

OBSERVING DOUBLE STARS

Some of the most beautiful and intriguing objects in the night sky are not enshrouded in nebulosity, shaped like rings or dumbbells or eagles, or crossed by mysterious lanes of dark, cosmic dust. They are stars that come in pairs, trios, and sometimes larger numbers, star systems that are among the few objects in the deep sky to show real color, in some cases amazingly bright and vibrant colors. Albireo (beta Cygni) comes immediately to mind and although this double star is deservedly well known, it is not really all that unique among double stars. Many other pairs glitter like gems in the dark sky. Tracking down and observing double stars can be like going on a nocturnal treasure hunt.

Searching for double stars teaches you something about resolving power, the ability of your telescope to provide detailed looks at an object. You can, while observing double stars, develop a general sense for how well your telescope handles closely spaced objects. By comparing the elements of double and multiple star systems you also gain practice in recognizing stellar magnitudes. Double star components often differ greatly in magnitude and the comparisons you will be able to make between two such stars close together will clearly illustrate how much difference in brightness a magnitude or two can make. (It's one thing to know that going from magnitude 2 to magnitude 3 is a reduction of 2.5 times in brightness, and something quite different to look at two such stars side by side and really *see* what this means.) The act of tracking down these stellar systems also gives you some excellent practice in star hopping (unless, of course, you use GOTO) and in reading and using star charts. Seeing conditions can very strongly influence your success or failure in splitting doubles, so by observing double stars you gain familiarity with how stars appear in your telescope under varying conditions. Need more reasons to observe double stars? Here's one more: like lunar and planetary observing you can observe double stars from your own back yard. No need to wait for a trip to TIMPA.

With all this beauty and interest going for them, you would think double star observing is one of the most popular aspects of amateur astronomy. And yet, although this facet of amateur astronomy has a respectable number of participants, it does not currently enjoy as much popularity as it has in years past. This is a pity, and once you've observed a few objects from the BSIG double star list, quite likely you will agree that double stars do not receive the attention they deserve. Perhaps some of you will become hooked on double and multiple star observing.

Resolving Power

Seeing fine detail in the eyepiece is a matter of great importance for all aspects of visual astronomy and being able to see small rilles on the Moon or knots of gas in Jupiter's clouds will depend on the resolving power of your telescope. But nowhere is resolving power more simply and directly a potentially limiting factor than in the observation of double and multiple star systems. The resolving power of your telescope

is measured in arc seconds and you can find this number – if you are interested – by using either version of the formula that William Dawes developed in the 19th century. You will need to know the aperture of your telescope in either inches or millimeters.

$$\text{Resolving power (in arc seconds)} = 4.56 / \text{aperture in inches}$$

or

$$\text{Resolving power (in arc seconds)} = 116 / \text{aperture in millimeters}$$

Using these formulae quickly reveals why the phrase ‘aperture rules’ is heard so often during discussions of telescopes. A 70mm refractor can, going strictly by the numbers, resolve a pair of stars as closely spaced as 1.6 arc seconds, which is not bad by a long shot! But an 8 inch Newtonian reflector can – according to Dawes’ theory – resolve two stars as closely spaced as 0.5 arc seconds (also written as 0.5”). That’s a big difference, to be sure, but before the owners of smaller telescopes begin to worry, there’s more to this than just the numbers. The formulae for the Dawes Limit indicate only the potential, not the actual, resolving power. That 8 inch Newtonian does not, in fact, have a full 8 inches of aperture, since the secondary mirror blocks some of the incoming light. Owners of SCTs face a similar complication. And the diffraction spikes caused by the spider vanes holding that mirror beneath the eyepiece of a Newtonian reflector can sometimes make picking out a faint secondary star a bit of a challenge, especially on a night when the seeing is not very good. But over and above such concerns are the seeing conditions that prevail when you are out observing. Seeing conditions alone can limit how close your telescope can come to realizing its Dawes Limit. So, as useful as the number can be, it is not a perfect description of the resolving power of a telescope. An awareness of the Dawes Limit for your telescope will, however, aid you in planning an observing session, keeping you from wasting time trying to split double stars (or see lunar or planetary details) that are beyond your reach even under the best skies you will ever encounter. But try not to take it too literally!

The Colors of Stars

One of the most noteworthy features of double stars is the range of colors they often display. (This is actually true of stars in general, of course.) The members of a double (or multiple) star system do not always share the same hue, which makes these colors stand out all the more. The color of a star can provide an indication of its temperature, with stars that are blue or white being much hotter than stars of a reddish hue. Our own yellow sun is on the cool side of this continuum. The colors you see will not always be a completely reliable indicator of a star’s temperature, however. For one thing, the brightness of the primary star can alter the way you see the color of its companion and sometimes lead your eye to see shades of green, mauve, or other exotic colors that are not really present. This effect is known as ‘dazzle tint.’ The color seen also depends very much on your *perception* of color. Different observers often report very different colors, and the same observer may not see the same colors on different occasions when the conditions change dramatically. What you see in terms of color is always worth recording, but there is no reason to be concerned if what you see does not

quite match what is listed in books such as *Burnham's Celestial Handbook*. The magnification used, the observing conditions, and your own eyesight can greatly affect color perception. *Always record exactly what colors you see, no matter what the references you use lead you to expect.*

Position Angle and Separation

Two other aspects of double star observation involve how far apart the components appear to be (separation) and what angle a line drawn between them forms relative to north in your field of view (position angle).

The separation of double stars is most often given in arc seconds. This measure of separation ranges from stars that are Very Close (between 0.5" and 2") and stars that are so far apart they are called 'Open' (30" apart or more). The list for this project will include both very close and wide open doubles. The reason for this wide range is that we cannot, of course, predict the sort of telescope you will be using, and we want it to be accessible – as well as a bit challenging – to as wide a variety of observer/instrument combinations as possible.

Position angle describes the location of the companion star (or stars) relative to the primary. It is measured in degrees from north in the field of view around through east, south, and west for a full 360°. Here is where knowing how to determine cardinal directions in the field of view is essential. Determine west by where stars drift out of your view, then determine north by nudging the scope toward Polaris; the center of the side at which new stars appear is north. Mark north and west on your sketch and you will easily be able to mark the points for south and east.

North = 360° (or 0° if you prefer)

East = 90°

South = 180°

West = 270°

With the information provided above you should be able to sketch double stars accurately in terms of their position angles. The position angles of the stars we will use are provided in the list, so you will not need to determine these numbers. But for the sketch to count the double star under observation must be drawn in the correct relation to the direction marks you place around the sketch. You can use the position angles and the cardinal directions you include in the sketch to verify that the sketch is correct.

Making Double Star Observations

Our list includes thirty double and multiple stars from which to select the stars you observe. The reason for such a large list is the possibility that some of these doubles may simply not be accessible to all telescopes. From this list, observe and describe at

least fifteen of them. If two or more observations of a specific double star fail to resolve it into its components then chances are your telescope is not up to that specific challenge. It is recommended that you keep track of the stars that do not split, since these results will teach you something about the capabilities of your telescope. To facilitate this, the list includes a column for indicating 'split' and 'not split.' You do not need to attempt every star on the list, and can consider this portion of the program completed when you have split fifteen. Working the entire list is, of course, a recommended option. (Many of the stars on our list are also on the AL list for their double star observing club, and like their list ours is ordered according to right ascension. If you want to use your observations to make a start on an AL observing club, familiarize yourself with their rules first in order to be sure you meet their requirements as well as those of the BSIG when you record observations.)

For the fifteen stars that you are able to split, record these observations on the log sheet of your choice. Include the usual time, date, telescope, and conditions information. Make a sketch of the pair, including a few of the brighter field stars (meaning the stars in the field of view). Clearly mark the directions west and north at the correct points around the edges of the sketch. Indicate differences in magnitude by representing brighter stars with larger, darker spots. In your observing notes, consider the following questions when describing what you see:

1. Do the components differ in color, and what colors do you see?
2. Are they of different magnitude, and how obvious is that difference?
3. How much magnification was required for a clean split?
4. Does a change in magnification alter whatever colors you see?

A complete observing log contains a record of failures as well as successes and a project on double star observations is a good place to discuss this. The reason for recording unsuccessful attempts to observe any type of object is to better understand the performance of your telescope under varying observing conditions. In time, by looking back over these records, you will be able to determine whether or not to attempt a particular observation (a very close double star in this case), or to hold off on that object for a better night and hunt down objects less affected by poor seeing conditions (more widely spaced doubles, to follow through on this example.) Objects not found or not clearly observed, such as an unresolved double star, are *not* the mark of a failed observer. They are merely steps along the learning curve, and in some cases lessons in what to expect of the telescope you are using. Keep track of these experiences, if for no other reason than to remind you to go back and try these objects at a later date.

Double Star References

The Night Sky Observer's Guide (two volumes) George R. Kepple & Glen W Sanner (Willman-Bell)

Burnham's Celestial Handbook (three volumes) Robert Burnham Jr. (Dover Publications)

Norton's Star Atlas and Reference Handbook 19th Edition Ian Ridpath (Prentice-Hall)

A Visual Atlas of Double Stars Mike Ropelewski (The Webb Society)

A Field Guide to Double Star Observing Joe DalSanto (self published)

Double/Multiple Star List

STAR	MAG	R.A.	DEC.	P.A.	SEP.	SPLIT
						y/n
η Cas	A3.4 B7.5	0h 49.1m	+57° 49'	307°	12.6"	
ψ ¹ Psc	A5.6 B5.8	1h 5.6m	+21° 28'	159°	30"	
γ Ari	A4.8 B4.8	1h 53.5m	+19° 19'	0°	7.8"	
γ And	A2.3 B5.5	2h 3.9m	+42° 20'	63°	9.8"	
ι Tri	A5.3 B6.9	2h 12.4m	+30° 18'	71°	3.9"	
α UMi	A2.0 B9.0	2h 31.8m	+89° 16'	218°	18.4"	
η Per	A3.8 B8.5	2h 51.7m	+55° 54'	300°	28.3"	
λ Ori	A3.6 B5.5	5h 35.1m	+09° 56'	43°	4.4"	
σ Ori	A4.0 B7.5	5h 38.7m	-02° 36'	84°	12.9"	
(note below)	C6.5			61°	43"	
γ Lep	A3.7 B6.3	5h 44.5m	-22° 27'	350°	96"	
β Mon	A4.7 B5.2	6h 28.8m	-07° 02'	132°	7.3"	
ν Gem	A4.2 B8.0	6h 29m	+20° 13'	330°	111.6"	
ι Cnc	A4.2 B6.6	8h 46.7m	+28° 46'	307°	30"	
δ Crv	A3.0 B9.2	12h 29.9m	-16° 31'	214°	24.2"	
α CVn	A2.9 B5.5	12h 56m	+38° 19'	229°	19.4"	
ζ UMa	A2.3 B4.0	13h 23.9m	+54° 56'	152°	14.5"	
ξ Boo	A4.7 B7.0	14h 51.4m	+19° 06'	332°	6.9"	
ι Lib	A4.5 B9.8	15h 12.2m	-19° 48'	111°	57.7"	
μ Boo	A4.3 B7.0	15h 24.5m	+37° 23'	171°	108"	
β Sco	A2.6 B4.9	16h 5.4m	-19° 48'	21°	13.6"	
κ Her	A5.3 B6.5	16h 8.1m	+17° 03'	12°	28"	
ν Dra	A4.9 B4.9	17h 32.2m	+55° 11'	312°	62"	
μ Sgr	A3.8 B10.5	18h 13.8m	-21° 04'	258°	16.9"	
β Lyr	A3.4 B8.6	18h 50.1m	+33° 22'	149°	46"	
β Cyg	A3.1 B5.1	19h 30.7m	+27° 58'	54°	34.4"	
σ Cap	A5.3 B9.0	20h 19.4m	-19° 07'	179°	56.5"	

STAR	MAG	R.A.	DEC.	P.A.	SEP.	
γ Del	A4.5 B5.5	20h 46.7m	+16° 07'	268°	9.6"	
61 Cygni	A5.2 B6.0	21h 6.9m	+38° 45'	146°	28"	
δ Equ	A4.5 B9.5	21h 14.5m	+10° 00'	7°	69.5"	
δ Cep	A3.9 B6.3	22h 29.2m	+58° 25'	192°	41"	
note: There is a 10.3 mag star associated with σ Orionis. Can you see four stars in this system?						