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Toward a Common Language: the Washington Multiplicity Catalog

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Abstract. Due to improvements in technology (interferometers, precision radial-velocity techniques, etc.), the traditional separation/period regimes of "wide" and "close" binaries are witnessing increasing overlap. This is expected to lead to increasing confusion in component identification, since different observing techniques adopted their own rules for designation of these components. A quick overview will be given of the *Washington Multiplicity Catalog*, an effort to create a common nomenclature scheme for all types of stellar and sub-stellar companions.

Author's note: The following is an abbreviated version of remarks made at Symposium 240; see Hartkopf & Mason (2004) for a more detailed description of the WMC and its history.

1. Introduction

The introduction of new observing and reduction techniques in recent years — from long-baseline interferometers to iodine–cell spectrographs to millimag–precise photometry to Doppler tomography techniques — have revolutionized much of our field. New classes of companions (e.g., brown dwarfs, exoplanets) have been discovered, and the previously distinct classes of binaries (e.g., "visual" or "spectroscopic") are now observable by multiple techniques. The result is greater understanding for the scientist, but greater challenges for the cataloger; furthermore, future generations of interferometers, astrometric satellites, computers, etc. means the "problems" will only become worse.

So what *are* the problems?

(a) Different techniques mean different nomenclature! Visual binaries are traditionally given "discoverer designations" (e.g., Σ or STF 14, β or BU 96). Spectroscopic binaries are usually referred to by their HD numbers, eclipsing binaries by variable star designations, occultation binaries by SAO or ZC numbers. Discovery or analysis using multiple techniques results in multiple designations in the literature; cross–reference resources such as SIMBAD are great aids in reducing the ensuing confusion, but much useful research on a given object may remain unknown to another astronomer simply due to the use of different object designations.

(b) A bigger problem is component confusion! Practitioners of different observing techniques have adopted different designation schemes for identifying the primary, secondary, etc.: capital letters (**A/B**, **N/S** or **E/W**, etc.), lower–case letters (**a/b**, **p/s**, etc.), numbers, or some combination. Further, the definition of "primary" may differ (for example, the brightest star in V- or B- or K-band, the most massive star, the star with sharpest spectral lines, etc.), meaning one astronomer's **AB** pair may be another's **BA**. An additional component to a binary may be assigned a **C** designation by someone unaware that the system is already a known triple via discovery of a different component using a different technique.

The purpose of the *Washington Multiplicity Catalog* (WMC) is to attempt to address these problems by creating a single catalog of all types of binary and multiple stars and developing a consistent designation scheme for all components of those systems.

2. Addressing the Problem

Informal working groups dating back to 1999 began work on various schemes for a common component designation. Discussions were held at IAU Symposium 200 (Reipurth & Zinnecker 2000), and later during the XXIVth and XXVth General Assemblies, where a Working Group was formed, a nomenclature scheme was adopted, and a sample catalog was presented. The plan formulated at the Sydney GA was to have a completed all-sky version of the WMC ready in time for the XXVIth General Assembly in Prague. However, manpower shortages have delayed completion of the catalog.

The root of the WMC is the *Washington Double Star* (WDS; Mason *et al.* 2006) database, maintained at the U.S. Naval Observatory and updated nightly. At present it is comprised of over 725,000 measures of 100,000+ pairs; as the largest single database of double stars, it was logical to propose a scheme based on its component rules. Of course, the WDS lists only resolved systems (i.e., it excludes spectroscopic pairs, eclipsing binaries, occultation systems, etc.), but it was agreed that WDS nomenclature rules (with slight modification) could accommodate all types of double stars.

3. Designations and Hierarchies

The WMC is a **hierarchical** scheme. Rules of component designation are as follows:

- **Level 1** = capital letters (e.g., STF 1523 **A,B**)
- **Level 2** = lower case letters (e.g., FIN 347 **Aa,Ab**)
- **Level 3** = numbers (e.g., BNK 1 **Ba1,Ba2**)
- **Higher levels**: alternate lower case letters and numbers (no examples yet known)

System hierarchy is ideally based on orbital period and/or semi-major axis separation, with a ~3:1 ratio of semi-major axes generally followed. However, wider, long-period systems (including most visual doubles) typically have insufficent information to determine whether motion is Keplerian or rectilinear. In these cases, apparent separation is all that is available. Typically systems with separations $> 1''$ are given upper-case letters, as are known optical pairs. The *primary* of a system is defined as the most massive object in the system, if known. Otherwise, this designation is given to the brightest object (preferably in V) in the system.

Figure 1 (from Hartkopf & Mason 2004) illustrates an imaginary system, where a simple wide pair becomes more complex as an additional faint companion is found, then newer observing techniques resolve components into two or more objects. The most important thing to note is that definitions of existing components do not change as new objects are discovered. For example, when the **C** component of the system is resolved into two objects by interferometry, the individual stars comprising **C** are labelled **Ca** and **Cb**, but **C** still refers to that collection of material unresolved on those astrographic plates. In terminology developed by Andrei Tokovinin, **C** is described as the "parent" of **Ca** and **Cb**.

No designation scheme is perfect, of course. The imaginary system in Figure 1 is rather idealized, in that new components are discovered in such an order that their designations evolve logically. What if, for example, a level-3 hierarchical pair (such as a

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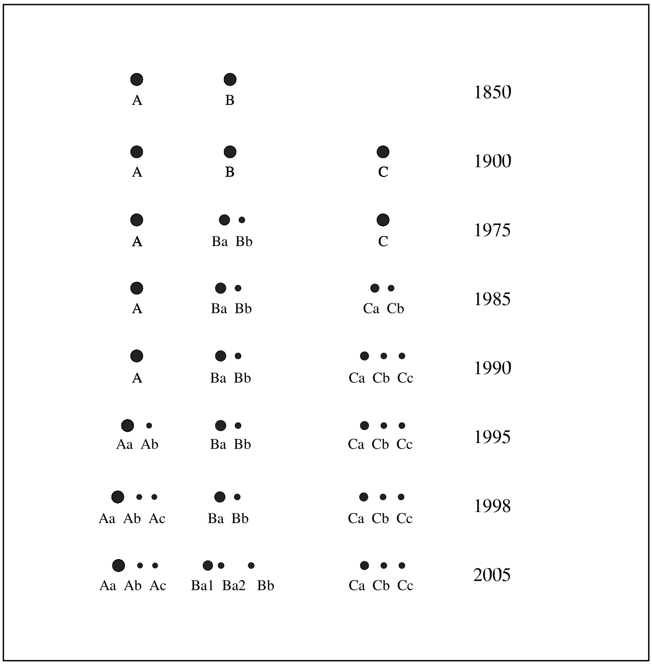

Figure 1. Nomenclature assignment as a (ficticious) system grows more complex:
1850: visual pair is discovered
1900: wide common proper motion companion is found on astrograph plates
1975: **B** component is found to be spectroscopic binary
1985: **C** component is split by speckle interferometry
1990: additional speckle **C** component is resolved at a similar separation
1995: planet is found orbitting the **A** component
1998: second planet is found
2005: primary of **B** is resolved by long-baseline interferometry

close spectroscopic pair) is discovered — and components are designated — before the level-2 hierarchical pair which includes it (e.g., a speckle binary) is resolved? What do we do if we know that one component of a close interferometric pair is an SB but we can't tell which one? What do we do with all the "incorrect" or mutually incompatible designations already in the literature? We of course cannot just ignore published designations and rename system components as we learn more about them. As in all aspects of science (and life), complications cannot be avoided.

The sample version of the WMC generated for the Sydney GA used data available from various double-star catalogs covering a half-hour band in RA. The techniques which contributed to that sample broke down as follows:

95.8%	visual binaries and optical pairs,
1.7%	spectroscopic binaries,
1.4%	cataclysmic variables or related objects,
1.0%	occultation binaries,
0.3%	astrometric binaries,
0.2%	each eclipsing binaries and X-ray binaries,
0.1%	each spectrum binaries and planets.

Please note that these totals are strongly biased by several factors (two examples: (1) exoplanet discovery is a new field, so the number of discoveries is still small; (2) visual binaries are cataloged upon discovery, while SB's are usually not cataloged until their orbits have been determined). These relative numbers are expected to change drastically in the future, as new surveys (e.g., Gaia) release their findings.

Individual pairs in this sample were then grouped into 1,465 multiple systems and designations were assigned to all components; the breakdown was as follows:

1,336	(91%)	simple binaries
80	(5.5%)	non-hierarchical triples
16	(1.1%)	non-hierarchical systems, >3 components
25	(1.7%)	hierarchical triples
8	(0.5%)	hierarchical systems, >3 components

Again, this breakdown will undoubtedly change as the optical/physical nature of wider pairs are determined and as the results of surveys for SBs, EBs, and other closer pairs are published.

4. WMC Contents

The WMC will include the following information:

- ⋆ J2000 arcsecond coordinates
- ⋆ component designation (A,B; Aa,Ab; etc.)
- ⋆ components' *parent*
- ⋆ identifiers:
  - – HD, DM, variable star designation, discoverer designation, etc.
  - – Tycho-2, GSC2, UCAC, etc.
  - – GJ or other nearby star designation, cluster ID, Bayer/Flamsteed, WDS, etc.
- ⋆ physicality (optical, physical, cpm, etc.) and method
- ⋆ magnitudes, spectral types, masses if known
- ⋆ orbital period and/or angular separation
- ⋆ references for all information

It is expected that the parent designations and extensive notes will be able to clarify most hierarchy problems that may arise due to the complications mentioned above.

5. So why this talk?

The reasons for giving this brief overview of the WMC to this audience are twofold:

1. To promote use of a consistent designation scheme
2. To urge all observers to send their data to databases

Much of the information in catalogs such as SB9 (Pourbaix *et al.* 2004) or the WDS has arrived there via literature searches by the authors of those databases. Both these projects are severly understaffed, and would benefit enormously if, as a matter of course, appropriate electronic data tables are sent to relevant catalogers by authors when their journal papers are accepted for publication†.

† By the way, if you wish your data to be of use to future researchers, *please* include the date of observation with your published binary star data.

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Further information on the WMC and the catalogs used in its complilation may be found on the USNO's *Double Star Library* website:

(`http://ad.usno.navy.mil/wds/dsl.html`).

Your input or comments are welcome!

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Discussion

Carlson Chambliss: In eclipsing binaries with third components (e.g., V505 Sgr, 44 Boo, etc.) the variable pair should be referred to by its "classical" variable star name. What about the third component — either resolved on unresolved?

Hartkopf: Individual systems will of course have to be examined on a case-by-case basis. In general, however, the components of close eclipsing pairs would probably be assigned component designations of **Aa** and **Ab** (assuming the eclipsing pair is brighter than the third body) and the third component would be labelled the **B** component. The more massive (or brighter if masses are unknown) star of the eclipsing pair would be assigned the **Aa** designation.

Terry Oswalt: This is not really a question but a compliment to you for trying to make some sense out of a growing problem of nomenclature in binary star research **and** also to suggest that we address the equally challenging problem of multiple NAMES for binaries. Perhaps we should consider, as Luyten and others did so long ago, that the basic name of a binary be the earliest one given in the literature. Then the hierarchical scheme you proposed can be added as a suffix.

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