Chapter 2

Why Observe Double Stars?

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2.1 Introduction

Like many branches of astronomy, the observation of double stars can be appreciated at several levels. For those who enjoy the night sky, double stars offer some of the most attractive sights around and they are particularly good in small telescopes where the colours are much more obvious. For a good list of the most impressive pairs, consult the list of 100 best pairs on the Astronomical League Double Star Club website (Astronomical League 2012) or lists of pairs in *Sky & Telescope* and other journals (Mullaney and McCall 1965a,b, 1966; Mitton and MacRobert 1989; Adler 2002a,b; Ropelewski 1999).

Some observers use double stars as a test object to see what their telescope is capable of in terms of angular resolution. Tables 2.1 and 2.2 give a range of test pairs for both binoculars and telescopes with a range of apertures from 9- to 60-cm.

A few observers, find double stars to be so endlessly fascinating that they wish to make to useful contributions to the subject. This may be by making measures of ρ and θ for the binary systems using a micrometer, doing photometry of wider pairs with a CCD camera or calculating orbits from the observed positions. The majority of this book will be dedicated to the description of such techniques and opportunities for useful work are discussed further in Chap. 23.

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Table 2.1 Resolution tests for binoculars

Catalogue	Comp	RA 2000	Dec 2000	Date	PA	Sep	Va	Vb
STF 3053	AB	00026	+6606	2007	70	15.0	5.96	7.17
STF 60*	AB	00491	+5749	2009	322	13.1	3.52	7.36
STF 100	AB	01137	+0735	2009	63	25.5	5.22	6.15
STF 205	A-BC	02039	+4220	2009	63	9.5	2.31	5.02
STF 239		02174	+2845	2010	212	14.0	7.09	7.83
PZ 2		02583	−4018	2009	91	8.4	3.20	4.12
STF 401		03313	+2734	2008	269	11.3	6.58	6.93
STF 550	AB	04320	+5355	2009	308	10.3	5.78	6.82
STF 590		04436	−0848	2007	318	9.2	6.74	6.78
STF 630	A−BC	05020	+0137	2007	53	13.7	6.50	7.71
STF 688		05193	−1045	2008	95	10.6	7.52	7.55
STF 872	AB	06156	+3609	2007	216	11.4	6.89	7.38
HWE 13		06358	−1606	1991	296	12.6	7.38	7.51
STF 948	AC	06462	+5927	2009	308	8.9	5.44	7.05
STF 1044		07164	+4738	2004	170	12.8	7.70	7.72
STF 1065		07223	+5009	2005	255	14.9	7.51	7.67
H N 19		07343	−2328	2007	117	9.7	5.82	5.85
STF 1122		07459	+6509	2005	186	14.9	7.78	7.80
STF 1245	AB	08358	+2009	2009	25	10.0	5.98	7.16
STF 1315		09128	+6141	2000	27	24.7	7.33	7.65
SHJ 110	AC	10040	−1806	2008	274	21.2	6.22	6.97
DUN 97	AB	10432	−6110	1998	175	12.4	6.59	7.88
BSO 6		11286	−4240	2009	164	13.9	5.13	7.38
DUN 117	AB	12048	−6200	2000	149	22.7	7.40	7.83
STF 1627		12182	−0357	2008	195	19.9	6.55	6.90
STF 1694		12492	+8325	2008	326	21.0	5.29	5.74
STF 1744	AB	13239	+5456	2009	153	14.3	2.23	3.88
STF 1821		14135	+5147	2009	235	13.3	4.53	6.62
HJ 4690	Aa−B	14373	−4608	2002	26	19.6	5.55	7.65
STF 1919		15127	+1917	2008	10	23.2	6.71	7.38
PZ 4		15569	−3358	2007	47	10.6	5.09	5.56
H 3 7	AC	16054	−1948	2008	21	14.2	2.59	4.52
DUN 206	AC	16413	−4846	2002	265	9.5	5.71	6.76
STF 2202	AB	17446	+0235	2009	93	20.7	6.13	6.47
STF 2273	AB	17592	+6409	2010	283	21.3	7.31	7.63
SHJ 264	AB−C	18187	−1837	2009	52	16.9	6.86	7.63
STF 2417	AB	18562	+0412	2009	103	23.0	4.59	4.93

(continued)

Table 2.1 (continued)

Catalogue	Comp	RA 2000	Dec 2000	Date	PA	Sep	Va	Vb
STF 2474	Aa–B	19091	+3436	2008	263	16.0	6.78	7.88
STF 2578	AB	19457	+3605	2008	125	14.9	6.37	7.04
SHJ 324		20299	−1835	2009	237	23.2	5.91	6.68
STF 2727*		20467	+1607	2009	266	9.0	4.36	5.03
STF 2769		21105	+2227	2009	300	18.0	6.65	7.42
STF 2840	AB	21520	+5548	2007	196	17.7	5.64	6.42
STF 2873	AB	21582	+8252	2008	67	13.7	7.00	7.47
DUN 246		23072	−5041	2010	254	9.1	6.29	7.05

* = binary

2.2 Colours

Much has been written on this subject and it will continue to exercise fascination amongst observers. It is perhaps the most compelling reason why people observe double stars. Although watching the stars swing around their huge orbits over the years can also be interesting, it does not strike with the same immediacy.

Here some optical aid makes all the difference. With the naked-eye few colours can be ascertained. The contrast between the reddish-orange Betelgeuse and the white Rigel in Orion can be seen and the deep red of Antares certainly stands out but none of the more subtle colours visible in telescopes appear. Colours tend to be much easier to see when some optical aid is used for a number of reasons. Firstly, there is more light incident on the eye, and the cones which are small receptors in the eye which detect colour, can be more easily stimulated. Next, if the telescope is then deliberately defocussed, the star colours become more prominent. The reason for this appears to be psychological in origin. Thirdly, star colours become more intense when contrasted with other stars of different hues (Fig. 2.1). In some double stars such as iota Cancri the companion (distant 30 arcsec) appears blue alongside the orange-yellow of the primary star. Yet the spectral types of G7 and A3 indicate that the secondary star should be white and it is simply the contrast with the primary which gives the star its blue colour. In alpha Herculis, the companion which is less than 5 arcsec away is distinctly green although no single stars of this colour are known to exist. (Some observers have reported that Beta Librae is green or pale green but Robert Burnham who mentions this in his Handbook, states that the star is white). It might be interesting to see how the contrast effect varies as the distance between the two stars in a double star system, for stars of similarly different spectral types and brightnesses.

Table 2.2 Test pairs for various apertures

Catalogue	Comp	RA 2000	Dec 2000	HIP	PA	Sep	Va	Vb	Ap. (cm)
STF 3056	AB	00046	+3416	374	144	0.69	7.72	8.08	15
BU 1026	AB	00121	+5337	981	313	0.34	7.25	8.46	40
STT 2		00134	+2659	1076	262	0.39	6.77	7.66	30
STF 13		00163	+7653	1296	51	0.95	6.98	7.23	15
HDS 37		00166	+0814	1319	220	0.48	6.32	9.92	60
HDS 41		00179	+3435	1441	281	0.52	8.62	11.54	60
A 1504	AB	00287	+3718	2252	43	0.59	8.84	8.92	15
A 914		00366	+5609	2886	20	0.44	8.42	9.29	30
BU 232	AB	00504	+5038	3926	253	0.88	8.58	8.82	15
COU 1505		00594	+4057	4626	138	0.23	9.70	9.45	60
HO 213		01040	+3528	4990	119	0.28	7.81	8.25	60
STT 515		01095	+4714	5434	120	0.52	4.52	5.18	40
BU 303		01096	+2348	5444	291	0.61	7.32	7.56	15
HU 520		01178	+4946	6058	166	0.36	9.14	8.70	40
COU 1659		01298	+4547		26	0.32	(9.0	9.3)	40
COU 1214		01373	+4015		175	0.31	(9.6	9.6)	40
KR 12		01415	+6240	7895	291	0.37	7.81	7.88	40
A 1		01424	−0646	7968	252	0.81	8.90	8.83	15
B 2550	AB	01425	+5000	7979	285	0.23	9.08	9.55	60
COU 452		01510	+2551	8600	181	0.29	8.42	9.78	40
A 951		01512	+6021	8629	220	0.45	8.32	9.44	30
I 450		01519	−2309		222	0.50	9.02	9.08	30
A 953		01547	+5955		63	0.82	9.07	9.17	15
COU 1510		02016	+4107		131	0.36	(9.6	9.6)	40
KUI 8		02280	+0158	11474	38	0.52	7.09	7.63	30
VOU 36		02513	+0141		9	0.38	8.23	9.54	30
COU 2013		02520	+1831		93	0.21	(9.1	9.1)	60
STF 314	AB−C	02529	+5304	13424	313	1.55	6.95	7.26	9
RST 4220		03038	−0542	14255	339	0.42	9.11	9.80	30
STF 346		03055	+2515	14376	254	0.40	6.21	6.19	30
STF 367		03140	+0044	15058	134	1.21	8.21	8.26	9
STF 412	AB	03345	+2428	16664	353	0.74	6.73	6.76	15
STT 75		04186	+6029	20105	183	0.36	7.49	7.78	30
STT 86		04366	+1945	21465	357	0.48	7.73	8.68	30
BU 316		04528	−0517	22692	3	0.80	8.57	8.62	15
RST 4781		05301	−0145	25762	26	0.43	8.29	8.53	30
HEI 42 Aa		05320	−0018	25930	131	0.33	2.41	3.76	60

(continued)

Table 2.2 (continued)

Catalogue	Comp	RA 2000	Dec 2000	HIP	PA	Sep	Va	Vb	Ap. (cm)
FIN 345		05354	−0426	26234	97	0.42	6.45	7.89	30
COU 2037		05219	+3934	25060	147	0.41	8.29	8.06	30
A 1562		05373	+4339		352	0.39	8.94	8.85	30
BU 1032		05387	−0236	26549	88	0.27	4.06	5.24	60
STT 112		05398	+3758		50	0.89	7.92	8.21	15
KUI 24		06145	+1754	29616	142	0.34	6.67	6.70	40
A 668		06166	−0902	29705	333	0.22	6.34	7.74	60
A 2719		06203	+0744	30120	65	0.44	6.76	6.83	30
AC 4		06490	−1509	32677	335	0.40	5.56	7.31	30
STF 987		06541	−0552	33154	176	1.27	7.13	7.29	9
BU 328	AB	07067	−1118	34301	106	0.55	5.69	7.04	30
STF 1037		07128	+2714	34860	308	1.00	7.28	7.36	9
BU 1023		07151	+2553	35070	304	0.45	9.11	9.30	30
STF 1291		08542	+3034	43721	312	1.47	6.21	6.43	9
A 1588		09273	−0913	46365	195	0.43	7.22	7.40	30
A 2152	AB	10290	+3452	51320	50	0.40	8.52	8.79	30
YSJ 1	Aa	10329	−4700	51504	91	0.46	5.29	7.66	30
I 78		11336	−4035	56931	278	0.70	6.13	6.16	15
STF 1555	AB	11363	+2747	56601	149	0.73	6.41	6.78	15
STF1639	AB	12244	+2535	60525	324	1.78	6.79	7.94	9
STT 250		12244	+4306	60522	353	0.33	8.65	8.79	40
BU 341		13038	−2035	63738	132	0.61	6.46	6.43	15
BU 114		13343	−0837		167	1.26	8.05	8.18	9
A 347		14369	+4813	71467	245	0.56	8.69	8.49	15
RST 4534		15089	−0610	74116	13	0.45	8.93	9.29	30
STF 1932		15183	+2649	74893	263	1.64	7.43	7.48	9
HU 149		15246	+5413	75425	271	0.66	7.48	7.62	15
COU 610		15329	+3121	76127	200	0.81	4.42	6.64	15
HU 1274		15550	−1923	77939	115	0.46	6.04	8.50	30
BU 1298		16595	+0942	83143	129	0.43	8.25	9.16	30
STT 337		17505	+0715	87325	162	0.54	8.18	8.98	30
HO 98		19081	+2705	93994	78	0.24	8.28	8.30	60
STF 2583		19487	+1148	97473	105	1.43	6.47	6.75	9
AC 16	AB	19579	+2715	98248	230	0.38	7.81	9.17	30
A 1204		20143	+3129		143	0.36	9.52	9.49	40
STT 403		20143	+4206	99749	17	0.93	7.31	7.68	15
KUI 97		20295	+5604	101084	129	0.79	5.95	8.84	15

(continued)

Table 2.2 (continued)

Catalogue	Comp	RA 2000	Dec 2000	HIP	PA	Sep	Va	Vb	Ap. (cm)
STF 2783		21141	+5818	104812	357	0.72	7.71	8.07	15
COU 1183		21180	+3049	105146	18	0.25	9.0	8.9	60
STT 435		21214	+0254	105438	238	0.68	8.31	8.20	15
BU 688	AB	21426	+4103	107137	200	0.42	8.10	8.02	30
STF 2843	AB	21516	+6545	107893	149	1.33	7.07	7.36	9
BU 694	AB	22030	+4439	108845	6	1.00	5.72	7.82	15
HU 981		22306	+6138	111112	213	0.28	7.61	7.84	40
HO 475	AB	22327	+2625		305	1.06	9.34	9.62	15
STT 510	AB	23516	+4205	117646	118	0.60	7.86	8.47	30
A 1498		23594	+5441	118287	90	0.38	7.73	7.77	30

Fig. 2.1 A CCD image of Albireo (β Cygni) taken from USA by Bob Francke, the separation is $34''.7$. North is at the top, east to the left

Whilst a telescope enhances the colours in double stars, if too large an aperture is used as Mullaney (1993) pointed out some years ago, colour perception is made more difficult. This can be partly explained by the fact that the smaller telescope produces a larger diffraction disk and the eye is more susceptible to colour in extended images than in point sources.

Colours can be determined in a more systematic manner than by eye estimates which are affected by personal equation. One method is to take colour slides of double stars and project the resulting images against a commercially available colour chart (such as the Macbeth Color Checker) to determine the colour of each component. Such a project was carried out some years ago by a group, led by Joseph Kaznica and others (Kaznica et al. 1984) at the Mount Cuba Observatory in Delaware.

2.3 Tests of Resolution

2.3.1 Binocular Tests

Before the appearance of the stabilising binoculars it used to be thought that the best resolution available with the standard pair of 7 × 50 binoculars was around 25 arcsec. The limiting magnitude also improves with the field being more stable and again it would be most interesting to see what the limit of these instruments is. Table 2.1 lists a number of test objects.

2.3.2 Resolution Tests for Binoculars

Table 2.1 gives a list of 50 double stars that are suitable tests for image-stabilised (and other) binoculars. The pairs have been selected from the WDS with the criteria that the magnitudes should both be brighter than 8.0 and the separations lie between 8 and 25 arcsec. The pairs are well distributed around the sky so a number of them will be visible at any time of year. The positions are given for J2000 and the position angle and separation (in degrees and arcseconds respectively) refers to the date given in the previous column. In most cases the motion is very small but a number of these pairs are binary and are indicated by an asterisk (*) after the catalogue name. The magnitudes are visual and come from the WDS. The components AB refer to the brightest two stars in a multiple system—no components given means that the given pair is a double only. For an explanation of the catalogue names, see Chap. 25.

2.4 Resolution Tests for Telescopes

Table 2.2 presents some test of resolution for telescopes of apertures ranging from 90-mm to 60-cm. These pairs are chosen because they appear to be moving fairly slowly at the present time and the following list should be accurate until about 2015. The pairs are chosen from the CHARA 4th catalogue of interferometric measures (Hartkopf et al. 2011) and the values given below are for the epoch 2012.0. The complete catalogue is available on the CD-ROM.

The closest pair in each list corresponds approximately to the Dawes limit for that aperture ($11''$/D in cm) although the magnitude of both components varies so that the fainter and more unequal pairs will be more difficult to resolve than the bright equal pairs of similar separation.

Note that these lists are merely suggestions for testing telescope objectives and test objects should not be selected rigorously from one table. Resolution depends, after all, not only on the collimation and quality of the optics, but the state of the atmosphere. It is most likely that the last word on any attempts to resolve close pairs will be had by the seeing so attempts should be made when atmospheric conditions are suitable.

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