

24. COMMISSION DES PARALLAXES STELLAIRES ET DES MOUVEMENTS PROPRES

PRÉSIDENT: M. H. L. Alden, Leander McCormick Observatory.

MEMBRES: MM. Cecchini, A. N. Deutsch, Haas, R. G. Hall, Hertzsprung, J. Jackson, C. Jackson, Mlle Jenkins, MM. Kohlschütter, König, Kuiper, Lavdovski, Lindblad, Lourens, Luyten, E. G. Martin, W. W. Morgan, Paloque, Parenago, Podobed, Smart, Stearns, Strand, van de Kamp, van Rhijn, Vyssotsky, Wagman.

TRIGONOMETRIC PARALLAXES

Half a century has elapsed since Schlesinger first demonstrated the feasibility of using long focus telescopes for the accurate determination of trigonometric parallaxes and devised methods of treating the observational data efficiently. In that interval about fifteen observatories with telescopes of various apertures have derived more than 10,000 relative parallaxes. Most of these are included in the *General Catalogue of Trigonometric Stellar Parallaxes* published in 1952 by the Yale University Observatory. This catalogue, besides giving the original relative parallaxes, includes absolute parallaxes and probable errors obtained by applying certain precepts. Whether the system adopted is the best that could be derived was the subject of discussion at a conference on Problems in Astrometry held at Northwestern University in September 1953. Harris confirmed that the adjusted probable errors and weights used in the Catalogue were of the right order. Schilt, however, thinks that the printed absolute parallaxes may have a systematic error and require corrections up to $+0''.007$. For nearby stars the systematic error may not be serious. But as we extend our investigations to more distant stars, a correction of this size becomes important. The matter merits further study.†

Trigonometric parallax determinations

Allegheny	1875	Mount Wilson	550
Bosscha	150	Sproul	420
Cape	1805	Stockholm	50
Dearborn	193	Uppsala	50
Greenwich	760	Van Vleck	235
Leander McCormick	1970	Yale	1950
London—Mill Hill	58	Yerkes	454

In some cases the above numbers are approximations. They total 10,520, being an increase of 599 over the previous list. The annual rate is therefore around 200 parallaxes per year. Of the total increase, Yale has contributed more than one-third and the Cape nearly one-quarter, followed by McCormick and Allegheny in that order. It is estimated that 400–450 of the above stars do not appear in the Yale Catalogue.

The annual output of trigonometric parallaxes will probably diminish in the future for a number of reasons. One of these may be the feeling that sufficient data have now been accumulated for the calibration of more effective methods of reaching the distant stars. This is no doubt the case except for stars of unusual spectral characteristics or stars which do not fit the H-R diagram. Cluster parallaxes, which gain in accuracy with the passage of time, have proved useful for many stars of this kind. The development of photometric methods of determining distance is outside the province of this commission but should be mentioned.

Since the last report several observatories suspended or curtailed parallax observations. London (Mill Hill) is winding up its current programme and does not propose to

† The proceedings of the conference are reported in *Astr. J.* **59**, 1954. Harris' and Schilt's remarks appear on pp. 59 and 55 respectively.

continue. Stockholm has ceased parallax work altogether. The Greenwich observations, interrupted by the move to Herstmonceux Castle, may be resumed later. The Yale-Columbia telescope was moved in 1952 from South Africa to Australia, but will be in commission soon. Future parallax observations with this instrument are contemplated on a reduced scale. Strand reports that a minimum of fifty plates is now required for each parallax. At Allegheny stars as faint as magnitude fifteen photographic are being added to the programme. These will strengthen the luminosity curve for faint absolute magnitudes and help fill the vacuum caused by the cessation of observations with the Mount Wilson reflectors. While the McCormick telescope is used for photography only half the time, there is a sufficient backlog of material on hand for many years at the present rate of measurement. The observing programme consists mainly of stars showing orbital motion and red dwarf stars of small proper motion, in order to provide better statistical data for the latter. The search for unseen companions of nearby stars and the determination of mass ratios and orbital motion continue to occupy a considerable part of the time at several observatories. Allegheny, McCormick and Van Vleck all report stars with apparent periodic motions which are being followed. Experience has shown that many of these are spurious, but only continued observation can decide which are real.

Among the topics suggested for discussion at the Dublin meeting are the following:

1. Means of improving the accuracy of the observations. König reports experiments with this in view. Strand suggests the use of automatic timing and plate transport as has been done successfully for double stars at Dearborn and possibly automatic guiding.
2. Future parallax programmes. It is hoped to have some specific suggestions for presentation.
3. Closer co-operation among observers to insure adequate coverage and avoid unnecessary duplication.
4. Matters arising in connexion with the *Yale Parallax Catalogue*.

SPECTROSCOPIC PARALLAXES

The only report on spectroscopic parallaxes from members of this commission comes from Yerkes. Morgan states that a catalogue of spectroscopic parallaxes of around 1000 O and B stars of high luminosity is now nearing completion. A catalogue of spectroscopic parallaxes of main-sequence B2-B5 stars is being prepared by Blaauw and Morgan. Approximately 250 additional early-type stars of high luminosity have been classified for the determination of spectroscopic parallaxes in connexion with certain research programmes of Hiltner. It is planned to determine the spectroscopic parallaxes of all early-type stars of high luminosity, including those being discovered at the Tonantzintla and Yerkes-McDonald Observatories.

The 1952 Parallax Catalogue did not include spectroscopic parallaxes as was the case with previous editions. The consensus of opinion of the members of the commission is that the time is not ripe for a separate general catalogue of either spectroscopic or dynamical parallaxes. The contributions since 1935 are not numerous. Further improvements may be made in the correlation of luminosity classification and spectral criteria.

PROPER MOTIONS

Proper motion investigations are usually long-range projects. The detailed reports that have been received are mainly progress reports and no attempt will be made to reproduce them in full. Pertinent material will be available at the Dublin meeting if desired. Most proper motions come within the province of other commissions also. Thus the zone catalogue of the stars down to about magnitude 9 are the concern of Sub-commission 8*a*. In this category Yale reports the published revision of the zones $+20^\circ$ to $+30^\circ$ and the preparation for the printer of the zones $+60^\circ$ to $+90^\circ$. The projected

AGK 3 will fall in this class. Work on the Selected Areas, such as that reported by Groningen for the equatorial Areas from a repetition of the Algiers plates after an average interval of 45 years and for the Areas at -15° from Yale plates with an interval of 24 years is covered by Commission 32. The increasing use of the astrographic cameras after intervals of 40 to 60 years comes under Commission 23. Commission 33 on stellar statistics is vitally interested in proper motion data.

Regarding his proper motion survey of the southern hemisphere, Luyten writes that all stars found have now been measured and a catalogue is in preparation which will contain 80,000 to 85,000 stars. The blinking of all Harvard plates taken with the Bruce telescope on fields in the northern hemisphere is complete and yields almost 20,000 stars with appreciable proper motion. A catalogue of approximately 1750 stars with proper motions over $0\cdot5$ annually is being prepared and also one containing $15,000 \pm$ stars with motions in excess of $0\cdot2$. A list is being made of several hundred more wide double stars with common proper motion, especially those that contain a white dwarf component. Together with W. C. Miller of Mount Wilson, Luyten has determined the proper motions of all blue stars found by Humason and Zwicky in high galactic latitudes.

At Heidelberg König has published a discussion of the motions in a field 6 degrees square centred on α Persei. A second field near 17 Comae is measured and contains about 100 stars of rather large motion. He is particularly interested in the stars of high velocity and invites co-operation by those with more powerful equipment.

Vysotsky has completed the determination of the proper motions of all the 850 red dwarfs discovered spectrophotometrically at McCormick which were not previously known. About half the motions are new. The total number of relative motions of long-period variables measured on McCormick plates and plates taken at Johannesburg with the Yale telescope is now about 300. A discussion of the secular parallaxes and peculiar motions will begin shortly.

Prof. A. N. Deutsch reports that the normal astrographs at Pulkovo and Tashkent and the astrographs in Moscow and Kiev, with focal lengths of 6.4 and 5.5 m. respectively continue to be employed in investigations of absolute proper motions with respect to the extragalactic nebulae. A catalogue of these nebulae contained in 157 areas of the sky from $+90^\circ$ to -5° has been prepared by Deutsch, Lavdovsky and Patchikhin, giving positions and descriptions as to their suitability for precise measurement. A minimum of two plates suitable for a first epoch were obtained at Pulkovo for each area. Patchikhin has determined the absolute proper motions of 1446 stars to magnitude 15 in respect to thirteen extragalactic nebulae in four regions of the sky. Photographs of the second epochs for sixteen open clusters have been completed at Pulkovo. Lavdovsky determined the relative proper motions of stars in twelve clusters and their surroundings, with intervals between epochs of 40 to 60 years. The mean of four plates gives $\pm 0\cdot001$ as the probable error of a proper motion. Patchikhin has published a determination of the proper motion of the globular cluster M 13. With a difference of epochs of about 30 years Onegina has investigated the motions of stars in the neighbourhood of ten bright stars. From the common proper motion she found distant companions to α Cas and α UMa and several wide pairs and triples. She also determined the proper motion of the cluster NGC 6910 near γ Cyg. Latypov has investigated the motion and expansion of the planetary nebula in Lyra on normal astrograph plates with intervals of 40 to 55 years.

From the Sternberg Astronomical Institute, Parenago reports the determination of the proper motions of 1565 stars to magnitude 15-16 in the region of the Orion nebula, also proper motions for 1073 stars in the neighbourhood of the north galactic pole by Artiukhina. A number of proper motions of variable stars have been published, among which are 23 stars by Lozinsky, 9 long-period variables by Safronov, 17 RV Tauri stars by Pavlovskaya, 37 short-period cepheids, also by Pavlovskaya and 17 T Tauri variables by Uranova, all from Moscow plates. Uranova found 67 stars of appreciable proper motion in three areas by means of the blink-microscope. Intervals between epochs ranged from 35 to 46 years.

At Stockholm, progress is reported on the programme outlined in the last report in the Lacerta, Taurus-Auriga, and Cygnus regions and at the north galactic pole. Second epoch plates of several galactic clusters have been obtained.

Dr Palouque writes that there is in preparation The Fourth Catalogue of Toulouse which contains proper motions of standard stars between declinations $+4^\circ$ and $+12^\circ$ with four stars per square degree or a total of approximately 10,000 stars. The first six hours of right ascension have already been published and other sections will soon follow. They are planning to derive the proper motions of all the stars in the photographic catalogues of Toulouse using differential measures with plate intervals of 40 to 60 years. Data for 30,000 stars have been published in the first six hours of right ascension. The work will continue through 6 and 7 hours of R.A. where the Milky Way crosses the Toulouse zone. Observations of spiral nebulae will provide reductions to absolute proper motions for the stars in the Fourth Catalogue. Variable stars from Plaut's list are also being observed.

The proper motions of approximately 80,000 stars have now been determined from plates taken at the Cape Observatory. It is intended in the future to undertake programmes suggested by the Groningen conference. Plates in the zone -40° to -52° will be repeated with the astrographic telescope for various purposes, especially in regions around some of the Selected Areas and open clusters.

Mention has been made of the conference on Problems in Astronomy held at Northwestern University in September 1953, of which the proceedings have been published in Vol. 59 of the *Astronomical Journal*. Attention should also be called to the *Publications of the Tenth Astrometrical Conference held at Pulkovo*, which contains a number of papers bearing on the work of this commission.

H. L. ALDEN
President of the Commission

Report of meeting. 30 August 1955

PRESIDENT: Prof. H. L. Alden.

SECRETARY: Prof. K. Aa. Strand.

The Chairman opened the meeting, reporting that he had received communications from Prof. König and Prof. Kohlschütter, both regretting not being able to attend.

The Chairman next referred to the Draft Report which he wished discussed, together with such other problems as the members would desire to bring up. An important question was whether the programme of trigonometric parallaxes as a whole were near completion and whether it was necessary to set up a list of stars most in need of new parallaxes, as had been discussed by a sub-committee consisting of Alden, Strand, and van de Kamp, who agreed that the publication of such a list was not necessary.

The Chairman pointed out that, on the whole, important work could be done by selecting objects from the following four categories: (1) double stars with known orbits and measurable parallaxes; (2) stars with discordant parallaxes in the Yale catalogue; (3) stars which show deviation from the Hertzsprung-Russell diagram; and (4) stars with invisible companions.

In reference to spectroscopic parallaxes, the Commission felt that it would not be appropriate to have a comprehensive catalogue published at the present time.

In matters arising in connexion with the Yale Parallax Catalogue, the Chairman mentioned the statistical investigations by Harris, who found that the Allegheny parallaxes had too high weight, and by Schilt, who believes that the parallaxes in the catalogue need positive corrections.

Prof. Hertzsprung suggested that the parallaxes of members of the Hyades cluster be examined for possible systematic corrections. However, it was agreed that this would involve too few stars.

Prof. van de Kamp wished to emphasize that he did not believe that parallax work was coming to an end. He felt that there is still need for parallaxes for a large number of stars, each parallax determined from a large number of plates. This would require the use of many large telescopes. He urged that more people work in this field.

The Chairman referred to the need of absolute magnitudes of faint dM stars.

Prof. Luyten pointed to the lack of telescopes for parallax work. The Yale refractor is still out of operation and no reflectors are used in this field, which means that stars fainter than 13th magnitude cannot be observed for parallaxes. For this reason it is not possible to get parallaxes for the wide binaries with white-dwarf companions discovered in his proper motion programme.

Dr Jackson spoke further on the desirability of obtaining parallaxes of faint stars at least to the 16th magnitude, stating that this would require the use of large reflectors.

Prof. Luyten then suggested that the Commission adopt the following recommendation:

Commission 24 strongly recommends that observatories possessing large reflectors (40 in. and over) seriously consider a programme of determinations of trigonometric parallaxes for faint stars.

This recommendation was agreed to unanimously.

Dr van den Bos then called attention to the importance of determining mass ratios for binary systems from parallax series. He also called attention to a list of sixty-one dynamical parallaxes of faint double stars published by Dr Jonckheere. Some of these appeared to be very large and should perhaps be investigated for trigonometric parallaxes.

Dr Jonckheere mentioned that his General Catalogue of 3300 faint binaries, discovered by him, was expected to be ready for publication in about three years. One thousand two hundred pairs have so far been measured at three or four epochs. The dynamical parallaxes for 200 of these pairs show a mean parallax of $0^{\circ}.033$ and will be published shortly.

In the ensuing discussion Prof. Luyten mentioned that time and effort would be saved by measuring the proper motions of these pairs. The Chairman thought that determining the spectra would be simpler, and that Prof. Vyssotsky had already done so for some of the pairs and found spectra of types A and F. Dr Jonckheere stated that the spectra for his stars were M3 on the average.

Prof. van de Kamp next brought up the question of stellar masses. He wished to emphasize the need for parallaxes determined with very high precision for this problem.

Prof. Strand mentioned the Yerkes programme which included approximately thirty binary systems, for which parallaxes and mass ratios were determined from extended series of plates.

The Chairman next suggested for discussion means of improving the accuracy of the observations. He called upon Prof. Strand, who reported on the experiments carried out at the Dearborn and Yerkes Observatories in regard to automatic guiding, timing and plate transport.

The Chairman next read a letter from Dr Beyer, who wished to point out the difficulty of identifying the faint parallax stars from the positions now given in the Yale Parallax Catalogue. He suggested that for stars fainter than the 10th magnitude the positions should be given at least to the nearest second in right ascension and the nearest $0^{\circ}.1$ in declination.

Dr Luyten reported that his Observatory had the positions with this precision for all the proper motion stars in the southern hemisphere and for most of the northern sky also.

Dr Gliese called attention to his work on a catalogue of 850 stars with parallaxes larger than $0^{\circ}.05$, for which he was anxious to get the co-ordinates of the stars with the same precision as suggested by Dr Beyer for the equinox 1950.

Prof. Luyten then displayed a sample page of his catalogue of proper-motion stars and inquired if the Commission would consider submitting a request to the Finance Committee of the I.A.U. to support the printing of his catalogue.

The following resolution was then passed:

Commission 24 requests the subvention of a sum not to exceed 1000 dollars towards the publication of a catalogue of all stars in the southern hemisphere known to have motions larger than $0''.2$ annually (catalogue contains about 9000 stars).

Prof. Luyten then suggested, in connexion with the desire expressed by Sub-committee 8a (p. 117, line 27, of this volume) to extend the Lick proper-motion plan to the southern hemisphere, that the old plates taken with the Bruce 24-inch telescope be repeated. There must be at least 100 really good old plates, now between fifty and sixty years old. As against the Lick plates, they have the advantage of slightly fuzzier images, hence less systematic error between measures of stars and nebulae. If these can be repeated now, they could yield proper motions of faint stars down to $16\mu g$, relative to galaxies with a p.e. of $0''.004$ or so and this could be done now, whereas a new telescope of the Lick type could not be expected to produce comparable results for another fifty years.