

## COMMISSION G1

## BINARY AND MULTIPLE STAR SYSTEMS

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**ORGANIZING COMMITTEE**

**Brian Mason, John Southworth, Robert Mathieu, Terry Oswalt, Tomaž Zwitter**

### TRIENNIAL REPORT 2015-2018

#### 1. Introduction

Commission G1, Binary and Multiple Star Systems, came into existence at the 2015 General Assembly following a proposal to the IAU from Andrej Prša, Brian Mason, Mercedes Richards<sup>†</sup> and Virginia Trimble, having previously existed as two separate commissions, C26 (Double and Multiple Stars) and C42 (Close Binary Stars). Andrej Prša (USA) is the founding President, Virginia Trimble (USA) is Vice-President. Five Organizing Committee Members were elected in 2015 – Brian Mason (USA), Robert Mathieu (USA), Terry Oswalt (USA), Christopher Tout (UK) and Tomaž Zwitter (Slovenia) – with Christopher Tout elected by the OC as Secretary. Commission G1 currently has 276 members.

Binary and multiple stellar systems are an essential part of stellar physics, as single stars like the Sun are shown to be in the minority. Binary stars provide the most tractable, calibration-free path to fundamental stellar parameters (masses, radii, luminosities and temperatures). They also have significant overlap with planetary science, stellar structure and evolution, high energy astrophysics, galactic chemical evolution by way of supernovae, general theory of relativity (gravity waves), and cosmology. Binary stars also serve as standard distance calibrators, where the precision in the determined distance does not depend on the distance itself. The Commission focuses on all relevant types of observations of individual systems and populations, statistical studies, both analytical and numerical calculations, and database maintenance.

The main science topics central to the Commission are:

- the full range of observational tools that apply to binary and multiple systems (astrometry, photometry, spectroscopy, polarimetry, structure of cluster HR diagrams, products of space missions including *Kepler*, *Gaia* and *LSST*), and the interface of these with the focus of other Divisions and Commissions;
- kinematics, and ultimately dynamics, of binary and multiple systems;
- improved codes for binary and multiple systems, stellar atmospheres, structure and evolution, yielding surface compositions, tracks in the HR diagram, temporal changes in system masses and separations, etc;
- improvements of existing binary and multiple star system databases, regular production of publications (online and perhaps in print on paper), sharing databases, new codes, exciting discoveries, and opportunities for interaction with other parts of the astronomical community; and

- accurate knowledge of the history of the subject and its continuing impact on astronomy in general.

Historically, the different techniques for the observation of double or multiple stars observed different objects and there was little, if any, overlap between the objects, the scientific goals or the individual astronomers working in these areas. Technical advances, such as long baseline optical interferometry, have resulted in a greater degree of synergy, something we expect to increase with time. Based on current duplicity and multiplicity studies, binary and multiple stars are the predominant stellar evolution path. With single stars being the special case, interest in binary and multiple stars is unlikely to dissipate any time soon.

## 2. Sponsored Working Groups

**Ninth Catalogue of the Orbital Elements of Spectroscopic Binary Stars** was established by C30 and inherited by Commission G1. It is chaired by Dimitri Pourbaix. The working group continues the compilation of the published spectroscopic orbits of binary stars together with the radial velocities on which these orbits are based. The orbits and velocities are made available to the community.

**Working Group on Maintenance of the Visual Double Star Database** maintained by the United States Naval Observatory is the world's principal database of astrometric double and multiple star information. 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 142596 systems based on 1,612,410 means as of Apr 2018. The catalog is chaired by Brian Mason.

**Working Group on Fundamental Units** was predominantly active in the previous triennium. Chaired by Petr Harmanec and Eric Mamajek, it was tasked to propose *exact* values for the principal Sun, Earth and Jupiter parameters to be used as nominal values rather than observed measures. This eliminates proliferating systematics that stems from using the current estimates as units. This work resulted in two resolutions: B2 (Recommended Zero Points for the Absolute and Apparent Bolometric Magnitude Scales) and B3 (Recommended Nominal Conversion Constants for Selected Solar and Planetary Properties).

**Working Group on Active B Stars** has over 130 members and it has been active for over 33 years. Its primary goal is to promote and stimulate research and international collaboration in the field of the active early-type (O and B) stars. The original focus was on the classical Be stars, some of which are in interacting binaries, however, their topics now include active phenomena in B-type stars, including mass loss and accretion, pulsations, rotation, magnetic fields, and binarity; as well as the derivation of fundamental parameters for these objects.

**Working Group on Binary Orbit Definitions** was established in 2017, chaired by Brian Mason. The aim of the working group was proposed by George Kaplan of the US Naval Observatory: to set conventions for double star parameters that are currently defined ambiguously. The G1 Organizing Committee unanimously supported the motion. The members of the working group are Manuel Andrade, Phil Bennett, Jose-Angel Docobo, Aruna Goswami, Jean-Louis Halbwachs, Petr Harmanec, William Hartkopf, Berry Holl, George Kaplan, Lifang Li, Josefina Ling, Brian Mason, Michele Montgomery, Nami Mowlavi, Dimitri Pourbaix, Andrej Prsa, Timo Prusti, Robert Stencel, Andrei Tokovinin, Christopher Tout, Virginia Trimble, Robert Zavala and Tomaz Zwitter.

### 3. Commission circulars and catalogs

Commission G1 continues the tradition of Commissions 26 and 42 in maintaining several circulars and catalogs:

- Double Star Circular (Ed. Jose Angel Docobo). Three circulars have been published in this triennium, #187 (Oct 2015), #188 (Feb 2016) and #189 (Jun 2016).

The Information Circular was started in 1954 by Paul Muller of the Observatoire de Strasbourg, France, and was formerly known as the “Commission 26 Information Circular”. Publication of the Circular was taken over in 1983 by Paul Couteau of the Observatoire de Nice and in 1993 by J. A. Docobo, who proposed J. F. Ling to be a co-editor. Both are members of the Observatorio Astronomico “Ramon Maria Aller”, of the Universidad de Santiago de Compostela, Spain. The 120 Circulars published by Drs. Muller and Couteau were scanned to pdf files by Brian Mason.

The lists of new binaries and orbital elements which have traditionally comprised the Circulars were recently supplemented by bibliographies of recently published binary star papers. Both paper and electronic mail versions of the Circular are published by Drs. Docobo and Ling. Contributions to this most worthwhile publication should be sent to the authors at joseangel.docobo@usc.es or josefinaf.ling@usc.es, respectively.

We are grateful to Drs. Muller and Couteau for their major efforts over the past 40 years, as well as to Drs. Docobo and Ling for their continuation and expansion of this effort. Thanks should also go to the Universidad de Santiago de Compostela, for their financial assistance in the publication of these Circulars.

- Bibliography of Close Binaries (Eds. Colin Scarfe, Walter van Hamme). Three issues have been published in this triennium, #101 (Sep 2015), #102 (Mar 2016) and #103 (Mar 2016).

A survey on the use of the Bibliography of Close Binaries has been conducted in May 2016 among the members of G1 and it received continued support. Colin Scarfe stepped down as Editor-in-Chief, he is replaced by Walter van Hamme. Colin Scarfe led this effort for over 15 years, and on behalf of G1 and the entire IAU, we thank him for his service! Ettore Tamajo and Elena Kilpio were replaced by Miloslav Zejda and Christopher Tout as Editors.

- Visual Double Star Database (Ed. Brian Mason). The Catalog was updated in July 2016.

- Information Bulletin of Variable Stars (IBVS; Eds. Robert Szabo, Laszlo Molnar). 54 issues have been published in this triennium, #6147–6201.

The IBVS underwent the Editorial Office change. Robert Szabo stepped down as Editor-in-Chief in 2015 and was succeeded by Laszlo Molnar. He is assisted by Emese Plachy and Laszlo Szababos. Andras Hall remains the Technical Editor and Evelin Banyai continues to work as a part-time Technical Assistant. The current Board of Editors consists of Boris Gaensicke (chair), Karen Pollard, Donald Kurtz, Laszlo Kiss, Ronald Mennickent, Andrej Prša, Slavek Rucinski, Nikolai Samus and Christiaan Sterken.

- Catalog of Orbital Elements of Spectroscopic Binary Systems (Ed. Dimitri Pourbaix). The Ninth Catalogue of Spectroscopic Binary Orbits is being updated frequently, as new data come in.

### 4. Commission Associates and Cooperating Organizations

The Commission currently includes 5 associates: Raymond Clark, Editor of the Journal of Double Star Observations; Edgardo Rubén Masa Martín, Editor of El Observador de Estrellas Dobles; Florent Losse, Editor of Observations & Travaux; Giuseppe Mi-

cello, Editor of *Il Bollettino delle Stelle Doppie*, and Andreas Alzner, observer and orbit calculator.

The following organizations have formally cooperated with the Commission in the last triennium: The Webb Deep-Sky Society, Double Star Section; Astronomical Society of Southern Africa, the Double Star Section; The Spirit of 33; The LIADA Double Star Section; The Double Star Club of the Astronomical League; The Double Star Commission of the French Astronomical Society; and the Garraf Astronomical Observatory.

## 5. IAU Symposia

The IAU Symposium 329: The Lives and Death-Throes of Massive Stars, was supported by Commission G1. It took place in Auckland, New Zealand, on Nov 28–Dec 2, 2016. The chairs of the SOC were John Eldridge, Margaret Hanson and Artemio Herrero.

The Commission proposed for the IAU General Assembly Symposium titled “Binaries, Multis and Astrostatistics at the Crossroads”, with Division G acting as coordinating division and Divisions B and F as supporting divisions. The proposal was not selected for the General Assembly but it will be organized in 2019 independently of the IAU.

## 6. Commission G1 website

The Commission’s web site has been set up and maintained by Brian Mason. We encourage all members of G1 to inform the Secretary of news, including meeting announcements, prizes, job openings, etc. The website can be found at:

<http://ad.usno.navy.mil/wds/bsl>.

## 7. Deceased G1 members

It is with great sadness that we bid a final farewell to the following members: Edouard Oblak (1940–2016), Mercedes Richards (1955–2016), Jean-Paul Zahn (1935–2015) and Robert Kraft (1927–2015). They will be sorely missed.

Andrej Prša  
*President of the Commission*