Christian Mayer's Double Star Catalog of 1779

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Abstract: I discuss modern reviews of the first double star catalog in the history of astronomy by comparing the historical data set with current values or ephemeris.

Christian Mayer was a German astronomer, who initiated the construction of an astronomical observatory in the city of Mannheim in 1771. His observatory was completed in 1775 and Mayer began his observations in January 1776 with a 2.5 inch achromatic telescope made by Peter Dollond in England. The focal length was about 8 feet and 1 inch. For his observations he used a power of 85. The telescope was mounted on an 8 foot mural quadrant made by John Bird also in England. It was Bird's last mural quadrant, see Figure 1. Figure 2 shows a part of Mayer's observation notes from January 24 and 25, 1776 after mounting the mural quadrant.

Mayer's interest was the study of the proper motion of the stars. During his observations, he often remarked on the stars that stood close together. During the time from 1776 to 1777 he found about 100 such close systems. He gives an account of his observations in the academy in Mannheim in 1777. Mayer believed in the physical togetherness of such systems, called "Doppel(t)sterne". His account was published in newspapers in different countries (Mayer, 1778).

Much criticism came from Maximilian Hell, a well known astronomer, who lived in Vienna. It came to a public dispute between them, published in the news paper in Mannheim and Vienna. Hell's opinion was that the faint companions are background stars and not physically connected with the brighter primary stars (Mayer, 1778). At the end of their dispute, Hell said, "Mayer shall compile a table with his double stars, so every astronomer can observe them when he wants." Hell's demand for a table of Mayer's double stars was Mayer's motive for publishing the first double star catalog in history of astronomy.

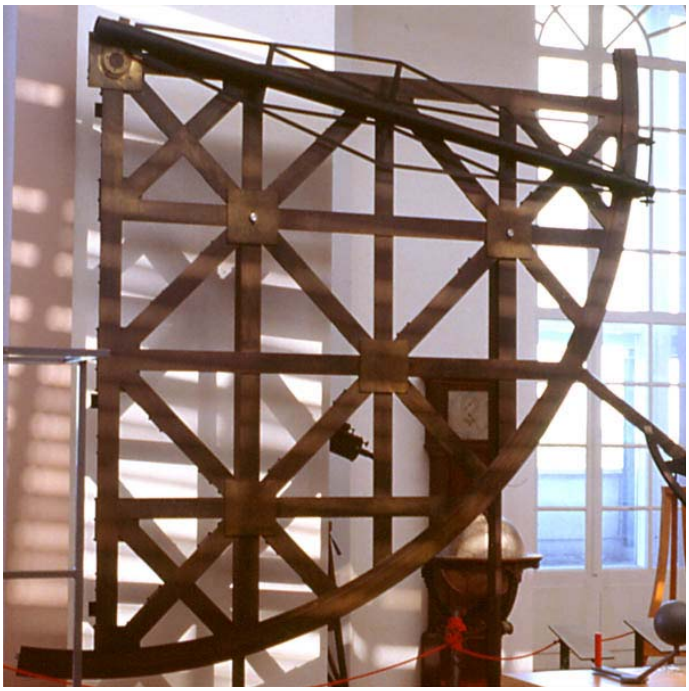

Figure 1: Mayer's mural quadrant from 1776. Photo: J.S. Schlimmer, 2005

In its first version in 1779, the catalog included 72 double stars (Mayer, 1779). Two years later, Mayer's catalog was published in an astronomical circular by the Berlin astronomer Johann Elert Bode, who added 8 more well known double stars (Bode, 1781). In the

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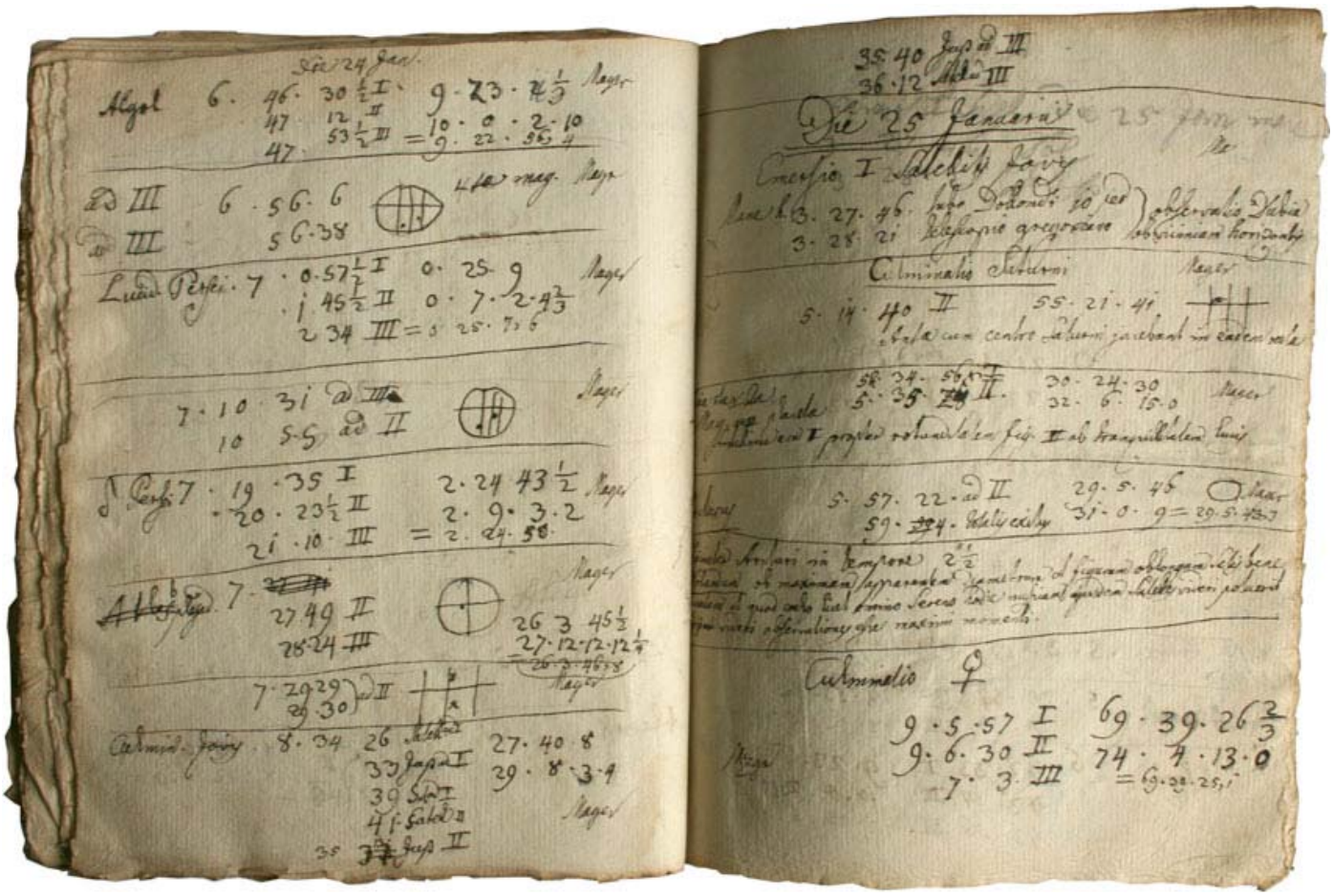

Figure 2: Mayer's observation notes from January 24 and 25 1776, photo: J. S. Schlimmer 2007

1781 version, the catalog included 80 double stars. The closest system was 5 epsilon Lyrae with a separation of 2.9 arc seconds. It gives us a good impression of the quality of Mayer's telescope. The minimum separation of a perfect 2.5 inch reflector is about 1.7".

William Herschel heard in 1779 about Mayer's work and started his own observations of double stars. His intention was not to study the proper motion, he wanted to measure parallax (Herschel, 1782). Their method of operation in making their measurements was very different. With a mural quadrant, differences in declination were pick up directly, the differences in right ascension were measured with help of an astronomical pendulum clock (Mayer, 1778). With a declination of 0 degree, a star moves 15 arc second in one time second. In this way measurements were done in Cartesian coordinates. In opposition to Mayer Herschel measured the separation and the position angle directly in polar coordinates by comparing his observation with the placement of his lamp micrometer. In 1782 Herschel published his first double star catalog in the Philosophical Transactions.

In Mayer's catalog, often the stars had no name, but the coordinates for the year of his observations 1777 and 1778 are described. Because the precession of the earth's axis, the coordinates are obsolete. For example, gamma Arietis has moved 12 arc minutes in right ascension and 1 degree in declination. The first step of my review of Mayer's catalog was to calculate the current coordinates. With the, new coordinates many unnamed doubles could be identified.

The second step of my review was to transform Mayer's Cartesian coordinates into polar coordinates. Because the way a star moves in time depends on its

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declination, the calculations were done by the individual declinations of 1778.

Mayer's observation results could then be checked by comparison with current values of separation and angular position. Often there is no movement between the companions and separation and position angle are the same as in 1778. However, for some double star systems there is an orbit. With known orbital elements the position angle and separation can be calculated for 1778 and used for comparison. In some cases of components with equal brightness the position angles disagree by about 180 degrees.

By checking Mayer's values with data sets of The Washington Double Star Catalog, I often found entries for 1777 with equal or similar values cited by Herschel, Lewis and Strand (Mason, et al. 2007).

In the following table you'll find my calculations based on Mayer's observations of 1778 described in detail in his "Tabula Nova Stellarum Duplicium" (Mayer, 1779). Mayer 8, Mayer 10, Mayer 15, Mayer 32, Mayer 37, Mayer 48, Mayer 51 and Mayer 63 were not included in Mayer's first catalogue of 1779. The value of those stars were in the astronomical circular of Bode in 1781.

In some cases, I couldn't identify Mayer's observations. For Mayer 10, Mayer 16, Mayer 26, Mayer 27, Mayer 45, Mayer 53, Mayer 63, Mayer 69, Mayer 71, Mayer 74 and Mayer 78 I give the double stars which best match Mayer's transformed coordinates. In other cases like alpha Arietis or omega Piscis, the stars are not visual double stars.

Figure 3 represents the relative error of Mayers distance measurements. In 12 cases the error is under 5%, in 7 cases the error lies between 5 and 10%, and in a further 14 cases the error lies between 10 and 20%. In some cases the relative error is explained by the independent movement of the components e.g. with Mayer 36. In other cases, for example with Castor (Mayer 21), incorrect time measurement of the distance in right ascension significantly affects the results.

With a relative error of nearly 300%, Mayers measurements of 54 Virginis (Mayer 35) are the worst. Out of 57 measurements between 1777 and 2006 it follows that neither distance nor position angle has changed.

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(Continued on page 158)

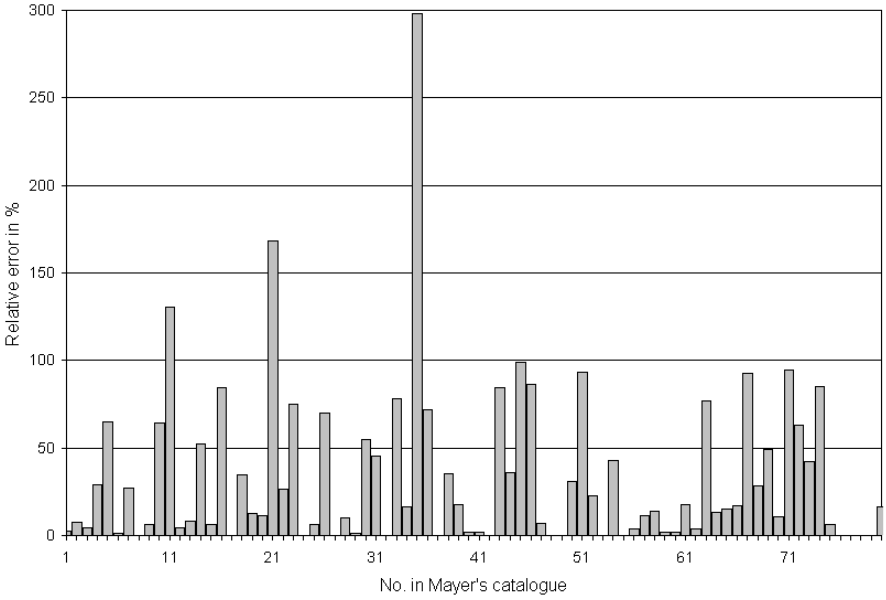

Figure 3: Relative error for Mayers' distance measurements for each double star system in his catalog.

No.	Mayer's Description	Current Description	Code	WDS Identifier	Sep. 1778	Sep. 2007	Sep. Diff.	pa 1778	pa 2007	pa diff	mag. WDS	note
Mayer 1	Andromeda	HIP3617	STFA 1	00464+3057	45.9	47.1	-1.2	238	46	192	7.25,7.43	
Mayer 2	Androm.	74 ψ Pisces	STF 88AB	01057+2128	32.5	30.3	2.2	154	159	-5	5.27,5.45	
Mayer 3	zeta Fische	ζ Piscis	STF 100AB	01137+0735	24.3	23.3	1.0	67	63	4	5.22,6.15	
Mayer 4	bei my Fische	BSC 419	STF 122	01269+0332	4.2	5.9	-1.7	180	328	-148	6.65,9.51	
Mayer 5	Gamma Widder	γ Arietis	STF 180AB	01535+1918	12.5	7.6	4.9	193	0	193	4.52,4.58	
Mayer 6	Lambda Widder	λ Arietis	H 5 12AB	01579+2336	38.7	38.2	0.5	46	47	-1	4.80,6.65	
Mayer 7	Gamma Andromeda	γ Andromedae	STF 205A-BC	02039+4220	12.2	9.6	2.6	62	63	-1	2.31,5.02	
Mayer 8	Alpha Widder	α Arietis	-	-	-	-	-	-	-	-	2.0	1,2
Mayer 9	30 Widder	30 Arietis	STFA 5	02370+2439	41.4	39.0	2.4	276	275	1	6.50,7.02	
Mayer 10	Wahlfisch	BSC 587	HJ 3476AB	02004-0831	22.2	62.6	-40.4	98	200	-102	5.5,9.8	1
Mayer 11	Stier	BSC 1065	STF 401	03313+2734	26.7	11.6	15.1	90	270	-180	6.58,6.93	
Mayer 12	tau Stier	τ 94 Taurus	S 455Aa-B	04422+2257	60.3	63.0	-2.7	210	214	-4	4.24,7.02	
Mayer 13	Stier	BSC 1600	SHJ 49AB	04590+1433	43.6	40.3	3.3	303	305	-2	6.06,7.43	
Mayer 14	Orion	σ Orionis	STF 762AB,C	05387-0236	25.8	13.4	12.4	36	84	-49	3.76,6.56	
		σ Orionis	STF 762AB,E	05387-0236	36.6	41.5	-4.9	55	62	-7	3.76,6.34	
Mayer 15	Delta Orion	δ Orionis	STFA 14Aa-C	05320-0018	50.0	53.3	-3.3	0	1	-1	2.41,6.83	1
Mayer 16	bei Zeta Orion	TYC 4771-01005-1	A 291.8A-BC	05441-0229	15.0	94.8	-79.8	90	316	-226	9.43,9.77	
Mayer 17	Zwillinge	-	-	-	72.9	-	-	310	-	-	-	2
Mayer 18	Or. (11 Einh.)	Or. (11 Einh.)	STF 919AB	06288-0702	9.6	7.1	2.5	322	133	189	4.62,5.00	
Mayer 19	30 Zwillinge	HIP 31158	STF 924AB	06323+1747	22.2	19.7	2.5	211	211	0	6.31,6.88	
Mayer 20	Zwillinge	HIP 31323	S 524AB	06341+2207	47.0	53	-6.0	62	244	-182	7.17,7.41	
Mayer 21	Castor	α Gemini	STF1110AB	07346+3153	9.6	3.6	6.0	293	310	-17	1.93,2.97	3
Mayer 22	Zeta Krebs	ζ Cancri	STF1196AB-C	08122+1739	7.7	6.1	1.6	180	181	-1	5.05,6.20	
Mayer 23	2. Phi Krebs	2 Phi Cancri	STF1223	08268+2656	8.8	5.0	3.8	131	215	.-84	6.16,6.21	11

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No.	Mayer's Description	Current Description	Code	WDS Identifier	Sep. 1778	Sep. 2007	Sep. Diff.	pa 1778	pa 2007	pa diff	mag. WDS	note
Mayer 24	Krebs, dunkel	24 Canceri	STF1224A-BC	08267+2432		5.4	-5.4		50	-50	6.92,7.53	
Mayer 25	iota Krebs	ι Canceri	STF1268	08467+2846	32.6	30.7	1.9	307	308	-1	4.13,5.99	
Mayer 26	bei pi Krebs	TYC0825-01529-1	STT 569Aa-C	09123+1500	6.0	20	-14.0	0	216	-216	6.56,10.40	
Mayer 27	bei pi Krebs	-	-	-	-	-	-	-	-	-	-	2
Mayer 28	54 Löwe	54 Leonis	STF1487	10556+2445	7.2	6.5	0.7	110	112	-2	4.48,6.30	
Mayer 29	bei tau Löwe Nr. 83	83 Leonis	STF1540AB	11268+0301	28.9	28.6	0.3	51	150	-99	6.55,7.50	
Mayer 30	tau Löwe	τ Leonis	STFA 19AB	11279+0251	39.9	88.9	-49.0	158	181	-23	5.05,7.47	
Mayer 31	a Wasserschlange	BSC4443	H 3 96	11323-2916	13.6	9.4	4.2	137	210	-73	5.64,5.73	
Mayer 32	Haar der Berenike	BSC4698	STF1633	12207+2703	-	8.9	-	-	245	-	7.04,7.13	1
Mayer 33	gamma Jungfrau	γ Virginis	STF1670AB	12417-0127	9.8	5.5	4.3	130	314	-184	3.48,3.53	4
Mayer 34	12 Jagdhunde	α Canis Venatici	STF1692	12560+3819	22.4	19.3	3.1	226	229	-3	2.85,5.52	
Mayer 35	54 Jungfrau	54 Virginis	SHJ 151	13134-1850	21.5	5.4	16.1	266	34	232	6.78,7.19	
Mayer 36	Jungfrau	HIP64638	SHJ 162Aa-B	13149-1122	30.3	107.6	-	77	-	-	7.11,8.18	5
Mayer 37	Zeta gr. Bären *)	ζ Ursa Majoris	STF1744AB	13239+5456	0.0	13.9	-13.9		153	-153	2.23,3.88	1
Mayer 38	Pi Bootes	π 29 Bootes	STF1864AB	14407+1625	7.4	5.5	1.9	106	111	-5	4.88,5.79	
Mayer 39	Beta Scorpion	β Scorpii	H 3 7AC	16054-1948	15.4	13.1	2.3	40	24	16	2.59,4.52	
Mayer 40	Ny Scorpion	ν Scorpii	H 5 6Aa-C	16120-1928	42.0	41.2	0.8	336	338	-2	4.35,5.31	
Mayer 41	12 im Herkules	36 Hercules	STFA 31Aa-B	16406+0413	70.3	69.1	1.2	228	229	1	5.76,6.92	
Mayer 42	alpha Ophiuch.	α Ophiuchi	-	-	13.2	-	-	180	-	-	-	2
Mayer 43	alpha Herkules	α Hercules	STF2140Aa-B	17146+1423	8.7	4.7	4.0	118	105	13	3.48,5.40	
Mayer 44	39 Ophiuch.	39 Ophiuchi	H 3 25	17180-2417	14.0	10.3	3.7	180	352	-172	5.23,6.64	
Mayer 45	71 Herkules	70 (!) Hercules	S 687AB	17209+2430	2.4	224.7	-222.3	90	56	34	5.12,9.33	
Mayer 46	roh Herkules	ρ Hercules	STF2161Aa-B	17237+3709	7.6	4.1	3.5	291	319	-28	4.50,5.40	
Mayer 47	61 Ophiuch.	61 Ophiuchi	STF2202AB	17446+0235	19.9	21.3	-1.4	102	93	9	6.13,6.47	

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No.	Mayer's Description	Current Description	Code	WDS Identifier	Sep. 1778	Sep. 2007	Sep. Diff.	pa 1778	pa 2007	pa diff	mag. WDS	note
Mayer 48	b Schützen	β Sagittarius	DUN 226	19226-4428	-	28.6	-	-	76	-	3.98,7.21	1
Mayer 49	beim Oph.	-	-	-	1.4	-	-	90	-	-	-	2
Mayer 50	Herkul.	95 Her	STF2264	18015+2136	8.5	6.5	2.0	260	257	3	4.85,5.20	
Mayer 51	rho Ophiuchi	ρ Ophiuchi	H 2 19AB	16256-2327	7.6	3.1	2.9	90	340	-250	5.07,5.74	1
Mayer 52	Herkules	100 Her	STF2280Aa-B	18078+2606	17.5	14.3	3.2	180	183	-3	5.81,5.84	
Mayer 53	Schlange	HIP89489	STF2296	18157-0321	0.0	3.3	-3.3	90	6	84	7.48,10.22	
Mayer 54	Schütze	BSC6848	SHJ 264AB-C	18187-1837	9.9	17.5	-7.6		51	-51	6.86,7.63	
Mayer 55	Ophiuchus	61 Serpentis	-	-	2.0	-	-	0	-	-	-	2
Mayer 56	zeta Leyer	ζ Lyrae	STFA 38AD	18448+3736	45.3	43.6	1.7	148	150	-2	4.34,5.62	
Mayer 57	epsilon Leyer	4 ε Lyrae	STF2382AB	18443+3940	3.8	3.4	0.4	38	31	7	5.15,6.10	6
Mayer 58	5. Leyer	5 ε Lyrae	STF2383Cc-D	18443+3940	2.5	2.9	-0.4	180	155	25	5.25,5.38	7
Mayer 59	beta Leyer	β Lyrae	STF 39AB	18501+3322	48.4	47.4	1.0	151	149	2	3.63,6.69	
Mayer 60	theta Schlange	θ Serpentis	STF2417AB	18562+0412	23.4	23.0	0.4	106	104	2	4.59,4.93	
Mayer 61	eta Leyer	η Lyrae	STF2487AB	19138+3909	23.5	28.6	-5.1	90	81	9	4.38,8.58	
Mayer 62	beta Schwan	β Lyrae	STFA 43Aa-B	19307+2758	33.9	35.3	-1.4	54	54	0	3.19,4.68	
Mayer 63	bei gamma Schwan	HIP104064	STF2753	21050+3526	7.0	29.9	-22.9	180	336	-156	7.38,10.74	1
Mayer 64	omega Steinbock	ω Capricornus	SHJ 324	20299-1835	25.6	22.6	3.0	242	239	3	5.91,6.68	
Mayer 65	Delphin	BSC7840	STF2690Aa-BC	20312+1116	15.2	17.8	-2.6	103	255	-152	7.12,7.39	
Mayer 66	über beta Delphin	HIP101698	STF2703AB	20368+1444	29.5	25.2	4.3	249	290	-41	8.35,8.42	
Mayer 67	gamma Delphin	γ Delphinus	STF2727	20467+1607	17.5	9.1	8.4	278	266	12	4.36,5.03	
Mayer 68	beim Füllen	ε Equuleus	STF2737AB-C	20591+0418	13.8	10.7	3.1	78	67	11	5.30,7.05	
Mayer 69	Schwan	HIP104064	STF2753	21050+3526	15.3	29.9	-14.6	126	336	-210	7.38,10.74	
Mayer 70	Schwan	61 Cygni	STF2758AB	21069+3845	15.3	13.8	1.5	51	48	3	5.35,6.10	8
Mayer 71	Schwan	HIP104417	S 779	21091+3844	6.0	111.6	-105.6	180	11	169	7.61,9.57	

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No.	Mayer's Description	Current Description	Code	WDS Identifier	Sep. 1778	Sep. 2007	Sep. Diff.	pa 1778	pa 2007	pa diff	mag. WDS	note
Mayer 72	my Schwan	μ Cygni	STF2822AB	21441+2845	11.2	6.9	4.3	109	109	0	4.75,6.18	9
Mayer 73	Wassermann	HD 208718	STF2848	21580+0556	15.5	10.9	4.6	75	57	18	7.21,7.73	
Mayer 74	Zeta Wassermann	74 ψ Pisces	STF 88AB	01057+2128	4.6	30.3	-25.7	221	156	65	5.27,5.45	
Mayer 75	Wassermann	HIP114702	STF2993AB	23141-0855	26.0	24.4	1.6	180	177	3	7.60,8.17	
Mayer 76	Wassermann	HD 220436	STF3008	23238-0828	-	6.3	-	-	151	-	7.21,7.67	
Mayer 77	Fische	HIP116035	STF3019	23307+0515	-	10.4	-	-	184	-	7.77,8.37	
Mayer 78	Andromeda	TYC2772-00004-1	SHJ 358	23543+3154	0.0	36.5	-	-	334	-	8.25,10.37	
Mayer 79	omega Fische	ω Piscis	-	-	-	-	-	-	-	-	-	2
Mayer 80	Andromeda	BSC9075	STF3050	23595+3343	4.3	3.7	0.6	180	179	1	6.46,6.72	10

Description :

Column 1 : Number from (Bode, 1781)

Column 2 : Mayer's Description from (Bode, 1781)

Column 3 : Current Description from (Hoffleit, 1991) and Redshift 5

Column 4 : Code from Washington Double Star Catalog

Column 5 : Separation for 1778 from (Mayer,1779) except note 1

Column 6 : Current separation from Washington Double Star Catalog except note 3,4,6-10,11

Column 7 : Separation differences = Column 5 – Column 6

Column 8 : Position angle for 1778 from (Mayer, 1779), except note 1

Column 9 : Current position angle from Washington Double Star Catalog, except note 3,4,6-10,11

Column 10: Position angle differences = Column 8 – Column 9

Column 11: Brightness from Washington Double Star Catalog

Column 12: Notes

Notes:

1. Published first in Bode's astronomical yearbook in 1781
2. No double star
3. Ephemeris for 1778, Doc1985
4. Ephemeris for 1778, Sca2006b
5. The proper motion is 0.37"/year
6. Ephemeris for 1778, Nov.2006e
7. Ephemeris for 1778, Doc1984b
8. Ephemeris for 1778, Kis1997
9. Ephemeris for 1778, Hei1995
10. Ephemeris for 1778, Sta1977b
11. Ephemeris for 1778, Hei1996b

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