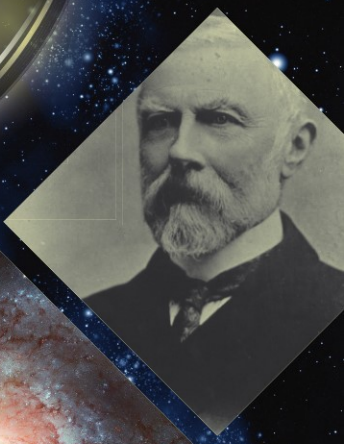
Jerry D. Cavin

The Amateur Astronomer's Guide to the Deep-Sky Catalogs

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The Amateur Astronomer's Guide to the Deep-Sky Catalogs

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Jerry D. Cavin
Austin, TX, USA
jcavin@yahoo.com

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Top left: Johann Elert Bode, German astronomer.
Top right: John Louis Emil Dreyer.
Bottom left: Sir William Herschel, , as depicted in the book Sir William Herschel, His Life and Works by Edward Singleton Holden (W. H. Allen & Co, 13 Waterloo Place, S W, London, (1881), Frontispiece.
Bottom right: Tycho Brahe, illustration from J. L. E. Dreyer biography of his fellow countryman Tycho Brahe – A Picture of Scientific Life and Work in the Sixteenth Century (1890).

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Preface

This book provides an introduction to a few of the historical deep space sky catalogs. It is intended to provide amateur astronomers with historical information and the catalog entries with coordinates. In some cases, the information recorded in the original catalog have been omitted to allow the contents to be formatted properly on the page. To this end, I have chosen to keep the data that will allow the amateur the enjoyment of observing the objects of each catalog.

Almost 2,000 years of historical catalogs are covered in this book. Chapter One describes Ptolemy's Almagest created in A. D. 140, and Chapter Twelve describes the Caldwell Catalog created in 1995. In choosing the set of catalogs used in this book, I provided what I thought the most interesting historic catalogs. I apologize if I have omitted to list and describe your favorite. The history of astronomy is rich with many catalogs that equally deserve to be noted, and it is nearly impossible to include all here.

I would like to thank the many people who helped during the preparation of this book. The idea for writing this book came in part from the many research papers I wrote in earning my Master of Science in Astronomy at the Swinburne University of Technology Astronomy Online Program. My sincere thank you goes out to the many Swinburne professors and astronomers who taught me over the years. I would like to the thank the many people who provided the information used to compile the catalogs documented in these chapters, including Joerg Schlimmer, Carol Huston, Neda Mobara, Brenda Branchett and Carol Iorg, of the Astronomy League; Dennis Duke, Professor of Physics at the Florida State University; Dennis J Webb, co-author of the book *The Arp Atlas of Peculiar Galaxies*, and Robert Erdmann of the NGC/IC Project. Finally, I would like to thank my wife Halima, my daughter Sheila, and my son Zachariah for understanding and accepting the private time I needed to compile and write this book.

Jerry D. Cavin

About the Author

Jerry Cavin first turned to amateur astronomy while growing up under the dark skies of Iowa. After leaving the farm, he completed a BS in Computer Science with a minor in Electrical Engineering at the University of Nebraska at Omaha. He worked for 10 years as the Lead Software Engineer at the Control Data Corporation specializing in real time control systems. After getting married he moved to Austin, Texas and spent over 15 years at the University of Texas at Austin working as a Research Scientist Associate on electronic warfare systems and 6 years at Overwatch Systems.

He is currently working as a Quality Engineer at Bridge360 on a wide variety of software projects. He has recently completed his second MSc degree in Astronomy at the Swinburne Astronomy Online, via the Swinburne University of Technology located in Melbourne, Australia.

Contents

Chapter 1

Claudius Ptolemy and the *Almagest*

We know of many ancient astronomers. Aristarchus of Samos (310 BC–c 230 BC) was the first to argue for a heliocentric view of the Solar System putting the Sun at the center of the universe. Eratosthenes of Cyrene (c 276 BC–c 195 BC) created the technique of measuring Earth-based locations by using latitudes and longitudes and also accurately computed the circumference of Earth. The calculations of Thales of Miletus (c 624 BC–c 546 BC) allowed him to accurately predict solar eclipses. Aristyllus (c 280 BC), with the help of Timocharis (c 320 BC–c 260 BC), was the first astronomer to create sky catalogs at the astronomical observatory of the library of Alexandria. The observations of Aristyllus and Timocharis are the earliest known Greek observations and can be dated to the year 290 BC But it was Hipparchus of Nicaea that became known as the founder of astronomy.

Hipparchus of Nicaea (c. 200–126 BC)

What little we know about Hipparchus is found in the writings of Strabo of Amasya and Ptolemy of Alexandria. They recorded that Hipparchus performed his astronomical observations in Bithynia, on the island of Rhodes southwest of Turkey in the Aegean Sea, and in Alexandria. He wrote many astronomy books, including one that documented his accomplishments; unfortunately the only surviving work of Hipparchus is the *Phenomena,* a commentary on a poem about the constellations by Aratus and Eudoxus.

Hipparchus would have been exposed to the Babylonians' knowledge of the stars. Using the historical records he made many improvements to the observational instruments, allowing him to make more precise measurements of the heavens than

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anyone before him. His groundbreaking works in astronomy led him to discover new areas of mathematics.

In 134 BC Hipparchus was witness to a supernova, or "guest star," in the ancient sky. The supernova would have been an extraordinarily bright object in the sky during the day and night. During Hipparchus's time the sky was thought to be unchanging with the exception a few known 'wanderers' (the planets). This brilliant new object would have shaken his belief in an unchanging, static heaven. The event was reported to have encouraged him to measure and compile a catalog of the positions of the stars.

According to Ptolemy, Hipparchus spent 20 years making painstaking measurements of nearly 1,000 stars. After constructing his new star catalog he found another mystery concerning the stars. He compared his measurements to the measurements from the early catalogs of Aristyllus and Timocharis, taken 150 years before him. Although the latitude remained consistent he saw that the longitude measurement showed an increase of 2° from the older measurements. This difference in measurements indicated that the equator was slowly moving towards the ecliptic at a rate of 48 s a year. From this he deduced the "precession of the equinoxes." This is known today to be caused by the gradual shift in the orientation of Earth's axis, which traces out a circle once every 26,000 years.

Claudius Ptolemaeus (AD 90–AD 160)

Claudius Ptolemaeus (Ptolemy) was a mathematician, geographer, astrologer, and astronomer living in Egypt under Roman rule. What is known about Ptolemy is based solely on his three great books that have been passed down through the ages, the *Almagest,* his treatise on Greek astronomy; the *Geography*, a treatise on the cartography of the Persian and Roman world; and the *Tetrabiblos*, a treatise on astrology.

The name Almagest is an Arabic name meaning the "Great Book" or "Great Work." Ptolemy called his work the "*Mathematical Treatise.*" The *Almagest* became the most influential work in astronomy for the next 1,500 years. The star catalog of the *Almagest* contained 1,028 stars. Each star is listed with the name of the constellation in which it appeared, its location within the constellation, its ecliptic longitude and latitude, and the magnitude (brightness) of the star, from 1 (brightest) to 6 (dimmest). The method of measuring the brightness of stars is believed to have been created by Hipparchus. With some changes this is still the way we measure the brightness today (Table 1.1).

Ptolemy's *Almagest* has been embroiled in controversy for many years. If the measurements are closely examined it shows that Ptolemy had plagiarized another catalog. Many scholars believe Hipparchus's catalog was the real source of the catalog of the *Almagest*. Ptolemy had simply adjusted the measurements to allow for 150 years of precession. Early Persian and European astronomers such as Ulugh Beg and Tycho Brahe also believed this to be true.

Fig. 1.1 An imagined depiction of Claudius Ptolemy holding a cross staff (some historians have traced the origins of the cross staff to the Chaldeans in 400 BC) used to measure the separation between stars from the book *Great Astronomers* by Sir Robert Stawell Ball, published by the J.B. Lippincott Company in 1895

Table 1.1 The catalog of the *Almagest* listed by constellation. The data in this table is provided with permission of Dennis Duke, professor of physics at the Florida State University

#	HR number	Full star name	Constellation			Almagest measurement		Actual (Epoch 137 AD)		V Mag	aV Mag
			Name	#	Star	Long	Lat	Long	Lat		
1	424	1Alp UMi	UMi	1	1	60.17	66	62.63	65.88	3	2
2	6789	23Del UMi	UMi	1	2	62.5	70	65.29	69.73	4	4.4
3	6,322	22Eps UMi	UMi	1	3	70.17	74.33	73.11	73.68	4	4.2
4	5,903	16Zet UMi	UMi	1	4	89.67	75.67	91.07	74.89	4	4.3
5	6,116	21Eta UMi	UMi	1	5	93.67	77.67	94.2	77.73	4	4.9
6	5,563	7Bet UMi	UMi	1	6	107.5	72.83	106.87	72.83	2	2.1
7	5,735	13Gam UMi	UMi	1	7	116.17	74.83	114.98	75.1	2	3
8	5,430	5 UMi	UMi	1	8	103	71.17	102.05	71.25	4	4.3
9	3,323	1Omi UMa	UMa	2	1	85.33	39.83	87.06	40.09	4	3.4
10	3,354	2 UMa	UMa	2	2	85.83	43	85.64	44.38	5	5.5
11	3,403	4Pi 2UMa	UMa	2	3	86.33	43	86.85	43.8	5	4.6
12	3,576	8Rho UMa	UMa	2	4	86.17	47.17	87.96	47.72	5	4.8
13	3,616	13Sig2UMa	UMa	2	5	86.67	47	89.23	47.65	5	4.8
14	3,771	24 UMa	UMa	2	6	88.17	50.5	90.35	51.01	5	4.6
15	3,624	14Tau UMa	UMa	2	7	90.5	43.83	91.48	44.37	4	4.7
16	3,757	23 UMa	UMa	2	8	92.5	44.33	94.71	44.92	4	3.7
17	3,888	29Ups UMa	UMa	2	9	99	42	100.35	42.59	4	3.8
18	3,894	30Phi UMa	UMa	2	10	101	44	103.31	38.06	4.3	4.6
19	3,775	25The UMa	UMa	2	11	100.67	35	101.66	35.15	3	3.2
20	3,569	9Iot UMa	UMa	2	12	95.5	29.33	97.01	29.55	3	3.1
21	3,594	12Kap UMa	UMa	2	13	96.33	28.33	97.95	28.81	3	3.6
22	3,662	18 UMa	UMa	2	14	95.67	36	97.28	35.86	4	4.8
23	3,619	15 UMa	UMa	2	15	95.83	33	97.18	33.29	4	4.5
24	4,301	50Alp UMa	UMa	2	16	107.67	49	109.14	49.57	2	1.8
25	4,295	48Bet UMa	UMa	2	17	112.17	44.5	113.29	44.94	2	2.4
26	4,660	69Del UMa	UMa	2	18	123.17	51	124.81	51.5	3	3.3

27	4,554	64Gam UMa	UMa	2	19	123	46.5	124.27	46.98	2	2.4
28	4,033	33Lam UMa	UMa	2	20	112.67	29.33	113.6	29.78	3	3.5
29	4,069	34Mu UMa	UMa	2	21	114.17	28.25	115.26	28.85	3	3
30	4,335	52Psi UMa	UMa	2	22	121.67	35.25	122.77	35.44	3.7	3
31	4,377	54Nu UMa	UMa	2	23	129.83	25.83	130.64	26.06	3	3.5
32	4,375	53Xi UMa	UMa	2	24	130.33	25	131.39	25	3	3.9
33	4,905	77Eps UMa	UMa	2	25	132.17	53.5	132.62	54.2	2	1.8
34	5,054	79Zet UMa	UMa	2	26	138	55.67	139.32	56.29	2	2.1
35	5,191	85Eta UMa	UMa	2	27	149.83	54	150.75	54.42	2	1.9
36	4,914	12Alp2CVn	UMa	2	28	147.83	39.75	148.59	40.11	3	2.8
37	4,785	8Bet CVn	UMa	2	29	140.17	41.33	142.09	40.56	5	4.3
38	3,705	40Alp Lyn	UMa	2	30	105	17.25	105.99	17.81	4	3.1
39	3,690	38 Lyn	UMa	2	31	103.33	19.17	104.59	19.98	4	3.8
40	3,800	10 LMi	UMa	2	32	106.17	20	107.83	20.58	7	4.6
41	3,809		UMa	2	33	102.17	22.5	106.81	23.64	7	4.8
42	3,612		UMa	2	34	101.17	20.33	101.58	20.71	7	4.6
43	3,275	31 Lyn	UMa	2	35	90	22.25	91.59	22.94	7	4.3
44	6,370	21Mu Dra	Dra	3	1	206.67	76.5	208.46	76.41	4	5.1
45	6,554	25Nu 2Dra	Dra	3	2	221.83	78.5	223.68	78.33	3.7	4.8
46	6,536	23Bet Dra	Dra	3	3	223.17	75.67	225.8	75.51	3	2.8
47	6,688	32Xi Dra	Dra	3	4	237.33	80.33	238.44	80.48	4	3.8
48	6,705	33Gam Dra	Dra	3	5	239.67	75.5	242.04	75.18	3	2.2
49	6,923	39 Dra	Dra	3	6	264.67	82.33	266.99	81.97	4	5
50	7,049	46 Dra	Dra	3	7	272.33	78.25	274.53	78.07	4	5
51	6,978	45 Dra	Dra	3	8	268.83	80.33	270.38	79.98	4	4.8
52	7,125	47Omi Dra	Dra	3	9	289.5	81.5	289.82	80.98	4	4.7
53	7,371	58Pi Dra	Dra	3	10	338	81.67	339.01	81.82	4	4.6
54	7,310	57Del Dra	Dra	3	11	350.5	83	352.74	82.86	4	3.1
55	7,582	63Eps Dra	Dra	3	12	7.67	78.83	7.8	79.4	4	3.8

(continued)

Table 1.1 (continued)

#	HR number	Full star name	Constellation Name	#	Star	Almagest measurement Long	Lat	Actual (Epoch 137 AD) Long	Lat	V Mag	aV Mag
56	7,685	67Rho Dra	Dra	3	13	352.83	77.83	355.4	78.08	4	4.5
57	7,462	61Sig Dra	Dra	3	14	10.67	80.5	11.55	80.93	5	4.7
58	7,180	52Ups Dra	Dra	3	15	21.67	81.33	25.64	83.06	5	4.8
59	7,352	60Tau Dra	Dra	3	16	26.17	80.25	29.44	80.48	5	4.4
60	6,636	31Psi1Dra	Dra	3	17	73.33	84.5	77.03	83.82	4	4.3
61	6,927	44Chi Dra	Dra	3	18	50.33	83.5	53.24	83.24	4	3.6
62	6,920	43Phi Dra	Dra	3	19	41.83	84.83	45.89	84.66	4	4.2
63	6,566	27 Dra	Dra	3	20	118.67	87.5	117.97	86.78	6	5.1
64	6,596	28Ome Dra	Dra	3	21	111.67	86.83	105.47	86.83	6	4.8
65	6,223	18 Dra	Dra	3	22	159	81.25	156.77	81.65	5	4.8
66	6,315	19 Dra	Dra	3	23	159.33	83	156.79	83.22	5	4.9
67	6,396	22Zet Dra	Dra	3	24	158.33	84.83	154.9	84.78	3	3.2
68	6,132	14Eta Dra	Dra	3	25	160	78	167.54	78.49	3	2.7
69	5,986	13The Dra	Dra	3	26	160.33	74.67	170.8	74.51	3.7	4
70	5,744	12Iot Dra	Dra	3	27	162.67	70	158.34	71.11	3	3.3
71	5,226	10 Dra	Dra	3	28	127.33	64.67	128.51	65.27	4	4.7
72	5,291	11Alp Dra	Dra	3	29	131.17	65.5	131.07	66.29	3	3.7
73	4,787	5Kap Dra	Dra	3	30	109.17	61.25	110.05	61.62	3	3.9
74	4,434	1Lam Dra	Dra	3	31	103.17	56.25	104.18	57.08	3	3.8
75	7,750	1Kap Cep	Cep	4	1	35	75.67	37.55	75.28	4	4.4
76	8,974	35Gam Cep	Cep	4	2	33	64.25	34.31	64.41	4	3.2
77	8,238	8Bet Cep	Cep	4	3	7.33	71.17	10.19	71.01	4	3.2
78	8,162	5Alp Cep	Cep	4	4	346.67	69	347.31	68.91	3	2.4
79	7,957	3Eta Cep	Cep	4	5	339.33	72	338.28	71.57	4	3.4
80	7,850	2The Cep	Cep	4	6	340	74	339.77	73.93	4	4.2
81	8,417	17Xi Cep	Cep	4	7	358.5	65.5	358.56	65.71	5	4.3

82	8,694	32Iot Cep	Cep	4	8	7.5	62.5	7.87	62.49	3.7	3.5
83	8,494	23Eps Cep	Cep	4	9	346.33	60.25	347.16	60.04	5	4.2
84	8,465	21Zet Cep	Cep	4	10	347.33	61.25	348.46	61.09	4	3.3
85	8,469	22Lam Cep	Cep	4	11	349	61.33	350.51	61.83	5	5
86	8,316	Mu Cep	Cep	4	12	343.67	64	344.29	64.15	5	4.1
87	8,571	27Del Cep	Cep	4	13	351.33	59.5	352.07	59.47	4	3.8
88	5,328	17Kap2Boo	Boo	5	1	152.33	58.67	153.58	58.88	5	4.4
89	5,350	21Iot Boo	Boo	5	2	154.17	58.33	154.95	58.86	5	4.8
90	5,404	23The Boo	Boo	5	3	155.33	60.17	156.18	60.36	5	4.1
91	5,351	19Lam Boo	Boo	5	4	159.67	54.67	160.92	54.67	5	4.2
92	5,435	27Gam Boo	Boo	5	5	169.67	49	171.61	49.59	3	3
93	5,602	42Bet Boo	Boo	5	6	176.67	53.83	178.04	54.28	3.7	3.5
94	5,681	49Del Boo	Boo	5	7	185.67	48.67	186.91	49.14	3.7	3.5
95	5,733	51Mu 1Boo	Boo	5	8	185.67	53.25	187.13	53.55	4	4.2
96	5,763	52Nu 1Boo	Boo	5	9	185	57.5	186.29	57.21	4	5
97	5,727	2Eta CrB	Boo	5	10	187.67	46.5	190.88	47.01	3.7	5
98	5,709	1Omi CrB	Boo	5	11	188.5	45.5	190.55	46.12	5	5.5
99	5,634	45 Boo	Boo	5	12	188.17	41.33	189.07	40.66	5	4.9
100	5,616	43Psi Boo	Boo	5	13	186.67	41.67	187.52	42.34	5	4.5
101	5,638	46 Boo	Boo	5	14	187	42.5	188.83	42.04	5	5.7
102	5,600	41Ome Boo	Boo	5	15	187.33	40.33	187.71	40.34	5	4.8
103	5,505	36Eps Boo	Boo	5	16	180	40.25	182.04	40.74	3	2.6
104	5,447	28Sig Boo	Boo	5	17	175.67	41.67	177.7	42.14	4	4.5
105	5,429	25Rho Boo	Boo	5	18	175	42.17	176.76	42.52	3.7	3.6
106	5,477	30Zet Boo	Boo	5	19	185.33	28	186.97	28.02	3	3.9
107	5,235	8Eta Boo	Boo	5	20	171.33	28	173.24	28.34	3	2.7
108	5,185	4Tau Boo	Boo	5	21	170.5	26.5	172.16	26.67	4	4.5
109	5,200	5Ups Boo	Boo	5	22	171.33	25	173.23	25.28	4	4.1
110	5,340	16Alp Boo	Boo	5	23	177	31.5	178.32	32.01	1	0

(continued)

Table 1.1 (continued)

#	HR number	Full star name	Constellation			Almagest measurement		Actual (Epoch 137 AD)			aV Mag
			Name	#	Star	Long	Lat	Long	Lat	V Mag	
111	5,793	5Alp CrB	CrB	6	1	194.67	44.5	196.1	44.51	1.7	2.2
112	5,747	3Bet CrB	CrB	6	2	191.67	46.5	193.15	46.2	3.7	3.7
113	5,778	4The CrB	CrB	6	3	191.83	48	193.33	48.72	5	4.1
114	5,855	9Pi CrB	CrB	6	4	193.67	50.5	196.08	50.64	6	5.6
115	5,849	8Gam CrB	CrB	6	5	197.17	44.75	198.87	44.68	4	3.8
116	5,889	10Del CrB	CrB	6	6	199.17	44.83	200.98	44.99	4	4.6
117	5,947	13Eps CrB	CrB	6	7	201.33	46.17	203.07	46.3	4	4.2
118	5,971	14Iot CrB	CrB	6	8	201.67	49.33	202.94	49.36	4	5
119	6,406	64Alp1Her	Her	7	1	227.67	37.5	230.2	37.51	3	3.3
120	6,148	27Bet Her	Her	7	2	213.67	43	215.13	42.94	3	2.8
121	6,095	20Gam Her	Her	7	3	211.67	40.17	213.23	40.2	3	3.8
122	6,008	7Kap Her	Her	7	4	208	37.17	209.72	37.43	4	4.7
123	6,410	65Del Her	Her	7	5	226.67	48	228.78	48.01	3	3.1
124	6,526	76Lam Her	Her	7	6	232	49.5	233.92	49.53	3.7	4.4
125	6,623	86Mu Her	Her	7	7	237.67	52	239.5	51.74	3.7	3.4
126	6,779	103Omi Her	Her	7	8	245.5	52.83	246.8	52.43	3.7	3.8
127	6,707	94Nu Her	Her	7	9	241.67	54	243.54	53.87	3.7	4.4
128	6,703	92Xi Her	Her	7	10	241.5	53	243.21	52.94	4	3.7
129	6,212	40Zet Her	Her	7	11	213.83	53.17	215.84	53.21	3	2.8
130	6,324	58Eps Her	Her	7	12	220.17	53.5	222.33	53.47	5	3.9
131	6,332	59 Her	Her	7	13	220	56.17	221.95	56.13	5	5.3
132	6,377		Her	7	14	221.17	58.5	223.6	58.7	3	5.4
133	6,418	67Pi Her	Her	7	15	224	59.83	226.05	59.79	4	3.2
134	6,436	69 Her	Her	7	16	225.33	60.33	226.97	60.31	4	4.7
135	6,484	75Rho Her	Her	7	17	226.33	61.25	229.39	60.36	3.7	4.1
136	6,695	91The Her	Her	7	18	240.83	61	242.55	60.93	4	3.9

137	6,588	85Iot Her	Her	7	19	232.17	69.33	233.87	69.51	4	3.8
138	6,464	74 Her	Her	7	20	225.33	70.25	224.51	69.23	6	5.6
139	6,509	77 Her	Her	7	21	226.83	71.25	226.49	71.44	6	5.8
140	6,574	82 Her	Her	7	22	229.67	72.25	231.45	71.98	6	5.4
141	6,220	44Eta Her	Her	7	23	210.67	60.25	212.59	60.54	3.7	3.5
142	6,168	35Sig Her	Her	7	24	205.33	63	207.07	63.33	4	4.2
143	6,092	22Tau Her	Her	7	25	195.67	65.5	198.11	65.99	3.7	3.9
144	6,023	11Phi Her	Her	7	26	193.67	63.67	195.39	63.93	4	4.3
145	5,982	6Ups Her	Her	7	27	190.17	64.25	191.97	64.49	4	4.8
146	5,914	1Chi Her	Her	7	28	191.17	60	191.85	60.06	4	4.6
147	5,763	52Nu 1Boo	Her	7	29	185	57.5	186.29	57.21	4	5
148	6,117	24Ome Her	Her	7	30	212.67	38.17	215.54	35.41	5	4.6
149	7,001	3Alp Lyr	Lyr	8	1	257.33	62	259.26	61.84	1	0
150	7,051	4Eps1Lyr	Lyr	8	2	260.33	62.67	262.84	62.6	3.7	3.8
151	7,056	6Zet1Lyr	Lyr	8	3	260.33	61	262.29	60.56	3.7	4.1
152	7,139	12Del2Lyr	Lyr	8	4	263.67	60	265.91	59.54	4	4.3
153	7,298	20Eta Lyr	Lyr	8	5	272	61.33	274.37	60.89	4	4.4
154	7,314	21The Lyr	Lyr	8	6	271.67	60.33	274.82	59.78	4	4.4
155	7,106	10Bet Lyr	Lyr	8	7	261	56.17	263.09	56.22	3	3.5
156	7,102	9Nu 2Lyr	Lyr	8	8	260.83	55	262.8	55.43	4.3	5.3
157	7,178	14Gam Lyr	Lyr	8	9	264.17	55.33	266.14	55.24	3	3.2
158	7,192	15Lam Lyr	Lyr	8	10	264.17	54.75	266.35	54.66	4.3	4.9
159	7,417	6Bet1Cyg	Cyg	9	1	274.5	49	275.49	49.18	3	2.9
160	7,478	12Phi Cyg	Cyg	9	2	279	50.5	279.18	50.81	5	4.7
161	7,615	21Eta Cyg	Cyg	9	3	286.33	54.5	287.28	54.46	3.7	3.9
162	7,796	37Gam Cyg	Cyg	9	4	298.5	57.33	299.24	57.26	3	2.2
163	7,924	50Alp Cyg	Cyg	9	5	309.17	60	309.8	60.01	2	1.3
164	7,528	18Del Cyg	Cyg	9	6	289.33	64.67	290.64	64.57	3	2.9
165	7,469	13The Cyg	Cyg	9	7	292.5	69.67	293.05	69.66	4	4.5

(continued)

Table 1.1 (continued)

#	HR number	Full star name	Constellation			Almagest measurement		Actual (Epoch 137 AD)		V Mag	aV Mag
			Name	#	Star	Long	Lat	Long	Lat		
166	7,420	10Iot2Cyg	Cyg	9	8	291.17	71.5	292.47	71.56	3.7	3.8
167	7,328	1Kap Cyg	Cyg	9	9	286.67	74	289.4	73.93	3.7	3.8
168	7,949	53Eps Cyg	Cyg	9	10	300.83	49.5	301.71	49.47	3	2.5
169	7,963	54Lam Cyg	Cyg	9	11	303.83	52.17	304.09	51.74	3.7	4.5
170	8,115	64Zet Cyg	Cyg	9	12	306.67	44	307.35	43.84	3	3.2
171	8,028	58Nu Cyg	Cyg	9	13	310	55.17	310.55	55.02	3.7	3.9
172	8,079	62Xi Cyg	Cyg	9	14	314.5	57	315.23	56.66	3.7	3.7
173	7,735	31 Cyg	Cyg	9	15	301.17	64	302.57	63.73	4	3.8
174	7,751	32 Cyg	Cyg	9	16	302.67	64.5	304.32	64.41	4	4
175	7,851	46Ome2Cyg	Cyg	9	17	312.17	64.75	311.31	64.26	5	5.4
176	8,130	65Tau Cyg	Cyg	9	18	310.67	49.67	312.67	50.5	3.7	3.7
177	8,143	67Sig Cyg	Cyg	9	19	313.83	51.67	314.72	51.57	3.7	4.2
178	153	17Zet Cas	Cas	10	1	7.83	45.33	9.34	44.58	3.7	3.7
179	168	18Alp Cas	Cas	10	2	10.83	46.75	12.05	46.5	3	2.2
180	219	24Eta Cas	Cas	10	3	13	47.83	14.1	47.41	4	3.4
181	264	27Gam Cas	Cas	10	4	16.67	49	18.2	48.65	2.7	2.5
182	403	37Del Cas	Cas	10	5	20.67	45.5	22.02	46.32	3	2.7
183	542	45Eps Cas	Cas	10	6	27	47.75	28.98	47.36	4	3.4
184	707	Iot Cas	Cas	10	7	31.67	47.33	36.44	48.74	4	4.5
185	343	33The Cas	Cas	10	8	14.67	44.33	15.92	43.02	4	4.3
186	382	34Phi Cas	Cas	10	9	17.67	45	19.76	44.92	5	5
187	9,071	8Sig Cas	Cas	10	10	2.33	50	4.45	49.29	6	4.9
188	130	15Kap Cas	Cas	10	11	15	52.67	16.91	52.11	4.3	4.2
189	21	11Bet Cas	Cas	10	12	7.83	51.67	9.21	51.32	3	2.3
190	9,045	7Rho Cas	Cas	10	13	3.67	51.67	5.4	51.04	6	4.5
191	10,869		Per	11	1	26.67	40.5	28.4	40.17	8	5.8

192	834	15Eta Per	Per	11	2	31.17	37.5	32.87	37.28	4	3.8
193	915	23Gam Per	Per	11	3	32.67	34.5	34.19	34.32	3.3	2.9
194	799	13The Per	Per	11	4	27.5	32.33	28.66	31.52	4	4.1
195	854	18Tau Per	Per	11	5	30.67	34.5	32.08	34.16	4	4
196	937	Iot Per	Per	11	6	31.5	31.17	32.72	30.67	4	4.1
197	1,017	33Alp Per	Per	11	7	34.83	30	36.22	29.92	2	1.8
198	1,052	35Sig Per	Per	11	8	35.33	27.83	36.74	27.82	4	4.4
199	1,087	37Psi Per	Per	11	9	37	27.67	37.88	27.77	4	4.2
200	1,122	39Del Per	Per	11	10	37.67	27.33	38.93	27.1	3	3
201	941	27Kap Per	Per	11	11	30.5	27	31.77	25.97	4	3.8
202	936	26Bet Per	Per	11	12	29.67	23	30.3	22.22	2	2.1
203	947	28Ome Per	Per	11	13	29.17	21	30.51	20.76	4	4.6
204	921	25Rho Per	Per	11	14	27.67	21	28.99	20.44	4	3.4
205	879	22Pi Per	Per	11	15	26.83	22.25	28.04	21.55	4	4.7
206	1,324		Per	11	16	44.83	28	45.92	28.25	4	4.6
207	1,261	47Lam Per	Per	11	17	43	28.17	43.89	28.67	4	4.3
208	1,273	48 Per	Per	11	18	42.33	25	43.61	26.02	4	4
209	1,303	51Mu Per	Per	11	19	44	26.25	44.91	26.48	4	4.1
210	1,350	53 Per	Per	11	20	44.17	24.5	45.73	24.4	5	4.8
211	1,454	58 Per	Per	11	21	46.33	18.75	47.69	18.78	5	4.3
212	1,135	41Nu Per	Per	11	22	36.83	21.83	37.96	21.93	3.7	3.8
213	1,220	45Eps Per	Per	11	23	38.67	19.25	39.79	18.9	3	2.9
214	1,228	46Xi Per	Per	11	24	38.33	14.75	39.08	14.72	4	4
215	1,131	38Omi Per	Per	11	25	34.17	12	35.25	11.97	3.3	3.8
216	1,203	44Zet Per	Per	11	26	36.33	11	37.23	11.12	2.7	2.8
217	1,306	52 Per	Per	11	27	41.83	18	43.25	18.71	5	4.7
218	1,314		Per	11	28	45	31	46.45	31.51	5	5.2
219	840	16 Per	Per	11	29	24.67	20.67	25.89	20.83	7	4.2
220	2,077	33Del Aur	Aur	12	1	62.5	30	63.95	30.67	4	3.7

(continued)

Table 1.1 (continued)

#	HR number	Full star name	Constellation			Almagest measurement		Actual (Epoch 137 AD)		V Mag	aV Mag
			Name	#	Star	Long	Lat	Long	Lat		
221	2,029	30Xi Aur	Aur	12	2	62.33	31.83	63.23	32.02	4	5
222	1,708	13Alp Aur	Aur	12	3	55	22.5	55.93	22.84	1	0.1
223	2,088	34Bet Aur	Aur	12	4	62.83	20	64.02	21.26	2	1.9
224	2,012	32Nu Aur	Aur	12	5	61.17	15.25	62.36	15.48	4	4
225	2,095	37The Aur	Aur	12	6	62.83	13.33	64	13.56	3.7	2.6
226	1,605	7Eps Aur	Aur	12	7	52	20.67	52.94	20.7	3.7	3
227	1,641	10Eta Aur	Aur	12	8	52.17	18	53.53	18.08	3.7	3.2
228	1,612	8Zet Aur	Aur	12	9	52	18	52.73	17.97	4	3.8
229	1,577	3Iot Aur	Aur	12	10	49.83	10.17	50.73	10.22	3.3	2.7
230	1,791	112Bet Tau	Aur	12	11	55.67	5	56.65	5.23	2.7	1.6
231	1,843	25Chi Aur	Aur	12	12	56	8.5	58.25	8.65	5	4.8
232	1,805	24Phi Aur	Aur	12	13	56.33	12.17	57.3	11	5	5.1
233	1,706	14 Aur	Aur	12	14	50.67	10.33	54.6	9.36	6	5
234	6,556	55Alp Oph	Oph	13	1	234.83	36	236.43	36.19	2.7	2.1
235	6,603	60Bet Oph	Oph	13	2	238	27.25	239.44	28.1	3.7	2.8
236	6,629	62Gam Oph	Oph	13	3	239	26.5	240.72	26.4	4	3.8
237	6,281	25Iot Oph	Oph	13	4	223.33	33	224.7	32.76	4	4.4
238	6,299	27Kap Oph	Oph	13	5	224.67	31.83	226.03	32.1	4	3.2
239	6,149	10Lam Oph	Oph	13	6	218.33	24.5	219.64	23.82	4	3.8
240	6,056	1Del Oph	Oph	13	7	215	17	216.36	17.54	3	2.7
241	6,075	2Eps Oph	Oph	13	8	216	16.5	217.52	16.63	3	3.2
242	6,567	57Mu Oph	Oph	13	9	236.67	15	238.4	15.47	4	4.6
243	6,698	64Nu Oph	Oph	13	10	242.33	13.67	243.84	13.97	4.3	3.3
244	6,733	69Tau Oph	Oph	13	11	243.33	14.33	244.86	15.52	4	4.8
245	6,378	35Eta Oph	Oph	13	12	231.17	7.5	232.03	7.39	3	2.4
246	6,445	40Xi Oph	Oph	13	13	233.67	2.25	234.84	2.36	3.7	4.4

247	6,401	36 Oph	Oph	13	14	233	−2.25	234.3	−2.7	4	4.3
248	6,453	42The Oph	Oph	13	15	234.33	−1.5	235.48	−1.59	3.7	3.3
249	6,486	44 Oph	Oph	13	16	235	−0.33	236.41	−0.65	4	4.2
250	6,519	51 Oph	Oph	13	17	235.83	−0.25	237.55	−0.43	5	4.8
251	6,595	58 Oph	Oph	13	18	237.17	1	240.28	1.97	5	4.9
252	6,175	13Zet Oph	Oph	13	19	222.17	11.83	223.29	11.61	3	2.6
253	6,147	8Phi Oph	Oph	13	20	221.67	5.33	222.76	5.45	4.7	4.3
254	6,118	7Chi Oph	Oph	13	21	220.67	3.17	222.06	3.47	5	4.4
255	6,104	4Psi Oph	Oph	13	22	219.83	1.67	221.64	1.81	4.7	4.5
256	6,153	9Ome Oph	Oph	13	23	222.33	0.67	223.7	0.64	5	4.4
257	6,112	5Rho Oph	Oph	13	24	220.67	−0.75	222.52	−1.51	4	4.6
258	6,712	66 Oph	Oph	13	25	242	28.17	244.16	28.06	4	4.6
259	6,714	67 Oph	Oph	13	26	242.67	26.33	244.26	26.62	4	4
260	6,723	68 Oph	Oph	13	27	243	25	244.56	25	4	4.4
261	6,752	70 Oph	Oph	13	28	243.67	27	245.54	26.68	4	4
262	6,771	72 Oph	Oph	13	29	244.67	33	246.29	33.19	4	3.7
263	5,842	21Iot Ser	Ser	14	1	198.83	38	201.16	38.32	4	4.5
264	5,899	38Rho Ser	Ser	14	2	201.67	40	203.5	40.19	4	4.8
265	5,933	41Gam Ser	Ser	14	3	204.33	36	206.36	35.99	3	3.8
266	5,867	28Bet Ser	Ser	14	4	202	34.25	203.87	34.53	3	3.7
267	5,879	35Kap Ser	Ser	14	5	201.33	37.25	203.75	37.35	4	4.1
268	5,972	44Pi Ser	Ser	14	6	203.17	42.5	206.08	42.64	4	4.8
269	5,788	13Del Ser	Ser	14	7	201.67	29.25	202.38	29.07	3	3.8
270	5,868	27Lam Ser	Ser	14	8	204.83	26.5	206.53	26.8	4	4.4
271	5,854	24Alp Ser	Ser	14	9	204.33	25.33	206.02	25.66	3	2.7
272	5,892	37Eps Ser	Ser	14	10	206.33	24	208.29	24.16	3	3.7
273	5,881	32Mu Ser	Ser	14	11	208.83	16.5	210.03	16.47	4	3.5
274	6,129	3Ups Oph	Ser	14	12	218.17	13.25	220.65	13.45	5	4.6
275	6,446	53Nu Ser	Ser	14	13	233.67	10.5	234.35	10.5	4	4.3

(continued)

Table 1.1 (continued)

#	HR number	Full star name	Constellation			Almagest measurement		Actual (Epoch 137 AD)		V Mag	aV Mag
			Name	#	Star	Long	Lat	Long	Lat		
276	6,561	55Xi Ser	Ser	14	14	237	8.5	238.64	8.21	3.7	3.5
277	6,581	56Omi Ser	Ser	14	15	237.83	10.83	239.51	10.77	4	4.3
278	6,710	57Zet Ser	Ser	14	16	243.67	20	244.13	20.02	4	4.6
279	6,869	58Eta Ser	Ser	14	17	248.67	21.17	250.09	21.03	3.7	3.3
280	7,141	63The1Ser	Ser	14	18	258.33	27	259.85	27.1	4	4
281	7,635	12Gam Sge	Sge	15	1	280.17	39.33	281.2	39.38	4	3.5
282	7,546	8Zet Sge	Sge	15	2	276.67	39.17	278.23	39.61	6	5
283	7,536	7Del Sge	Sge	15	3	275.83	39.5	277.58	39.11	5	3.8
284	7,479	5Alp Sge	Sge	15	4	274.67	39	275.25	39.01	5	4.4
285	7,488	6Bet Sge	Sge	15	5	273.33	38.67	275.39	38.45	5	4.4
286	7,669	63Tau Aql	Aql	16	1	277.17	26.83	279.18	27.22	4	5.5
287	7,602	60Bet Aql	Aql	16	2	274.83	27.17	276.61	27.11	3	3.7
288	7,557	53Alp Aql	Aql	16	3	273.83	29.17	275.57	29.38	1.7	0.8
289	7,560	54Omi Aql	Aql	16	4	274.67	30	276.26	31.1	3.3	5.1
290	7,525	50Gam Aql	Aql	16	5	273.17	31.5	275.09	31.46	3	2.7
291	7,610	61Phi Aql	Aql	16	6	276	31.5	278.09	31.71	5	5.3
292	7,429	38Mu Aql	Aql	16	7	269.67	28.67	270.85	28.97	5	4.4
293	7,474	44Sig Aql	Aql	16	8	271.17	26.67	271.95	26.69	4.7	5.2
294	7,235	17Zet Aql	Aql	16	9	262.17	36.67	263.95	36.47	3	3
295	7,570	55Eta Aql	Aql	16	10	273.67	21.67	274.56	21.74	3	3.9
296	7,710	65The Aql	Aql	16	11	278.83	19.17	279.02	18.93	3	3.2
297	7,377	30Del Aql	Aql	16	12	266	25	267.62	25.02	3.7	3.4
298	7,447	41Iot Aql	Aql	16	13	268.5	20	269.96	20.24	3	4.4
299	7,446	39Kap Aql	Aql	16	14	269.67	15.5	268.96	14.57	5	4.9
300	7,236	16Lam Aql	Aql	16	15	261.17	18.17	261.45	17.85	3	3.4
301	7,852	2Eps Del	Del	17	1	287.67	29.17	288.24	29.26	3.3	4

302	7,883	5Iot Del	Del	17	2	288.67	29	289.48	29	4.3	5.4
303	7,896	7Kap Del	Del	17	3	288.67	27.75	289.24	27.7	4	5.1
304	7,882	6Bet Del	Del	17	4	288.5	32	290.48	32.13	3.3	3.6
305	7,906	9Alp Del	Del	17	5	290.17	33	291.55	33.19	3.3	3.8
306	7,928	11Del Del	Del	17	6	291.33	32	292.33	32.12	3.3	4.4
307	7,947	12Gam2Del	Del	17	7	293.17	33.17	293.61	32.96	3.3	3.9
308	7,858	3Eta Del	Del	17	8	287.5	30.25	288.97	30.85	6	5.4
309	7,871	4Zet Del	Del	17	9	287.5	31.83	289.92	32.33	6	4.7
310	7,892	8The Del	Del	17	10	289	31.5	290.41	30.78	6	5.7
311	8,131	8Alp Equ	Equ	18	1	296.33	20.5	297.26	20.32	7	3.9
312	8,178	10Bet Equ	Equ	18	2	298	20.67	299.57	21.17	7	5.2
313	8,097	5Gam Equ	Equ	18	3	296.33	25.5	297.61	25.41	7	4.7
314	8,123	7Del Equ	Equ	18	4	297.67	25	298.65	25.03	7	4.5
315	15	21Alp And	Peg	19	1	347.83	26	348.48	25.72	2.3	2.1
316	39	88Gam Peg	Peg	19	2	342.17	12.5	343.29	12.56	2.3	2.8
317	8,775	53Bet Peg	Peg	19	3	332.17	31	333.47	31.12	2.3	2.4
318	8,781	54Alp Peg	Peg	19	4	326.67	19.67	327.63	19.46	2.3	2.5
319	8,880	62Tau Peg	Peg	19	5	334.5	25.5	335.24	25.57	4	4.6
320	8,905	68Ups Peg	Peg	19	6	335	25	336.06	24.81	4	4.4
321	8,650	44Eta Peg	Peg	19	7	329	35	329.97	35.14	3	2.9
322	8,641	43Omi Peg	Peg	19	8	328.5	34.5	329.17	34.45	5	4.8
323	8,667	47Lam Peg	Peg	19	9	326.17	29	327.24	28.84	4	4
324	8,684	48Mu Peg	Peg	19	10	327	29.5	328.54	29.46	4	3.5
325	8,634	42Zet Peg	Peg	19	11	318.83	18	320.27	17.76	3	3.4
326	8,665	46Xi Peg	Peg	19	12	320.5	19	322.1	18.73	4	4.2
327	8,717	50Rho Peg	Peg	19	13	321.33	15	322.67	14.54	5	4.9
328	8,697	49Sig Peg	Peg	19	14	320.5	16	322.21	15.84	5	5.2
329	8,450	26The Peg	Peg	19	15	309.33	16.5	310.83	16.47	3	3.5
330	8,413	22Nu Peg	Peg	19	16	308	16	309.39	15.76	4	4.8

(continued)

Table 1.1 (continued)

#	HR number	Full star name	Constellation			Almagest measurement		Actual (Epoch 137 AD)		V Mag	aV Mag
			Name	#	Star	Long	Lat	Long	Lat		
331	8,308	8Eps Peg	Peg	19	17	305.33	22.5	306.04	22.22	2.7	2.4
332	8,454	29Pi 2Peg	Peg	19	18	323.33	41.17	323.86	41.03	3.7	4.3
333	8,430	24Iot Peg	Peg	19	19	317.33	34.25	318.48	34.37	3.7	3.8
334	8,315	10Kap Peg	Peg	19	20	312.33	36.83	313.16	36.73	3.7	4.1
335	165	31Del And	And	20	1	355.33	24.5	355.96	24.32	3	3.3
336	154	29Pi And	And	20	2	356.33	27	356.87	27.06	4	4.4
337	163	30Eps And	And	20	3	354.33	23	355.28	23	4	4.4
338	68	25Sig And	And	20	4	353.67	32	354.67	31.51	4	4.5
339	63	24The And	And	20	5	354.67	33.5	355.47	33.29	4	4.6
340	82	27Rho And	And	20	6	355	32.33	355.84	32.32	5	5.2
341	8,965	17Iot And	And	20	7	349.67	41	350.36	40.97	4	4.3
342	8,976	19Kap And	And	20	8	350.67	42	351.55	41.67	4	4.1
343	8,961	16Lam And	And	20	9	352.17	44	352.66	43.92	4	3.8
344	215	34Zet And	And	20	10	354.17	17.5	354.8	17.55	4	4.1
345	271	38Eta And	And	20	11	355.67	15.83	356.55	15.85	4	4.4
346	337	43Bet And	And	20	12	3.83	26.33	4.53	25.91	3	2.1
347	269	37Mu And	And	20	13	2	30	3.29	29.55	4	3.9
348	226	35Nu And	And	20	14	1.83	32.5	3.36	32.45	4	4.5
349	603	57Gam1And	And	20	15	16.83	28	18.39	27.67	3	2.2
350	496	Phi Per	And	20	16	17.17	37.33	18.79	36.69	4.3	4.1
351	464	51 And	And	20	17	15.17	35.67	16.65	35.31	3.7	3.6
352	458	50Ups And	And	20	18	12.33	29	12.92	28.97	4	4.1
353	477	53Tau And	And	20	19	12	28	13.08	27.79	4	4.9
354	335	42Phi And	And	20	20	10.17	35.5	10.65	36.23	5	4.3
355	390	46Xi And	And	20	21	12.67	34.5	12.05	33.68	5	4.9
356	417	48Ome And	And	20	22	14.17	32.5	12.84	33.28	5	4.8

357	8,762	1Omi And	And	20	23	341.67	44	342.08	43.72	3	3.6
358	544	2Alp Tri	Tri	21	1	11	16.5	11.04	16.77	3	3.4
359	622	4Bet Tri	Tri	21	2	16	20.67	16.43	20.46	3	3
360	660	8Del Tri	Tri	21	3	16.33	19.67	17.2	19.48	4	4.9
361	664	9Gam Tri	Tri	21	4	16.83	19	17.65	18.81	3	4
362	545	5Gam2Ari	Ari	22	1	6.67	7.33	7.27	7.09	3.3	4
363	553	6Bet Ari	Ari	22	2	7.67	8.33	8.05	8.42	3	2.6
364	646	17Eta Ari	Ari	22	3	11	7.67	12.15	7.28	5	5.3
365	669	22The Ari	Ari	22	4	11.5	6	12.98	5.6	5	5.6
366	563	8Iot Ari	Ari	22	5	6.83	5.83	7.61	5.34	5	5.1
367	773	32Nu Ari	Ari	22	6	17.67	6	18.24	6	6	5.4
368	887	48Eps Ari	Ari	22	7	21.33	4.83	22.6	3.99	5	4.6
369	951	57Del Ari	Ari	22	8	23.83	1.67	24.86	1.66	4	4.3
370	972	58Zet Ari	Ari	22	9	25.33	2.5	26.06	2.73	4	4.9
371	1,005	61Tau1Ari	Ari	22	10	27	1.83	27.48	2.42	4	5.3
372	869	46Rho3Ari	Ari	22	11	19.67	1.5	20.9	1.15	5	5.6
373	847	43Sig Ari	Ari	22	12	18	−1.5	19.01	−1.45	5	5.5
374	813	87Mu Cet	Ari	22	13	15	−5.25	15.87	−5.67	3.7	4.3
375	617	13Alp Ari	Ari	22	14	10.67	10.5	11.71	9.92	2.7	2
376	838	41 Ari	Ari	22	15	21.67	10.17	22.3	10.33	4	3.6
377	824	39 Ari	Ari	22	16	21.33	12.67	22.43	12.38	5	4.5
378	801	35 Ari	Ari	22	17	19.67	11.17	21.05	11.14	5	4.7
379	782	33 Ari	Ari	22	18	19.17	10.67	20.22	10.73	5	5.3
380	1,066	5 Tau	Tau	23	1	26.33	−6	27.65	−6.11	4	4.1
381	1,061	4 Tau	Tau	23	2	26	−7.25	27.16	−7.63	4	5.1
382	1,038	2Xi Tau	Tau	23	3	24.33	−8.5	25.95	−8.97	4	3.7
383	1,030	1Omi Tau	Tau	23	4	24.33	−9.25	25.27	−9.5	4	3.6
384	1,174	30 Tau	Tau	23	5	29.67	−9.5	31.4	−8.83	5	5.1
385	1,239	35Lam Tau	Tau	23	6	33.67	−8	34.7	−8.17	3	3.5

(continued)

Table 1.1 (continued)

#	HR number	Full star name	Constellation Name	#	Star	Almagest measurement Long	Lat	Actual (Epoch 137 AD) Long	Lat	V Mag	aV Mag
386	1,320	49Mu Tau	Tau	23	7	36.67	−12.67	37.63	−12.39	4	4.3
387		38Nu Tau	Tau	23	8	33	−14.83	33.97	−14.66	4	3.9
388	1,473	90 Tau	Tau	23	9	42.17	−10	43.77	−9.72	4	4.3
389	1,458	88 Tau	Tau	23	10	43	−13	42.84	−11.94	4	4.3
390	1,346	54Gam Tau	Tau	23	11	39	−5.75	39.82	−5.94	3.3	3.7
391	1,373	61Del1Tau	Tau	23	12	40.33	−4.25	40.89	−4.17	3.3	3.8
392	1,411	77The1Tau	Tau	23	13	40.83	−5.83	41.98	−5.96	3.3	3.8
393	1,457	87Alp Tau	Tau	23	14	42.67	−5.17	43.84	−5.6	1	0.9
394	1,409	74Eps Tau	Tau	23	15	41.83	−3	42.49	−2.77	3.3	3.5
395	1,547	97 Tau	Tau	23	16	47.17	−4	47.79	−3.85	4	5.1
396	1,656	104 Tau	Tau	23	17	50.33	−5	51.33	−4.45	5	5
397	1,658	106 Tau	Tau	23	18	50	−3.5	51.88	−2.7	5	5.3
398	1,910	123Zet Tau	Tau	23	19	57.67	−2.5	58.86	−2.43	3	3
399	1,497	94Tau Tau	Tau	23	20	45.67	−0.25	46.24	0.49	4	4.3
400	1,791	112Bet Tau	Tau	23	21	55.67	5	56.65	5.23	3	1.6
401	1,392	69Ups Tau	Tau	23	22	42	0.5	42.53	0.91	5	4.3
402	1,387	65Kap1Tau	Tau	23	23	41.67	0.25	42.24	0.43	5	4.2
403	1,256	37 Tau	Tau	23	24	37	0.67	37.5	1.08	5	4.4
404	1,329	50Ome2Tau	Tau	23	25	39	−1	40.17	−0.95	6	4.9
405	1,287	44 Tau	Tau	23	26	38.5	5	39.77	5.11	5	5.4
406	1,269	42Psi Tau	Tau	23	27	38	7.33	39.44	7.72	5	5.2
407	1,369	59Chi Tau	Tau	23	28	42	3	42.2	3.8	5	5.4
408	1,348	52Phi Tau	Tau	23	29	41.67	5	42.02	5.61	5	4.9
409	1,140	16 Tau	Tau	23	30	32.17	4.5	33.52	4.18	5	5.5
410	1,142	17 Tau	Tau	23	31	32.5	3.67	33.5	4	5	3.7
411	1,165	25Eta Tau	Tau	23	32	33.67	3.33	34.08	3.86	5	2.9

412	1,188		Tau	23	33	33.67	5	35.03	5.2	4	5.3
413	1,101	10 Tau	Tau	23	34	25	−17.5	26.17	−18.42	4	4.3
414	1,620	102Iot Tau	Tau	23	35	50	−2	50.83	−1.42	5	4.6
415	1,739	109 Tau	Tau	23	36	54	−1.75	54.65	−1.21	5	4.9
416	1,810	114 Tau	Tau	23	37	56	−2	56.58	−1.53	5	4.9
417	1,990	130 Tau	Tau	23	38	59	−6.33	61.08	−5.92	5	5.5
418	1,985	129 Tau	Tau	23	39	59	−7.67	60.86	−7.82	5	6
419	1,821	118 Tau	Tau	23	40	57	0.67	57.12	1.67	5	5.5
420	1,928	125 Tau	Tau	23	41	59	1	59.52	2.3	5	5.2
421	2,002	132 Tau	Tau	23	42	61	1.33	61.58	0.91	5	4.9
422	2,034	136 Tau	Tau	23	43	62.33	3.33	62.6	3.94	5	4.6
423	2,084	139 Tau	Tau	23	44	63.33	1.25	63.63	2.27	5	4.8
424	2,890	66Alp Gem	Gem	24	1	83.33	9.5	84.4	9.96	2	1.6
425	2,990	78Bet Gem	Gem	24	2	86.67	6.25	87.6	6.54	2	1.1
426	2,540	34The Gem	Gem	24	3	76.67	10	75.19	10.81	4	3.6
427	2,697	46Tau Gem	Gem	24	4	78.67	7.33	79.53	7.54	4	4.4
428	2,821	60Iot Gem	Gem	24	5	82	5.5	83.09	5.58	4	3.8
429	2,905	69Ups Gem	Gem	24	6	84	4.83	85.43	5.05	4	4.1
430	2,985	77Kap Gem	Gem	24	7	86.67	2.67	87.75	2.88	4	3.6
431	2,808	57 Gem	Gem	24	8	81.67	2.67	82.96	2.75	5	5
432	2,846	63 Gem	Gem	24	9	83.17	0.33	84.44	−0.62	5	5.2
433	2,473	27Eps Gem	Gem	24	10	73	1.5	74.02	1.83	3	3
434	2,650	43Zet Gem	Gem	24	11	78.25	−2.5	79.08	−2.28	3	3.8
435	2,777	55Del Gem	Gem	24	12	81.67	−0.5	82.61	−0.41	3	3.5
436	2,763	54Lam Gem	Gem	24	13	81.67	−6	82.89	−5.85	3	3.6
437	2,216	7Eta Gem	Gem	24	14	66.5	−1.5	67.55	−1.13	3.7	3.3
438	2,286	13Mu Gem	Gem	24	15	68.5	−1.25	69.35	−1.01	3.7	2.9
439	2,343	18Nu Gem	Gem	24	16	70.17	−3.5	70.89	−3.29	3.7	4.2
440	2,421	24Gam Gem	Gem	24	17	72	−7.5	73.19	−6.95	3	1.9

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