

Color in Double Stars

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An article by Richard Harshaw

In 1987, I purchased a Celestron C-8. This was my fourth telescope (my first being a 60mm refractor on an alt-azimuth mount I bought when I was 12, the second a 4.25-inch reflector on an equatorial mount at age 16, the third a 60mm refractor on an equatorial mount at age 27). Being used to smaller apertures, I was not quite ready for the wealth of material now available to me. Therefore, I decided to build an observing database to help me log and systematically do an observing program that is still ongoing.

My database is stored in Microsoft's Access and now contains over 8,000 observations of everything from single stars that I thought were particularly stunning in the view to a quasar (3C273). Since I now live only 10 miles (16 km) from downtown Kansas City, Missouri (a city graced with about 500 megawatts of high pressure sodium lighting!), my observing program has changed over the last 7 years. I no longer have the joy of chasing faint galaxies and difficult nebulae and planetaries. I have instead concentrated on what is easily visible from my foggy skies, namely star clusters and double stars. (My database lists 370 open clusters, 78 globulars, and over 6,000 double stars.)

The construction of the C-8 makes using a filar micrometer virtually impossible (especially as the primary mirror moves to achieve focus and thus the field size can vary however slightly depending on the focus and ocular used), so I have not been able to do any pair measurement. I do own an illuminated reticule that is of some value, but I have had to content myself with observations of colors, contrasts, and tests of resolving power with varying sky conditions. (I have pushed my C-8 to its Dawes limit of 0.57" with a clean split of Rho Cap, currently listed as slightly under 0.5" and STF 1863, STF 3056, Burnham 69, Burnham 180, and 24 Aqr, all listed as 0.6".)

In pursuing the issue of color, I have built a list of over 150 pairs that exhibit either striking color contrasts, strong colors in one or more of the stars, or odd colors in one or more of the stars. This article will present that list. Color in stars is a subtle thing most of the time. There are, of course, some well-known exceptions to this rule, such as ruddy Betelgeuse and bluish-white Rigel. But most of the time, the colors are very pale. That stars should exhibit different colors is not surprising as a star's color is a function of its surface temperature, and stars show a wide range of surface temperatures. What can be surprising, however, is the contrast in color of two or more stars that comprise a system. For instance, consider Albireo (Beta Cygni). Here we have a bright golden star (the A star) and a fairly bright deep blue star (B). From stellar physics, we should assume that the B star is the hotter of the two, and since it is considerably fainter, it must be much smaller than A. The question that always crosses my mind as I view such a contrasting pair at the eyepiece is what sort of physics is at work here? Both stars are (we assume) of the same age. So how did two stars of such different masses form from the parental cloud of gas and dust? How have these masses affected the evolution of the pair? Although both are of the same age, is one "more advanced" along the H-R diagram than the other?

Another interesting point about star colors is the report that they may change with time. We have the case, for instance, of Sirius. A large number of classical writers (such as Horace, Cicero, Ptolemy and Seneca) wrote of Sirius as being of a reddish color. Extensive research by a number of historians leads us to believe that this is no fluke — that Sirius was, indeed, redder two millennia ago than today. Since the companion is so hot, it must just have left its red giant phase. Could it be that this is what gave Sirius its ruddy appearance only 2,000 years ago? (A major problem with this hypothesis is that stellar theory predicts at least 100,000 years for a star to evolve from a red giant to a white dwarf, not a mere 2,000.)

Could there have been a mass transfer mechanism that altered the stellar chemistry here, as in the case of Capella A and Capella A'? Could this explain the ruddy color of Sirius 2,000 years ago and yet why it appears as a normal Main Sequence star accompanied by a white dwarf today?

In reading the table that follows, the reader needs to understand my database "shorthand." The first column, *R*, is a personal rating system I use to describe the visual effect in the eyepiece. It is a subjective scale ranging from 1 (superb!) to 5 (hardly worth the effort), and was developed to help me generate an observing list of stunning objects whenever I entertain visitors at my scope. The *Id* column is the pair's identity. When possible, I use the

Greek or Flamsteed system; otherwise, I have tried to list the pair by the earliest known observer's catalog designation.

The *Position* column gives the position for Equinox 2000.0. The *Mag* column contains the magnitude for each star in the system. *Sep* is the separation in arc seconds. A plus sign (+) means the pair is currently widening; a minus (-) indicates decreasing distance; and no change since discovery is indicated by "nc". *PA* is the position angle. Again, a plus (+) means the PA is increasing; minus (-) means decreasing; and nc means "no change".

Yr is the most recent year of measurements that I have available. Many of these come from the Webb Society's own *Double Star Section Reports* and volume 1 of our 8-volume library.

Spec is the spectroscopic class of the star. (It is amazing here to see how many different classes for the same star one can find as one scans the literature!)

Colors are the colors as I saw them. I realize that people have different perceptions of color, as well as the fact that the atmospheric conditions at the time of observation can play a major role in the color one perceives in a star, so I would not take the colors listed as absolutely or universally true! I have also discovered that color shows up better in smaller apertures. Larger telescopes gather more light, but also tend to over stimulate the cones so that colors become more and more "pastel" in nature. You may find it useful to build an off-axis aperture mask for your 'scope if it is of large aperture. This will reduce the amount of light you pick up, but should help increase the color sensation you'll see.

The color code follows the old "Roy G Biv" acronym (red, orange, yellow, green, blue, indigo, violet), with the addition of D for gold and L for lilac. I use a lower-case "p" for pale. In addition, two letters indicate a combination with the major color component capitalized. Thus bW would be read as 'bluish-white' and pO as "pale orange". Finally, as you'll see in the table, a strong color is shown with a single exclamation point (!) and very strong colors with two points (!!). Questionable colors are shown with one or two question marks (?, ??). Odd or elusive colors are shown with ?! or !?, depending on which struck me more — the color or the elusiveness. A "pec" means the color is very peculiar (and therefore may not actually be the color I am showing).

The *Dist* and *Lum* columns show the approximate distance in light years (if known, and sometimes by spectrographic analysis and not parallax) and the resulting luminosity in solar units.

Following some listings are comments about what I observed. A reference to a "diffraction mask" means I used a hexagonal mask over my C-8's objective, similar to the one described on pages 15-17 of Volume 1 of the Webb Society Deep-Sky Observer's Handbook: *Double Stars*.

I would be interested in hearing from others their reports of rich color in double stars, either of any on this list or others.

R	Id	Position	Mag	Sep	PA	Yr	Spect	Colors	Dist	Lum
4	ε3064	0008+4009	A: 7.0 E: 10.0	- AE: 25+	- AE: 3+	1956	G5	Y dB!		
2	ν52	0013+2700	A: 6.7 B: 9.1	- AB: 18	- AB: 225	1957	G3III F2I	Y! dB!	560	57
2	h1991	0039-2506	A: 6.6 B: 9.7	- AB: 46	- AB: 93	1953	K0	O! dB!		
1	η Cas	0049+5749	A: 3.4 B: 7.5	- AB: 12-	- AB: 312-	1989	G0V dM0	Y!! dR!!	18	1.1
4	γ301	0049-2124	A: 8.4 B: 9.4	- AB: 11 nc	- AB: 300 nc	1943	F5	W B!		
3	Espin 940	0057+5214	A: 7.5 B: 9.5 b: 13.0	- AB: 62 Bb: 7	- AB: 356 Bb: 33	1910	K2	dO! B ?		
3	ε87	0106+1523	A: 7.3 B: 8.5	- AB: 7 nc	- AB: 198 nc	1967	K0V	O! pB!	72	0.85
3	φ Psc	0114+2434	A: 4.7 B: 10.1 C: 13.0	- AB: 8 AC: 144	- AB: 225 AC: 173	1936	K0III	Y!! O ?	280	91
A diffraction mask is (surprisingly) not much help here.										
4	h1077	0118+4438	A: 7.3 B: 9.4	- AB: 40+	- AB: 294-	1988	K5	O!! W		
There are many stars fainter than 11m in the field, and a 6.3m rooster (SAO 37077) rules the roost 17° NNW.										
2	ε124	0126-1354	A: 8.5 B: 10.5	- AB: 7 nc	- AB: 233 nc	1964	F5	Y! dB!		
1	ι Ari	0158+2335	A: 4.9 B: 7.7	- AB: 38 nc	- AB: 47 nc	1933	F0V G1	Y!! dB!!	100	9.2
1	γ And	0204+4220	A: 2.3 B: 5.1	- AB: 10 nc	- AB: 63 nc	1991	K2III B9V	yO! B!	330	1,100
Both William Herschel and F. Struve saw them as Y and B, but Admiral Smyth called them "orange and emerald green."										
1	H 80	0226-1519	A: 5.9v B: 8.8 C: 10.8	- AB: 12 AC: 108	- AB: 295 AC: 30	1923	AVp	Y!! B!! ?	210	16
1	ν Cet	0236+0535	A: 4.9 B: 9.5	- AB: 8 nc	- AB: 83 nc	1972	G8III F7	Y! dB!	360	110
5	15 Tri	0236+3441	A: 5.6 B: 6.8	- AB: 141	- AB: 17	1959	M3III	Y!! W	580	200
1	ε301	0248+5358	A: 7.8 B: 8.8	- AB: 8 nc	- AB: 16 nc	1938	A0	O!! W		
2	ε336	0302+3224	A: 6.9 B: 8.4	- AB: 9 nc	- AB: 8 nc	1971	G5IV A5	W dB!		
4	h2166	0308+7548	A: 7.6 B: 9.4 C: 9.5 D: 9.7	- AB: 59 AC: 60 AD: 64	- AB: 249 AC: 192 AD: 140	1957	M0	O!! W W W		
3	ε392	0330+5254	A: 7.4 B: 9.6	- AB: 26	- AB: 347	1921	K0	dY! R!		
3	ε411rej	0332-0706	A: 7.8 B: 8.8 C: 11.2	- AB: 19 nc AC: 38 nc	- AB: 88 nc AC: 28 nc	1936	F8 F8	pY! dB! ?		

R	Id	Position	Mag	Sep	PA	Yr	Spect	Colors	Dist	Lum
1	Webb	0343+5958	A: 5.9 B: 8.5	- AB: 55	- AB: 35	1925	K5II B8II	D!! dB!!	2,050	1,600
4	Franks 4	0345+4005	A: 7.6 B: 9.9 Star B is difficult.	- AB: 50	- AB: 133	1918	G5	yW dB!		
3	h3601	0352-2256	A: 7.7 B: 9.7	- AB: 11	- AB: 300	1932	G5	yW dB!		
4	OΣ47	0421+5015	A: 7.3 B: 8.2 C: 10.8 It lies at the center of NGC 1545.	- AB: 73- AC: 150	- AB: 327 AC: 261	1922	K2 F8	dO! B! V	2,600	940
2	h342	0423-0500	A: 8.1 B: 9.1 C: 11.9	- AB: 17 nc AC: 28 nc	- AB: 235 nc AC: 83 nc	1916	K2	Y! dB! ?		
3	Stein 8	0429-2511	A: 7.8 C: 9.3	- AC: 7	- AC: 351	1932	G5	pO! pB!		
1	OΣ84	0431+0648	A: 7.3 B: 8.2 Two stunning jewels!	- AB: 9 nc	- AB: 254 nc	1932	G5	O! W		
2	Σ583	0441+0058	A: 8.0 B: 9.6 C: 9.8 Nice color combination.	- AB: 6 AC: 100	- AB: 326 AC: 265	1927	A0	W O B		
4	Σ579	0442+2244	A: 8.9 B: 11.1 τ Tau is 14' NNE and overpowering. Σ579 is the N vertex of a small triangle of 9m stars.	- AB: 16	- AB: 37	1964	K7	dO! R?		
3	Σ587	0448+5307	A: 7.4 B: 9.4 b: 9.8 It lies in a sparse field; the color on star B is odd too.	- AB: 21 nc Bb: 28	- AB: 185 nc Bb: 129	1925	A3	Y V? W?		
2	Σ598	0449+1748	A: 8.1 B: 9.6 B is a wonderful peacock blue!	- AB: 9	- AB: 318	1937	F2 F2	W dB!		
2	β Cam	0503+6029	A: 4.0 B: 8.6 b: 11.2 Star b is very difficult. A dark nebula lurks behind, so the field is very bleak.	- AB: 80 nc Bb: 14 nc	- AB: 208 nc Bb: 14 nc	1923	G0II A5	Y! dB! ?	1,700	5,800
3	Σ640	0507+3325	A: 8.7 B: 10.0 C: 11.3	- AB: 9 AC: 25	- AB: 98 AC: 316	1900	A3	W rO! W?		
3	Σ680	0519+2008	A: 6.1 B: 10.0 Some observers report colors of Y and B. The color of star B is most unusual.	- AB: 9 nc	- AB: 204 nc	1938	G8III G1I	O Gpec	800	190
1	Σ688	0519-1045	A: 8.6 B: 8.7	- AB: 11 nc	- AB: 273 nc	1950	F0	pO! pB!		
3	OΣ106	0522+0524	A: 7.2 B: 10.7	- AB: 9 nc	- AB: 42 nc	1917	F5	W R!!		
3	β Lep	0528-2045	A: 2.8 B: 7.3 C: 11.8 D: 10.3 E: 10.3	- AB: 3- AC: 64 AD: 206 AE: 242	- AB: 330+ AC: 145 AD: 75 AE: 78	1957	G5III dK	dY! bW ? ? ?	290	500

R	Id	Position	Mag	Sep	PA	Yr	Spect	Colors	Dist	Lum
3	Δ721	0530+0308	A: 7.2 B: 8.4 The color of B is elusive.	- AB: 25	- AB: 150+	1985	B:IV F8	W G?	1,200	200
2	Δ790	0546+0416	A: 6.4 B: 8.7	- AB: 7	- AB: 88	1990	K1III G0I	rO! B!	600	90
2	Δ780	0551+6545	A: 6.9 B: 8.1 C: 10.0	- AB: 4 nc AC: 13+	- AB: 104 nc AC: 150	1954	F8	Y dB! ?		
3	Δ809	0551-0125	A: 7.9 B: 8.8	- AB: 25	- AB: 97	1937	G5	O dB!		
4	40 Cam	0616+6000	A: 5.6 B: 10.7	- AB: 103	- AB: 356	1908	K0III	dY! W	360	60
5	β CMa	0623-1758	A: 2.0 B: 9.8	- AB: 188+	- AB: 340	1988	B1III	bW! W	850	9,000
4	Bairdud 1695	0629+0239	A: 6.2 B: 10.2 Use averted vision for star B.	- AB: 19	- AB: 299+	1958	M1III	yO! W		
Note the nice faint pair γ ENE (about 60" apart in pa 80).										
2	Δ926	0632+0546	A: 7.1 B: 8.5	- AB: 11-	- AB: 289	1988	A0 A0	Y! dB!		
2	h3869	0633-3202	A: 5.7 B: 7.7	- AB: 24 nc	- AB: 258 nc	1930	B3/IV A0	W dB!	1,700	1,400
1	γ CMa	0636-1840	A: 5.8 B: 8.5	- AB: 17 nc	- AB: 262 nc	1926	G8/IV	Y!! dB!!	110	4.9
5	γ Aur	0639+4230	A: 5.1 B: 10.6 C: 11.3 Use high power and averted vision to glimpse B.	- AB: 53 AC: 99	- AB: 109 AC: 75	1907	G5III	Y! W ?	600	260
5	30 Gem	0644+1314	A: 4.5 B: 11.0 Star B is very difficult; use averted vision.	- AB: 27-	- AB: 184	1904	K0III	Y! ?	220	62
3	Espin 67	0651+4030	A: 8.9 B: 10.2	- AB: 6	- AB: 308	1923		W rO!		
2	h740	0652+0027	A: 8.9 B: 9.3 It lies in the center of the open cluster NGC 2301.	- AB: 21	- AB: 8	1915	K0	dO! W		
3	h2355	0709+7158	A: 7.1 B: 11.3 The color of A is very nice.	- AB: 64	- AB: 248	1909	K0	O! B		
5	γ Gem	0711+3015	A: 4.5 B: 12.4	- AB: 60 nc	- AB: 343 nc	1963	K0III	yO! bW	200	50
4	51 Gem	0713+1609	A: 5.3 B: 10.5 C: 10.5 You'll need averted vision to see the companions.	- AB: 149 AC: 221	- AB: 20 AC: 37	1903	MIII	yO! W W	460	128
1	Δ1045	0713-0311	A: 8.4 B: 9.6	- AB: 6	- AB: 239+	1964	F5	yW! dB!		
1	h3945	0717-2318	A: 4.8 B: 6.8 A superb pair.	- AB: 27-	- AB: 53-	1959	M0II F0V	O!! pB	1,200	1,600
3	Δ1038	0721+6832	A: 7.9 B: 10.3 The B star is about the bluest I've ever seen.	- AB: 11	- AB: 96	1975	A5	W dB!!		

R	Id	Position	Mag	Sep	PA	Yr	Spect	Colors	Dist	Lum
1	Δ 1084	0724-0359	A: 7.1 B: 9.6	- AB: 14+	- AB: 286	1990	K0	D!! dB!!		
			This is a fainter version of μ Cygni (Albireo).							
2	γ CMa	0724-2918	A: 2.4 B: 6.9	- AB: 179	- AB: 285	1909	B7Ia A0V	bW! W	2,300	46,000
5	β CMi	0727+0817	A: 3.1 B: 11.2 C: 11.1 D: 10.9	- AB: 99 AC: 125 AD: 139	- AB: 23 AC: 77 AD: 311	1907	B8Ve	bW! ? ? W?	170	130
			The companions are all very difficult.							
5	γ CMi	0728+0854	A: 4.6 B: 12.3	- AB: 119	- AB: 262	1911		dY! ?	230	60
4	h3973	0732-2055	A: 8.3 B: 9.3	- AB: 9 nc	- AB: 38 nc	1947	B8	bW R?		
			The color of B is not certain. It may be V.							
5	h425	0735+2416	A: 8.1 B: 10.7	- AB: 8	- AB: 46	1914	M0	dO! ?		
			Star B is very difficult and will require averted vision.							
4	γ Gem	0739+3502	A: 5.6 B: 10.6	- AB: 160	- AB: 100	1926	G5III	dY! rO	390	69
5	α Gem	0743+2853	A: 4.3 B: 10.8	- AB: 182	- AB: 316	1909	K0III	dO! W	250	93
5	δ Gem	0804+2747	A: 5.0 B: 12.0 C: 11.0	- AB: 60 AC: 79	- AB: 188 AC: 81	1907	K0III	yO! ? W?	390	120
			Use averted vision to pick up B and C.							
4	DUN 61	0807-2707	A: 7.0 B: 8.5	- AB: 71	- AB: 35	1920	B9III K0	W dO!	1,140	200
3	O Δ 93	0825+4200	A: 6.1 B: 8.6	- AB: 83	- AB: 174	1979	K5III B	Y! B	520	84
4	ϕ Cnc	0827+2754	A: 5.8 B: 10.1	- AB: 131	- AB: 21	1923	K2III	yO! bG	520	100
			Some observers report both as W.							
2	F Hya	0844-0713	A: 4.7 B: 8.8	- AB: 79	- AB: 310	1925	G0II	D B	1,700	3,000
			Wonderful color contrast!							
5	See 106	0845-2347	A: 6.8 B: 11.5 C: 12.0	- AB: 18+ AC: 3.5	- AB: 238+ AC: 333	1960	K0	dO! ? ?		
5	O Δ 104	1024+3411	A: 7.8 B: 8.3	- AB: 208	- AB: 286	1958	M6III	rO! Y		
5	33 LMi	1032+3223	A: 5.8 B: 11.8	- AB: 43+	- AB: 245	1924	B9IV	bW! ?	420	66
3	O Δ 239rej	1144+2513	A: 6.0 B: 10.3	- AB: 37	- AB: 24+	1967	K5III rO!	dY! rO!	590	110
4	Sh136	1211+8143	A: 6.5 B: 8.5	- AB: 67	- AB: 76	1924	K0III F5	Y! dB!	490	55
3	16 Vir	1220+0319	A: 5.1 B: 11.6	- AB: 132	- AB: 4	1925	K0III	dY! W	300	64
			Very neat! A 10m triangle lies 4' SW.							

R	Id	Position	Mag	Sep	PA	Yr	Spect	Colors	Dist	Lum
1	24 Com	1235+1822	A: 5.2 B: 6.7	- AB: 20 nc	- AB: 271 nc	1990	K2III A7V	Y! B!	310	95
2	Δ 1664	1238+1131	A: 8.1 B: 9.3 C: 11.5	- AB: 26 AC: 63	- AB: 247- AC: 306	1923	K0 G5	dO! W W		
2	λ Vir	1239+0760	A: 4.8 B: 9.1 C: 10.4	- AB: 173 AC: 221	- AB: 138 AC: 111	1919	K0III	dY! B W	240	56
										Very nice triangle! The color of star A is very intense.
3	Δ 1688	1254+3758	A: 8.8 B: 10.3 C: 12.4	- AB: 14 nc AC: 77 nc	- AB: 345 nc AC: 359 nc	1930	G0	yW! dB! ?		
4	α Vir	1256+0324	A: 3.7v? B: 10.7	- AB: 165	- AB: 138	1925	M3III	dY! ?	260	180
3	h4571	1312+3508	A: 6.6 B: 9.0	- AB: 24 nc	- AB: 267 nc	1958	K0III	yO! pB!	200	8.0
5	61 Vir	1319+1816	A: 4.8 B: 10.3	- AB: 32	- AB: 29	1911	G5V	dY! ?	28	0.76
										Star B was very difficult, even with a mask.
2	Δ 1775	1344+0416	A: 7.5 B: 7.9	- AB: 28 nc	- AB: 336 nc	1938	K2III	O! W	800	85
2	4 Cen	1353+3155	A: 4.7 B: 8.4	- AB: 15 nc	- AB: 185 nc	1955	B7IV Am	yW! dB	800	680
3	Oι 276	1405+3645	A: 7.5 B: 10.0	- AB: 10	- AB: 72+	1953	G0	W dB!		
5	h2700	1406+3959	A: 8.4 B: 12.4	- AB: 22	- AB: 216	1900	K5	dO! ?		
2	Δ 1804	1408+2111	A: 8.6 B: 9.6	- AB: 5 A	- B: 14	1973	F8	bW dO!		
										Nice color contrast.
3	Δ 1808	1410+2636	A: 8.8 B: 9.7 C: 11.9	- AB: 3 AC: 50	- AB: 81 AC: 117	1980	G5	Y rO! W		
3	h4679	1426+2208	A: 8.2 B: 9.3	- AB: 17 nc	- AB: 306 nc	1967	F2	W! dB!		
5	5 UMi	1428+7541	A: 4.4v? B: 9.9	- AB: 59	- AB: 131	1959	K2III	Y! ?	250	85
5	ι Boo	1432+3022	A: 3.6v? B: 11.3	- AB: 42	- AB: 339+	1953	K0III	yG! ?	175	91
3	Δ 1874	1442+4907	A: 8.8 B: 10.3	- AB: 26	- AB: 288	1915	G5	O! dB!		
										Great contrast.
5	Bos 2781	1504+0734	A: 8.2 B: 11.5	- AB: 41	- AB: 14	1957	M	rO! ?		
3	Sh195	1515+1826	A: 7.1 B: 8.1	- AB: 47	- AB: 140	1916	F5 F5	W dB!	200	6.6
4	ι CrB	1520+2937	A: 5.6v? B: 9.5	- AB: 147	- AB: 337	1918	K0III	yO! W?	360	60
2	Oι 300	1540+1203	A: 6.4 B: 9.5	- AB: 15 nc	- AB: 261 nc	1969	G5IV F5V	W dB!	2,000	900

R	Id	Position	Mag	Sep	PA	Yr	Spect	Colors	Dist	Lum
3	κ Lib	1542-1941	A: 5.0 B: 10.0	- AB: 172	- AB: 279	1910	M0III	dO! W?	82	5.3
5	ν Ser	1544+0625	A: 2.8 B: 11.8	- AB: 58	- AB: 350	1911	K0III	Y! ?	72	31
										Use averted vision and high powers to see the elusive B. A diffraction mask was no help.
5	η1281	1557-1602	A: 6.8 B: 12.3	- AB: 35	- AB: 232	1930	M0	dO! ?		
										Use averted vision and high powers to glimpse B.
5	ι CrB	1558+2653	A: 4.2 B: 11.5	- AB: 10 1	- AB: 174	1959	K0III	Y! ?	230	87
										The A star is one of the yellowest stars I've ever seen!
3	λ2003	1604+1126	A: 7.5 B: 11.3	- AB: 14 nc	- AB: 171 nc	1975	K2	Y! dB!		
3	Franks B	1630+0818	A: 6.5 B: 7.0	- AB: 58	- AB: 72	1914		Y! B!		
3	λ2068	1634+4716	A: 8.5 B: 8.5	- AB: 5 A	- B: 252	1985	F5	B! pO!		
3	43 Her	1646+0835	A: 5.4 B: 9.8	- AB: 83	- AB: 230	1916	K2III	dY! dB	390	84
1	19 Oph	1647+0204	A: 6.1v? B: 9.4 C: 11.3	- AB: 23 AC: 215	- AB: 89- AC: 194	1989	A2V dR!	Y! ?	260	24
4	30 Oph	1701-0412	A: 5.0 B: 9.8	- AB: 94	- AB: 69	1919	K0III	dY! ?	300	71
2	λ2135	1712+2114	A: 7.4 B: 8.7 C: 11.9	- AB: 8 A AC: 169	- B: 280+ AC: 208	1982	K0	Y! dB! ?		
3	λ2137	1715+1548	A: 8.0 B: 9.0	- AB: 4 nc	- AB: 144 nc	1971	A2	bW! O!		
5	72 Her	1721+3230	A: 5.4 B: 9.7	- AB: 30-1	- AB: 335+	1923	G0	Y! ?		
5	Hussey 752	1738-2003	A: 9.3 C: 11.3	- AC: 50	- AC: 92	1933	A0	W dB!		
2	λ2213	1745+3108	A: 8.0 B: 8.5	- AB: 5+	- AB: 326-	1984	F8	Y! dB!		
2	λ2259	1759+3003	A: 7.3 B: 8.3	- AB: 20+	- AB: 278+	1989	A0V	Y! gB!		
2	λ2306	1822-1505	A: 7.9 B: 9.0 C: ?	- AB: 10- AC: 1+	- AB: 220 AC: 70	1975	F5II dB!	dO! ? ?		
2	λ2399	1849+1312	A: 8.8 B: 9.4 C: 10.3	- AB: 16 nc AC: 32 nc	- AB: 119 nc AC: 48 nc	1919	A0 A2	Y! dB! ?		
3	λ2411	1852+1432	A: 8.6 B: 9.4	- AB: 14 nc	- AB: 95 nc	1965	K0IV	yO! rO!		
4	ν' Sgr	1854-2245	A: 4.8 B: 10.6 C: 10.6	- AB: 2 AC: 28	- AB: 98 AC: 60	1930	K2III B9	Y! ? ?	4,200	16,800
2	O1.525	1855+3358	A: 6.1 B: 7.8	- AB: 45	- AB: 350	1846	G0	Y! dB!		

R	Id	Position	Mag	Sep	PA	Yr	Spect	Colors	Dist	Lum
2	λ2426	1900+1253	A: 7.4 B: 8.8	- AB: 17 nc	- AB: 259 nc	1959	K5	dO! B!!		
4	Gaisher	1904+2321	A: 8.3 B: 11.5	- AB: 39	- AB: 321	1840	K0 W?	dY! W?		
A zig-zag line of five stars (8m-9m) runs E-W across the field. This pair is the 2nd star from the W end of that line.										
1	λ2445	1905+2320	A: 7.2 B: 8.9 C: 8.9	- AB: 12 nc AC: 143 nc	- AB: 263 nc AC: 106 nc	1951	B3V	Y!! dB!! W	1,700	400
1	λ2481	1911+3847	A: 8.3 B: 8.3	- AB: 5+	- AB: 201-	1977	G5	dR! B!		
5	h2863	1919-1532	A: 6.1 B: 11.6	- AB: 49	- AB: 18	1909	K2III	O!! B	460	60
1	28 Aql	1920+1222	A: 5.5 B: 9.0	- AB: 59	- AB: 175	1913	F0III	Y!! dB!!	320	50
1	ι Cyg	1931+2758	A: 3.1 B: 5.1	- AB: 35 nc	- AB: 54 nc	1982	K3III B8V	D!! dB!!	410	880
Superb! Smyth called them "topaz yellow and sapphire blue." Webb wrote, "one of the finest double stars in the heavens." I agree!										
2	AG 386	1935+1156	A: 8.1 B: 9.7	- AB: 28	- AB: 312	1903	K5	O!! W		
The area to the NE looks almost nebulous it is so rich.										
1	H 84	1940+1634	A: 6.5 B: 8.9	- AB: 28	- AB: 301	1931	M0II B3V	D! dB!	4,900	5,240
4	Scheiner 666	1943+3840	A: 6.7 B: 9.7	- AB: 25	- AB: 326	1896	K0	yO! B		
3	λ2566rej	1945+0459	A: 7.8 B: 10.8	- AB: 25	- AB: 234	1908	K5	O!! W?		
5	γ Aql	1946+1036	A: 2.8 B: 10.8	- AB: 13 3	- AB: 258	1907	K2IIIe	Y!! W?	270	430
A nice area lies to the S.										
2	Oλ1191	1946+3501	A: 6.5 B: 8.5	- AB: 38	- AB: 27	1958	K0III A2V	yO! B	680	105
2	AG 391	1948+1002	A: 8.0 B: 9.3	- AB: 50	- AB: 294	1918	K5 G0	O!! W		
5	56 Aql	1954-0834	A: 5.8 B: 11.9	- AB: 47	- AB: 77	1901	K5III	O!! ?	460	80
2	Oλ1404rej	2016+5230	A: 7.4 B: 9.9	- AB: 29	- AB: 114	1952	K5III	Y!! dB!!	360	12
The field nearby goes suddenly dark- is there a dark nebula nearby?										
5	T Cyg	2047+3422	A: 4.9 B: 9.9 C: 11.2	- AB: 10 AC: 14	- AB: 121 AC: 201	1934	K0III	yO! ? ?	650	370
Stars B and C were very difficult.										
2	Oλ1414	2047+4225	A: 7.6 B: 8.7 C: 9.7	- AB: 10 AC: 107	- AB: 94 AC: 16	1988	B9III	W R!! W	1,430	220
4	Hough 145	2052+3513	A: 9.2 B: 10.7	- AB: 11	- AB: 298	1945		Y dB!		
4	24 Cap	2107-2500	A: 4.6 B: 11.7	- AB: 26	- AB: 186	1933	M1III	Y!! ?	360	175

R	Id	Position	Mag	Sep	PA	Yr	Spect	Colors	Dist	Lum
4	ι2780	2112+5959	A: 5.6v? B: 7.0 C: 8.7 At least one report gives ruby red for the color of A.	- AB: 1.2 AC: 121	- AB: 216- AC: 212	1979	B0V	Wpec W W	1,600	1,500
3	ι2787	2122+0202	A: 8.0 B: 9.3 C: 10.6	- AB: 23 nc AC: 65 nc	- AB: 20 nc AC: 94 nc	1931	A2	yW dO! ?		
1	1 Peg	2122+1948	A: 4.1 B: 8.2 C: 11.9	- AB: 36 nc AC: 75 nc	- AB: 312 nc AC: 20 nc	1967	K1III K0	Y! dR! ?	220	90
4	2 Peg	2130+2338	A: 4.6 B: 11.6	- AB: 30	- AB: 332	1934	K5III	Y!! ?	360	150
2	ι2841	2154+1943	A: 6.4 B: 7.9 Four or five 9.5m stars lie to the S and a few more to the N.	- AB: 22 nc	- AB: 110 nc	1958	K0III F7V	yO! B!	600	100
2	ι2893	2213+7318	A: 6.2v? B: 8.3 Some observers report Y and W.	- AB: 29 nc	- AB: 348 nc	1969	K0III A3	D! dB!!	800	180
4	h1746	2214+3943	A: 4.6 B: 10.5	- AB: 30 +	- AB: 189+	1986	K2III	yO! W?	260	76
5	35 Peg	2228+0442	A: 4.9 B: 9.8 A 9.9m star is 80° away in pa 230.	- AB: 182	- AB: 241	1908	K0III	yO! bW	250	54
4	κ' Aqr	2238-0414	A: 5.3 B: 8.8 The companion is difficult in the glare of the primary.	- AB: 98	- AB: 247	19	K0	dY! W		
4	h1796	2239+5646	A: 5.5 B: 10.8	- AB: 31	- AB: 9-	1988	M4III	O! W	550	150
4	ι2948	2250+6633	A: 7.2 B: 8.9 The odd color of B makes it difficult to see.	- AB: 3 nc	- AB: 5 nc	1965	B9	W L		
2	ι452	2257+4301	A: 6.9 B: 11.0	- AB: 7	- AB: 256	1933	K5	dO! B!		
2	ι2971	2257+7830	A: 8.0 B: 9.2	- AB: 6 nc	- AB: 4 nc	1968	G5IV	Y! O!		
3	ι2967	2259+2745	A: 8.0 B: 9.6	- AB: 7 A	- B: 6	1964	F5	W dB!		
5	4 And	2308+4623	A: 5.3 B: 11.7	- AB: 48	- AB: 347	1925	K5III	dO! ?	450	120
5	h1862	2315+2729	A: 9.1 B: 10.3 The color of the B star makes it a difficult find. An 8.6m star lies 7° N.	- AB: 18	- AB: 233	1910	G0	W dB!		
4	4 Cas	2325+6217	A: 5.3 B: 7.8 C: 8.7	- AB: 99 AC: 215	- AB: 226 AC: 258	1917	K5III	dY! W B	5,200	18,400
5	ι388	2335+3801	A: 6.2 B: 11.7	- AB: 20	- AB: 333	1908	K5	dY! ?		
4	ι And	2338+4628	A: 4.0 B: 10.5	- AB: 21 8	- AB: 89	1908		dY! bW	75	11