

Appendix 1

Constellation Names and Abbreviations

The following table gives the standard International Astronomical Union (IAU) three-letter abbreviations for the 88 officially recognized constellations, together with both their full names and genitive (possessive) cases, and order of size in terms of number of square degrees. Those in **bold type** are represented in the double star lists in Chapter 7 and Appendix 3.

Table A1. Constellation Names and Abbreviations

Abbrev.	Name	Genitive	Size
And	Andromeda	Andromedae	19
Ant	Antlia	Antliae	62
Aps	Apus	Apodis	67
Aqr	Aquarius	Aquarii	10
Aql	Aquila	Aquilae	22
Ara	Ara	Arae	63
Ari	Aries	Arietis	39
Aur	Auriga	Aurigae	21
Boo	Bootes	Bootis	13
Cae	Caelum	Caeli	81
Cam	Camelopardalis	Camelopardalis	18
Cnc	Cancer	Cancri	31
CVn	Canes Venatici	Canum Venaticorum	38
CMa	Canis Major	Canis Majoris	43
CMi	Canis Minor	Canis Minoris	71
Cap	Capricornus	Capricorni	40
Car	Carina	Carinae	34
Cas	Cassiopeia	Cassiopeiae	25
Cen	Centaurus	Centauri	9
Cep	Cepheus	Cephei	27
Cet	Cetus	Ceti	4
Cha	Chamaeleon	Chamaeleontis	79
Cir	Circinus	Circini	85
Col	Columba	Columbae	54
Com	Coma Berenices	Comae Berenices	42
CrA	Corona Australis	Coronae Australis	80
CrB	Corona Borealis	Coronae Borealis	73
Crv	Corvus	Corvi	70
Crt	Crater	Crateris	53
Cru	Cruce	Crucis	88

Table A1. Constellation Names and Abbreviations (*continued*)

Abbrev.	Name	Genitive	Size
Cyg	Cygnus	Cygni	16
Del	Delphinus	Delphini	69
Dor	Dorado	Doradus	7
Dra	Draco	Draconis	8
Equ	Equuleus	Equulei	87
Eri	Eridanus	Eridani	6
For	Fornax	Fornacis	41
Gem	Gemini	Geminorum	30
Gru	Grus	Gruis	45
Her	Hercules	Herculis	5
Hor	Horologium	Horologii	58
Hya	Hydra	Hydrae	1
Hyi	Hydrus	Hydri	61
Ind	Indus	Indi	49
Lac	Lacerta	Lacertae	68
Leo	Leo	Leonis	12
LMi	Leo Minor	Leonis Minoris	64
Lep	Lepus	Leporis	51
Lib	Libra	Librae	29
Lup	Lupus	Lupi	46
Lyn	Lynx	Lyncis	28
Lyr	Lyra	Lyrae	52
Men	Mensa	Mensae	75
Mic	Microscopium	Microscopii	66
Mon	Monoceros	Monocerotis	35
Mus	Musca	Muscae	77
Nor	Norma	Normae	74
Oct	Octans	Octantis	50
Oph	Ophiuchus	Ophiuchi	11
Ori	Orion	Orionis	26
Pav	Pavo	Pavonis	44
Peg	Pegasus	Pegasi	7
Per	Perseus	Persei	24
Phe	Phoenix	Phoenicis	37
Pic	Pictor	Pictoris	59
Psc	Pisces	Piscium	14
PsA	Piscis Austrinus	Piscis Austrini	60
Pup	Puppis	Puppis	20
Pyx	Pyxis	Pyxidis	65
Ret	Reticulum	Reticuli	82
Sge	Sagitta	Sagittae	86
Sgr	Sagittarius	Sagittarii	15
Sco	Scorpius	Scorpii	33
Scl	Sculptor	Sculptoris	36
Sct	Scutum	Scuti	84
Ser	Serpens	Serpentis	23
Sex	Sextans	Sextantis	47
Tau	Taurus	Tauri	17
Tel	Telescopium	Telescopii	57
Tri	Triangulum	Trianguli	78
TrA	Triangulum Australe	Trianguli Australis	83

Table A1. Constellation Names and Abbreviations (*continued*)

Abbrev.	Name	Genitive	Size
Tuc	Tucana	Tucanae	48
UMa	Ursa Major	Ursae Majoris	3
UMi	Ursa Minor	Ursae Minoris	56
Vel	Vela	Velorum	32
Vir	Virgo	Virginis	2
Vol	Volans	Volantis	76
Vul	Vulpecula	Vulpeculae	55

Appendix 2

Double Star Designations

Presented here is an alphabetical listing of all known double and multiple star designations, dating from the earliest reported discoveries in the mid-1600s up to the present time. By long-standing tradition, a double star is “named” for the person who either discovers it or first makes measures of it, the name itself usually being abbreviated or denoted by a symbol followed by a running serial number from that observer’s list, catalog or observatory where he worked.

The great *Index Catalogue of Visual Double Stars* (or *IDS*), originally compiled at the Lick Observatory in 1963, contained essentially all previous discovery catalogues. It eventually became the basis for the *Washington Double Star Catalog* (or *WDS*), which is maintained at the United States Naval Observatory and is now the world’s standard such reference. (Chapter 5 contains more about it, including how to access it on-line.) The one-, two- and three-letter codes below are those used in these two works. **Bold** entries are ones containing many of those pairs of particular interest to amateur astronomers and within range of their instruments.

Table A2. Codes for Star Designations

Designation	IDS/WDS Code	Discoverer or Observatory
A	A	R.G. Aitken
Abt	ABT	Giorgio Abetti
AbH	ABH	H.A. Abt
AC	AC	Alvan Clark
AG	AG	<i>Astronomische Gesellschaft Katalog</i>
AGC	AGC	Alvan G. Clark
AlbO	ALB	Albany Observatory
Ald	ALD	H.L. Alden
AlgO	ALG	Algiers Observatory
Ali	ALI	A. Ali
All	ALL	R.M. Aller
Anj	ANJ	J.A. Anderson
Ara	ARA	S. Aravamudan
Ard	ARD	S. Arend
Arg	ARG	F.W.A. Argelander
Arn	ARN	Dave Arnold
Ary	ARY	Robert Argyle
B	B	W.H. van den Bos
Bal	BAL	R. Baillaud

Table A2. Codes for Star Designations (*continued*)

Designation	IDS/WDS Code	Discoverer or Observatory
Bar	BAR	E.E. Barnard
Baz	BAZ	Paul Baize
Bond	BDW	W.C. Bond
Bem	BEM	A. Bemporad
Bes	BES	F.W. Bessel
Bgh	BGH	S. van den Berg
Bha	BHA	T.P. Bhaskavan
Big	BIG	G. Bigourdan
Bird	BRD	F. Bird
Bll	BLL	R.S. Ball
Blo	BLO	M. Bloch
Boo	BOO	S. Boothroyd
Bot	BOT	G. von Bottger
Bra	BRA	M. Brashear
Brt	BRT	S.G. Barton
BrsO	BSO	Brisbane Observatory
Btz	BTZ	E. Bernewitz
β	BU	S.W. Burnham
βpm	BUP	S.W. Burnham's proper motion catalogue
Che	CHE	P.S. Chevalier
Chr	CHR	Center for High Resolution Astronomy
Cog	COG	W.A. Cogshall
Com	COM	G.C. Comstock
CorO	COO	Cordoba Observatory
Cou	COU	Paul Couteau
CPD	CPD	Cape Photographic Durchmusterung
CapO	CPO	Cape Observatory
Cru	CRU	L. Cruls
Ctt	CTT	Jean-Francois Courtot
CamU	CUA	Cambridge University
Dem	D	Ercole Dembowski
Da	DA	W.R. Dawes
Dal	DAL	J.A. Daley
Dan	DAN	Andre Danjon
δ	DAW	B.H. Dawson
DrbO	DEO	Dearborn Observatory
Deu	DEU	A.J. Deutsch
Dick	DIC	J. Dick
Dju	DJU	P. Djurkovic
Dob	DOB	W.A. Doberck
Doc	DOC	D.J. Docobo
Dom	DOM	Jean Dommanget
Don	DON	H.F. Donner
Doo	DOO	Eric Doolittle
DorO	DOR	Dorpat Observatory
Δ	DUN	J. Dunlop
Dur	DUR	M.V. Duruy
Dyer	DYR	E.R. Dyer, Jr.

Table A2. Codes for Star Designations (*continued*)

Designation	IDS/WDS Code	Discoverer or Observatory
Edd	EDD	Arthur Stanley Eddington
Edg	EDG	D.W. Edgecomb
Egg	EGG	O.J. Eggen
Elr	ELT	G.A. Elliott
Enc	ENC	J.F. Encke
Eng	ENG	R. Engelmann
Es	ES	T.E.H. Espin
Fab	FAB	C. Fabricius
ϕ	FIN	W.S. Finsen
Fla	FLA	Camille Flammarion
Fle	FLE	J.O. Fleckenstein
For	FOR	L. Forgeron
Fox	FOX	Philip Fox
Fra	FRA	R. Frangetto
Frh	FRH	R. Furuhielm
Frk	FRK	W.S. Franks
Frz	FRZ	J. Franz
Fur	FUR	H. Furner
Gallo	GAL	J. Gallo
GAn	GAN	G. Anderson
Gat	GAT	G. Gatewood
Gee	GEE	W.T. Geertsens
Gic	GIC	Henry Giclas
Gir	GIR	P.M. Girard
Gale	GLE	W.F. Gale
Gli	GLI	J.M. Gilliss
Glp	GLP	S. de Glasenapp
Gol	GOL	H. Goldschmidt
Grb	GRB	Steven Groombridge
GrnO	GRO	Greenwich Observatory
Gsh	GSH	J. Glaisher
Gtb	GTB	K. Gottlieb
Gui	GUI	J. Guillaume
Gyl	GYL	A.N. Goyal
Gsh	GSH	J. Glaisher
H	H	William Herschel (1782–1784 catalogues)
HI	H	“–difficult
HI	H	“–close but measurable
HI	H	“–5 to 15 arc seconds separation
HI	H	“–15 to 30 arc seconds separation
HI	H	“–30 to 60 arc seconds separation
HI	H	“–60 to 120 arc seconds separation
HN	H	William Herschel (1821 catalogue)
Hcw	HCW	H.C. Wilson
HvdO	HDO	Harvard Observatory
HDS	HDS	Hipparcos Double Star
HvdC	HDZ	Harvard Observatory zone catalogues
hei	HEI	Wulff Heintz

Table A2. Codes for Star Designations (*continued*)

Designation	IDS/WDS Code	Discoverer or Observatory
Hill	HIL	L. Hill
HipC	HIP	Hipparcos Catalogue 1997
h	HJ	John Herschel
Hall	HL	Asaph Hall
Hld	HLD	E.S. Holden
Hlm	HLM	E. Holmes
Hln	HLN	Frank Holden
Ho	HO	G.W. Hough
Hrg	HRG	L. Hargrave
Hrl	HRL	G. Harlan
Hrs	HRS	D.L. Harris
Hrt	HRT	W.I. Hartkopf
Htg	HTG	C.S. Hastings
Hu	HU	W.J. Hussey
Howe	HWE	H.A. Howe
Hzg	HZG	E. Hertzsprung
Hooke	–	Robert Hooke
Huygens	–	Christiaan Huygens
Hynek	–	J. Allen Hynek
I	I	R.T.A. Innes
J	J	Robert Jonckheere
Jc	JC	W.S. Jacob
Jck	JCK	John Jackson
Jef	JEF	H.M. Jeffers
Joy	JOY	Alfred Joy
Jsp	JSP	M.K. Jessup
Kam	KAM	Peter van de Kamp
Klk	KLK	P.G. Kulikovsky
Knt	KNT	G. Knott
Kop	KOP	Z. Kopal
Kr	KR	A. Kruger
Kron	KRO	G. Kron
Kru	KRU	E.C. Kruger
Ku	KU	F. Kustner
Kui	KUI	Gerard Kuiper
L	L	Thomas Lewis
Lac	LAC	G.B. Lacchini
Lal	LAL	F. de Lalande
Lam	LAM	J. von Lamont
Lar	LAR	J. Larink
Lau	LAU	H.E. Lau
Law	LAW	G.K. Lawton
Lbz	LBZ	P. Labitzke
Lcl	LCL	N.L. de Lacaille
LDS	LDS	W.J. Luyten (1 st proper motion catalogue)
Lee	LEE	O.J. Lee
Leo	LEO	Frederick Leonard
Lem	LEM	Lembang Observatory

Table A2. Codes for Star Designations (*continued*)

Designation	IDS/WDS Code	Discoverer or Observatory
Ling	LIN	J.F. Ling
Lip	LIP	Sarah Lee Lippincott
LicO	LO	Lick Observatory
Lob	LOB	D.C. Lobao
LplO	LPO	La Plata Observatory
LPM	LPM	W.J. Luyten (2 nd proper motion catalogue)
Lsl	LSL	William Lassell
Lyot	LT	B. Lyot
Luy	LUY	W.J. Luyten
Lv	LV	F.P. Leavenworth
Maa	MAA	A. van Maanen
Ma	MA	J.H. Madler
MadO	MDO	Madras Observatory
Mau	MAU	E.W. Maunder
Mca	MCA	Harold McAlister
Mic	MIC	A.A. Michelson
Mil	MIL	J.A. Miller
Mkt	MKT	Mark III Interferometer
Mla	MLA	Dean McLaughlin
Mlb	MLB	W. Milburn
Mlf	MLF	Frank Muller
Mll	MLL	S.A. Mitchell
MlbO	MLO	Melbourne Observatory
Mlr	MLR	Paul Muller
Mrz	MRZ	William Markowitz
Msn	MSN	Brian Mason
Mtl	MTL	O.M. Mitchell
NeS	NES	Simon Newcomb
Nic	NIC	Seth Nickleson
NwzO	NZO	New Zealand Observatory
Ol	OL	C.P. Olivier
Opik	OPI	E.J. Opik
Ost	OST	P.T. Oosterhoff
Par	PAR	J.A. Parkhurst
Per	PER	J. Perrotin
Phl	PHL	T.E. Phillips
Pic	PIC	W.H. Pickering
Pit	PIT	Colin Pither
PulO	PKO	Pulkovo Observatory
Plq	PLQ	E. Paloque
Pnk	PNK	Dale Penkala
Pol	POL	J.A. Pollock
Pop	POP	G.M. Popovic
Pou	POU	M.A. Pourteau
Prn	PRN	C.D. Perrine
PerO	PRO	Perth Observatory
Pry	PRY	J.J.M. Perry
Prz	PRZ	E. Przbyllok

Table A2. Codes for Star Designations (*continued*)

Designation	IDS/WDS Code	Discoverer or Observatory
Ptt	PTT	Edison Pettit
Pz	PZ	Giuseppi Piazzi
R	R	H.C. Russell
Rei	REI	Karl Reinmuth
Rhd	RHD	Jean Richaud
Rmk	RMK	C.L.C. Rumker
Roe	ROE	E.D. Roe
Rss	RSS	J.M. Rousseau
Rst	RST	R.A. Rossiter
Rus	RUS	Henry Norris Russell
S	S	James South
San	SAN	Roscoe Sanford
Sbk	SBK	G.M. Seabroke
Sca	SCA	Marco Scardia
Scj	SCJ	H.C.F.C. Schjellerup
Sct	SCT	J.L. Scott
Se	SE	A. Secchi
See	SEE	T.J.J. See
Sei	SEI	J. Scheiner
Shb	SHB	J.M. Schaeberle
Sh	SHJ	J. South & J. Herschel joint catalogue
Sle	SLE	G. Soulie
Slo	SLO	F. Slocum
Slr	SLR	R.P. Sellors
Sma	SMA	W.M. Smart
Sml	SMK	Paul Schmidtke
Smy	SMY	William Henry Smyth
Sod	SOD	S. Soderhjelm
Sp	SP	Giovanni Schiaparelli
SprO	SPR	Sproul Observatory
St	ST	Carl Stearns
Σ	STF	Wilhelm Struve – Dorpat Obs. catalogue
Σ	STF	Wilhelm Struve – 1st supplement
Σ	STF	Wilhelm Struve – 2nd supplement
G Σ	STG	G. Struve
H Σ	STH	Hermann Struve
Sti	STI	John Stein
Stm	STM	Mark Stauffer
Stn	STN	Ormond Stone
Str	STR	K.A. Strand
OΣ	STT	Otto Struve – Pulkovo Obs. catalogue
O$\Sigma\Sigma$	STT	O. Struve – Pulkovo Obs. cat. supplement
Stu	STU	K. Sturdy
Swi	SWI	Lewis Swift
SydO	SYO	Sydney Observatory
Tar	TAR	K.J. Tarrant
Tay	TAY	P.H. Taylor
TDS	TDS	Tycho Double Star
Tea	TEA	E.T.H. Teague

Table A2. Codes for Star Designations (*continued*)

Designation	IDS/WDS Code	Discoverer or Observatory
Tgy	TGY	Ronald Charles Tanguay
Thk	THK	Ronald Thorkildson
Tob	TOB	Tofol Tobal
Tp	TP	N. Tapia
Tru	TRU	R.J. Trumpler
Tuc	TUC	Richard Tucker
TycC	TYC	Tycho-2 Catalogue 2000
vab	VAB	G.B. van Albada
VatO	VAT	Vatican Observatory
VBs	VBS	George van Biesbroeck
You	VOU	J.G.E.G. Youte
VanO	VVO	Van Vleck Observatory
Wak	WAK	R.L. Walker
Ward	WAR	I.W. Ward
War	WAR	O.C.R. Warren
Wat	WAT	R. Waterworth
WDF	WDF	Washington Fundamental Cat. (transits)
Webb	WEB	T.W. Webb
Wei	WEI	M. Weisse
Wey	WEY	C. Weymouth
West	WJD	J.D. West
WFC	WFC	Washington Fundamental Cat. (astrographs)
Wg	WG	R.W. Wrigley
Whc	WHC	H.C. Wilson
Wolf	WLF	Max Wolf
Wnc	WNC	F.A. Winnecke
WshO	WNO	U.S. Naval Observatory
Wor	WOR	Charles Worley
Wre	WRE	R.E. Wilson
Wrh	WRH	R.H. Wilson, Jr.
Ws	WS	J.M. Wilson
WSI	WSI	Washington Speckle Interferometry
Wz	WZ	Carl Wirtz
Y	Y	Yale (Observatory) Catalogue
Yng	YNG	C.A. Young
You	YOU	S.P. Young
YR	YR	Yale-Rochester (observatories)
YSJ	YSJ	Yale-San Juan (observatories)
Zag	ZAG	F. Zager
Zin	ZIN	E. Zinner
Zul	ZUL	D.J. Zulevic

NOTE: Another double star designation that is often seen in catalogues and observing lists is "ADS" – which stands for "Aitken Double Star" – followed by the running number in R.G. Aitken's great *New General Catalogue of Double Stars Within 120° of the North Pole*, compiled at the Lick Observatory in 1932. This monumental work was the predecessor to the *Index Catalogue of Visual Double Stars (IDS)* and included many discoveries by other observers in addition to his own (which carry the symbol "A" given above).

Double and Multiple Star Working List

Presented here is an extended table of 400 double and multiple star systems intended for those who desire to see more of these starry jewels after viewing the hundred showpieces provided in Chapter 7, or who wish to pursue some of the projects suggested in Chapter 6, such as revising Dawes' Limit or making micrometer measures of binaries. This working list is arranged by Right Ascension rather than by constellation as in the showpiece roster. A few entries from that compilation will be found repeated here if one of their components happens to be a close binary of interest. A wide range of objects is offered, from naked-eye/binocular pairs to those requiring a 14-inch telescope and excellent seeing. Three objects of special interest lying below our -45 -degree Declination limit are included.

Primary data sources for both lists were *Sky Catalogue 2000.0* and the *Washington Double Star Catalog*. Right Ascension (RA) in hours and minutes and Declination (Dec) in degrees and minutes are for the current standard Epoch 2000.0. Constellation (Con) abbreviations are the official three-letter designations adopted by the International Astronomical Union (see the constellation listing in Appendix 1.) Other table headings are the apparent visual magnitudes (Mags) of the components, their approximate current angular separation (Sep) in arc-seconds and their spectral types (Spec) on either the standard MKK (Morgan-Keenan-Kellman) system or the HD (Henry Draper) system, if available. (For more information on spectral classes see Michael Inglis's excellent *Observer's Guide to Stellar Evolution*, Springer-Verlag.) Position angles are not given for a variety of reasons (among them the confusion resulting from the common use of star diagonals with refracting and compound telescopes, producing "inside-out" mirror-images of the sky). Those observers desiring the latest available position angles, as well as measures of component separations, should consult the U.S. Naval Observatory's *Washington Double Star Catalog* on-line at <http://ad.usno.navy.mil/wds/>

Approximate distance in lightyears (LY) is also given in many cases. Unless an orbital period is indicated, or a pair is noted as being "optical" (meaning it consists of two unrelated stars that happen to lie along the same line of sight), the objects are common proper motion (or CPM) systems – those drifting through space together and, therefore, gravitationally-bound. In most (if not all) cases such pairs are actually very slowly orbiting each other, but in periods measured in thousands of years. Finally, this listing extends down to -45 degrees Declination, covering that three-fourths of the entire heavens visible from mid-northern latitudes.

Table A3. Double and Multiple Star Working List

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
WZ Cas	00 ^h 01 ^m	+60° 21'	7.6–10, 8.7	58"	N1, A	Dim but striking; red and blue!
Σ3053 Cas	00 ^h 03 ^m	+66° 06'	5.9, 7.3	15"	G0, A2	Beautiful orange and blue pair.
Σ2 Cep	00 ^h 09 ^m	+79° 43'	6.6, 6.9	0.8"	A7IV	Tight 300-yr. binary.
κ-1 Scl	00 ^h 09 ^m	-27° 59'	6.1, 6.2	1.4"	F2, F2	Slow (very long period) binary.
34 Psc	00 ^h 10 ^m	+11° 09'	5.4, 9.4	8"	B8	Close, unequal pair.
OΣ2 And	00 ^h 13 ^m	+26° 59'	6.7, 7.5	0.5"	G0III, F2IV	Binary – period 695 yrs.
35 Psc	00 ^h 15 ^m	+08° 49'	6.0, 7.6	12"	FOIV, A7	Fixed (no orbital motion).
Σ13 Cep	00 ^h 16 ^m	+76° 57'	7.0, 7.3	0.9"	B8V	Slow 1600-yr. binary.
Σ24 And	00 ^h 18 ^m	+26° 08'	7.6, 8.4	5"	A2	Neat little pair.
λ Cas	00 ^h 32 ^m	+54° 31'	5.5, 5.8	0.6"	B8V	Tight binary – period 640 yrs.
π And	00 ^h 37 ^m	+33° 43'	4.4, 8.6	36"	B3	Wide, unequal double.
β395 Cet	00 ^h 37 ^m	-24° 46'	6.3, 6.4	0.7"	G5V	Fast binary – period 25 yrs!
α Cas	00 ^h 40 ^m	+56° 32'	2.2, 8.9	64"	K0	Mag. contrast pair – optical.
55 Psc	00 ^h 40 ^m	+21° 26'	5.4, 8.7	6"	K0I, F3V	Fixed, orange and blue pair.
HNI22 Cas	00 ^h 46 ^m	+74° 59'	5.7–6.1, 9.4	36"	A2	Optical. Primary = YZ Cas.
h3395 Phe	00 ^h 46 ^m	-41° 55'	8.4, 8.9	6"	K0	Faint reddish near-twins.
65 Psc	00 ^h 50 ^m	+27° 43'	6.3, 6.3	4"	F4III, F5III	Identical twin yellowish duo.
36 And	00 ^h 55 ^m	+23° 38'	6.0, 6.4	0.9"	K1IV	Binary – period 165 yrs.
66 Psc	00 ^h 55 ^m	+19° 11'	6.2, 6.9	0.5"	A1V	Binary – period 360 yrs.
26 Cet	01 ^h 04 ^m	+01° 22'	6.2, 8.6	16"	F0	Subtle color contrast.
77 Psc	01 ^h 06 ^m	+04° 55'	6.8, 7.6	33"	F2, F2	Neat roomy pair.
β Phe	01 ^h 06 ^m	-46° 43'	4.0, 4.3	1.4"	G8III	Bright tight pair, slow binary.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
ϕ And	01 ^h 10 ^m	+47° 15'	4.6, 5.5	0.5"	B7V	Very close 370-yr. binary.
β And	01 ^h 10 ^m	+35° 37'	2.1, 11.8	80"	M	Galaxy NGC 404 in field.
ϕ Cas	01 ^h 20 ^m	+58° 14'	5.1, 7.8	134"	F5, B5	In cluster NGC 457.
42 Cet	01 ^h 20 ^m	-00° 31'	6.5, 6.8	2"	A7V	Slow binary.
ψ Cas	01 ^h 26 ^m	+68° 08'	4.7, 9.6, 9.7	25", 3"	K0	Delicate triple – B-C fixed.
τ Scl	01 ^h 36 ^m	-29° 54'	6.0, 7.1	2.3"	F4	Binary – period 1900 yrs.
ϵ Scl	01 ^h 46 ^m	-25° 03'	5.4, 8.6	5"	F0	Binary – period 1200 yrs.
1 Ari	01 ^h 50 ^m	+22° 17'	6.2, 7.4	3"	K1III, A6V	Slow binary.
χ Cet	01 ^h 50 ^m	-10° 41'	4.9, 6.9	184"	F3III, G0	Wide, bright easy pair.
Σ 163 Cas	01 ^h 51 ^m	+64° 51'	6.8, 8.8	35"	K5	Pretty orange and blue pair.
ζ Cet	01 ^h 52 ^m	-10° 20'	3.7, 9.9	187"	K0, K0	Wide orange mag. contrast.
Σ 186 Cet	01 ^h 56 ^m	+01° 51'	6.8, 6.8	1.1"	F9V	Identical-twin 170-yr. binary.
48 Cas	02 ^h 02 ^m	+70° 54'	4.7, 6.4	0.9"	A3IV	Binary – period 60 yrs.
γ -2 And	02 ^h 04 ^m	+42° 20'	5.5, 6.3	0.4"	B9V, A0V	Blue and green, 61-yr. binary.
10 Ari	02 ^h 04 ^m	+25° 56'	5.9, 7.3	1.3"	F8IV	Binary – period 309 yrs.
59 And	02 ^h 11 ^m	+39° 02'	6.1, 6.8	17"	A0, A2	Neat fixed bluish-white pair.
66 Cet	02 ^h 13 ^m	-02° 24'	5.7, 7.5	16"	F8V	Slow binary, yellow and blue.
Σ 239 Tri	02 ^h 17 ^m	+28° 45'	7.0, 8.0	14"	F5	Neat silvery-white pair.
ω For	02 ^h 34 ^m	-28° 14'	5.0, 7.7	11"	B9V	Slow binary.
15 Tri	02 ^h 36 ^m	+34° 41'	5.7, 6.9	140"	M, A5	Wide color contrast.
30 Ari	02 ^h 37 ^m	+24° 39'	6.6, 7.4	39"	F5V, F6III	Easy wide yellowish pair.
O Σ 44 Per	02 ^h 42 ^m	+42° 47'	8.4, 9.1	1.4"	B9	In cluster M34.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
h1123 Per	02 ^h 42 ^m	+42° 47'	8.0, 8.0	20"	A0, A0	In cluster M34.
θ Per	02 ^h 44 ^m	+49° 14'	4.1, 9.9	20"	F7V, M1V	Unequal, wide slow binary.
Σ305 Ari	02 ^h 48 ^m	+19° 22'	7.4, 8.2	4"	F9V	Binary – period 720 yrs.
π Ari	02 ^h 49 ^m	+17° 28'	5.2, 8.7, 10.8	3", 25"	B6V	Challenging triple.
ε Ari	02 ^h 59 ^m	+21° 20'	5.2, 5.5	1.4"	A2V, A2V	Close, matched slow binary.
Σ331 Per	03 ^h 01 ^m	+52° 21'	5.3, 6.7	12"	B5	Nice easy double.
α+93 Cet	03 ^h 02 ^m	+04° 05'	2.5, 5.6	960"	M2III, B7III	Ultra-wide red and blue duo.
α For	03 ^h 12 ^m	-28° 59'	4.0, 7.0	5"	F7IV, G7V	Binary – period 314 yrs.
95 Cet	03 ^h 18 ^m	-00° 56'	5.6, 7.5	1.0"	K1IV, G8V	Binary – period 217 yrs.
τ-4 Eri	03 ^h 20 ^m	-21° 45'	3.7, 9.2	6"	M2	Tight mag. contrast pair.
7 Tau	03 ^h 34 ^m	+24° 28'	6.6, 6.7	0.7"	A3V	Close 568-yr. binary.
Σ400 And	03 ^h 35 ^m	+60° 02'	6.8, 7.6	1.6"	F4V	Binary – period 288 yrs.
Σ422 Tau	03 ^h 37 ^m	+00° 35'	5.9, 8.8	7"	G9V, K6V	With 10 Tau in field.
η Tau	03 ^h 48 ^m	+24° 06'	2.9, 8.0	117"	B5, A0	Striking, delicate quadruple system in Pleiades Cluster.
30 Tau	03 ^h 48 ^m	+11° 09'	5.1, 10.1	9"	B3	Tough mag. contrast pair.
f Eri	03 ^h 49 ^m	-37° 37'	4.8, 5.3	8"	B8, A0	Lovely bright double.
ζ Per	03 ^h 54 ^m	+31° 53'	2.9, 9.5, 9.5	13", 4"	B1I	Fixed. Other stars close by.
OΣ67 Cam	03 ^h 57 ^m	+61° 07'	5.3, 8.5	1.9"	K3II	Fixed, gold and green pair.
ε Per	03 ^h 58 ^m	+40° 01'	2.9, 7.6	9"	B0V, A2V	Like ζ Per. Fixed.
Σ484 Cam	04 ^h 07 ^m	+62° 23'	10, 10, 10	5", 23"	—	In open cluster NGC 1502.
Σ485 Cam	04 ^h 08 ^m	+62° 20'	7.0, 7.1, 9.8	18", 70"	B0	In open cluster NGC 1502.
Σ460 Cep	04 ^h 10 ^m	+80° 42'	5.5, 6.3	0.6"	G8III, A6V	Binary – period 415 yrs.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
39 Eri	04 ^h 14 ^m	-10° 15'	5.0, 8.0	6"	K3III	Distant 9.5-mag. star.
φ Tau	04 ^h 20 ^m	+27° 21'	5.0, 8.4	52"	K0	Wide optical pair.
β87 Tau	04 ^h 22 ^m	+20° 49'	6.0, 9.1	1.9"	M0, A0	Close, dim red and blue duo.
χ Tau	04 ^h 23 ^m	+25° 38'	5.5, 7.6	19"	B9	Fixed pair.
Σ552 Per	04 ^h 31 ^m	+40° 01'	7.0, 7.2	9"	B8	Neat matched combo.
81 Tau	04 ^h 31 ^m	+15° 42'	5.5, 9.4	162"	A5, K0	Wide color/mag. contrast.
1 Cam	04 ^h 32 ^m	+53° 55'	5.7, 6.8	10"	B0III	Attractive but neglected pair.
57 Per	04 ^h 33 ^m	+43° 04'	6.1, 6.8	116"	F0, F0	Nice wide matched duo.
α Tau	04 ^h 36 ^m	+16° 31'	0.8-1.0, 11	122"	K5III	Radiant Aldebaran! Optical.
53 Eri	04 ^h 38 ^m	-14° 18'	4.0, 7.0	0.7"	K0	Tight bright pair – closing.
2 Cam	04 ^h 40 ^m	+53° 28'	5.6, 7.3	0.7"	F5V	Binary – period 425 yrs.
55 Eri	04 ^h 44 ^m	-08° 48'	6.7, 6.8	9"	G8III, F4III	Pretty matched twins.
σ-1/2 Tau	04 ^h 39 ^m	+15° 55'	4.7, 5.1	430"	A3, A2	Wide pair in Hyades cluster.
ω Aur	04 ^h 59 ^m	+37° 53'	5.0, 8.0	5"	A0	Slow, tight binary.
β314 Lep	04 ^h 59 ^m	-16° 23'	5.9, 7.3	0.9"	F3V, F9V	Binary – period 55 yrs.
Σ627 Ori	05 ^h 01 ^m	+03° 37'	6.6, 7.0	21"	A0, A0	Neat nearly matched duo.
β Cam	05 ^h 03 ^m	+60° 27'	4.0, 8.6	81"	G0, A5	Roomy mag. contrast pair.
γ Cae	05 ^h 04 ^m	-35° 29'	4.6, 8.1	3"	K0	Tight mag. contrast pair.
11/12 Cam	05 ^h 06 ^m	+58° 58'	5.2, 6.1	179"	B2V, K0III	Wide, striking color contrast.
14 Ori	05 ^h 08 ^m	+08° 30'	5.8, 6.5	0.8"	A0	Binary – period 200 yrs.
Σ644 Aur	05 ^h 10 ^m	+37° 18'	6.7, 7.0	1.6"	B2II, K3	Lovely tight color contrast.
ρ Ori	05 ^h 13 ^m	+02° 52'	4.5, 8.3	7"	K0	Fixed tight mag. contrast duo.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
κ Lep	05 ^h 13 ^m	-12° 56'	4.5, 7.4	2.6"	B8	Tight mag. contrast pair.
14 Aur	05 ^h 15 ^m	+32° 41'	5.1, 7.4-7.9	15"	A9IV, A2	Neat pair with var. comp.
S476 Lep	05 ^h 19 ^m	-18° 31'	6.2, 6.4	39"	B8, B8	Matched bluish pair.
h3750 Lep	05 ^h 20 ^m	-21° 14'	4.7, 8.5	4"	A0	Pretty mag. contrast pair.
Σ 681 Aur	05 ^h 21 ^m	+46° 58'	6.7, 8.7	23"	F0	In wide field with Capella.
22 Ori	05 ^h 22 ^m	-00° 23'	4.7, 5.7	242"	B2IV, B3V	Very wide blue-white combo.
41 Lep	05 ^h 22 ^m	-24° 46'	5.4, 6.6, 9.1	3", 62"	G0, A3, K0	Unequal tinted triple.
23 Ori	05 ^h 23 ^m	+03° 33'	5.0, 7.1	32"	O9II, B2V	Nice blue-white, easy pair.
Σ 698 Aur	05 ^h 25 ^m	+34° 51'	6.6, 8.7	31"	K0, K	Attractive orange combo.
β Lep	05 ^h 28 ^m	-20° 46'	2.8, 7.3	2.5"	G0	Bright close, unequal double.
118 Tau	05 ^h 29 ^m	+25° 09'	5.8, 6.6	5"	B8V, A1V	Neat snug, blue-white pair.
32 Ori	05 ^h 31 ^m	+05° 57'	4.5, 5.8	1.1"	B5IV	Bright, close 585-yr. binary
33 Ori	05 ^h 31 ^m	+03° 18'	5.8, 7.1	1.8"	B3	Snug unequal pair.
α Lep	05 ^h 33 ^m	-17° 49'	2.6, 11, 12	36", 91"	F0	Wide, dim delicate triple.
Σ 750 Ori	05 ^h 35 ^m	-04° 22'	6.5, 8.5	4"	B5	In cluster NGC 1981.
Σ 743 Ori	05 ^h 35 ^m	-04° 24'	8.3, 9.4	2"	B8	In cluster NGC 1981.
θ -2 Ori	05 ^h 35 ^m	-05° 25'	5.2, 6.6	52"	O9V, B7IV	Wide pair in Orion Nebula.
Σ 737 Aur	05 ^h 36 ^m	+34° 08'	8.5, 9.0	11"	B	In open cluster M36.
Σ 742 Tau	05 ^h 36 ^m	+22° 00'	7.2, 7.8	4"	F8	Neat duo near Crab Nebula.
26 Aur	05 ^h 39 ^m	+30° 30'	6.0, 8.0	12"	A2	Yellow and blue combo.
σ Ori AB	05 ^h 39 ^m	-02° 36'	4.0, 6.0	0.2"	B0	Ultra-tight 170-yr. binary.
h3780 Lep	05 ^h 39 ^m	-17° 51'	7.5, 8.5, 8.4	89", 76"	B9	Other stars = cl. NGC 2017.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
52 Ori	05 ^h 48 ^m	+06° 27'	5.3, 5.3	1.2"	A3	Perfect twins – in contact!
α Ori	05 ^h 55 ^m	+07° 24'	0.4–1.3, 10.6	174"	M11M21	Radiant Betelgeuse! Optical.
Σ855 Ori	06 ^h 09 ^m	+02° 30'	6.0, 7.0	29"	A0	Plus 9 th -mag. at 118"
41 Aur	06 ^h 12 ^m	+48° 43'	6.3, 7.0	8"	A0, A0	Neat slow, white binary.
η Gem	06 ^h 15 ^m	+22° 30'	3.3–3.9, 8.8	1.6"	M3III	Challenging 47.4-yr. binary.
Σ872 Aur	06 ^h 16 ^m	+36° 09'	6.9, 7.9	11"	F0	Nice color contrast.
ξ CMa	06 ^h 20 ^m	-30° 04'	3.0, 7.6	176"	B8, K0	Bright, wide tinted duo.
10 Mon	06 ^h 28 ^m	-04° 46'	5.1, 9.3, 9.3	77", 81"	B3	Triple in cluster NGC 2232.
ν Gem	06 ^h 29 ^m	+20° 13'	4.2, 8.7	112"	B5	Wide unequal pair.
20 Gem	06 ^h 32 ^m	+17° 47'	6.3, 6.9	20"	F8III	Yellow and blue fixed pair.
β755 Col	06 ^h 35 ^m	-36° 47'	6.0, 6.8	1.3"	B9	Snug matched double.
Σ939 Mon	06 ^h 36 ^m	+05° 18'	8.3, 9.6, 9.7	30", 40"	B5, B8	Dim, nearly equilateral triple.
γ-1 CMa	06 ^h 36 ^m	-18° 40'	5.8, 8.5	18"	G5, G0	Fixed mag. contrast pair.
15/S Mon	06 ^h 41 ^m	+09° 53'	3.9, 7.4, 7.7	3", 156"	O5	In open cluster NGC 2264.
14 Lyn	06 ^h 53 ^m	+59° 27'	5.6, 6.8	0.4"	G0I, A2	Close 480-yr. binary.
38 Gem	06 ^h 55 ^m	+13° 11'	4.7, 7.7	7"	F0V, G4V	Slow binary – color contrast.
μ CMa	06 ^h 56 ^m	-14° 03'	5.3, 8.6	3"	G5	Tight orange and blue – fixed.
15 Lyn	06 ^h 57 ^m	+59° 25'	4.8, 5.9	0.9"	G0	Bright, tight slow binary.
ε CMa	06 ^h 59 ^m	-28° 58'	1.5, 7.8	8"	B2II, B6	Adhara. Like fainter Sirius!
δ38 Pup	07 ^h 04 ^m	-43° 36'	5.6, 7.2, 8.1	20", 185"	G0, G0, K2	Nice pair + wide orange star.
Σ1009 Lyn	07 ^h 06 ^m	+52° 45'	6.9, 7.0	4"	A2	Cozy, matched duo.
Σ1035 Gem	07 ^h 12 ^m	+22° 17'	8.2, 8.2	9"	F5, F5	Perfect twin yellowish pair.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
π Pup	07 ^h 17 ^m	-37° 06'	2.7, 8.0	69"	K5, B9	Wide color/mag. contrast.
λ Gem	07 ^h 18 ^m	+16° 32'	3.6, 10.7	10"	A2	Dim, delicate mag. contrast.
τ CMa	07 ^h 19 ^m	-24° 57'	4.4, 8.8	85"	O9I	Heart of cluster NGC 2362.
20 Lyn	07 ^h 22 ^m	+50° 09'	7.3, 7.4	15"	F0, F0	Nice matched pair.
19 Lyn	07 ^h 23 ^m	+55° 17'	5.6, 6.5	15"	B8V, A0V	Neat duo with 8.9-mag. near.
η CMa	07 ^h 24 ^m	-29° 18'	2.4, 6.9	179"	B7, A0	Bright wide – color contrast.
Σ 1104 Pup	07 ^h 29 ^m	-15° 00'	6.4, 7.5	2"	F7V	Binary – period 1100 yrs.
σ Pup	07 ^h 29 ^m	-43° 18'	3.3, 9.4	22"	M0, G5	Color/mag. contrast pair.
h3973 Pup	07 ^h 32 ^m	-20° 56'	8.3, 9.3	9"	B8	Dim white and red pair.
Σ 1108 Gem	07 ^h 33 ^m	+22° 53'	6.5, 8.3	12"	G5	Easy unequal double.
η Pup	07 ^h 34 ^m	-23° 28'	5.1, 5.1	10"	F4, F5	Striking twins – slow binary.
Σ 1121 Pup	07 ^h 37 ^m	-14° 30'	7.9, 7.9	7"	B9, B9	Equal pair – in cluster M47.
Σ 1126 Cmi	07 ^h 40 ^m	+05° 14'	6.6, 6.9	0.9"	A0	In field with Procyon.
κ Gem	07 ^h 44 ^m	+24° 24'	3.6, 8.1	7"	G8III	Mag. contrast – slow binary.
β Gem	07 ^h 45 ^m	+28° 02'	1.1, 8.8, 9.6	201", 234"	K0III	Pollux. Other fainter comps.
2 Pup	07 ^h 46 ^m	-14° 41'	6.1, 6.8	17"	A0, A0	Neat nearly matched pair.
9 Pup	07 ^h 52 ^m	-13° 54'	5.6, 6.2	0.6"	G1V	Ultra-close 23-yr. binary.
14 CMi	07 ^h 58 ^m	+02° 13'	5.4, 8.4, 9.3	89", 120"	K0	Wide delicate triple.
ζ Mon	08 ^h 09 ^m	-02° 59'	4.3, 7.8	66"	G2, K2	Nice wide optical pair.
h4063 Pup	08 ^h 16 ^m	-37° 22'	7.5, 9.6	18"	B8	Blue-white and red pair.
Σ 1216 Hya	08 ^h 21 ^m	-01° 36'	7.1, 7.4	0.7"	A2V	Binary – period 435 yrs.
ϕ -2 Cnc	08 ^h 27 ^m	+26° 56'	6.3, 6.3	5"	A6V, A3V	Identical twin slow binary.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
24 Cnc	08 ^h 27 ^m	+24° 32'	7.0, 7.8	6"	F7V, G	B unresolved 22-yr. binary.
β205 Pyx	08 ^h 33 ^m	-24° 36'	6.9, 7.0	0.6"	A8IV	Matched 160-yr. binary.
Σ1245 Cnc	08 ^h 36 ^m	+06° 37'	6.0, 7.2	10"	F6, G5	Two wider, fainter comps.
β208 Pyx	08 ^h 39 ^m	-22° 40'	5.3, 6.7	1.1"	G6	Binary – period 145 yrs.
S571 Cnc	08 ^h 40 ^m	+19° 33'	6.9, 7.2, 6.7	45", 93"	A0, A0, K0	Triple in Beehive Cluster.
39 Cnc	08 ^h 40 ^m	+20° 00'	6.5, 6.5	150"	K0, K0	Wide orange pair in Beehive.
ε Cnc	08 ^h 40 ^m	+19° 33'	6.3, 7.4	135"	A2, A0	Another wide one in Beehive.
Σ1254 Cnc	08 ^h 40 ^m	+19° 40'	6.4, 8.9 8.6, 8.9	20" 63", 83"	G5, A0 —	Wide, delicate quadruple system in Beehive Cluster.
ζ Pyx	08 ^h 40 ^m	-29° 34'	4.9, 9.1	52"	G4, G0	Unequal mag. contrast pair.
γ Cnc	08 ^h 43 ^m	+21° 28'	4.7, 8.7	106"	A0	Wide mag. contrast combo.
57 Cnc	08 ^h 54 ^m	+30° 35'	6.0, 6.5, 9.1	1.4", 56"	G7III, K0	Close pair both yellow.
17 Hya	08 ^h 56 ^m	-07° 58'	6.8, 7.0	4"	A3	Neat cozy matched duo.
10 UMa	09 ^h 01 ^m	+41° 47'	4.1, 6.2	0.6"	F5V	Bright, rapid 22-yr. binary.
σ-2 UMa	09 ^h 10 ^m	+67° 08'	4.8, 8.2, 9.3	4", 205"	F7IV	Close pair 1100-yr. binary.
Σ1321 UMa	09 ^h 14 ^m	+52° 41'	7.6, 7.7	17"	M0V, M0V	Wide ruddy 975-yr. binary.
27 Hya	09 ^h 20 ^m	-09° 33'	5.0, 6.9, 9.1	229", 9"	G5, F2	Unequal triple.
Σ1338 Lyn	09 ^h 21 ^m	+38° 11'	6.5, 6.7	0.5"	F3V	Binary – period 220 yrs.
κ Leo	09 ^h 25 ^m	+26° 11'	4.5, 10, 10	3", 53"	K0	Challenging triple.
ω Leo	09 ^h 28 ^m	+09° 03'	5.9, 6.5	0.6"	F9V	Binary – period 118 yrs.
τ-1 Hya	09 ^h 29 ^m	-02° 46'	4.9, 7.9	66"	F5	Wide color contrast pair.
ζ-1 Ant	09 ^h 31 ^m	-31° 53'	6.2, 7.1	8"	A0	Fixed pair. ζ-2 near.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
ψ Vel	09 ^h 31 ^m	-40° 28'	4.1, 4.6	0.7"	F2IV	Bright rapid 34-yr. binary.
23 UMa	09 ^h 32 ^m	+63° 04'	3.7, 8.9	23"	F0	Fixed mag. contrast pair.
Σ 1365 Hya	09 ^h 32 ^m	+01° 28'	7.8, 8.4	3"	F8	Subdued close double.
ϕ UMa	09 ^h 52 ^m	+54° 04'	5.3, 5.4	0.3"	A3IV	Ultra-tight 106-yr. binary.
γ Sex	09 ^h 53 ^m	-08° 06'	5.6, 6.1	0.6"	A1V	Rapid binary – period 76 yrs.
O Σ 215 Leo	10 ^h 16 ^m	+17° 44'	7.2, 7.4	1.5"	A9IV	Binary – period 550 yrs.
ζ +35 Leo	10 ^h 17 ^m	+23° 25'	3.4, 5.9	330"	F0III, G2IV	Wide bright binocular pair.
49 Leo	10 ^h 35 ^m	+08° 39'	5.8, 8.5	2.4"	A0	Like dim δ Cyg.
β 411 Hya	10 ^h 36 ^m	-26° 40'	6.7, 7.5	1.4"	F6V	Binary – period 210 yrs.
35 Sex	10 ^h 43 ^m	-04° 45'	6.3, 7.4	7"	K0	Golden-orange and blue-green.
Σ 1474 Hya	10 ^h 48 ^m	-15° 16'	6.7, 7.8, 6.8	70", 76"	A0, —, F5	In field with Σ 1473.
Σ 1473 Hya	10 ^h 48 ^m	-15° 37'	7.7, 8.6	31"	F8	In field with Σ 1474.
Σ 1495 UMa	11 ^h 00 ^m	+58° 54'	7.2, 9.5	34"	K2	Gold and blue double.
α UMa	11 ^h 04 ^m	+61° 45'	1.9, 4.8, 7.0	0.7", 378"	K0III, —, F8	45-yr. binary + tinted combo.
ν UMa	11 ^h 19 ^m	+33° 06'	3.5, 9.9	7"	K0	Fixed mag. contrast pair.
Σ 1529 Leo	11 ^h 19 ^m	-01° 39'	7.0, 8.0	10"	F8	Neat pair with subtle hues.
ι Leo	11 ^h 24 ^m	+10° 32'	4.0, 6.7	1.8"	F2IV, F4	Binary – period 192 yrs.
τ Leo	11 ^h 28 ^m	+02° 51'	5.1, 8.0	91"	K0, G5	Color and mag. contrast pair.
57 UMa	11 ^h 29 ^m	+39° 20'	5.3, 8.3	5"	A2	Close unequal slow binary.
O Σ 235 UMa	11 ^h 32 ^m	+61° 05'	5.8, 7.1	0.7"	F6V	Rapid binary – period 73 yrs.
88 Leo	11 ^h 32 ^m	+14° 22'	6.4, 8.4	15"	G0	Fixed unequal pair.
178 Cen	11 ^h 34 ^m	-40° 35'	6.2, 6.2	1.0"	A2	Snug matched fixed pair.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
90 Leo	11 ^h 35 ^m	+16° 48'	6.7, 7.3, 8.7	3", 63"	B3	Unequal triple system.
Σ1561 UMa	11 ^h 39 ^m	+45° 07'	6.3, 8.4, 8.5	9", 85"	G0, —, F2	Also distant 9 th -mag.
β Leo	11 ^h 49 ^m	+14° 34'	2.1, 8.5	264"	A3V, F8	Denebola. 5.9-mag. in field.
β Hya	11 ^h 53 ^m	-33° 54'	4.7, 5.5	0.9"	B9	Slow binary – closing.
65 UMa	11 ^h 55 ^m	+46° 29'	6.7, 8.3, 6.5	4", 63"	A0	Triple system – like 90 Leo.
ξ Com	12 ^h 04 ^m	+21° 28'	5.9, 7.4	4"	F0	Tight fixed pair.
2 Cvn	12 ^h 16 ^m	+40° 40'	5.8, 8.1	11"	M1III, F7V	Golden-orange and blue duo.
Σ1627 Vir	12 ^h 18 ^m	-03° 57'	6.6, 6.9	20"	F0, F0	Nice matched double.
Σ1633 Com	12 ^h 21 ^m	+27° 03'	7.0, 7.1	9"	F2	Pretty matched pair.*
Wnc4 UMa	12 ^h 22 ^m	+58° 05'	9.0, 9.3	50"	—	Wide dim pair = M40.
17 Vir	12 ^h 22 ^m	+05° 18'	6.6, 9.4	20"	F8	Subtle color contrast.
Σ1639 Com	12 ^h 24 ^m	+25° 35'	6.8, 7.8	1.7"	F0V	Binary – period 680 yrs.*
17 Com	12 ^h 29 ^m	+25° 55'	5.3, 6.6	145"	A0, A3	* In Coma star cluster.
Σ1664 Vir	12 ^h 38 ^m	-11° 31'	8.1, 9.3	26"	K0, G5	In Sombrero Galaxy field.
Σ1669 Crv	12 ^h 41 ^m	-13° 01'	6.0, 6.1	5"	F5V, F3V	Lovely matched double.
γ Cen	12 ^h 42 ^m	-48° 58'	2.9, 2.9	0.8"	A0III	Brilliant tight 84-yr. binary.
32/33 Com	12 ^h 52 ^m	+17° 04'	6.3, 6.7	195"	M0III, F8	Wide, colorful binocular duo.
35 Com	12 ^h 53 ^m	+21° 14'	5.1, 7.2, 9.1	1.2", 29"	G8III, F6, —	Close pair 500-yr. binary.
78 UMa	13 ^h 01 ^m	+56° 22'	5.0, 7.4	1.5"	F2V	Neat, tight 115-yr. binary.
17 CVn	13 ^h 10 ^m	+38° 30'	6.0, 6.2	84"	F0, B9	Wide matched pair.
α Com	13 ^h 10 ^m	+17° 32'	5.0, 5.1	0.4"	F6V	Close, rapid 26-yr. binary.
θ Vir	13 ^h 10 ^m	-05° 32'	4.4, 9.4, 10.4	7", 70"	A1V	Delicate fixed triple.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
54 Vir	13 ^h 13 ^m	-18° 50'	6.8, 7.3	5"	A0	Neat cozy pair.
OΣΣ123 Dra	13 ^h 27 ^m	+64° 44'	6.7, 7.0	69"	F0, F0	Nice matched wide duo.
β932 Vir	13 ^h 35 ^m	-13° 13'	6.5, 6.9	0.4"	A0V	Very close 200-yr. binary.
25 CVn	13 ^h 38 ^m	+36° 18'	5.0, 6.9	1.8"	A7III	Binary – period 240 yrs.
1 Boo	13 ^h 41 ^m	+19° 57'	5.8, 8.7	5"	A2	Tight mag. contrast pair.
Σ1785 Boo	13 ^h 49 ^m	+26° 59'	7.6, 8.0	3"	N2	Reddish 155-yr. binary.
4 Cen	13 ^h 52 ^m	-31° 56'	4.7, 8.4	15"	B7	Fixed mag. contrast pair.
3 Cen	13 ^h 52 ^m	-33° 00'	4.5, 6.0	8"	B5, B8	Striking bright fixed pair.
η Boo	13 ^h 55 ^m	+18° 24'	2.7, 8.7	112"	G0	Attractive wide unequal duo.
Σ1788 Vir	13 ^h 55 ^m	-08° 04'	6.5, 7.7	3.5"	F8V	Slow binary.
ι Boo	14 ^h 16 ^m	+51° 22'	4.9, 7.5	38"	A5	Nice fixed double.
Σ1835 Boo	14 ^h 23 ^m	+08° 27'	5.1, 7.4	6"	A0V, F3V	Neat cozy pair.
τ-1 Lup	14 ^h 26 ^m	-45° 13'	4.6, 9.3	158"	B3, M0	Wide color/mag. contrast.
Σ1838 Boo	14 ^h 24 ^m	+11° 15'	7.4, 7.5	9"	F5	Pretty identical twins.
φ Vir	14 ^h 28 ^m	-02° 14'	4.8, 9.3	5"	K0	Challenging mag. contrast.
Σ1850 Boo	14 ^h 29 ^m	+28° 17'	7.0, 7.4	26"	A0, A0	Easy matched combo.
54 Hya	14 ^h 46 ^m	-25° 27'	5.1, 7.1	9"	F2III, F9	Nice pair with subtle tints.
Σ1883 Vir	14 ^h 49 ^m	+05° 57'	7.6, 7.6	0.9"	F6V	Twin binary – period 228 yrs.
μ Lib	14 ^h 49 ^m	-14° 09'	5.8, 6.7	1.8"	A2	Tight slow binary.
39 Boo	14 ^h 50 ^m	+48° 43'	6.2, 6.9	3"	F6V, F5V	Slow binary, closing.
α Lib	14 ^h 51 ^m	-16° 02'	2.8, 5.2	230"	A3IV, F4IV	Bright binocular double.
HN28 Lib	14 ^h 57 ^m	-21° 25'	5.7, 8.0	23"	K4V, M0	Orange and ruddy combo.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
59 Hya	14 ^h 59 ^m	-27° 39'	6.3, 6.6	0.3"	A4V	Ultra-close 340-yr. binary.
44 Boo	15 ^h 04 ^m	+47° 39'	5.3, 5.8-6.4	2"	G0V, G2	Binary – period 220 yrs.
π Lup	15 ^h 05 ^m	-47° 03'	4.6, 4.7	1.4"	B5, B5	Bright slow binary – opening.
ι Lib	15 ^h 12 ^m	-19° 47'	5.1, 9.4	58"	B9IV	Wide mag. contrast pair.
δ Boo	15 ^h 16 ^m	+33° 19'	3.5, 7.4	105"	G8III, G0V	Wide yellow and bluish pair.
Σ1932 CrB	15 ^h 18 ^m	+26° 50'	7.3, 7.4	1.6"	G0V	Snug matched 203-yr. binary.
5 Ser	15 ^h 19 ^m	+01° 46'	5.1, 10	11"	G0	Fixed pair, near globular M5.
η CrB	15 ^h 23 ^m	+30° 17'	5.6, 5.9	1.0"	G2V, G2	Rapid binary – period 42 yrs.
ε Lup	15 ^h 23 ^m	-44° 41'	3.7, 5.2, 8.8	0.6", 26"	B3	A-B likely binary.
π-1 UMi	15 ^h 29 ^m	+80° 27'	6.6, 7.3	31"	G5	Neat, far-northern pair.
ι-1/2 Boo	15 ^h 31 ^m	+40° 50'	5.0, 5.0	900"	K5III, A5V	Binoc. pair – orange and blue.
γ Lup	15 ^h 35 ^m	-41° 10'	3.5, 3.6	0.7"	B3V	Bright, tight 147-yr. binary.
Σ1964 CrB	15 ^h 38 ^m	+36° 15'	7.0, 7.6, 8.7	15", 16"	F5	Neat equilateral triangle.
Σ1962 Lib	15 ^h 39 ^m	-08° 47'	6.5, 6.6	12"	F6V, F6V	Striking, identical twin suns.
γ CrB	15 ^h 43 ^m	+26° 18'	4.1, 5.5	0.7"	A0IV	Close binary – period 91 yrs.
2 Sco	15 ^h 54 ^m	-25° 20'	4.7, 7.4	2"	B3	Snug unequal pair.
ξ Lup	15 ^h 57 ^m	-33° 58'	5.3, 5.8	10"	A3V, B9V	Striking matched fixed pair.
η Lup	16 ^h 00 ^m	-38° 24'	3.6, 7.8, 9.3	15", 115"	B3,—,F5	Fixed unequal triple.
ξ Sco AB	16 ^h 04 ^m	-11° 22'	4.8, 5.1	0.7"	F5IV	Rapid binary – period 46 yrs.
ω-1/2 Sco	16 ^h 07 ^m	-20° 40'	4.0, 4.3	720"	B1V, G3III	Naked-eye/binocular combo.
12 Sco	16 ^h 12 ^m	-28° 25'	5.9, 7.9	4"	B9	Cozy unequal pair.
Σ2021 Her	16 ^h 13 ^m	+13° 32'	7.4, 7.5	4"	K0	Very slow matched binary.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
σ Sco	16 ^h 21 ^m	-25° 36'	2.9, 8.5	20"	B1, B9	Nice mag. contrast.
ν -1/2 CrB	16 ^h 22 ^m	+33° 48'	5.2, 5.4	360"	M2III, K5III	Wide, colorful binocular pair.
Σ 2054 Dra	16 ^h 24 ^m	+61° 42'	6.0, 7.2	1.0"	G5	In field with η Dra.
η Dra	16 ^h 24 ^m	+61° 31'	2.7, 8.7	5"	G5	Tight unequal, slow binary.
ρ Oph	16 ^h 26 ^m	-23° 27'	5.3, 6.0	3"	B2IV, B2V	Slow binary. 7.0, 7.9 nearby.
Σ 2052 Her	16 ^h 29 ^m	+18° 25'	7.7, 7.8	2"	K2V	Snug 236-yr. binary.
λ Oph	16 ^h 31 ^m	+01° 59'	4.2, 5.3	1.5"	A2V	Nice, cozy 130-yr. binary.
37 Her	16 ^h 41 ^m	+04° 13'	5.8, 7.0	70"	A0, A0	Neat wide pair.
ζ Her	16 ^h 41 ^m	+31° 36'	2.9, 5.5	0.7"	F9IV, G7V	Bright, rapid 34-yr. binary.
See293 Sco	16 ^h 54 ^m	-41° 48'	5.6, 7.3	57"	B0, B0	In open cluster NGC 6231.
ξ -1/2 Sco	16 ^h 54 ^m	-42° 22'	3.6, 4.7	408"	K4III, B1I	Bright, ultra-wide and colorful.
μ -1/2 Sco	16 ^h 52 ^m	-38° 03'	3.0, 3.6	347"	B2V, B2IV	Bright, ultra-wide bluish duo.
20 Dra	16 ^h 56 ^m	+65° 02'	7.3, 7.3	1.4"	F2V	Twin binary – period 580 yrs.
24 Oph	16 ^h 57 ^m	-23° 09'	6.2, 6.5	0.8"	A0	Close nearly-equal pair.
Σ 2120 Her	17 ^h 05 ^m	+28° 05'	7.3, 10.1	17"	K0	Dim tinted optical pair.
η Oph	17 ^h 10 ^m	-15° 43'	3.0, 3.5	0.6"	A2V	Bright close 84-yr. binary.
MlbO4 Sco	17 ^h 19 ^m	-34° 59'	6.1, 7.6	1.8"	K3V	Rapid 42-yr. binary.
ν Ser	17 ^h 21 ^m	-12° 51'	4.3, 8.3	48"	A0	Wide mag. contrast pair.
Σ 2173 Oph	17 ^h 30 ^m	-01° 04'	6.0, 6.1	1.1"	G8IV	Binary – period 46 yrs.
λ + ν Sco	17 ^h 34 ^m	-37° 06'	1.6, 2.7	2100" (35')	B2IV, B2IV	The Stingers. Famed brilliant naked-eye/binocular combo.
26 Dra	17 ^h 35 ^m	+61° 52'	5.3, 8.0	1.6"	G0V	Unequal, close 76-yr. binary.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
61 Oph	17 ^h 45 ^m	+02° 35'	6.2, 6.6	21"	A1V, A0V	Neat matched white pair.
90 Her	17 ^h 53 ^m	+40° 00'	5.2, 8.5	1.6"	K0	Slow binary – color contrast.
67 Oph	18 ^h 01 ^m	+02° 56'	4.0, 8.6	54"	B5	Wide mag. contrast pair.
7/9 Sgr	18 ^h 03 ^m	-24° 17'	5.3, 6.0	900"	F3III, O5	Wide pair in Lagoon Nebula.
τ Oph	18 ^h 03 ^m	-08° 11'	5.2, 5.9	1.7"	F4IV, F3	Binary – period 280 yrs.
HN40 Sgr	18 ^h 03 ^m	-23° 02'	7.6, 10.7, 8.7	6", 11"	O7	Triple in heart of Trifid Neb.
h5014 CrA	18 ^h 07 ^m	-43° 25'	5.7, 5.7	0.8"	A5	Binary – period 190 yrs.
Σ2289 Her	18 ^h 10 ^m	+16° 29'	6.5, 7.2	1.2"	B9V, F2	Very slow binary.
73 Oph	18 ^h 10 ^m	+04° 00'	6.1, 7.0	0.6"	F2V	Tight 270-yr. binary.
μ Sgr	18 ^h 14 ^m	-21° 04'	3.9, 9.8, 9.3	48", 50"	B8, B3, —	Delicate wide triple.
η Sgr	18 ^h 18 ^m	-36° 46'	3.2, 7.8	3"	M4	Close unequal pair.
Σ2306 Sct	18 ^h 22 ^m	-15° 05'	7.9, 8.6, 9.0	10", 10"	F5	Nice equilateral triple.
39 Dra	18 ^h 24 ^m	+58° 48'	5.0, 8.0, 7.4	4", 89"	A3V, F6V, F8	Easy double – tough triple.
Σ2315 Her	18 ^h 25 ^m	+27° 23'	6.5, 7.5	0.8"	A2V	Binary – period 775 yrs.
AC11 Ser	18 ^h 25 ^m	-01° 35'	6.8, 7.0	0.8"	A9III	Binary – period 240 yrs.
21 Sgr	18 ^h 25 ^m	-20° 32'	4.9, 7.4	1.8"	K0, A0	Close color/mag. contrast.
59 Ser	18 ^h 27 ^m	+00° 12'	5.3, 7.6	4"	A0	Nice close double.
κ CrA	18 ^h 33 ^m	-38° 44'	5.6, 6.3	21"	B9V, A0III	Neat bluish, fixed combo.
OΣ359 Her	18 ^h 35 ^m	+23° 36'	6.3, 6.5	0.7"	G9III	Binary – period 210 yrs.
OΣ358 Her	18 ^h 36 ^m	+16° 59'	6.8, 7.0	1.3"	G2V, G2V	Matched 290-yr. binary.
λ CrA	18 ^h 44 ^m	-38° 19'	5.1, 9.7	29"	A0, K0	Color/mag. contrast pair.
5 Aql	18 ^h 46 ^m	-00° 58'	6.0, 7.8	13"	A0, A0	Nice white pair.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
α Dra	18 ^h 51 ^m	+59° 23'	4.8, 7.8	34"	K0	Neat unequal double.
Σ 2404 Aql	18 ^h 51 ^m	+10° 59'	6.9, 8.1	4"	K5, K3	Tight orange combo.
O Σ 525 Lyr	18 ^h 55 ^m	+33° 58'	6.0, 7.7	45"	G5	Fainter Albireo look-alike.
β 648 Lyr	18 ^h 57 ^m	+32° 54'	5.4, 7.5	0.8"	G0V	Tough binary – period 61 yrs.
Σ 2438 Dra	18 ^h 58 ^m	+58° 14'	7.1, 7.4	0.9"	A2IV	Matched 260-yr. binary.
11 Aql	18 ^h 59 ^m	+13° 37'	5.2, 8.7	18"	F5	Mag. contrast pair.
ζ Sgr	19 ^h 03 ^m	-29° 53'	3.2, 3.4	0.4"	A2III, A2V	Radiant, tough 21-yr. binary.
γ CrA	19 ^h 06 ^m	-37° 04'	4.8, 5.1	1.3"	F8V, F8V	Yellowish, 120-yr. binary.
Σ 2470 Lyr	19 ^h 09 ^m	+34° 58'	7.0, 8.4	14"	B3	Together with Σ 2474 forms...
Σ 2474 Lyr	19 ^h 09 ^m	+34° 36'	6.8, 8.1	16"	G1, G5	the Double-Double's Double!
Σ 2472 Lyr	19 ^h 09 ^m	+37° 55'	7.5, 9	21"	K0	Unequal pair with dim 3rd...
Σ 2473 Lyr	19 ^h 09 ^m	+37° 56'	10, 10	6"	F5	star at 75" = Σ 2473.
Σ 2486 Cyg	19 ^h 12 ^m	+49° 51'	6.6, 6.8	8"	G5, G5	Neat yellowish twin combo.
θ Lyr	19 ^h 16 ^m	+38° 08'	4.4, 9.1, 10.9	100", 100"	K0	Faint, neat equilateral triple.
η Lyr	19 ^h 14 ^m	+39° 09'	4.4, 9.1	28"	B3	Fixed mag. contrast pair.
24 Aql	19 ^h 19 ^m	+00° 20'	6.4, 6.6	423"	K0, F0	Wide binocular combo.
β Sgr	19 ^h 23 ^m	-44° 28'	4.0, 7.1	28"	B8, A3	Nice color/mag. contrast pair.
α +8 Vul	19 ^h 29 ^m	+24° 40'	4.4, 5.8	414"	M, K0	Wide, colorful binocular pair.
Σ 2578 Cyg	19 ^h 46 ^m	+36° 05'	6.4, 7.2	15"	A0	Distant 9 th -mag. star.
Σ 2576 Cyg	19 ^h 46 ^m	+33° 36'	8.3, 8.4	2.7"	K3V	Matched 225-yr. binary.
17 Cyg	19 ^h 46 ^m	+33° 44'	5.0, 9.2, 9.0	26", 135"	F5, K5,-	Delicate triple.
ϵ Dra	19 ^h 48 ^m	+70° 16'	3.8, 7.4	3"	G8III, F6	Slow tight binary.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
ζ Sge	19 ^h 49 ^m	+19° 09'	5.5, 6.2, 8.7	0.3", 9"	A3V	A-B ultra-close 23-yr. binary.
π Aql	19 ^h 49 ^m	+11° 49'	6.1, 6.9	1.4"	F2	Fixed tight pair.
χ-1 Cyg	19 ^h 51 ^m	+32° 55'	4.2-14, 9, 9	26", 135"	S7	Famed variable – dim triple.
α Aql	19 ^h 51 ^m	+08° 52'	0.8, 9.5, 10	165", 247"	A7V	Altair. Wide optical triple.
ψ Cyg	19 ^h 56 ^m	+52° 26'	4.9, 7.4	3"	A3	Close mag. contrast pair.
η Cyg	19 ^h 56 ^m	+35° 05'	3.9, 10, 10	46", 50"	K0	Dim equilateral triple.
OΣ394 Cyg	20 ^h 00 ^m	+36° 25'	7.1, 9.9	11"	K0	Faintish color contrast duo.
h1470 Cyg	20 ^h 04 ^m	+38° 20'	7.3, 9.4	29"	M	Dim, red and blue-green pair.
15 Sge	20 ^h 04 ^m	+17° 04'	5.9, 6.8	204"	G1V, A2	Also two wide 9 th -mags.
κ Cep	20 ^h 09 ^m	+77° 43'	4.4, 8.4	7"	B9	Close unequal fixed pair.
θ Sge	20 ^h 10 ^m	+20° 55'	6.5, 8.5, 7.4	12", 84"	F5IV, G5, K2	Fixed delicate triple system.
29 Cyg	20 ^h 14 ^m	+36° 48'	5.0, 6.6	212"	A0, K5	Wide tinted pair.
Σ2671 Cyg	20 ^h 18 ^m	+55° 24'	6.1, 7.5	4"	A0	Neat cozy pair.
β Cap	20 ^h 21 ^m	-14° 47'	3.4, 6.2	205"	K0II, A0III	Wide, bright – orange and blue.
γ Cyg	20 ^h 22 ^m	+40° 15'	2.2, 9.9, 10.9	41", 1.8"	F8I	Delicate, close faint triple.
κ-2 Sgr	20 ^h 24 ^m	-42° 25'	6.0, 6.9	0.8"	A3	Slow binary – closing.
ο Cap	20 ^h 30 ^m	-18° 35'	6.1, 6.6	22"	A3V, A7V	Neat, easy matched pair.
48 Cyg	20 ^h 38 ^m	+31° 34'	6.9, 7.0	181"	A0, F0	Wide equal double.
β Del	20 ^h 38 ^m	+14° 36'	4.0, 4.9	0.5"	F5IV	Bright, rapid 27-yr. binary.
49 Cyg	20 ^h 41 ^m	+32° 18'	5.7, 7.8	3"	K0	Fixed tight colorful pair.
52 Cyg	20 ^h 46 ^m	+30° 43'	4.2, 9.4	6"	K0	Slow binary – in Veil Nebula.
λ Cyg	20 ^h 47 ^m	+36° 29'	4.9, 6.1	0.9"	B5V	Close 390-yr. binary.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
Σ 2725 Del	20 ^h 47 ^m	+16° 07'	7.6, 8.4	6"	K0	In field with γ Del.
4 Aqr	20 ^h 51 ^m	-05° 38'	6.4, 7.2	0.4"	F5V, F8V	Ultra-tight 147 yr. binary.
Σ 2735 Del	20 ^h 56 ^m	+04° 32'	6.1, 7.6	2"	G0	Challenging tight pair.
ϵ Equ	20 ^h 59 ^m	+04° 18'	6.0, 6.3, 7.1	0.7", 11"	F5III, —, G0V	Close pair 101-yr. binary.
HIW113 Cyg	21 ^h 02 ^m	+39° 31'	6.5, 10.6	18"	K2	Dim but colorful pair.
λ Equ	21 ^h 02 ^m	+07° 11'	7.4, 7.4	3"	F8	Neat, identical twin suns.
Σ 2744 Aqr	21 ^h 03 ^m	+01° 32'	6.7, 7.2	1.2"	F5V	Cozy 1500-yr. binary.
12 Aqr	21 ^h 04 ^m	-05° 49'	5.9, 7.3	3"	F5, A3	Close color contrast pair.
γ Equ	21 ^h 10 ^m	+10° 08'	4.7, 5.9	353"	F0, A2	Bright ultra-wide pair.
τ Cyg	21 ^h 15 ^m	+38° 03'	3.8, 6.4	0.7"	F0IV	Rapid binary – period 50 yrs.
1 Peg	21 ^h 22 ^m	+19° 48'	4.1, 8.2	36"	K0	Easy color/mag. contrast pair.
Σ 2799 Peg	21 ^h 29 ^m	+11° 05'	7.5, 7.5	1.6"	F2	Cozy pair – distant 9 th -mag.
Σ 2819 Cep	21 ^h 40 ^m	+57° 35'	7.5, 8.5	12"	F5	In field with following triple.
Σ 2816 Cep	21 ^h 40 ^m	+57° 29'	5.6, 7.7, 7.8	12", 20"	O6	Spectacular triple system.
μ Cyg	21 ^h 44 ^m	+28° 45'	4.8, 6.1	1.2"	F6V, G2V	Bright, close 500-yr. binary.
ϵ Peg	21 ^h 44 ^m	+09° 52'	2.4, 8.5	143"	K2I	Enif. h's Pendulum Star.
κ Peg	21 ^h 45 ^m	+25° 39'	4.7, 5.0, 10.6	0.3", 14"	F5IV	A-B 12-yr. rapid binary.
Σ 2840 Cep	21 ^h 52 ^m	+55° 48'	5.5, 7.3	18"	B6, A1	Striking bluish-green double.
Σ 2841 Peg	21 ^h 54 ^m	+19° 43'	6.4, 7.9	22"	K0	B is an 8.6 and 8.8, 0.2" pair.
Σ 2848 Peg	21 ^h 58 ^m	+05° 56'	7.2, 7.5	11"	A2	Nice subdued matched duo.
η PsA	22 ^h 01 ^m	-28° 27'	5.8, 6.8	1.7"	B8	Neat tight fixed pair.
29 Aqr	22 ^h 02 ^m	-16° 58'	7.2, 7.4	4"	A2	Cozy matched combo.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
π Peg	22 ^h 10 ^m	+33° 11'	4.3, 5.6	900"	F5III, G6III	Binocular pair with 27 Peg.
Σ 2883 Cep	22 ^h 11 ^m	+70° 08'	5.6, 7.6	15"	F2	Easy fixed pair.
Σ 2893 Cep	22 ^h 12 ^m	+73° 04'	6.2, 8.3	29"	G5	Unequal fixed pair.
41 Aqr	22 ^h 14 ^m	-21° 04'	5.6, 7.1	5"	K0III, F2V	Topaz and blue slow binary.
Σ 2890 Lac	22 ^h 15 ^m	+49° 53'	8.5, 8.5, 9.5	9", 73"	A0	Trio in cluster NGC 7243.
μ 1/2 Gru	22 ^h 16 ^m	-41° 21'	4.8, 5.1	900"	G8III, G8III	Naked-eye/binocular pair.
Σ 2894 Lac	22 ^h 19 ^m	+37° 46'	6.1, 8.3	16"	F0	Fixed pair – distant 9 th -mag.
Σ 2903 Cep	22 ^h 22 ^m	+66° 42'	6.7, 6.7	4"	F5, A2	Neat snug identical twins.
53 Aqr	22 ^h 27 ^m	-16° 45'	6.4, 6.6	3"	G1V, G2V	Yellowish equal slow binary.
Kr60 Cep	22 ^h 28 ^m	+57° 42'	9.8, 11, 10	3", 75"	dM4, dM6	A-B 44-yr. red-dwarf binary.
δ 1/2 Gru	22 ^h 29 ^m	-43° 30'	3.4, 4.1	900"	G7, M4	Bright, tinted naked-eye pair.
37 Peg	22 ^h 30 ^m	+04° 26'	5.8, 7.1	0.7"	F5IV	Close, tough 140-yr. binary.
β PsA	22 ^h 32 ^m	-32° 21'	4.4, 7.9	30"	A0	Mag. contrast pair – optical.
Δ 241 PsA	22 ^h 37 ^m	-31° 40'	5.8, 7.6	90"	K0, K0	Nice wide pale orange duo.
69 Aqr	22 ^h 48 ^m	-14° 03'	5.8, 9.0	24"	B9	Unequal optical pair.
τ Aqr	22 ^h 50 ^m	-13° 36'	4.0, 8.5	133"	K5	Wide mag. contrast pair.
γ PsA	22 ^h 52 ^m	-32° 53'	4.5, 8.0	4"	A0	Slow unequal binary.
52 Peg	22 ^h 59 ^m	+11° 44'	6.1, 7.4	0.7"	F0V	Tight 290-yr. binary.
θ Gru	23 ^h 07 ^m	-43° 31'	4.5, 7.0	1.1"	F4	Slow binary; distant 8 th mag.
π Cep	23 ^h 08 ^m	+75° 23'	4.6, 6.6	1.2"	G2III	Binary – period 147 yrs.
89 Aqr	23 ^h 10 ^m	-22° 27'	5.1, 5.9	0.4"	G2	Challenging tight pair.
o Cep	23 ^h 19 ^m	+68° 07'	4.9, 7.1	2.8"	K0III, F6V	Tinted 800-yr. binary.

Table A3. Double and Multiple Star Working List (continued)

Object/Con	RA	Dec	Mags	Sep	Spec	Remarks
4 Cas	23 ^h 25 ^m	+62° 17'	5.2, 7.7, 9.6	99", 10"	K5	An 8.6-mag. 215" away.
72 Peg	23 ^h 34 ^m	+31° 20'	5.7, 5.8	0.5"	K3III	Close, twin 240-yr. binary.
104 Aqr	23 ^h 42 ^m	-17° 49'	4.9, 7.7	120"	G0	Wide, unequal pair.
107 Aqr	23 ^h 46 ^m	-18° 41'	5.7, 6.7	7"	F0IV, F2III	Neat slow binary – opening.
6 CAS	23 ^h 49 ^m	+62° 13'	5.5, 8.0	1.5"	A2	Tough fixed unequal pair.
Σ3050 And	23 ^h 59 ^m	+33° 43'	6.6, 6.6	1.6"	G0V	Snug twin 355-yr. binary.

Telescope Limiting Magnitude and Resolution

Listed below are limiting magnitude and resolution values for a variety of common-sized (Size in inches) telescopes in use today, ranging from 2- to 14-inches in aperture. (The 2.4-inch entry represents the ubiquitous 60mm refractor, of which there are perhaps more than any other telescope in the world!)

Values for the minimum visual magnitude (Mag) listed here are for single stars and are only very approximate; experienced keen-eyed observers may see as much as a full magnitude fainter under excellent sky conditions. Companions to visual double stars – especially those in close proximity to a bright primary – are typically much more difficult to see than is a star of the same magnitude placed alone in the eyepiece field. Among the many variables involved here are light pollution, sky conditions, optical quality, mirror and lens coatings, eyepiece design, obstructed or unobstructed optical system, color (spectral type) of the star, and even the age of the observer. Given here in increments of aperture are a few representative limiting magnitudes to serve as a general indication of what can be expected to be seen in different sized telescopes.

Table A4. Telescope Limiting Magnitude and Resolution

Size	Mag	Dawes	Rayleigh	Markowitz
2.0	10.30	2.28	2.75	3.00
2.4		1.90	2.29	2.50
3.0	11.2	1.52	1.83	2.00
3.5		1.30	1.57	1.71
4.0	11.8	1.14	1.38	1.50
4.5		1.01	1.22	1.33
5.0		0.91	1.10	1.20
6.0	12.7	0.76	0.92	1.00
7.0		0.65	0.79	0.86
8.0	13.3	0.57	0.69	0.75
10.0	13.8	0.46	0.55	0.60
11.0		0.42	0.50	0.55
12.0		0.38	0.46	0.50
12.5	14.3	0.36	0.44	0.48
13.0		0.35	0.42	0.46
14.0	14.5	0.33	0.39	0.43

Three different values in arc seconds are listed for resolution, which are for two stars of equal brightness and of about the sixth magnitude. These figures differ significantly for brighter, fainter and, especially, unequal pairs. Dawes is that based on Dawes' Limit ($R = 4.56/A$), Rayleigh on the Rayleigh Criterion ($R = 5.5/D$), and Markowitz on Markowitz's Limit ($R = 6.0/D$). Note that in these equations A (for aperture) and D (for diameter) are the same thing. For more on these relationships, see the section on resolution studies in Chapter 6.

The Measurement of Visual Double Stars

A valuable reference for those seriously thinking about measuring double stars is the late Charles Worley's 1961 reprint *Visual Observing of Double Stars* from his acclaimed *Sky & Telescope* series of the same title. The section entitled "The Measurement of Visual Double Stars", which discusses the use of a filar micrometer, is especially useful. While the currently popular reticle eyepiece micrometer is both less expensive and easier to use than is the filar micrometer, the latter has long been the traditional instrument for such work. Even those observers who are using more modern devices will find a working knowledge of its operation worthwhile.

Unfortunately, this little booklet has been out of print for some time now. Through the kind permission of Sky Publishing Corporation, its measurement section has been excerpted below. Although the data in its table of 97 visual doubles expressly compiled for measurement by Dr. Worley was updated in 1970, it is now largely out of date due to the orbital motion of the pairs. His comments about this list in the final two paragraphs are of interest and have been retained, but the actual table itself has been dropped. Nearly every pair originally contained in it can be found in the compilations in Chapter 7 and Appendix 3 of this current book.

Charles Worley spent the latter half of his long career at the U.S. Naval Observatory in Washington, DC, where he measured double stars with the Observatory's 26-inch and 12-inch refractors (and occasionally with the 61-inch astrometric reflector at its field station in Flagstaff, Arizona). He was one of the most active observers of visual binaries in the world. Always a kind friend and mentor to any amateur expressing an interest in helping measure his beloved binary stars, he was truly an "observational astronomer" in the finest sense of the term. He wrote as follows:

The amateur who has acquired a filar micrometer has open to him a boundless field of interesting observational work in measuring double stars.

As mentioned [earlier], the telescope should have excellent optics, and a sturdy, accurately aligned equatorial mounting with a clock drive is essential. For systematic double star work, a refractor of 8-inch aperture or larger is a very effective instrument....

The observer must calibrate the micrometer before measures of double stars can be made. First, he finds the north point on the position-angle circle; this zero point has to be determined independently each night before he begins his observations. Second, he must find the number of seconds of arc corresponding to one revolution of the micrometer screw. Once it has been accurately determined, this value remains practically constant. To find the north point of the position-circle, proceed as follows. Using a low magnification, set the telescope on a star near the celestial equator and in [on] the meridian. Let the star trail along the fixed wire [of the micrometer], correcting any deviations by rotating the micrometer box and adjusting the tangent screw. When the star trails accurately, the wire is pointing east-west. Then, 90 degrees added to (or subtracted from) the position-circle reading gives the north point.

As an example, suppose that the circle reading is 98.6 degrees when a star trails along the fixed wire. Then 8.6 degrees is the north point on the circle. Later that night, in measuring the position angle of a double star, the circle reading is, say, 245.4 degrees. The true position angle is therefore 245.4 degrees – 8.6 degrees = 236.8 degrees.

The determination of R, the value of one revolution of the screw, is more complicated. We shall use the method of directly measuring the difference of declination between two stars whose positions are accurately known. R is found by dividing the number of screw revolutions into the known difference in Declination. This method give R with sufficient precision for reducing measures of close double stars, since the accidental and systematic errors of a measured separation are quite large even under the best conditions.

Tabulated below are three pairs of stars conveniently distributed around the sky. The bright pair 27 and 28 Tauri, Atlas and Pleione in the Pleiades, will probably prove best to use. [Indeed, since they and their famed associated cluster are easily located and readily visible at some hour of the night most nights of the year, the two fainter pairs mentioned have been dropped here.] In principle, the star positions should be individually corrected to the date of the observation by taking into account precession, aberration, and proper motion. By omitting these corrections, simplicity is gained with little loss in accuracy. Though the star positions in the table are for the date 1962.0 [here updated to the current standard epoch 2000.0], the *differences* in declination should remained practically unchanged for many years. A further correction for atmospheric refraction should be made, but if the pairs are observed when within 30 degrees of the zenith, the differential refraction is very small and may be safely neglected.

[Following are the data for these two stars: their designation, visual magnitudes, Right Ascension in hours, minutes and seconds of time, Declination in degrees, minutes and seconds of arc, and the difference in declination between the two in seconds of arc.]

Pleione (28 Tauri)	5.1	03h, 49m, 11.2s	+24°, 08', 13"	301".0
Atlas (27 Tauri)	3.6	03h, 49m, 09.7s	+24°, 03', 12"	301".0

The measurements to determine R should be made when the star pair is near the meridian. First, using a low power, carefully find the zero of the position-angle circle, and clamp the wires in the east–west direction. Then, with a higher power, make repeated measurements of the separation in declination of the star pair, by the technique described below. Measure the pair in the north-to-south direction, then rotate the micrometer 180 degrees and measure from south to north.

If the field of view is too small to encompass both stars simultaneously, one or more intermediate stars may be used. These should lie on nearly the same line as the star pair, but their exact positions are immaterial. The observations of 27 Tauri and 28 Tauri [below] are an example:

N-S: 28 Tau to intermediate star – 10.46 revolutions. Intermediate star to 27 Tau – 14.56 revolutions. Sum = 25.02
 S-N: 27 Tau to intermediate star – 14.53 revolutions. Intermediate star to 28 Tau – 10.47 revolutions. Sum = 25.00
 Average = 25.01
 Then R = 301.0"/25.01 = 12".04 per revolution of the screw.

Such determinations of R should be repeated on a number of nights, and the mean used in the reduction of double star measures.

We finally come to the problem of making an actual measurement of a double star. Observations should be attempted only on nights of good seeing, and the highest power that the seeing will permit should always be employed.

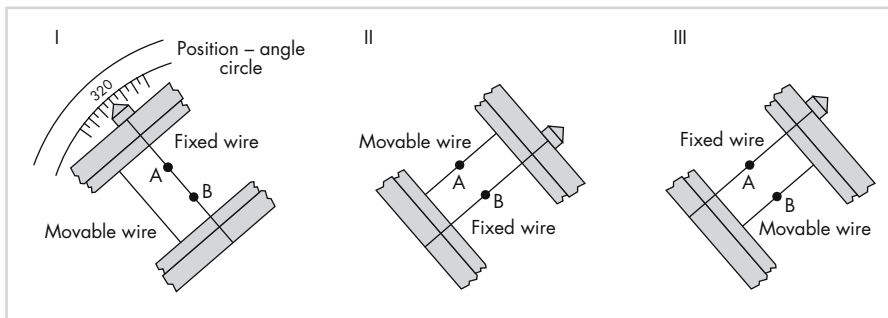


Figure A5.1. The setting for finding the position angle of a double star is shown in panel I. Panels II and III show that required for determining the separation of a pair. Two settings are needed for the separation, the difference between II and III giving twice its actual value as the moveable wire is shifted from one side of the fixed wire to the other. Courtesy *Sky & Telescope*.

The diagram labeled I shows the method of measuring the position angle of the double. With the aid of the tangent screw and position-angle pinion, the fixed wire is set across the star images A and B as accurately as possible. During this operation, the line joining the observer's eyes should always be held either parallel or perpendicular to the line joining the stars. When satisfied that the wire is properly oriented, read the position circle and give the micrometer box an arbitrary turn. This helps insure that successive settings are independent of one another. It is desirable to make four settings for position angle.

To measure the separation, rotate the micrometer box by 90 degrees and clamp it. Two or three settings are made with the wires in the position shown in the diagram that is labeled II, followed by an equal number as shown in diagram III. The interchange of wires eliminates the need to find the coincidence reading of the two wires, and gives the double distance. Since we know R , we find the separation, ρ , of the pair, in seconds of arc, from $\rho = \frac{1}{2}R$ (*second reading - first reading*). Note that separation measures are always made in the order of increasing readings of the screw, in order to eliminate backlash. In making such distance measures, you can lessen bias by taking your eye from the ocular and randomly turning the micrometer screw between settings.

An example of an actual observation made by the author with the Lick Observatory 12-inch refractor is shown. It was made on the double $\Sigma 1932$, on May 27, 1960. The practice of double star observers is to report the date of every measure, dividing the year decimally, 1960.402 in this case. To reduce accidental errors, the double star should be measured on three or more nights in the same season, and an average obtained.

In this article, only a brief outline of techniques can be given. The reader will find much information on micrometers and observing methods in R.G. Aitken's book, *The Binary Stars* (1935). Also worth consulting are J.B. Sidgwick's *Observational Astronomy for Amateurs* (1955) and *Amateur Astronomer's Handbook* (1955), as well as the chapter on micrometers in *Amateur Telescope Making - Book II* (1949). See also an article by W.H. van den Bos, "Some Hints for Double-Star Observers and Orbit Computers," in *Publications of the Astronomical Society of the Pacific*, 70, 160, 1958.

In the following list are 97 interesting double stars suitable for micrometric observations with 6-inch to 12-inch telescopes. Current position angles and separations are listed both as an aid in identification, and to help the casual observer test the resolving power of his telescope.

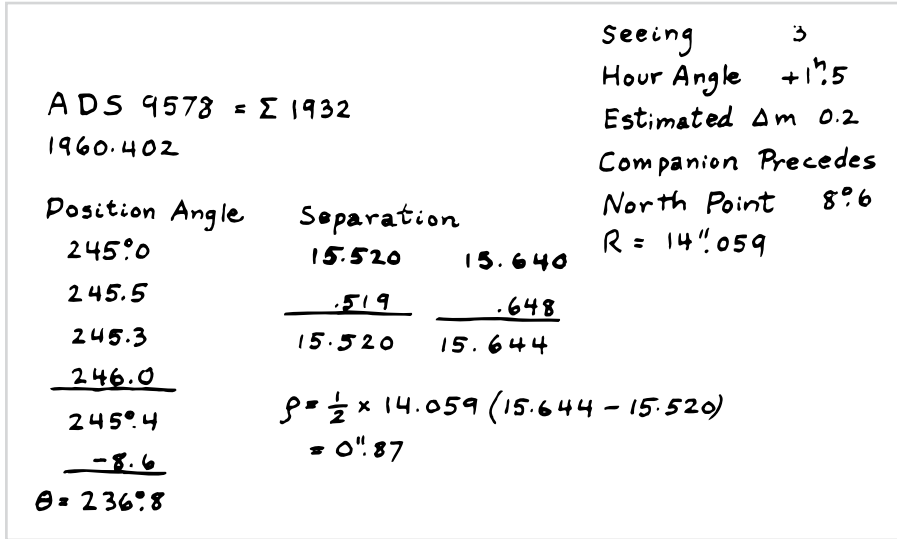


Figure A5.2. A sample double star observation recorded on an index card by Charles Worley using the 12-inch refractor of the Lick Observatory on the night of May 27, 1960. Courtesy *Sky & Telescope*.

All of the pairs listed here show appreciable orbital motion. In the last column, the period of revolution is given when known. Uncertain values are marked with a colon (:), very uncertain ones with a double colon (::). Asterisks indicate notes on the last page.

About the Author

James Mullaney is an astronomy writer, lecturer and consultant who has published more than 500 articles and five books on observing the wonders of the heavens, and logged nearly 25,000 hours of stargazing time with the unaided eye, binoculars and telescopes. Formerly Curator of the Buhl Planetarium and Institute of Popular Science in Pittsburgh and more recently Director of the Dupont Planetarium, he served as staff astronomer at the University of Pittsburgh's Allegheny Observatory and as an editor for *Sky & Telescope*, *Astronomy* and *Star & Sky* magazines. One of the contributors to Carl Sagan's award-winning *Cosmos* PBS-Television series, his work has received recognition from such notables (and fellow stargazers) as Sir Arthur Clarke, Johnny Carson, Ray Bradbury, Dr. Wernher von Braun and former student – NASA scientist/astronaut Dr. Jay Apt. His 50-year mission as a “celestial evangelist” has been to “celebrate the universe!” – to get others to look up at the majesty of the night sky and to personally experience the joys of stargazing.



The author, shown holding a copy of his book *Celestial Harvest: 300-Plus Showpieces of the Heavens for Telescope Viewing & Contemplation*. Originally self-published in 1998 (and updated in 2000), it was reprinted in 2002 by Dover Publications in New York. More than 40 years in the making, nearly half of its entries are attractive visual double and multiple stars. Courtesy of *Sky & Telescope* and Warren Greenwald.

Index

With the exception of a number of famous/well-known objects (mainly those having proper names) discussed in one or more places in the text itself, double and multiple stars themselves are not listed in this index since all of the 500 pairs covered in this book can be readily found in either the showpiece roster in **Chapter 7** or in the extended working list in **Appendix 3**. Several of the “first-magnitude” and other single stars are also included here, as they are mentioned in the main text in various contexts relating to their double and multiple star kin.

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