COMMISSION No. 25

STELLAR PHOTOGRAPHY AND POLARIMETRY

(PHOTOMETRIE ET POLARIMETRIE STELLAIRE)

Report of Meetings held on 5 August 1988

PRESIDENT: F. Rufener SECRETARIES: I.S. McLean
A.T. Young

The Commission 25 activities during Baltimore assembly consisted of 2 joint commission meetings, reported in Highlights of astronomy, and 2 commission meetings reported here. The joint commission meetings were (chairmen/organisers in brackets):

Aug. 4: Problems of IR Extinction and Standardization (E.F. Milone)
Aug. 8: Stellar photometry with modern array detectors (F. Rufener)

These meetings originated in our commission and were co-sponsored. The two commission meetings were held on Aug. 5.

First Scientific Session (A.T. Young, Secretary)

Absolute Calibration of the Geneva Photometric System
(B. Nicolet, presented by N. Cramer)

New absolute (expressed in SI units) spectrophotometric data have allowed us to obtain a new determination of the Geneva passbands as well as conversion formulae relating the photometric data to absolute fluxes (Rufener & Nicolet, Astron. Astrophys., in press).

The calibrations are based on the data of Hayes & Latham (1975) for α Lyrae and on those of Oke & Gunn (1983) for subdwarfs. Comparison between Geneva photometry and some other sources of spectrophotometry were carried out. A slight systematic deviation between the data of Gunn & Stryker (1983) and ours appeared for the whole range of spectral types. A similar comparison was made between the absolute fluxes of Kiehling (1986) and Geneva photometry; the agreement is good.

As an illustration, the fluxes of the Supernova 1987A, systematically monitored in the Geneva system, were showed.

Photometric Data Collections (J.C. Mermilliod, presented by B. Hauck)

L'Institut d'Astronomie de l'Université de Lausanne collaborates with the Strasbourg Data Centre since its foundation in 1972 as an associate Centre and collects photoelectric photometric data. The final aim is to prepare catalogues of photometric data and check the data before they are introduced in the SIMBAD Database. Some 75 photometric systems have been recognized, but about 10 are really active. The catalogues produced contain both the original data and weighted mean values. The latter are usually computed after assessment of the data quality by comparing them with standard values.

Mean values in the UBV system have been computed and a catalogue is prepared for publication. One of the severest problem encountered

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during this work was the inclusion of UBV observations of visual binaries: not because our procedure is not adapted, but because of the lack of precise information on which components have been separated or observed together. Finally the improvement of the catalogue is facing the lack of co-ordinates for several thousand anonymous stars, which delayed the achievement of the whole work.

The photometric data and references can be found in the Strasbourg Database SIMBAD by interactive interrogation or can be obtained on magnetic tapes (or microfiches) from the Strasbourg and NASA Data Centres.

The specific realisation of the Institute is an Index file which does not contain individual data but tells us in which photometric systems a star has been observed. It contains at present information on 101.500 stars. We are expanding this file to include co-ordinates, V magnitudes and duplicity and variability flags. We also plan to include information from UV and IR satellites. Our disk storage possibilities recently increased and we shall develop a photometric database offering all facilities for data compilation, analysis and retrieval and hope to be able to offer a public service.

All these data have been extensively used for the preparation of the Hipparcos satellite Input Catalogue. The comparisons of the data coming from several systems proved to be an excellent test of the data quality and revealed a number of yet undetected errors.

The most recently up-dated catalogues are:

uvby beta system: 1985, Astron. Astrophys. Suppl. 60, 61
Johnson UBVRI : 1986, Astron. Astrophys. Suppl. 65, 195
UBV system : 1987, Astron. Astrophys. Suppl. 71, 413.

Question: What limiting magnitude was used in the catalogue? Answer: No limit was imposed; all the data in the literature were used, to be as extensive as possible.

A comment was made about the reproducibility of the systems. In some observatories, the Strömgren y filter may have a center wavelength as short as 5460 Å or as long as 5550 Å, a difference of 90 Å. This is considerable if you consider the width of the filter, which is about 200 Å. If everything were linear in this region, interpolation would be OK; but the 5200 Å feature and emission lines occur, so some action should be taken against such strong variations of the filter passbands. F. Rufener was glad to hear this, because the passband definition is one of the first things to consider when doing photometry. As important as counting photons is to define what photons you are counting. We can use linear transformations, but must know what we are transforming. A.T. Young added that it is in principle impossible to make these transformations without more information, because all these systems are undersampled. "So", concluded Rufener, "the best thing is to have a good passband".

The Photometric Aspects of the Hipparcos and Tycho Mission (M. Grenon)

Besides mapping the sky and determining the attitude of the satellite, a by-product of the main channel will be photometry in a very wide band, Hp (an unfiltered S-20 photocathode). Dielectric filters plus glass filters in adjacent fields will also define a

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narrower-band system, called Tycho. This BT, VT system is not exactly like the Johnson system. The Tycho B is similar to the Geneva B band; the Tycho V extends a little more to the blue than Johnson V, and almost transforms linearly to it. Tycho B differs from Johnson B, showing effects from Balmer lines and reddening; but the Tycho band can be accurately reduced to the Geneva band.

The precision of 1 observation will be better than 0.01 mag for Hp < 7, increasing to 0.12 mag at Hp = 12. Because about 100 transits will be observed per star, the means should be quite satisfactory. The sampling is irregular in time, with 5 or 6 observations in 6-hour intervals separated by gaps of 3 to 6 weeks, depending on galactic latitude. This should detect variable stars very well, provided that the long-term changes in instrumental sensitivity are monitored carefully. This is expected to be due mainly to cosmic-ray and solar-flare protons; the loss in sensitivity is about 10%/year, or 30% over the life of the mission. The goal is to have systematic errors less than 0.5%; 16.000 stars will be used to monitor the instrument continuously.

To obtain good tangential velocities from Hipparcos's proper motions, good photometric distances will be needed for stars beyond one or two hundred parsecs (where the parallax errors become too big); the absolute magnitudes must be known to 0.5 mag. This means that good ground-based multicolor photometry is needed for the 58.000 survey stars, as well as many others that will be observed. A multi-observatory campaign has produced useful data on about 15.000 stars, but some 60.000 stars remain to be done. The ESO countries have paid more than $3000 per star to get Hipparcos data; for about 1% of this, ground-based data should be obtained to make the spacecraft data useful, preferably before the end of 1993.

Question: Absorption is very unevenly distributed. In the third galactic quadrant, you could go out to 500 pc. Did you take this into account? Answer: For most of the early-type stars it is possible to get the interstellar extinction, but for the K or M giants it is almost impossible. So the survey is extended to the north. Up to 200 pc it is almost clean.

Progress Report on Polarimetry Matters and VLT

(J. Tinbergen, presented by I.S. McLean)

The question of polarization in the new large telescopes has been examined. There will be serious polarization effects that will affect photometry and spectrophotometry. Beam combiners cause polarization: dielectric coatings, dichroic mirrors, even reflections from aluminized surfaces, and of course diffraction gratings. So the instrument is, by accident, a crude polarimeter. Faint objects tend to be rather strongly polarized, and will give apparent intensity variations if observed with a partially-polarized telescope, especially on an alt-az mounting. To obtain photometric accuracy (not just precision -- i.e., lots of photons) requires polarization measurements, not just photometric ones. (See the Liège Colloquium in 1987, and Tinbergen's paper at the VLT meeting held by ESO at Garching, 1988, in press). Someone has to model these instruments to understand the effects of instru-

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mental polarization. Funding agencies should support the development of polarization modulators before the beam-combining optics, to measure the instrumental effects.

CCD observations of 3000 binary stars with separations less than 5 arc sec (A.N. Argue, P.S. Bunclark, M.J. Irwin)

Astrometric and photometric observations of close binary stars have been made in 1986 and 1987, and are still underway, on the 1 m Jacobus Kapteyn Telescope at La Palma in order to contribute to HIPPARCOS. The objects had been selected by J. Dommanget, Coordinator of the WG on double stars responsible for that part of the Input Catalogue (40.118.013 p 153).

The CCDs used were an RCA chip (pixel size 0.3 x 0.3 arc sec) and a GEC chip (0.4 x 0.4) with field sizes each approximately 3 x 2 arc min. Used with Kitt Peak V and R filters (J. Mould System) the instrumental scales are very similar to Landolt's scales (33.113.003) with a negligible colour term (Fig. 1). Flatfielding was on the twilight sky. Night-sky emission lines were never a problem.

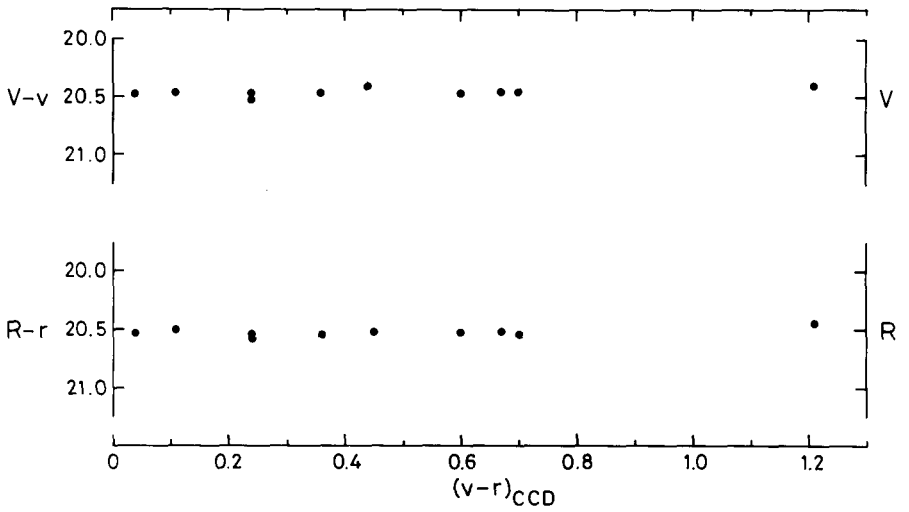

Fig. 1. Colour dependence of v and r (instrumental scales) for one night for RCA-CCD and Kitt Peak (J. Mould System) filters. Ordinates: differences from Landolt's Catalogue (33.113.003); abscissae: the instrumental colour index (v-r).

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Reductions are done using a program for automatic analysis of crowded fields written by Irwin (39.036.153). The computed accuracy is a function of the separation and magnitude difference between the binary star components (Table 1). In practical terms, repeated observations on a single extinction star (e.g. Landolt 205556, magnitude $8^m.30$) on a good night gave rms residuals about the linear regression (in air mass) of $0^m.005$ in v and $0^m.008$ in r. The reduction program resolves binaries down to separations of one-half the rms seeing spread when the components are of nearly equal brightness: in practice this means that resolutions of 0.5 arc sec are fairly often achieved.

Table 1. Theoretical accuracy for GEC-CCD on 1 m Jacobus Kapteyn Telescope at La Palma (pixel size 0.3 x 0.3 arc sec) as function of separation and magnitude difference between binary star components.

	Magnitude difference in V				
Separation	0^m	1^m	2^m	3^m	4^m
1".3	< 0.01	0.02	0.03	0.05	0.10
2".6	< 0.01	0.01	0.01	0.02	0.06
3".9	< 0.01	0.01	0.01	0.02	0.06

12-Channel Photometer-Polarimeter
(J. Tinbergen, presented by I.S. McLean)

At the Observatorio del Roque de los Muchachos, on the Canary Island of La Palma, there exists a 12-photomultiplier photometer/linear polarimeter, which has several unusual modes:

a) Line photometry in up to 6 lines simultaneously (multi-line "H-beta")
b) Quasi-simultaneous photometry and linear polarimetry in up to 12 channels
c) 10-msec photometry in up to 12 simultaneous channels (still being implemented).

Information about this system is available in the Observers' Guide to the Observatory, in a Users' Manual, and in Be Star Newsletter no 16. Telescope time is allocated through committees in Britain/Netherlands and in Spain. Enquire via Royal Greenwich Observatory or Instituto de Astrofisica de Canarias.

Polarimetry of Seyfert Galaxies (U.C. Joshi)

This program aims to determine the mechanisms and energy sources of Seyferts, and to determine whether single or multiple mechanisms are required, by studying the time variations and wavelength dependence of the polarization, measured through different aperture sizes. The 1-meter telescope at Kavalur is used. The PRL polarimeter is similar to Gehrels's MINIPOL. Half-wave plates rotating (at 100 Hz) and fixed modulate the light; a computer gives on-line polarization values. The increase of polarization with decreasing aperture size, and rapid time

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variations, indicate a non-termal source rather than dust scattering in NGC 2992 and 3081. In NGC 3227, a large wavelength dependence suggests a large dust component. IC 4329A shows polarization concentrated to the nucleus, but also a wavelength dependence; photometry is needed, to subtract the galaxy from the central source.

Business and Second Scientific Session (I.S. McLean, Secretary)

a) Business Part

The president of the commission welcomed all new members, and in particular welcomed back to this commission Dr. Ivan King. David Crawford recommended that Mr. R. Genet becomes a member rather than a consultant, and two attendees at the meeting asked to become members also. Fifteen new members were therefore expected.

The committee then stood in silence for a short period in tribute to three deceased members (J.C. Kemp, V.B. Nikonov, A.C. Velghe).

A few resignations were reported because those members had other pursuits; the president wished them well in their new activities. A letter was received from South Africa from Dr. Cousins who would have had his 85th birthday had he been able to attend the IAU in Baltimore. All those present signed a greeting card to be forwarded on behalf of the commission.

Next the elections of the new president and vice-president took place. Following tradition, a polarimetrist (Ian McLean) and current vice-president was proposed as the new president, and Andy Young (photometrist) was put forward for vice-president. There were no other nominations. With the candidates not present votes were taken and I. McLean and A. Young were both elected by unanimous decision.

The president reported that 6 retiring members of the organising committee (OC) needed replacements and that candidates had been suggested and circulated among the OC. He presented their names to the full committee and asked for amendments or additions. None were forthcoming and the new OC members were duly elected (I.K. Knude, J.D. Landstreet, J. Lub, J. Menzies, V. Straizys, P. Wesselius).

A report was given to the Commission by R. Buser on the matter of creating a working group on synthetic photometry. It was suggested that this would be jointly with Commission 36; Drs. Gustafsson and Kurucz have agreed to serve for Comm. 36. Major activities of the working group would be as follows:

. system response functions
. stellar spectrophotometry libraries
. model stellar atmospheres flux distributions
. standard star data
. actual use of synthetic photometry: limitations & precautions
. computer time request support
. reference document.

It would be important to address the issues of calibrations, transformations and standardisation, and especially the use of synthetic photometry as a tool for linking ground-based to space-based systems.

Following some discussion, it was agreed that R. Buser and I. King would represent Commission 25 and that the president should advise the IAU secretariat that a permanent working group is to be set up.

Out of the document circulated for this purpose, we notice: "The designated working group's members are in charge of coordinating the activities and exchanges. Interested members of Commission 25 and 36, or of any other Commission, who would like to collaborate should contact the president of the Working Group. The president will report on the Working Group's activities and projects to both parent Commissions (25 and 36) during their meeting at the General Assemblies of the IAU. He will also prepare a report which will be included as part of the tri-annual report of Commission 25. The four designated members of the Working Group convened for a first meeting on August 9, discussing the major tasks to be taken up as well as the priorities with which these are to be followed. They agreed that the president (R. Buser) will establish a comprehensive list of items and projects already under way, along with a proposed strategy for the work in the group. In an iterative process, this list will be edited by the individual members of the Working Group, and adoption of a final plan of action will ensue."

Andy Young reported briefly on a photometry meeting held in Washington last year, indicating that the proceedings were to be published by NASA and circulated to all members.

The president on behalf of the commission had agreed to sponsor several IAU Colloquia and Symposia. Two such future events were discussed, an IAU Symposium on the "Magellanic Clouds" and an IAU Colloquium on "Galactic Astrophysics with Precision Photometry", both for 1990. The members agreed to co-sponsor these also.

On opening the business session for wider discussion, John Landstreet asked if it would be possible for Commission 25 to join the "peculiar A-stars" Working Group. Everyone agreed and the president undertook to pursue this item.

b) Scientific Part

A series of papers were presented to complete the scientific session. Two presentations by C. Sterken and J. Manfroid deal with the consequences of passband mismatches.

A Practical Experience (C. Sterken and J. Manfroid)

Photometrists know that a linear transformation from one instrumental system into another is only possible when certain conditions are met. There is a widespread misconception that serious problems only arise when one observes exotic objects using widely divergent instrumental passbands.

The authors carried out "multi-site" photometric measurements by simultaneously using five different quasi-standard uvby filtersets at two ESO-telescopes which are separated by only 30 meters.

Surprisingly large systematic differences show up in the Strömgren m1 and c1 indices of early B stars. This effect may systematically alter the observational H-R diagrams of reddened young clusters. (Astron. Astrophys. Supp. 71, 539)

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Preservation of Authentic Photometric Systems: The Problem of Photometry on a Long Time-Baseline (J. Manfroid and C. Sterken)

In 1982 we started at ESO a programme of variable star monitoring on a long-term basis. A 50-cm telescope is committed for several months a year to carry out differential uvby measurements of about 100 variable stars of different types.

Over 5 active years we had 40 months of observations which yielded remarkable new results. The biggest problem is the preservation of the homogeneity of the dataset.

The problems are caused by the fact that different telescopes and filtersets are used, the photometers are occasionally replaced by newly designed instruments, the filters age, and the photomultipliers are sometimes replaced by ones which have different response curves.

Our conclusions are that, in spite of a consistent reduction procedure and a central data handling, it is impossible to correct some results by using analytical transformations. Moreover, systematic differences between the systems do not only show up in absolute photometry, but also in the differential data.

These talks generated considerable interest and discussion. Many members expressed concern. Most urged major observatories to standardise and D.L. Crawford urged for a "certification".

Faint Standard Stars for UBVRI (Arlo U. Landolt)

Nearly six hundred stars have been examined as possible candidates for broad-band UBVRI standard stars on the Johnson-Kron-Cousins photometric system. These new data were obtained at the 1.5-m telescope of the Cerro Tololo Inter-American Observatory over the past ten years. The detector was a RCA 31034 photomultiplier. The filters have been described in the literature (Astron. J., 88, 439, 1983).

A series of observations has established a 143-star subset from the initial six hundred stars as new standard stars in the approximate magnitude range $11 < V < 15$ and colour index range $-0.3 < (B-V) < +2.3$. These stars were observed on an average of 11 different nights and more than 20 times each. The average mean error of the mean is better than 0.005 magnitude for the magnitude and colour indices, except for (U-B) where the error is perhaps twice as large. All data have been tied into the standard stars defined in the above cited reference.

Another hundred stars, or so, almost are of standard star quality. Data acquisition is continuing; hopefully this last list of stars will be added to the above 143 in the near future.

Observational work has begun on stars reaching beyond V = 21st magnitude to provide very faint standard stars for the Hubble Space Telescope.

Geneva Photometric Catalogue (F. Rufener)

With 29.400 entries, the catalogue has been worked out from all the observations made until summer 1987. About 200.000 measures of the seven colours have been gathered in both hemispheres. Actually, the majority came from our La Silla Station (ESO, Chile). The catalogue gives informations on identification, normalized colours, usual

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indices and parameters, magnitude V. For each star, an evaluation of the internal precision is given and a general accuracy estimation of the data is proposed. A mag-tape version will be released by the Centre de Données Stellaires at Strasbourg. A paper-bound edition (340 pages, format 210 x 297 mm) photocomposed with Times font will be solded by Geneva Observatory (foreseen price including air-mail fee: 60 Swiss francs or 40 US$).

Dust Shell around Supernova SN1987a (U.C. Joshi et al.)

Polarimetric measurements of SN1987a in BVRI bands show that there are at least two intrinsic sources which contribute to the observed polarization; one source being the dust shell around SN1987a as is indicated by the wavelength dependence of linear and circular polarization. From the time variation of wavelength dependence of linear polarization, we have deduced the radius of dust shell ~ 0.05 pc and optical depth $\tau \sim 0.6$ at visual wavelength.

The meeting ended with a round of applause to thank the retiring president of Commission 25, F. Rufener, for his efforts over the past 3 years.

I.S. McLean
A.T. Young
F. Rufener

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