The Washington Double Star Catalog

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If we are free to wish, we ought to have two large reflectors, one in the North and one in the South, devoted to discovery and measures of double stars.

If we look back for a century or more and ask: What do we today appreciate mostly of the observations made then? the general answer will be: observations bound to time. They can, if missed, never be recovered. Of these observations measures of double stars contribute a major part.

As far as we can judge today this will also be the case in the future.

The search for new double stars should be made with the largest instruments available in order to discover close and faint companions.

--- Ejnar Hertzsprung to Charles Worley, April 2, 1965

Introduction and Growth of the WDS

The Washington Double Star Catalog (WDS) maintained by the USNO is the world's principal database of astrometric double and multiple star data. The WDS Catalog contains positions (J2000), discoverer designations, epochs, position angles, separations, magnitudes, spectral types, proper motions, and, when available, Durchmusterung numbers and Notes for the components of 84,489 systems based on 550,106 means.

The WDS has seen numerous changes since the last major incarnation of the catalog (WDS, 1996.0, Worley & Douglass A&AS, 125, 523; 1997). The application of many techniques, wavelengths, and growth in astronomy in the past years has seen unprecedented gains in both the number of systems and the number of measures.

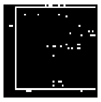

Figure 1: Growth in the number of means in the WDS since its inception in the early 1960's. The 1984.0 and 1996.0 editions of the WDS are indicated, as well as the number of means in mid 2000 (at the time of General Assembly XXIV of the International Astronomical Union), and at the present time (2000.9).

The growth since the 1996.0 edition is due to many sources, however the most significant additions are :

- Webb Society (4,224)
- CHARA speckle (7,122)
- Washington speckle (7,140)
- Tycho-2 (12,755)
- Hipparcos (13,141)
- Washington Fundamental Catalog (36,207)

These additions have been responsible for remarkable changes in the number of observations per system. While many thousand new systems have been added, we have seen the number of measures per system increase considerably as well. It is expected that with other large publications of data planned in the future (e.g., 2-MASS, UCAC, Tycho-3) the growth of the WDS will continue. The top 25 observers (based on the total number of measures and means) is available here.

Due to their historical importance and their continued use, a cross reference file from the ADS to the WDS discovery designation and abbreviated coordinates is provided here. In this file, all components associated with the ADS system are included even if they were not known at the time of the publication of the ADS. Further, duplicate are bogus systems included in the ADS have been excised.

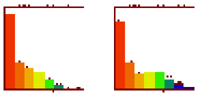

Figure 2: The number of measures per system in the WDS. The left figure is a histogram from late 1997 (the WDS 1996.0 with Hipparcos added) while the right figure illustrates the same information for late 2000. Note that while the total number of systems has increased by more than 1500, the number of systems with only one measure has dropped by more than 4500.

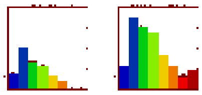

Figure 3: One source responsible for the increase in data is the prodigious publication of USNO speckle measures. The left figure illustrates a histogram of USNO speckle measures (also late 1997) binned vs. separation. The right figure indicates the same information for late 2000.

Neglected Doubles

A large number of systems in the WDS may be characterized as "neglected." These include unconfirmed binaries as well as systems which have not been resolved for many years. The reasons for this neglect are varied: poor coordinates or large proper motion (so the systems are "lost"), erroneous magnitude or delta-m estimates (so the systems are skipped over or misidentified), or true neglect (too many binaries and too few observers). While the veracity of some of these systems is certainly suspect, many (if not most) of these are *bona fide* double stars. Three sets of lists are provided in observing list format. The first set was compiled using the following selection parameters:

- Separation greater than three arcseconds
- Delta-m (V band) of less than three magnitudes
- Both components brighter than 11th magnitude
- and one of three possible parameters meriting inclusion
  - Not observed in twenty years (an N code)
  - Unconfirmed (a C code)
  - Orbit system in this parameter space, possibly useful for calibration (a * code)

A total of 6442 objects meet these criteria.

Neglected Doubles Lists I:

- Northern List (Dec > +20, num = 3072)
- Equatorial List (-20 < Dec < +20, num = 2331)
- Southern List (Dec < -20, num = 1039)

The second set of lists were compiled under the same criteria as above, but for separations under 3 arcseconds. A total of of 6632 systems fit these criteria.

Neglected Doubles Lists II:

- Northern List (Dec > +20, num = 1860)
- Equatorial List (-20 < Dec < +20, num = 2710)
- Southern List (Dec < -20, num = 2062)

The third and final set of lists includes those neglected systems not covered by the previous lists. These include systems with large magnitude differences, or fainter primary or secondary magnitudes, as well as systems whose magnitudes or separations are either unknown or unpublished. A total of 45,768 systems fit these criteria.

Neglected Doubles Lists III:

- Northern List (Dec > +20, num = 21,061)
- Equatorial List (-20 < Dec < +20, num = 11,491)
- Southern List (Dec < -20, num = 13,216)

These lists, especially the last, can be tailored to your specific observing needs. To have a custom-made observing list prepared with parameters different than those above, please fill out an observing list request form:

- Data or Observing List Request form

Hipparcos and Tycho-2

The current edition of the WDS contains the most recent, observational data available and includes systems newly discovered by the Hipparcos satellite. While Hipparcos did not provide discovery designations these are the primary system identifier in visual double star astronomy. A cross reference file of these 3,406 systems containing the abbreviated coordinate, as well as the HDS and HIP numbers is provided. A cross reference of WDS entries which had Hipparcos problem solutions (i.e., the G, X, O, V double star solutions as well as those which were suspected non-single) is also available. Systems with only one measure in the WDS which are Hipparcos problem stars (thus, providing a pseudo-confirmation) are indicated in the notes file.

The current version of the WDS also contains measures of 7,485 systems from the Tycho-2 Catalogue. These include 12,755 known systems as well as 1,234 newly determined (TDS) systems from the Tycho-2 database. Photometric information has been updated for systems not resolved by Hipparcos. Also, notes have been added for 2,757 systems of dubious veracity (N < 3) having a "failed double" or "photocenter" solution. A summary of double star data available in the Tycho-2 Catalogue was made at the April 2000 DDA meeting. A PostScript version of that poster is available here. A cross-reference of double stars measured by Tycho-2 is available here. A cross-reference of new TDS systems is available here.

Available files:

- HDS vs. Hipparcos cross reference
- Hipparcos Problem Star cross reference
- Description of Tycho-2 doubles in the WDS
- Double stars measured by Tycho-2
- New Tycho-2 double star (TDS) measures

Other Changes in the WDS

Changes in the reference file:

The reference file appears in a different format than previously available. In the past, three characters would specify to whom the reference belonged with a two digit number indicating the specific reference. In the case of some observers, this was proving inadequate. The problem was exacerbated when the three reference files (WDS, Orbit Catalog, and Delta-m DM Catalog) were combined. A new reference file is therefore provided which gives the new code (which is the current reference code for the 5th Orbit

Catalog), the old WDS code, and the old DM (Delta-m) Catalog code. followed by the reference. This is expected to change over time as the old DM Catalog code is replaced, and as the WDS is reformatted. The additional discoverer codes are included within this file.

Changes in the data request software:

The data request software has been re-written and the output is in a new format which is (hopefully) more user-friendly. In addition, data for systems having entries in the Delta-m Catalog have this data provided, as well as data from the new 5th Orbit Catalog. Over time we will be adding other features in a data request package.

In addition, we now also can provide custom-made observing lists. If you provide limitations as to RA+Dec, separation, magnitudes, as well as number of observations and date of last observation, we will custom make an observing list for you, based on the WDS.

The Delta-m Catalog:

Also new to the WDS is an additional indicator in columns 100-102. This ''D'' note code indicates the system has a separate Delta-M determined (in addition to those determined during astrometric measures). These results will eventually be incorporated in a weighted scheme for the magnitude listings of the WDS data line.

Discovery Designations Added:

The coordinates provided for entries in the WDS are neither unique nor constant, and are therefore, unsuitable to identify a system. Following the assignment of HDS designations to systems first resolved by the Hipparcos satellite, an effort was made to assign unique discovery codes to all other systems in the WDS. In some cases, two different systems can have the same discovery code and number but different components. Therefore, to uniquely identify a system it is necessary to include the component field. Eight hundred twenty-two systems have had their discovery number assigned by the USNO in this manner and are identified in the notes file.

Systems Removed:

Approximately 50 pairs of systems have been identified as being the equivalent system. Many of these were first identified by Fabricius and colleagues while working on the Tycho-2 double star reduction project. These have been added to the Notes file, and are provided as well in a Error Correction file. Many other systems remain to investigate as potential identical systems, as noted by Morlet et al. (A&AS 145, 67, 2000) as well as Fabricius & Makarov (A&AS 144, 45, 2000). There also remains some other dubious systems to be investigated.

Future of Designations:

On August 11, 2000 during the XXIVth General Assembly of the International Astronomical Union a Multi-Commission Meeting (MCM) on Stellar Designations was held. The purpose of which was to develop a simple, unambiguous, flexible, and computer friendly designation scheme for stellar companions (including planets). Members from 9 supporting commissions participated and as a result the following C type IAU Resolution was drafted and adopted by Commissions 26 and 42, and also later ratified by Commissions 5 and 8+24 at their respective business meetings. Subsequent to the MCM on October 24, Commission 45 SOC members unanimously supported the resolution.

- Home page of the Multi-Commission Meeting
- WMC (Washington Multiplicity Catalog) nomenclature scheme

Single Stars

For observations of double stars it is often necessary and beneficial to observe single stars. These can serve as an idealized point-source-function (psf) to determine the behavior of various elements in the optical chain, characterize various reduction algorithms, or can be used to generate artificial double stars or other more complicated morphologies by use of calcite crystals, slit masks, aperture masks, etc.

Unfortunately, finding a good list of these calibrator sources is easier said than done. Generally speaking, the more stars are studied the higher their multiplicity fraction. What is believed to be a good single star can render vital calibration data useless through the discovery of a previously unknown double star or the slight modification of the psf by an unresolved component.

The basic data for this list comes from the ‘‘Third Catalog of Interferometric Measures of Binary Stars’’ (Hartkopf, W.I., McAlister, H.A., & Mason, B.D. 2000). In addition to publishing measurements of double stars from speckle and Michelson interferometry, and lunar occultation measures, this also contains results from various duplicity surveys (n = 3,632). Selected stars from this catalog which are also found in ‘‘The Bright Star Catalogue’’ (D. Hoffleit & W. Warren, 1992, Fifth Revised Edition, preliminary) with a published null detection from a telescope with an aperture greater than two meters are then considered (n = 1,769). This list is then of bright stars which have no indication of duplicity by speckle interferometry. Any of these objects which have measures by other techniques in the 3*rd* Catalog (either interferometry or lunar occultation) are also excluded, as are systems which have entries in this current version of the WDS.

Further, all of these systems were observed by the Hipparcos Satellite (ESA 1997, The Hipparcos and Tycho Catalogues, ESA SP-1200), and they do not have any double star solution (C, G, X, V, or O in field H59 of the main catalogue) nor are they ‘‘suspected non-single’’ (S code in field H61).

The final all-sky list contains 1,170 systems fulfilling these criteria. In the future, it is planned to update this list to include systems which would be unresolved by optical interferometry.

Available Files and Links

- WDS Catalog (~8.6Mb)
  - 00-06 hour section (~1.9Mb)
  - 06-12 hour section (~2.4Mb)
  - 12-18 hour section (~1.6Mb)
  - 18-24 hour section (~2.8Mb)
- Format of the current WDS
- Notes file for the WDS
  - Synonyms to the Notes file
  - Error Correction file

- References and discoverer codes

- Top Twenty-five Observers list
- WDS vs. ADS cross reference

- HDS vs. Hipparcos cross reference
- Hipparcos Problem Star cross reference
- Double stars measured by Tycho-2
- New Tycho-2 double star (TDS) measures

- Single Star list

- Home page of the Multi-Commission Meeting
- New WDS nomenclature scheme

- Fifth Orbit Catalog
- Third Interferometric Catalog
- Double Star Library
- USNO Publication Page

Requests and Acknowledgements

Addition of the Delta-m information as well as other more significant changes to the WDS database is currently under consideration. The input from regular users of the database and other interested parties is greatly appreciated in our efforts to make the WDS as helpful and user-friendly as possible. Please provide comments on the format of the WDS, missed references, or any other items of interest to you on our Comment form.
Information is being added to the database on a continuing basis, and this edition of the WDS will also be updated regularly. You may request a reasonable amount of information from the double star catalog by e-mail.

- Data or Observing List Request form
- Comment form

We are in debt to Geoff Douglass for his work on the WDS database and his leadership in the speckle program at the USNO. The Washington Double Star Catalogs and USNO speckle program were conceived and nurtured by Charles Worley.

Concluding Remarks

If the WDS and associated databases were helpful for your research work, the following acknowledgement would be appreciated:

''This research has made use of the Washington Double Star Catalog maintained at the U.S. Naval Observatory.''

A notification of references to relevant papers is appreciated.

This page is maintained by Brian Mason

Approved by Theodore Rafferty, Astrometry Department, USNO

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