

DIVISION IV - STARS

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DIVISION IV: STARS

INTRODUCTION TO DIVISION IV'S COMMISSION REPORTS

DIVISION PRESIDENT: David L. Lambert

ORGANIZING COMMITTEE:

The Divisions's Organizing Committee is made up of the Presidents and Vice-presidents of these commissions and their immediate past-Presidents. By a process as yet unexplored by historians, I was asked to serve as President of the Division. Owing to a personality trait well known to psychologists, I agreed to serve! Division IV, which was formed at the last General Assembly, comprises five commissions:

Commissions	Presidents	Vice Presidents	past-Presidents
26: Double & multiple stars	C.E. Worley	H. Zinnecker	H. Abt
29: Stellar spectra	M.S. Bessell	B. Barbuy	D.L. Lambert
35: Stellar constitution	C.S. Chiosi	J.P. Zahn	P Demarque
36: Theory of stellar atmospheres	L.E. Cram	R. Pallavicini	W. Kalkofen
45: Stellar classification	O.H. Levato	M. Gerbaldi	D. J.MacConnell

Over the last approximately three years, I chose to act as a coordinator distributing proposals from commissions in and outside the Division to this Division's Commission Presidents for review by their Organizing Committees. Acting on the advice received, I then informed the chief organisers of the proposed meetings of the Division's concerns (few to none) and wrote a supporting letter. This activity peaked early last year as proposals for meetings to be held in conjunction with the Kyoto General Assembly were circulated. Inspection of the programme for Kyoto will show the Division's Commissions to be well represented. I thank the initiators of the various meetings - approved and unapproved - for their interest in the scientific activities spanned by this Division. I also thank my Executive Committee for their advice. I especially thank the few members of that committee who regularly responded to my various e-mails.

The Division will end its first three years structurally unchanged.

There has been no groundswell for re-organization. Perhaps, at Kyoto it will be possible for the Division's Organizing Committee to meet to discuss the future organisation. Reorganisation by e-mail (and letter) would likely not have worked; response to my e-mails always came from a small minority with a majority remaining silent even when their individual commission's views were explicitly sought. It seems clear that, in any reorganisation or restructuring, links need to be developed with certain other divisions, for example, 'Variable Stars' with intimate connections to each of Division IV's Commissions is in another division.

Perusal of the commission reports that follow these introductory remarks will show that 'stellar physics' as represented by the five commissions thrives. While it is a cliché to refer to the present as "The golden age of astronomy", it is demonstrably true, as scrutiny of the reports will reveal. What a close reading of the reports will also show is how often a discovery spreads across commission boundaries and across division boundaries. A few examples of recent advances must suffice.

- Long baseline optical interferometry has produced remarkable images of close binary stars: Worley in his report p. 252) refers to COAST and NPOI observations of Capella and ζ UMa respectively. These and new interferometers under construction will lead to more accurate basic data on a variety of stars. Challenges to models of stellar interiors and atmospheres will surely be required.
- These three years have seen the discovery at last of brown dwarfs. Bessell's report (p. 263) mentions the discovery by Oppenheimer et al. of a close companion to GL229 whose spectrum shows the presence of methane bands. Zahn's report (pp. 269-270), which also refers to discovery of Teide 1, notes progress in the physics of brown dwarf interiors and the necessity for models of the interiors to be matched to appropriate model atmospheres. Fortunately, in parallel with observational searches for brown dwarfs and characterization of the spectra of the discoveries has gone marvellous work by several groups on the modelling of these cold atmospheres replete with molecules such as methane and water vapour. In turn this has stimulated new theoretical work on such molecules leading to fruitful conversions of chemists and physicists into astrophysicists whose interests span the full range covered by the Division.
- Discoveries of planets around stars has set the media ablaze. All of these discoveries rest on radial velocity variations whose total amplitude is but a small fraction of the intrinsic width of the stellar absorption lines. This fact requires careful consideration of stellar atmospheric effects (i.e., pulsations) before a planet is taken in all cases to be the hidden body causing the radial velocity variations (see Bessell's report, p. 263).
- Many advances are driven by new telescopes and instruments. The Keck telescope, for example, has already made notable contributions which, in part, are reflected in commission reports. Cram's report (pp. 278-279) discusses "unified" model atmospheres of hot luminous stars. Work on these stars is motivated in part by observations by Keck, HST, and other telescopes of these stars in nearby galaxies. Thus, stellar physics intrudes further into the realm of the galaxies, and even cosmology. Exploratory work on "extragalactic" stars is necessarily done at low dispersion; Levato's report (pp. 287-294) provides an overview of the enormous amount of work done in this field in the last three years.

Several of the reports emphasise the growth of the WWW in providing access to data of all kinds. Clearly, this growth should be taken into account when the next set of triennial reports are to be prepared. There is little to no point in duplicating partially and imperfectly what is available readily on the WWW or in the published proceedings of many symposia, colloquia, and workshops, and other outlets for reviews. What can the IAU commission reports provide that is unique? Cram writes "Arguably, the report will be of greater value to astronomers working *outside* the area covered by the Commission". This topic will presumably receive attention in Kyoto.

COMMISSION 26: DOUBLE AND MULTIPLE STARS ETOILES DOUBLES ET MULTIPLES

President: C. Worley

Vice-President: H. Zinnecker

Organizing Committee: C. Allen, Y. Balega, F. Fekel, W. Hartkopf, C. Scarfe & A. Tokovinen.

Introduction

The last years have been an exciting time in double and multiple star research, both observationally and theoretically, with the continued development and use of powerful new observational tools, as well as for the insights gained concerning binary star formation and evolution. In addition to many new results in the literature, two colloquia have greatly contributed to this: "The Origins, Evolution, and Destinies of Binary Stars in Clusters", held at the University of Calgary (Canada) in June, 1995, and the workshop "Visual Double Stars: Formation, Dynamics, and Evolutionary Tracks", held at the University of Santiago (Spain) in July, 1996.

During this report period the application of speckle techniques has continued to enrich the quantity and quality of double star measurements. Now long-baseline optical interferometers have begun to make even more precise observations, and actual imaging has been reported from both the COAST and NPOI projects. CCD astrometry is also being employed, although there seem to be unresolved problems with some of this work. Of course, classical visual and photographic astrometry continue, although they are playing less of a role. Also, as of this writing, the long anticipated HIPPARCOS and TYCHO results are not yet available.

Combined astrometric and spectroscopic investigations have been made for a number of objects. With the improved accuracy now attainable for the orbits and radial velocities, significant gains in the definition of the fine structure of the mass-luminosity relation is to be expected.

A new edition of the Washington Visual Double Star Catalog (1996.0) has been prepared by Worley and Douglass. It contains information on 78100 systems, extensive revisions and additions to the basic astrometric data, as well as much new data concerning magnitudes, spectral types, proper motions, orbits, and notes. The catalog has been transmitted to the data centers, and is also available at the website maintained by the U.S. Naval Observatory on the World Wide Web.

Observations and Orbits

Because of personal equation, micrometer measures are made and listed by individuals. In this report period, Couteau, Docobo, Gili, Heintz, Ling, Muller, Prieto, Popovic, Thorel, and Zulevic have contributed observations. Other observations, made presumably in an "impersonal" way, are often presented as group efforts, and in these cases only the first author is cited. Speckle measures have been made by Balega, Douglass, Horch, Hartkopf, Mason, McAlister, and Miura, CCD observations by Argue and van Dessel, photographic measures by Jasinta, and phase-grating observations by Tokovinen. There remains a critical lack of southern hemisphere observations by any and all techniques.

The resurveys of the Northern sky by Couteau, Heintz, and Muller have been largely completed, and have yielded more than 4000 new pairs. Thus, as has been rarely true in astronomy, the completeness of the Northern survey now approaches that of the earlier Southern work!

CHARA has continued duplicity surveys by speckle, and has completed one for all O-stars brighter than $V=8$, as well as all known photoelectric occultation binaries and stars in several clusters. It is their intention to observe all the stars in the Bright Star Catalogue, a program which is now more than 20% complete.

New orbits appear frequently, and often without good scientific justification. In fact, the number of orbits computed since the 1983 Worley-Heintz orbit catalog now almost equals the total contained therein. On the other hand, we are also beginning to see orbits of much higher quality, based on the superior accuracy of interferometric measures, as well as on the now substantial time interval which these measures cover.

Hipparcos, Tycho, and HST

Preliminary reports on the Hipparchos/Tycho project (Halbwachs and others) indicate that a large number of both known and new double stars was detected, but that complete reductions will be available for only a fraction of them. Therefore, this writer is unable to estimate the impact of this project on both visual double astronomy and upon the WDS. One of the serious defects of the WDS however—the lack of any homogeneous magnitude system—is likely to be considerably alleviated by the new data, and this is indeed welcome news.

Scheduled observing time for binary stars with HST is extremely limited, and targets must be very carefully selected. Therefore, it is unrealistic to expect a large contribution from this source.

Interferometric Programs

By the achievement of phase-closure, two long baseline optical interferometers, COAST and NPOI, have now produced images of the pairs Capella ($P = 104d$) and Zeta UMa ($P = 20.5d$). These first results portend an era where many spectroscopic binaries will be resolved, thus providing much new and very accurate fundamental data. Construction at Mt. Wilson Observatory of the CHARA array of five to seven 1m telescopes, with maximum baselines of 350m, has begun, and first fringes are expected in 1999. The system will resolve binary stars to about the 150 microarcsecond level, and to a relatively faint magnitude limit. The resultant scientific harvest will be impressive.

The CHARA group also has initiated a program to derive differential magnitude and color information using the adaptive optics capabilities of the Starfire Optical Range 1.5m telescope. They plan to continue this work with the new AO system presently installed on the Mt. Wilson 2.5m instrument, which they are regularly using for speckle observations.

The 66cm refractor of the U.S. Naval Observatory in Washington has been used regularly for speckle observations since 1990. More than 8000 successful measures have been made, in a program designed both to bridge the gap between speckle with large telescopes and the classical observations, and at the same time to provide quality and repeated observations for many pairs not observed with the larger instruments.

A group has used the Yale southern facilities, as well as the CASLEO 2.1m telescope, for badly needed southern observations, and Japanese observers have used the Mexican 2m reflector at San Pedro Martir. Groups in Russia and the FSU remain active, using telescopes ranging in aperture from 6 to 1m.

Catalogs

A "Third Catalogue of Interferometric Measurements of Binary Stars" was published by Hartkopf. It contains all measures made by speckle or other interferometric techniques, and is available on the World Wide Web. There are plans to update it regularly.

As mentioned in the Introduction, Worley and Douglass have issued a new edition of "The Washington Visual Double Star Catalog" (WDS), dated 1996, and it, plus supporting documents, is available on the World Wide Web. Work also routinely continues on the updating and correction of the Catalog of Observations, where the tabulated means now exceed 453000. Information continues to be gathered for an eventual new edition of the Orbit Catalog.

Miscellaneous

Loden has studied the relationship between small open clusters and widely separated multiple systems. He finds that there is no observational way to distinguish between these two types of objects.

It is obvious from the replies received to the solicitation of information for this report that many European colleagues have been largely occupied in the reduction of the enormous amount of data arising from the Hipparcos project. We await release of this data with great interest. One should bear in mind, however, that even with the many accurate parallaxes that will result, the short operational life of Hipparcos will not provide much information on binary orbits or mass-ratios, hence the immediate effect on improving the Mass-Luminosity Relation will not be great. Follow-on projects of the same or similar type, as well as the exploitation of ground based techniques, are necessary.

In this report I have not attempted to list extensive references, as I believe such to be entirely redundant considering the material which is readily available in Astronomy and Astrophysics Abstracts and other abstracting resources.

I thank those who have contributed to this report.

Charles E. Worley,
President Commission 26