Known Binaries Excel Spreadsheet

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A useful spreadsheet collating double star parameters from multiple sources (WDS, 6th Orbit and associated Ephemerides catalogs) was created to aid in choosing large target lists for robotic telescope observations. The resulting 2792 pairs are easily sortable and searchable for various parameters. Histograms of interesting parameters help visualize the data.

Introduction

The Sixth Catalog of Orbits of Visual Binary Stars contains information on the orbital elements (and orbital plots) and predicted future positions (ephemerides) of known binary stars and is maintained by the United States Naval Observatory and hosted online at http://www.astro.gsu.edu/wds/orb6.html (R. Matson et al. 2022).

The Washington Double Star Catalogue (WDS) is a catalogue of double stars also maintained by the United States Naval Observatory. It currently contains 154,902 double stars as of July 2022, including all of the binary stars in the Sixth Orbit Catalog. The WDS can be accessed at http://www.astro.gsu.edu/wds/ (Worley, et al. 1997).

The increasingly sophisticated hardware and software that allows for automated observing runs of large numbers of double stars favors a streamlined method of creating target lists. The authors and others, for example, are using known binaries to explore the automated speckle interferometry capabilities of 0.6 - and 1.0-meter robotic PlaneWave Instrument telescopes at La Sauce Observatory in Chile, observing dozens of stars a night.

Spreadsheet Generation

To generate target lists for our observations, we decided to combine the information contained in both the "Orbital Elements" and "Ephemerides" sections of the *Sixth Catalog of Orbits of Visual Binary Stars* with relevant information in the *Washington Double Star Catalog* together in an Excel spreadsheet format for convenient searching and filtering.

To that end, the entire Sixth Orbit catalog Orbital Elements listing (3460 entries) was collated with the 6th Ephemerides listing after the removal of five stars in the former that are not included in the latter. The resulting data was augmented with the following WDS data:

- First and last Observations
- Primary and secondary magnitudes (in either v, k or r bands, as noted)
- Primary (and secondary, if listed) spectral types
- Number of observations

To avoid including multiple orbital solutions, 540 redundant or outdated orbital solutions were deleted. Finally, only graded orbits (1 through 5) were included, leaving 2792 pairs.

Some telescope users prefer RA and Dec coordinates in decimal form, so these have been provided. An additional column was added to show orbital periods in decimal years. Finally, a column was added (DDThe) that provides the difference between the projected absolute change in position angle θ from 2022 to 2023 from the Ephemerides and the rough annual expected change in θ, calculated from the given period by assuming a circular orbit and dividing 360° by the given period, in years.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	WDS	Discoverer	PMag	SMag	B	Dmag	Period	DThe	G	First	Last	#	Plot	P Spectral	hhmmss.ss+ddmmss.s	Dcml RA	Dcml Dec	The22	The23	Rho22	Rho23	Drho	Ref	DDThe
2	00003-4417	I 1477	6.80	7.56	v	0.76	384.1	1.1	5	1926	2001	31	X	G3IV	000019.10-441726.0	0.07958	-44.29056	131.4	132.5	0.374	0.401	0.027	Cve2010e	0.163
3	00006-5306	HJ 5437	6.55	9.85	v	3.3	904.0	0.7	5	1836	2019	30	X	G0/2IV	000034.35-530551.8	0.14313	-53.09772	340.9	341.6	1.315	1.3	-0.015	Izm2019	0.302
4	00008+1659	BAG 18	8.79	12.60	v	3.81	66.6	2.6	5	2001	2019	10	X	K0	000048.09+165917.5	0.20038	16.98819	327.3	324.7	0.727	0.728	0.001	Tok2019c	2.804
5	00014+3937	HLD 60	9.09	9.77	v	0.68	217.3	0.3	3	1881	2020	155	X	K0V+K1V	000123.67+393638.2	0.34863	39.61061	164.7	164.4	1.33	1.332	0.002	Izm2019	1.357
6	00015+3044	HO 208	8.20	9.81	v	1.61	649.6	0.4	5	1884	2016	42	X	G0IV	000129.19+304408.7	0.37163	30.73575	184.9	184.5	1.01	1.002	-0.008	Izm2019	0.154
7	00021-6817	I 699AB	9.71	10.56	v	0.85	290.0	0.2	5	1907	2015	15	X	K5/M0V	000208.72-681650.6	0.53633	-68.28072	131.5	131.7	4.223	4.217	-0.006	Zir2013d	1.041
8	00022+2705	BU 733AB	5.83	8.90	v	3.07	26.3	9.3	1	1878	2015	196	X	G5Vb+K5V	000210.18+270455.6	0.54242	27.08211	141.9	151.2	0.789	0.785	-0.004	Sod1999	4.399
9	00024+1047	A 1249AB	9.37	9.91	v	0.54	129.7	0.5	4	1905	2017	31	X	G0	000225.33+104635.9	0.60554	10.77664	244.1	243.6	0.309	0.319	0.01	Zir2003	2.275
10	00026-0829	A 428	9.82	10.07	v	0.25	415.0	6.2	4	1902	2018	44	X	G0	000238.92-082916.6	0.66217	-8.48794	272.6	266.4	0.106	0.109	0.003	Tok2015c	5.332

Figure 1: First 10 rows of the final spreadsheet.

Except for adding in the new columns described above, the column parameters are the same as in the original Orbital Elements, Ephemerides, and WDS listings, with some rearrangement of columns. Please refer to the catalogs for a full explanation of these column header parameters. However, we have renamed many of the parameters to provide a spreadsheet width compatible with including target lists in published papers. Table 1 lists the parameters.

Table 1: Parameter abbreviations and names

Parameter	**Name on Spreadsheet**	**Sixth Orbit or WDS**
WDS catalog name	WDS	WDS
Discoverer code	Discoverer	DD, Name, or Discovr
Primary star magnitude	PMag	V1
Secondary star magnitude	SMag	V2
Spectral Band	B	B
Absolute difference in magnitudes	DMag	
Period in decimal years	Period	ppppp.pppppp
Delta Theta, 2022 to 2023	DThe	
Grade (1-9)	G	G or Grade
First Observation	First	First
Last Observation	Last	Last
# of Observations	#	#
Plot Image	Plot	P
Primary + Secondary Spectral Type	P Spectral	Spectral Type
J2000 RA/Dec address	hhmmss.ss+ddmmss.s	RA, Dec (J2000)
Decimal RA address	Dcml RA	
Decimal Dec address	Dcml Dec	
Position angle 2022	The22	Theta 2022.0
Position angle 2023	The23	Theta 2023.0
Separation 2022	Rho22	Rho 2022.0
Separation 2023	Rho23	Rho 2023.0
Delta Rho 2022-2023	DRho	
Reference	Ref	Ref….
Delta Delta theta (see note above)	DDThe	

Histograms

Histograms of interesting parameters from the data are presented below and included in a separate tab in the spreadsheet.

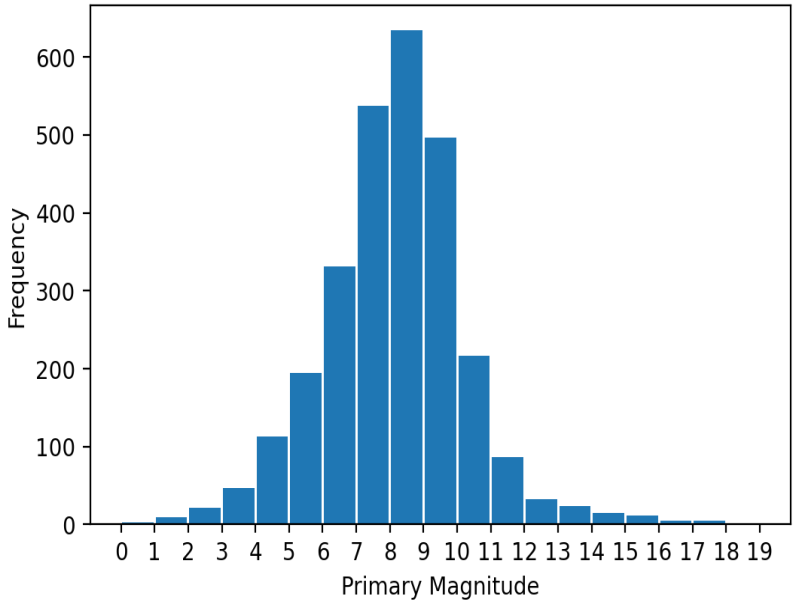

Figure 2: Frequency of Primary Magnitudes (those greater than 19 were ignored)

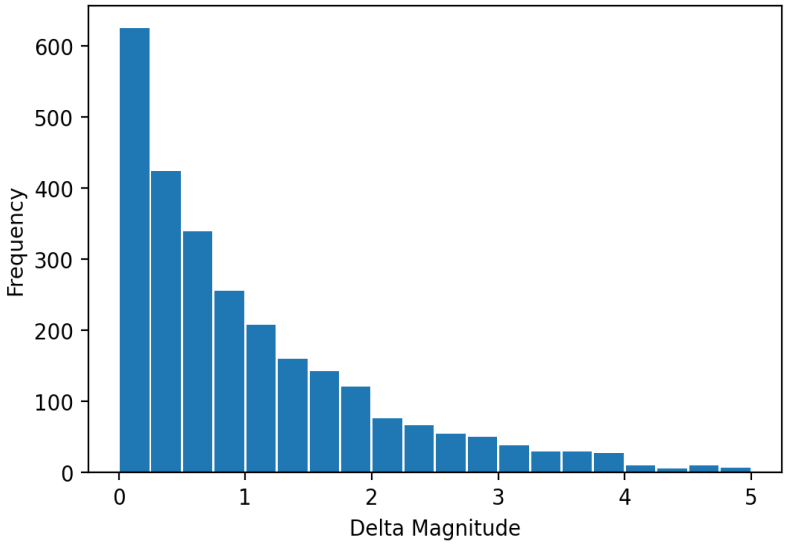

Figure 3: Frequency of Delta Magnitudes (those greater than 5.0 were ignored)

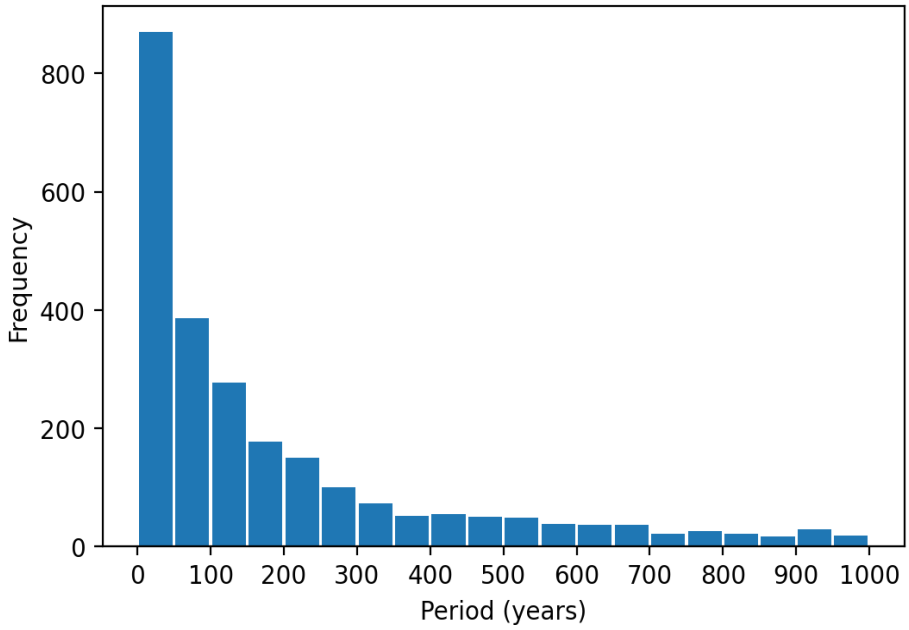

Figure 4: Frequency of Periods (those greater than 1000 years were ignored)

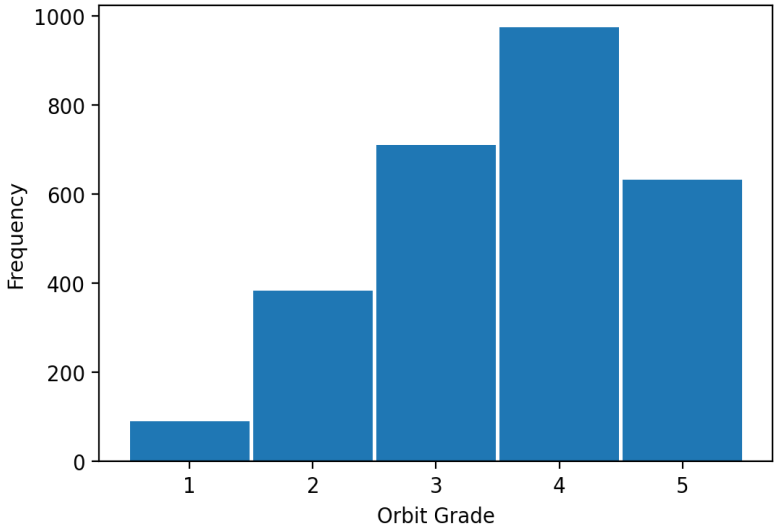

Figure 5: Frequency of Grades 1-5

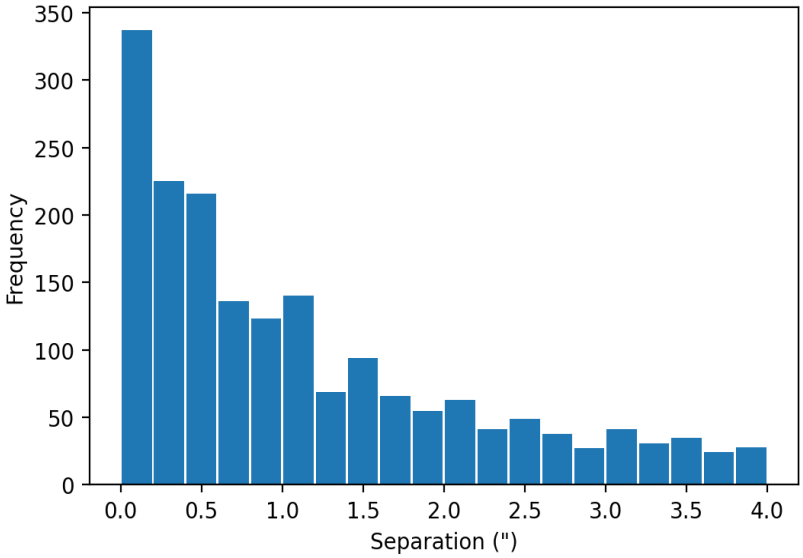

Figure 6: Frequency of Separations (those greater than 4.0" were ignored)

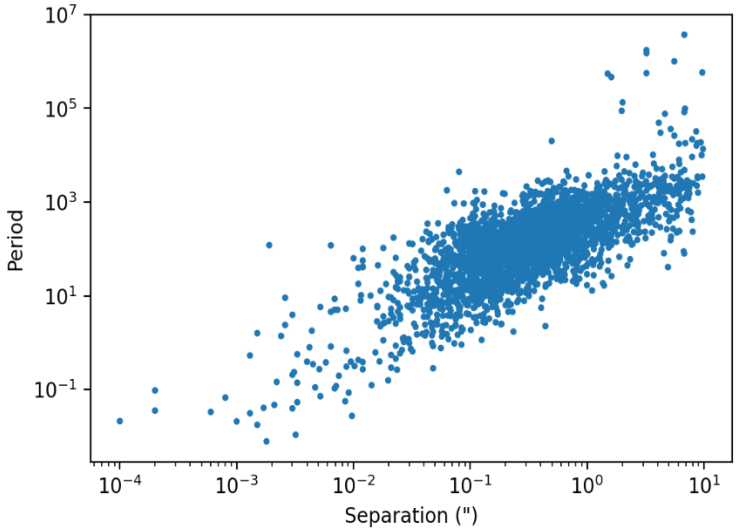

Figure 7: Log Period versus Log Separation

Access

The Known Binaries Excel Spreadsheets can be downloaded from the *Journal of Double Star Observations* website (http://www.jdso.org/), or the Institute for Student Astronomical Research website (https://www.in4star.org/).

Acknowledgements

This research has made use of the *Sixth Catalog of Orbits of Visual Binary Stars* and the *Washington Double Star Catalog* maintained by the U.S. Naval Observatory.

References

Rachel A. Matson, Stephen J. Williams, William I. Hartkopf & Brian D. Mason, 2022. Sixth Catalog of Orbits of Visual Binary Stars, U.S. Naval Observatory, Washington, DC, http://www.astro.gsu.edu/wds/orb6.html

The Washington Double Star Catalog (WDS, 1996.0), C. E. Worley, G. G. Douglass, Astron. Astrophys. Suppl. Ser. 125 (3) 523 (1997), DOI: 10.1051/aas:1997239