COMMISSION 25: STELLAR PHOTOMETRY AND POLARIMETRY
(PHOTOMETRIE ET POLARIMETRIE STELLAIRES)

Report of Meetings November 19,20,23

PRESIDENT: J.Tinbergen

SECRETARIES: I.S.McLean
J.Tinbergen
R.R.Shobbrook

The Commission 25 programme at the General Assembly in New Delhi consisted of 3 joint meetings, reported mainly elsewhere, and 3 of Commission 25 by itself, reported here. The subjects of the joint meetings were (chairmen/organisers in brackets):

Nov. 20 Synthetic Photometry (Buser)
Nov. 21 Precision Photometry in Clusters (Richer)
Nov. 23 Hipparcos (Kovalevski)

Of these, the first originated within our commission, the other two we co-sponsored.

The subjects of our own meetings were (chairmen/organisers in brackets):

Nov. 19 Polarimetry with the Space Telescope and with Ground-based Facilities (McLean)
Nov. 20 Business and short scientific reports (Tinbergen)
Nov. 23 The Zero Point of the Beta Index for B Stars (Shobbrook)

This programme reflected our primary task, viz. promoting good techniques in the fields of photometry and polarimetry while leaving applications to other commissions.

Synthetic Photometry: a Working Group?

The joint meeting on Synthetic Photometry was initiated by Commission 25, sponsored jointly by Commissions 25,29,36 and 45 and was organised by R.Buser. The main purpose of the meeting was to review the techniques and potentials of synthetic photometry. The papers presented will be published in Highlights of Astronomy.

At the end of the meeting, a general discussion about the possible formation of a Working Group showed that there is sufficient active support to proceed further with this idea. During the discussion, concern was expressed that such a Working Group might interfere with the work of the Hubble Space Telescope calibration team or with that of the Working Group on Standard Stars. It was stressed that this must not happen, but rather that these two groups should be supported and complemented. It was also agreed that spectrometry should be included within the scope of any such Working Group.

With these constraints, Buser (who is on our Organising Committee) will sound the community for further active support and, in consultation with the presidents of the commissions involved, will take further action as appropriate.

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Polarimetry with the Space Telescope and with Ground-based Facilities (I.S.McLean)

The meeting was quite well attended considering its unusual time-slot prior to the Inaugural Ceremony and was effective in drawing together a remarkably wide range of very interesting topics involving polarimetry. It was noted that, while all the talks referred to observational techniques and instrumentation, each speaker also demonstrated the worth of polarimetry by discussing real astrophysical results. Seven papers were presented and these are summarised below.

POLARIMETRY WITH THE SPACE TELESCOPE: O.L.Lupie and H.S.Stockman

The paper was given by Dr Olivia Lupie and embodied a description of the HST itself and each of the instruments having a polarimeter capability. Dr Lupie briefly reviewed the proposed calibration schemes and so-called "standard" targets, and appealed for as much ground-based support as possible for the improvement of the lists of standard sources. A written report of polarimetry with the Space Telescope is available from Dr Lupie at the Space Telescope Science Institute at Baltimore.

POLARIMETRY WITH VERY LARGE TELESCOPES: J.Tinbergen

In this short talk Dr Tinbergen emphasised that regrettably, at least some of the New Technology very large telescope designs do not preserve the polarization of the incident radiation. He indicated that with the support of the Commission he hoped to lodge a resolution at the XIXth General Assembly, which would be distributed to institutions responsible for large telescope projects, and which would underline the seriousness of the matter (see Business meeting - J.T.).

EXPERIENCE WITH A FIBER-LINKED GRATING SPECTROPOLARIMETER: R.Ostreicher

A unique spectropolarimeter system employing a grating spectrometer linked by an optical fiber to the telescope and a linear array detector was described in this presentation. Actual observational results were reported, in particular the polarization of R Aquarii.

INFRARED POLARIMETRY FROM 1-10 MICRONS: D.Aitken

In this presentation Dr Aitken gave a fine review of the physics and the techniques of infrared polarimetry. He described some recent and quite remarkable polarization observations of Orion and of the Galactic Centre and outlined for us some of the astrophysical implications. It was very clear to all that infrared polarimetry had undergone a significant transformation in recent years.

SIMULTANEOUS FIVE-COLOUR (UBVRI) POLARIMETRY OF STRONGLY INTERACTING CLOSE BINARIES: V.Piirola

Dr Piirola described his highly successful multi-channel photo-polarimeter system and reported UBVRI polarization observations of SS433. From these measurements he derives both the interstellar polarization and the intrinsic polarization. He finds that the average intrinsic polarization, probably due to electron scattering, is approximately parallel to the direction of the jets. A possible model was discussed. Dr Piirola also reported simultaneous observations of circular and linear polarization in five colours of AM Her binaries, but deferred discussion to the following review by Dr Bailey.

POLARIMETRY OF AM HERCULIS BINARIES: J.Bailey

In this talk the speaker carefully set out the physics of the cyclotron emission models for these compact magnetic objects and demonstrated the importance of obtaining simultaneous photometry and polarimetry over a wide wavelength baseline (0.4-2.2 micron). The circular polarization of these sources is very large. He described the dual optical/IR polarimeter used to make his measurements and reported detailed observations of several sources.

OPTICAL AND RADIO POLARIZATION OBSERVATIONS OF NEARBY GALAXIES: R.Wielebinski

The final paper was mainly an observational comparison of optical and radio polarization maps of galaxies. Dr Wielebinski showed several sources, discussed the implications and appealed for a greater awareness of the possibilities of combining optical and radio polarization data.

ACKNOWLEDGEMENT

I.S.McLean would like to take this opportunity to thank all the participants in this session, speakers and audience, for a stimulating meeting.

Business and short scientific reports (J.Tinbergen)

At the business meeting of Commission 25, the proposal, by the outgoing organising committee, for new Commission Officers was adopted unanimously. The very useful practice of teaming up a photometric president with a polarimetric vice-president (or v.v.) has been turned into a "tradition" with the election of Dr McLean as vice-president. Our officers for the 1985/88 triennium are:

President: F.G.Rufener Vice-president: I.S.McLean

Organising Committee: R.Buser, J.Dachs, P.J.Edwards, I.S.Glass, D.Kilkenny, J.S.Miller, E.F.Milone, A.J.Penny, V.Piirola, N.M.Shakhovskoj, J.Tinbergen, F.J.Vrba, R.Wielebinski, A.T.Young

The coming triennium will see widespread adoption of multi-element detectors with their own observational procedures and reduction algorithms. This shift in emphasis is beginning to be reflected in the composition of the organising committee: in addition to mainstream fields, its expertise now extends over very precise and/or differential photometry, IDS and CCD techniques, synthetic photometry and radio polarimetry. This development may eventually lead to the commission merging into a much larger technical commission, or to a general reallocation of scopes of the IAU technical commissions. In our commission's field of interest, wavelength limits are vague, "stellar" is becoming an unnecessary and illogical limitation and the dividing line between multi-colour photometry and spectrometry is fast disappearing. The next two triennia may well see a gradual move towards a commission structure more tailored to modern astronomical practice. If so, our new officers face a complex task.

The other main item of business was the resolution on polarization fidelity of large telescopes. This resolution, as published with background considerations in IAU Bulletin no 54, had been redrafted at P.Notni's suggestion to remove the limitation to "internal properties" and "point sources". The meeting suggested a further clarification, viz. that degradation of high-accuracy photometric data by telescope polarization effects could be irreversible. The text printed below resulted from this. Unfortunately, in cleaning it up, the Resolutions Committee reduced its scope to an apparent complaint by polarimetric specialists rather than the wide-ranging warning it was intended to be. This is why the less elegant but more relevant original resolution, passed by Commissions 25 and 9, is printed here:

Commissions 25 and 9 of the IAU,

considering that certain properties of astronomical objects express themselves only in the polarization of the observed radiation,

recognising that, astronomical polarizations being generally small at most wavelengths, high signal-to-noise and therefore relatively large telescopes are needed for polarization observations, and

moreover, that high-accuracy photometric observations in general, while

increasingly becoming both necessary and feasible, could be irrevocably degraded by polarization effects in the telescope,

affirm that high-accuracy observations of relatively bright objects are as legitimate a use of large telescopes as is the detection of very faint objects, and therefore

recommend that, in reaching the compromises involved in the design of the very largest telescopes, due weight is given to the need to use particularly those telescopes for the most accurate photometric observations, such as polarimetry, in the decades to come.

The remaining business items were two:

-- p.261 of Reports on Astronomy contains a collating error by Reidel; the correct text is available from J.Tinbergen
-- the list of new members and consultants was displayed and approved; see elsewhere in this volume for an up-to-date commission listing.

In the science part of the meeting, mention was made of J.S.Miller's new CCD polarimeter (his and I.S.McLean's being the only 2 known to be in operation) and of the LEST Technical Report by Stenflo and Povel on optical demodulation (this might be the best technique for pressing the CCD into precision polarimetric service). Short papers were then given on Calgary's rapid chopping differential photometry system (E.F.Milone), on UKIRT infrared array progress (I.S.McLean) and on annual and volcanic-origin extinction variations for a 10-year period at La Silla (F.G.Rufener). Details may be obtained from the authors.

The Zero Point of the Beta Index for B Stars (R.R.Shobbrook)

At this session R.Shobbrook and E.Schmidt demonstrated the existence of some problems with the zero point of the Beta index for B stars, in some regions of the sky.

Shobbrook first presented evidence from a 1980 paper (MNRAS 192, 821, fig. 2) which shows differences of about 0.015 mag for the southern sky between the Crawford, Barnes and Golson (Astr. J., 76, 621, 1971: CBG) and the Gronbech and Olsen (Astr. Astrophys. Suppl. 27, 442, 1976: G&O) Beta indices for Bright Star Catalogue (BSC) B stars. Such errors are significant, especially for B supergiants, since the slope $\Delta M_V/\Delta\beta > 50$ for such stars and the distance moduli may be in error by about 0.7 mag.

The new Balona and Shobbrook (MNRAS 211, 375, 1984) calibration of M_V in terms of β and c_o, determined from 13 clusters with uvbyβ photometry down to the late-B ZAMS, is believed to be the best that can be accomplished with the present data. However, figure 6 of that paper clearly indicates that (V_o-M_V) does vary with M_V for some clusters. The simplest (though admittedly not necessarily the correct) explanation for these apparent 'evolutionary' effects is that for some clusters there are errors in the Beta index zero points of up to 0.01 to 0.02 mag. The variation of (V_o-M_V) with V_o occurs because such an error in β corresponds to 0.5 - 1.0 mag for the most luminous members but only 0.1 to 0.3 mag for the late B dwarfs.

There is some evidence that the G&O scale is correct for the southern sky. Observations of members of NGC 2547 (Shobbrook: MNRAS, in press), whose Beta indices were determined using nearby G&O stars as secondary standards, are in excellent agreement (to 0.001 mag) with the β scales of Eggen (Ap.J. 238, 627, 1984) and of Lynga & Wramdemark (Astr.Astrophys. 132, 58, 1984), who both referred

their measurements directly to the primary Beta standards. NGC 2547 is in a region where the mean difference in β between the G&O and the CBG ESC stars is a maximum. This result therefore indicates that the G&O stars in this region are accurately on the scale defined by the primary standards.

Finally, Shobbrook compared 13 clusters which have distance moduli determined both from the Beta index (using the Balona & Shobbrook calibration) and by Mermilliod (Astr. Astrophys. Suppl. 44, 467, 1981) from UBV ZAMS fitting. For 9 of the clusters, the mean difference in distance modulus (in the sense BS - Mer) was only +0.03 (s.d. 0.21) mag. For the other 4 clusters, the differences are -0.7 for Chi Per, +1.1 for NGC 3114 and +0.6 for NGC 2362 and NGC 6231. It is not suggested at present that these problems are solely due to an error in the Beta indices, since ZAMS fitting for the youngest clusters is notoriously risky in the UBV system. However, it would be prudent to remeasure a few stars in each cluster, preferably against the primary Beta standards, to check the zero points.

Schmidt's contribution mainly addressed the problem of the calibration of the zero point of the Cepheid period/luminosity relation. Hβ photometry of B stars in clusters containing Cepheids results in a luminosity scale which is fainter by 0.1 to 0.4 mag than that determined from UBV studies of the same clusters. On the other hand, ultraviolet studies of the companions of Cepheids results in a scale which is a further 0.6 mag fainter than that from Hβ photometry and theoretical studies indicate a scale brighter by 0.2 to 0.4 mag. A calibration based on Walraven photometry and that using the recent Balona and Shobbrook β calibration are in excellent agreement if the Pleiades modulus is given the same value in both calibrations. Unacceptable discrepancies do remain, but there is no reason to assume that the Hβ scale of M_V is in error by more than a very few tenths of a magnitude.

To produce convergence of the various estimates of the Cepheid luminosities, each method needs to be investigated in detail. Schmidt suggested several possible difficulties with the Hβ scale, as follows:

a) Internal consistency of the photometric systems: Balona & Shobbrook showed that zero point errors between clusters are a plausible source of inconsistencies in the luminosity calibration for some clusters. One possible cause for such an error is the failure to apply a colour term to the β transformation which may be necessary for some filter sets. This may be important for some of the Cepheid clusters which tend to suffer more reddening than do most of the calibrating clusters. This can be checked by reobserving a few B stars in each cluster containing Cepheids and taking care to determine colour effects accurately. Schmidt has made a preliminary investigation by comparing a few stars in each of three Cepheid clusters and three calibrating clusters. Although the existence of a colour term was suspected, there was no evidence suggesting that a revision of the scale was necessary. More detailed checks are still required, however.

b) Emission line stars: because emission at Hβ causes the inferred luminosity and distance to be too large, Be stars must be excluded from the determination of the average cluster moduli. This would most effectively be accomplished by measuring a photometric Hα index in conjunction with the Beta index. As has been shown by several authors, the Be stars may thus be easily identified.

c) Cluster membership: membership studies based on motions are needed for all clusters with Cepheids.

d) Extension to fainter stars: the Hβ studies of clusters with Cepheids have been restricted to the B stars. The extension to fainter A and F stars would provide a valuable check on the moduli. Such an extension is now becoming feasible with the advent of new panoramic detectors.

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