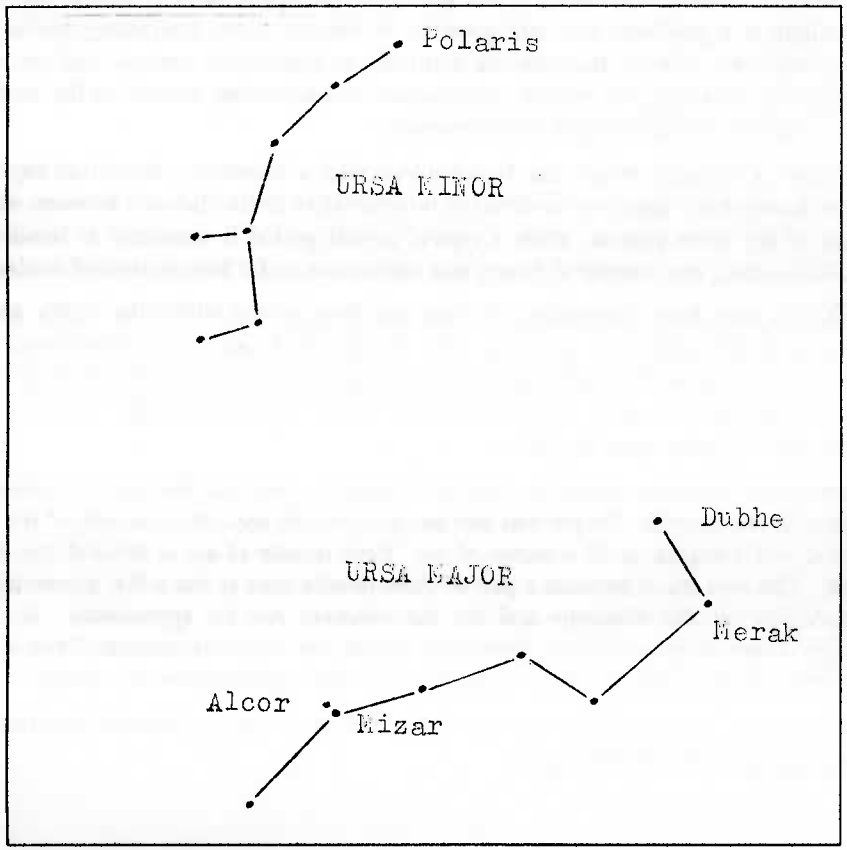
Perhaps the best way to start observing double stars is to choose several which form part of easily recognizable constellations.

Ursa Major and Ursa Minor

In Ursa Major a double star can just be seen with the naked eye on a clear night. The primary star to look for is **Mizar**, at the bend of the "handle" in the Plough, while its fainter companion is **Alcor**. If Mizar itself is observed through a telescope using a moderate power, a companion star will be seen, blue in colour, and at a separation of 14 arc-seconds, forming a system of three stars. There is even more than meets the eye, as each of the three stars has a spectroscopic companion, forming a system of six stars.

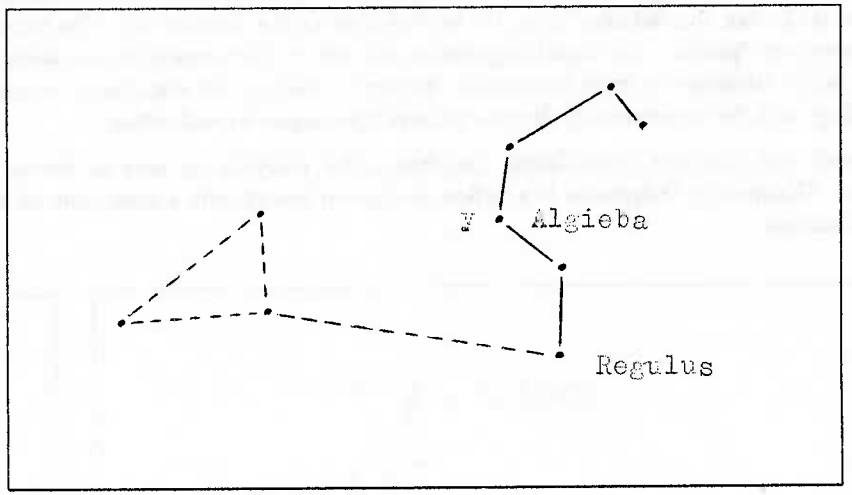
Mizar also has the distinction of being both the first binary star to be observed and the first spectroscopic binary. Italian astronomer Giovanni Riccioli observed its visible binary companion in 1650, while the American astronomer Antonia Maury confirmed, from the periodic doubling of Mizar's spectral lines, the presence of a spectroscopic companion in 1889.

In Ursa Minor, the **Pole Star (Polaris)** is another double, easily found from the two "pointer" stars in Ursa Major, Dubhe and Merak. There is good separation between the stars, at 18 arc-seconds, but the brightness of Polaris makes observations of the secondary star more difficult. It takes good seeing conditions to catch a glimpse of the companion using a moderate size telescope.



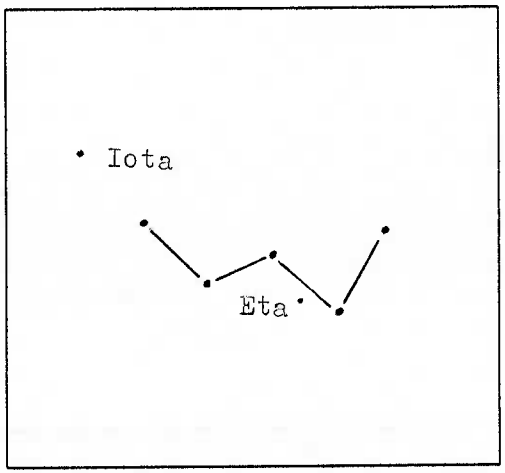
Leo

During the spring the constellation Leo is well placed in the southern sky for evening observation. The star **Gamma** (γ) named **Algieba**, has a close greenish coloured companion, at a separation of only 4 arc-seconds, and is regarded as one of the finest doubles in the sky. It can be seen with a small telescope, using a high-power eyepiece.



Cassiopeia

Cassiopeia, with its distinctive W shape formed by the five brightest stars, lies in a rich part of the Milky Way. The star **Eta** (η) is a beautiful double star, with yellow and red components visible in small telescopes, while **Iota** (ι) is an impressive triple star visible with a 4-inch telescope using high magnification.

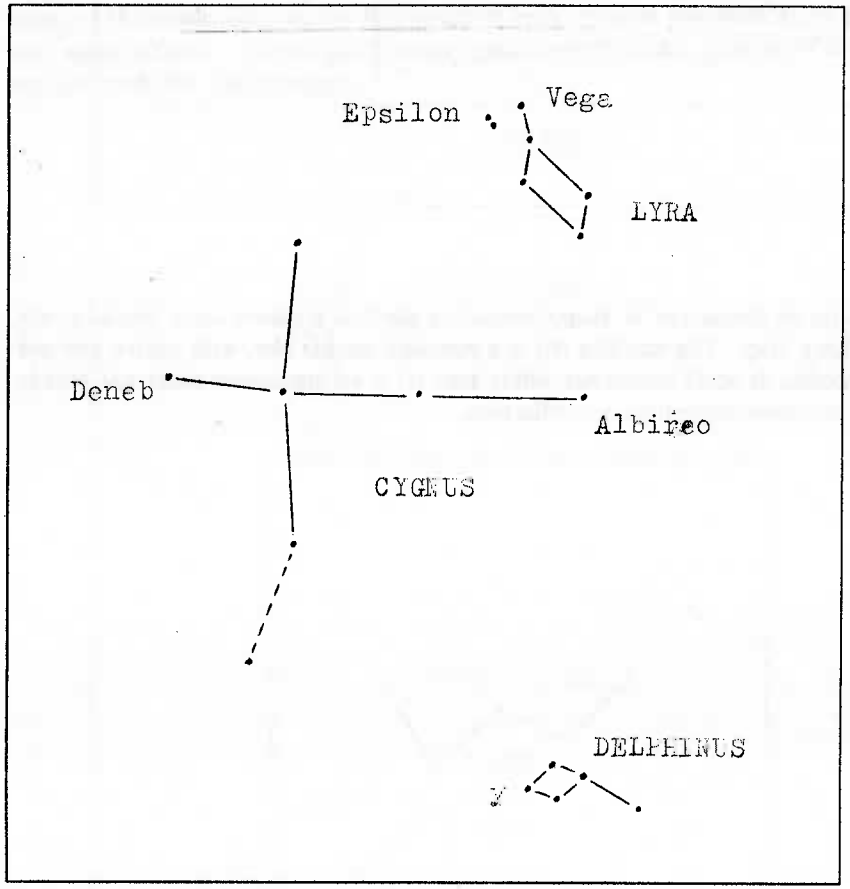


Cygnus, Lyra, and Delphinus

In the constellation Cygnus we find the beautiful double star **Albireo**. The two stars are a striking yellow and blue combination, and the separation of the stars, at 34 arc-seconds, makes this an easy object for a small telescope. If a larger telescope is used, a low-power is advisable to see the double star at its best.

In Lyra, a real challenge for a small telescope is the quadruple or double-double star **Epsilon (ε) Lyrae**, located near Vega, the brightest star in the summer sky. The two main components of Epsilon are of equal brightness, and with a wide separation are easily seen with a small telescope or even binoculars. However, each of the stars has a very close secondary, with the orientation of the two pairs at right angles to each other.

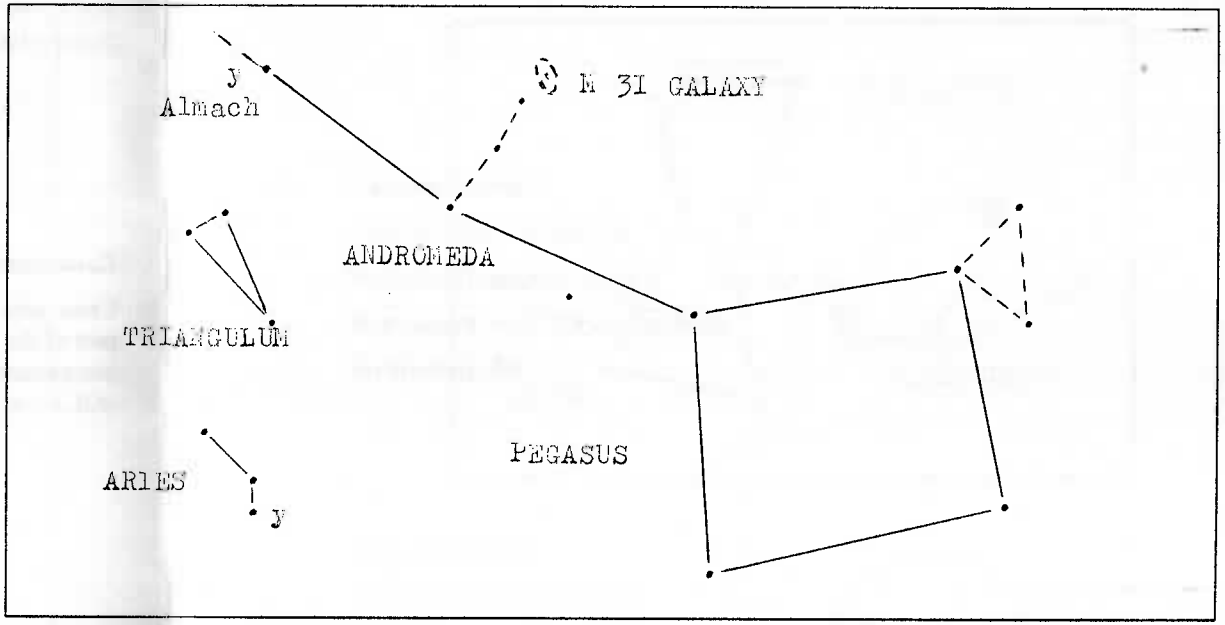
The small and compact constellation Delphinus, the Dolphin, is easy to locate near Cygnus. **Gamma (γ) Delphinus** is a yellow and green binary with a separation of about 10 arc-seconds.



Andromeda and Aries

The Square of Pegasus is prominent in the autumn evening sky, with the stars of the constellation Andromeda leading off towards th north. The star **Gamma (γ) Andromedae**, named **Almach**, is an outstanding yellow and blue double. The secondary star has its own close companion, forming a triple system.

In the small constellation Aries, below Andromeda, is another easy to locate double. **Gamma (γ) Arietis** consists of twin white stars of magnitude 4.6, and visible with a small telescope.

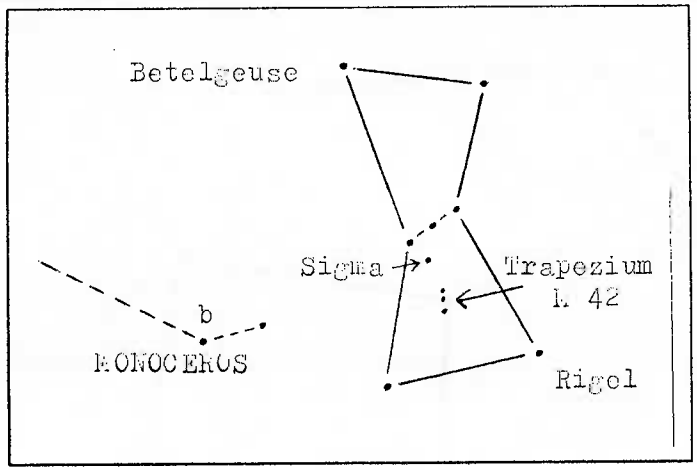


Orion and Monoceros

Orion, the Hunter, is the best known constellation of the winter evening sky, and contains both double and multiple star systems which are relatively easy to observe. The most famous multiple system is the **Trapezium**, a group of four close stars embedded in the Orion Nebula, M42. Another impressive and colourful sight is **Sigma** (σ), which is found just below the southern-most star in the Hunter's belt, and consists of several stars with blue and reddish components.

The blue giant **Rigel, Beta** (β) **Orionis** is much brighter than its companion star, which as a result is a more difficult challenge.

In the nearby constellation **Monoceros, Beta** (β) is regarded as one of the finest triple stars in the sky, and visible with a small telescope.

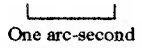


Orbits of double stars

Norton's 2000 lists dozens of double stars, and gives the orbital elements of 92 binary systems. I have used a computer to plot the orbits, as seen from Earth, of a few of the double stars mentioned by Geoff in his article. I give no guarantees as to the orientation of each orbit, but the relative orbital sizes and separations of the stars should be correct.

The size of each plotted star is proportional to its magnitude. The "inclination" is the angle between the plane of the orbit and the line of sight. The position of the secondary star with respect to the primary star is shown for the year 1994 AD. North is up.

David Le Conte



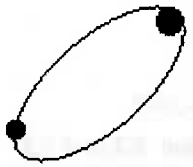
Gamma Leonis

Magnitudes: 2.2 and 3.5

Period: 619 years

Semi-major axis: 2.5 arc-seconds

Inclination: 36°



Iota Cassiopeia

Magnitudes: 4.6 and 6.9

Period: 840 years

Semi-major axis: 2.3 arc-seconds

Inclination: 132°