A Double Star Guide

Introduction

A double star (or visual double) is a pair of stars that appear close together when viewed from Earth.

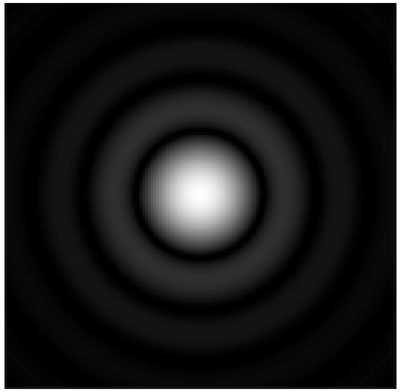
Many double stars appear initially to be a single star but on closer inspection (usually by telescope) reveal themselves to have two components. There are even some so called “doubles” that are actually triples or pairs of doubles.

The two components of a double star could either be two stars that happen to be in the same line of sight, often at very different distances from us, or could be the components of a gravitationally bound binary system, where the two stars revolve round a common centre of gravity. The orbital period of binary stars can be as long as many hundreds of years or as short as 3-4 days. In fact one totally eclipsing binary (ZTF J1539+5027) was discovered in 2019 with a period of 6.9 minutes. That system comprises two white dwarfs orbiting each other so closely that the whole binary could fit completely inside the planet Saturn!

Such exotic objects as ZTF J1539+5027 are quite out of reach of amateurs such as ourselves of course, but there are some rather nice “ordinary” double stars that warrant our attention.

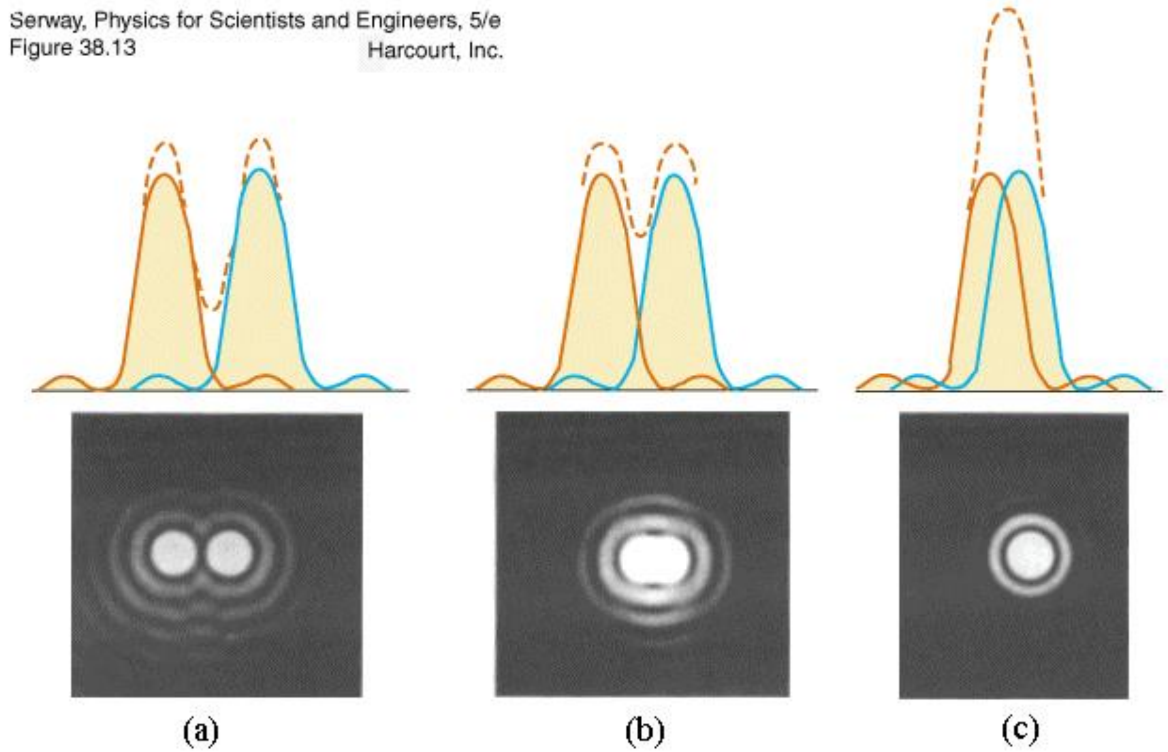
But First, a Bit About Optics and Visibility Limits

Perhaps one of the most important features of a double star is the separation of its components. (After all, without this separation, it wouldn’t be a double!) Relevant to this is the ***resolving power*** of the optical system (including the unaided eye) being used to observe it. In fact, “resolving power” is defined as the ability to separate two points that are close together. Whatever the optical system, the image of a true point source such as a star will not be a true and single point of light but rather a *diffraction pattern* comprising a disc of light (the Airy disc) surrounded by concentric rings of diminishing brightness. The whole pattern is commonly referred to as the Airy disc, though strictly, the Airy disc is just the disc in the centre.



The Airy disc

Now, consider what happens when we look at a double star. Each component will produce its own Airy disc. If the components are close enough, the two discs will touch each other; closer still and they'll overlap; too close and they'll overlap so much that they cannot be distinguished from each other.



It’s clear from the above three images that image (b) represents the closest the two patterns can get before they become indistinguishable from each other. This distance – measured as an angular separation in seconds of arc between the centres of the discs – defines the resolving power of the optical system. It is also clear that if the Airy discs themselves were to be smaller, that would improve the resolving power because the discs could get closer to each other before merging into one.

And now for the all-important truth: (drum roll please) ***The size of the Airy discs and consequently the resolving power is inversely proportional to the aperture of the optical system***. In simple terms: the bigger the telescope, the better the resolution. Doubling the aperture means halving the Airy disc diameter and separation that can be split. Here are the figures for ideal optical systems. (Well made, quality telescopes that can closely approach these ideal resolving powers are referred to as “diffraction limited”.)

System	Aperture (mm)	Empirical Resolution (arc secs.). The "Dawes Limit".
Dark-adapted human eye	7	~ 60**
3-inch telescope	75	1.54
4-inch telescope	100	1.16
6-inch telescope	150	0.77
8-inch telescope	200	0.58
10-inch telescope	250	0.46
12-inch telescope	300	0.39

*** The theoretical resolution of a 7mm diameter lens is 17 arc seconds, but at this maximum pupillary aperture, the abaxial aberrations of the human eye reduce this visual acuity by three or four times.*

So, we see from the above table that someone with excellent vision could "split" a double if the components were 1 arc minute apart, but as soon as even a modest telescope is employed, the minimum separation improves by at least 40 times. This immediately allows us to see hundreds more doubles.

How Double Stars are Described

In addition to the official name (e.g. Alpha Canis Majoris) and the star's R.A. and Declination, double stars are described as follows:

By their common name e.g. Sirius
With the suffixes A and B to name each component (A being the primary) e.g. Sirius B
With further suffixes (C, D etc) if there are more than two components involved.
The type: Optical double (chance alignment) or Visual Binary (gravitationally linked)
The magnitude of each component.
The spectral type* of each component.
The separation between the components (usually in arc seconds)
The position of the secondary with respect to the primary, measured in degrees eastwards from north.

*If you're not familiar with spectral type, do read about the famous mnemonic, "Oh Be A Fine Girl Kiss Me Right Now Smack". Also, see the easy-to-read Classification of Stellar Spectra.

The tables below include some of the best doubles that can be seen without and with optical aid. All the “telescopic” doubles should be resolvable with a modest telescope such as a 3-inch refractor. The hyperlinks have been chosen so as to take you to the best site for each double. In each case there is at least a finder chart and at best an interesting description as well. The doubles in these tables represent a small selection, visible in summer.

The “Loc.” column gives the Right Ascension and Declination of the double.
In the “Type” column, B is a standard binary.
“Mags” gives the magnitude of the components.
“ST” gives the spectral type (O,B,A,F,G,K,M and within each, sub-types from 0-9).
“Sep” gives the angular separation in arc seconds unless followed by “mins”.
“P.A.” gives the position angle of the secondary with respect to the primary, measured eastwards from north.

Naked Eye Doubles

Obviously, the view of these four would be improved with the use of binoculars but they’re by no means essential for the stars in this table.

Name	Loc.	Type	Mags (A, B)	ST (A, B)	Sep.	P.A.	Notes
Mizar - Alcor	13 24 +54 55	B?	2.0, 4.0	A2, A5	11.8 mins	70	Brightest and easiest of the true naked eye doubles. Mizar is a quadruple system; Alcor is a double, making this a stellar sextuplet. Alcor B is a mag 8.8 red dwarf only 1 arcsec away and impossible to see with an amateur telescope.
Alpha Librae	14 50 -15 59	B	2.7, 5.2	A3, F4	3.8 mins	315	Quite difficult. Its low altitude doesn’t help. Try averted vision. A and B are themselves spectroscopic binaries.
Epsilon Lyrae	18 44 +39 40	Double binary	4.66, 4.59	A3, A6	3.5 mins	172	The famous “Double Double”. A and B are themselves close doubles that a 3-inch or larger telescope should resolve.
Beta Capricorni	20 21 -14.47	Multiple binary	3.2, 6.1	K0, B8	3.4 mins	267	The difference in magnitude together with B only being Mag 6.1 makes this very challenging. This is a 5-star system.

Mizar and Epsilon Lyrae Telescopically

Name	Loc.	Mags (A, B)	ST (A, B)	Sep. (Secs.)	P.A.	Notes
Mizar	13 24 +54 56	2.23, 3.88	A2, A7	14.4	153	Both Mizar A and Mizar B are spectroscopic doubles, with separations of only fractions of an arc second.
Epsilon Lyrae	18 44 +39 40	4.7, 6.2; 5.1, 5.5	A3 + F0, A6 + A7	2.3, 2.4	347 & 79	Used often as a test for the resolving power of telescopes.

Doubles with Colour Differences (all telescopics)

Name	Loc.	Mags (A, B)	ST (A, B)	Sep. (Secs.)	P.A.	Notes
Eta Cass	00 49 +57 49	3.5, 7.2	G0, K7	13	317	Pale yellow primary, purple-red secondary
Cor Caroli	12 56 +38 19	2.9, 5.4	A0, F2	20	225	Beautiful blue-white and yellow
Xi Boo	14 51 +19 06	4.8, 7,0	G8, K4	6	343	A lovely yellow and rose duo. Delicate tints.
α Her	17 15 +14 23	3.1, 5.4	M5, G8	5	106	This star is way below the square of Hercules. Click on map from link.
95 Her	18 02 +21 36	4.9, 5.2	A5, G8	6	258	Look red and white.
Zeta Lyrae	18 45 +37 36	4.3, 5.6	B7, A8	44	150	Actually Zeta 1 and Zeta 2 Lyrae
Alberio	19 31 +27 57	3.4, 4.7	K3, B8	35	54	Gold and blue. Quite beautiful.
31 Cyg	20 14 +46 44	3.8, 4.8	K2, B3	107	325	Orange and blue-white. Note 30 Cyg (mag 4.8) six arc mins away.

Gamma Delphini	20 47 +16 07	4.4, 5.0	K1, F7	9	267	Orange and lime. “Very pretty”.
Delta Cephei	22 29 +58 25	4.1, 6.3	G2, B7	41	191	Yellow and white. Proto-type of the Cepheid variables as discovered by John Goodricke in York.