

# Double Stars at the IAU GA 2012

Brian D. Mason

U.S. Naval Observatory  
3450 Massachusetts Avenue, NW  
Washington, DC, 20392-5420  
bdm@usno.navy.mil

**Abstract:** In August 2012 the 28th General Assembly of the International Astronomical Union was held in Beijing, China. This summarizes some aspects of this meeting relevant to double and multiple star astronomy.

## 1. Introduction

From 20-31 August 2012 the 28th General Assembly of the International Astronomical Union (IAU) was held in Beijing, China. These triennial meetings provide an opportunity for astronomers from different countries to get together, present results and discuss future plans and collaborations. Examples of the larger policy issues that are discussed in an IAU General Assembly include a reorganization of the IAU Divisional structure, the definition of the astronomical unit or whether to continue the periodic insertion of leap seconds.

## 2. Commission 26: Double and Multiple Stars

One of the charter commissions of the IAU, Commission 26 (Double and Multiple Stars) has always been a relatively small commission. The study of visual double and multiple stars are typically programs that require many years to come to any sort of fruition and planning observing programs is well-suited to meetings with this sort of regularity.

The Commission 26 meeting was held on Tuesday afternoon from two to six p.m. Seventeen commission members and other interested parties attended the Commission meeting. In the absence of

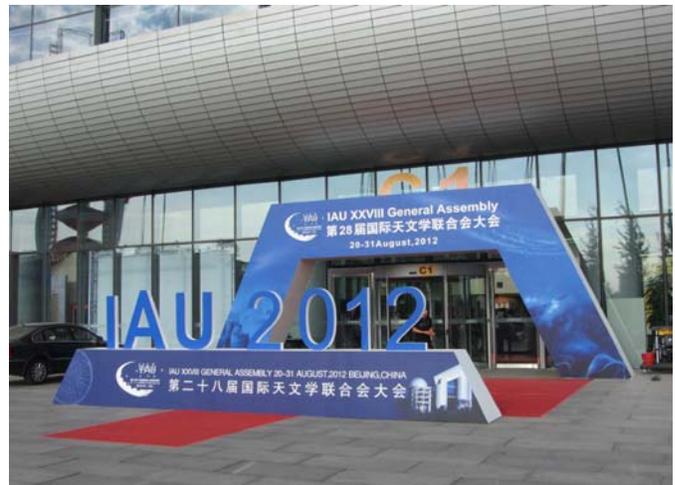


Figure1. IAU entry arch.

Commission President, Jose Docobo, the meeting was conducted by Vice President Brian Mason. The commission business portion of the meeting was brief. Following the listing of deceased members and the listing of prospective new members a video presentation from Dr. Docobo was shown. The slate of new officers were presented and those members rotating off the organizing committee: Dimitri Pourbaix,

## Double Stars at the IAU GA 2012

Terry Oswalt and Colin Scarfe, were thanked for their service. A review of some of the past meetings of relevance to the Commission was given as well as announcements of future meetings. Finally, a few brief points regarding the place of Commission 26 in the new Division structure was presented. We then moved directly into the science presentations.

As a result of the Commission 26 meeting at the Hamburg General Assembly of the IAU in 1964, the double star database was transferred from Lick Observatory to the U.S. Naval Observatory (USNO) and re-designated the Washington Double Star (WDS) catalog. The growth of the WDS and its ancillary catalogs over the triennial period was presented. The changes in the data line format, which many JDSO readers are familiar with, was presented. Also presented at this time were possible future changes in the format of the summary catalog. Difficulties at present include the inadequacy of the current arcminute precision identifier in very dense fields, inadequacies of the multiplicity field for nested hierarchies, the separation precision not sufficient for current techniques, and the need for other codes to clarify the data which are presented. As the base WDS format has been stable for a decade these major changes will not happen quickly. The current USNO observing program was then described. From wider arcsecond pairs observed with our fast readout ICCD in Washington to subarcsecond pairs observed with our stan-

dard speckle camera on larger telescopes in Arizona and Chile to collaborative efforts with the NPOI and CHARA Arrays the USNO program is optimized to observe brighter pairs over many decades of separation. These are the pairs which tend to be the most important for navigational (star tracker) purposes.

Gerard van Belle (Lowell Observatory) discussed the binary work that is being done with the Navy Precision Optical Interferometer (NPOI). Work by Jenny Patience and Rob De Rosa is being done to investigate the multiplicity of early-type stars with a volume limited A-star survey while Henrique Schmitt is investigating Be stars and their disks. Christian Hummel is continuing his study of binary stars, typically resolved spectroscopic binaries while Bob Zavala is working on radio stars to tie the optical reference frame to that of the radio. Theo ten Brummelaar continued the interferometry presentations by discussing CHARA Array contributions to double and multiple stars. Optical interferometers like the CHARA Array are now obtaining the same resolution as is capable with VLBA in the radio due to the wavelength at which they work and they are very good at measuring asymmetries caused by companions at milliarcsecond separation. They can also utilize separated fringe packet techniques for the study of wider pairs that can be observed with other more classical techniques. Imaging is now a routine byproduct and stimulating movies of Algol and  $\beta$  Lyrae were shown as well as



Figure 2. Simplified Chinese Armilla. Ming Dynasty.

### Double Stars at the IAU GA 2012

the eclipsing cloud of  $\epsilon$  Aurigae.

Dimitri Pourbaix gave a report on the current status of SB9: the 9th Catalogue of Orbits of Spectroscopic Binary Stars. The catalog now contains 3866 orbits of 3112 systems and is a comparable size with the USNO 6th Orbit Catalog. However, less than 10% of these respective catalogs have overlap. Like at the USNO, the most significant shortcoming is labor entering the data. This issue will be exacerbated when big survey projects begin the delivery of results. SB9 provides elements and orbit plots as well as lists of measures when available. These can be obtained either through single entry queries or through a downloadable tar ball. Dr. Pourbaix has also been very involved in the non single star activities in preparation for the Gaia launch. Since Gaia will not go brighter than 6th magnitude and will work best fainter than 12th magnitude, it is optimized to work best where we have the poorest historical data. Unlike HIPPARCOS, Gaia will not have an input catalog and will be too large for individual object inspection. It will go through a flowchart of options for non-single star solutions including familiar solution types such as acceleration, orbital, variability induced movers, etc. They are expecting some 500 million binaries to be in the Gaia output catalog. What is un-

known at this point is what percentage of them will be detected at some level. The preparation is running smoothly with most of the codes already in the fine tuning stage. By the end of the decade it is expected that millions of orbital solutions will be generated: both astrometric/visual, spectroscopic and photometric. How will these be incorporated in the existing databases is an unanswered question.

Finally, Miguel Monroy, a graduate student of former Commission President Christine Allen, presented work in the preparation of an improved catalog of halo wide binaries and on halo dark matter. The tenuous grip that some of these fragile binaries have on each other can tell us much of Galactic dynamics. While Yoo et al. (ApJ 601, 311; 2004) placed limits on MACHOs based on wide binaries and the observed distribution in their separations, the work here investigates the radial velocities of these wide pairs to determine which are or are not physical. After compiling their refined database of halo wide binaries they found an Öpik distribution worked well with  $\langle a \rangle = 10,000$  au for those which were most disk-like and  $\langle a \rangle = 63,000$  au for those which were most halo-like. The interaction with the disk is thus very important. A dynamical model for the evolution of wide halo binaries, subject to perturbations by



Figure 3. Some of the Commission 26 attendees and speakers. Left to right: Chris Corbally, Theo ten Brummelaar, Natalia Shakht, Brian Mason, Miguel Monroy, Frederic Arenou, Gerard van Belle, Dimitri Pourbaix and Ivan Andronov

## Double Stars at the IAU GA 2012

MACHOs was developed and validated, and applying this model taking into account time spent in the disk and non-uniformities in the halo density they were able to all but exclude MACHOs in the Galactic halo.

The power point and/or pdf presentations from the Commission 26 meeting are available online at the Commission website: <http://ad.usno.navy.mil/wds/dsl/Comm26/Beijing/beijing.html>.

The Commission dinner was held at M&E, a Cantonese Restaurant near the venue. Prospective Commission member M.B.N. (Thijs) Kouwenhoven of the local Kavli Institute and Peking University was able to act as interpreter and became, effectively, the dinner host. We turned the item selections over to him and were not disappointed. It was a delicious and quite economical evening. While general double star matters were discussed, among the most interesting aspects of the evening were the impressions of Thijs as a westerner living in China.

### 3. Other meetings of relevance

Other commissions and divisions also have interest in the study of double stars. Among these are Commission 8 (Astrometry), Commission 30 (Radial Velocities), Commission 42 (Close Binary Stars) and Commission 54 (Optical and Infrared Interferometry).

The optical and infrared interferometry meeting Gerard van Belle (Lowell Observatory) and Theo ten Brummelaar (GSU) both presented results from their respective interferometers (NPOI and CHARA, respectively) which highlighted some impressive work on resolved spectroscopic binaries.

Due to the high incidence of multiplicity among massive stars it was not surprising to see Joint Discussion 2 (Very Massive Stars in the Local Universe) discuss binaries and multiple systems explicitly as the candidate VMS are multiples. While Massive stars have a good astrophysical definition, a lot of this meeting seemed focused on defining the term “very massive” with the final consensus value ( $> 100M_{\odot}$ ) seeming rather arbitrary.

Among the talks at IAU Symposium 289 (“Advancing the Physics of Cosmic Distances”), results for binaries outside the Milky Way were discussed. Also at this symposium, Dimitri Pourbaix discussed the more recent van Leeuwen Hipparcos solution and finds that for spectroscopic binaries the precision is improved but not the accuracy. The Gaia reduction pipeline will build from Hipparcos and will consider various double star solutions depending on errors. Despite this Gaia results, due to how faint it will go, will not overlap with the most well studied



Figure 4. IAU member Dimitri Pourbaix discusses the 9th Spectroscopic Binary Catalog

and characterized binary stars. Gaia was discussed at several other meetings such as Joint Discussion 7 (“Space-time Reference Systems for Future Research”) where Francois Mignard set the bright magnitude limit for Gaia at  $V = 6$ .

At the Commission 30 meeting, Pourbaix presented results of the spectroscopic binary orbit catalog (SB9): 3112 systems (1469 systems in SB8), 3866 orbits, 2113 systems with RV, 635 papers (44 since last General Assembly). This is an orbit catalog. The closest thing to a spectroscopic analog to the WDS is Hugo Levato’s massive radial velocity database with over 250,000 radial velocities. There are many large scale radial velocity projects which will produce many, many radial velocities soon.

Symposium 293 (“Formation, Detection, and Characterization of Extrasolar Habitable Planets”) introduced some unfamiliar terminology of relevance in discussing extra-solar planets in binary systems. Circumbinary is a more distant planet orbiting a short period binary system (think Tatooine in Star Wars). Circumprimary is where a planet orbits a single star with a more distant stellar companion (think Jupiter/Lucifer in 2010). At present, 20% of known extrasolar planets are in binary star systems.

At the Commission 8 meeting, Gaia was again discussed and Mason presented some results for resolved astrometric binaries and what else you can get out of them. Recall, that both Sirius and Procyon were detected through periodic errors in their proper motion many years (18 and 52 years, respectively) before they were resolved.

**Double Stars at the IAU GA 2012**

There were also several interesting posters discussing work on, for example, binary stars at Pulkovo and wide physical binaries.

Recent Nobel Prize winner Brian Schmidt gave a talk on “Supernovae, the Accelerating Cosmos and Dark Energy.” While I’m sure the cosmologists were bored, for those of us not in that sub-field, he gave a cogent presentation in it’s proper historical context.

Overall, the meeting was very exciting and informative. Keeping up with the many presentations where binary stars were discussed required a careful reading of the program, a prioritized scrutinizing of the schedule, and a good pair of cross-trainers!

*The author is president of Commission 26 of the International Astronomical Union.*