33. COMMISSION DE LA STATISTIQUE STELLAIRE

PRÉSIDENT: M. B. LINDBLAD, *Director of the Stockholm Observatory, Saltsjöbaden, Sweden.*

MEMBRES: MM. Bok, Dziewulski, Eddington, Gratton, Gyllenberg, Heckmann, Hertzsprung, S. Hirayama, A. Kohlschütter, Lundmark, Luyten, Malmquist, Mineur, Mohr, Ogorodnikov, Oort, Pannekoek, Parvulesco, Russell, Schalén, Schilt, Schoenberg, Seares, Shapley, Strömberg, Trumpler, van de Kamp, Vanderlinden, van Maanen, van Rhijn, von der Pahlen.

The following report, which has been drawn up partly on the basis of the reports of the members of the Commission, touches briefly and without any attempt at completeness a few points of the recent developments in certain important fields falling within the domain of the Commission.

Stellar luminosities. From a study of the stars with proper motions exceeding 0″·5 annually van Maanen* estimates the total number of such stars to be about 2380. For 651 of these stars parallaxes are known, from which the mean parallaxes for stars of different magnitudes and proper motions may be derived. From the fact that the proper motion stars in question must include practically all stars with parallaxes exceeding 0″·158, van Maanen derives the luminosity curve within the corresponding volume of space. He finds the maximum of the luminosity curve at the absolute magnitude +12·7. The dispersion appears to be of the order of three magnitudes. He estimates the mean density in our neighbourhood to be about 0·2 stars per cubic parsec.

The spectral criteria of white dwarfs, namely the width of the lines of hydrogen, the absence of the high-numbered members of the Balmer series, and the comparatively strong intensity in the ultra-violet due to the absence of the Balmer continuum have been further tested at the Stockholm Observatory by Öhman† and Ramberg.‡ Öhman has developed a new colorimetric method for registering the ultra-violet intensity, which is of importance for the identification of very faint white dwarfs.

The results of Heckmann and Haffner§ on the relation between luminosity and colour for the members of the Praesepe cluster are of very great interest. It appears that the cluster stars belonging to the main series are very closely concentrated along the central line of the series, with very small dispersion for a given colour. Certain individual deviations are most easily explained as binary stars.

Concerning the general luminosity curve of the G stars Gratton‖ finds, in analogy to previous results obtained for the K stars, the existence of a "gap" between giants and dwarfs doubtful, and suggests that the gap hitherto found might be completely due to the selection of the material. Gratton further calls attention to the possibility that spectroscopic parallaxes of a cluster may be systematically wrong on account of a variation in the chemical composition of the stars in different clusters according to a suggestion advanced by Kuiper.¶ This might also influence the relation between spectral type and luminosity in the clusters. Gratton suggests the existence of such differences between the main series of the nearer stars, the Pleiades, Taurus and Ursa major clusters. He further points out, as a way of obtaining parallaxes of galactic clusters good enough for statistical study, a method based on the measurement of the intensity of interstellar lines.

* *Mt Wilson Contr.* No. 562; *Aph. J.* **85**, 26 (1937).
† *Stockholm Medd.* No. 31 (1937).
‡ *Stockholm Medd.* Nos. 38, 39 (1938).
§ *Göttingen Veröff.* Nos. 53–55 (1937).
‖ *Z. f. Aph.* **15**, 48 (1938).
¶ *Harv. Bull.* No. 903 (1936).

Strömberg* has continued his investigations on the distribution of absolute magnitudes as derived from radial velocities, proper motions, and apparent magnitudes. A contribution to the methods of solving numerically the integral equations involved has been made by Gyllenberg.†

Radial velocities with objective prism. Star-counts. At the Harvard Observatory the work on the problems of galactic structure by Bok and his associates has been conducted chiefly along two lines, star-counts and objective-prism radial velocities. Bok, Lindsay and Miller have perfected the methods for counting stars, while Bok and McCuskey have attempted to establish a satisfactory method for the measurement and reduction of radial velocities from objective-prism plates. Reports on the progress of the methods have been given in *Harvard Annals*, **105**, Nos. 14, 15, 16. In a brief report Dr Bok summarizes the plans for the future under three different headings as follows:

1. *The general radial velocity programme.* In the work on objective-prism radial velocities we hope to clean up first of all the radial velocities of the B–A and F stars with apparent magnitudes 7 to 10 in twelve fields roughly 30° apart along the entire Milky Way. The centres of the fields are given in Table I of paper 16 of *Harvard Annals*, **105**. The results for the field in Cygnus (163 stars) have already been published. The measurements for the fields in Orion, Auriga, Cassiopeia, Cepheus and Aquila are well under way, and I hope to have the radial velocities for most of the northern fields ready for publication at the time of the Stockholm meeting. Dr Paraskevopoulos, the superintendent of our South African station, has succeeded in adapting the 13-inch Boyden telescope for radial velocity work. A complete series of plates is not yet available for any single field, but the measurements have started for the fields Monoceros and Carina. My present collaborators in the work on objective-prism radial velocities are: Miss A. Marguerite Risley, Miss Rita L. Paraboschi and Mr W. W. A. Johnson. After the completion of the present northern programme we plan to determine 500 to 1000 radial velocities in each of a few selected Milky Way regions in Aquila, Cygnus, Perseus and Orion. For the south we plan to work further on fields in Carina, Sagittarius and Monoceros.

2. *The programme of star counts.* Most of the present work on star counts is being done from Harvard plates by astronomers, with the degree of Ph.D. from Harvard, employed at other institutions. The work for the southern hemisphere is largely in the hands of Dr E. M. Lindsay of the Armagh Observatory in N. Ireland. Lindsay is now engaged in the reduction and analysis of the counts for the zone $b = -20°$ to $+20°$ of stars with $m_{pg} = 10$ to 14, that were made by him during his stay at our southern station. The counts by Lindsay will cover the southern galactic belt completely. The counts for the region of the Ophiuchus nebula and the southern galactic window near $l = 300°$, $b = -10°$ are now under discussion.

The investigations for the northern hemisphere follow closely the general set-up used by Miller in his study of the stellar distribution in Cygnus. Dr F. D. Miller of Denison College is continuing his analysis from Cygnus down to Scutum; Dr S. W. McCuskey of Case School is working on fields in Taurus and Orion; Mr J. W. Evans of the University of Minnesota on the section in Perseus and Cassiopeia, and Miss A. Marguerite Risley of Harvard on the regions in Cepheus. The combined results of all four investigations will yield star-counts between $m_{pg} = 10$ and 16 for the entire northern galactic belt.

3. *The Carina programme.* In October 1937 plans were made for an extensive programme of study for the Milky Way in Carina. A total area of twelve hundred square degrees will be covered in the course of this study, for which all plates are to be taken at

* *Mt Wilson Contr.* No. 554; *Aph. J.* **84**, 412 (1936).
† *Lund Medd.* Ser. I, No. 145 (1936).

the Boyden station of the Harvard Observatory. Lindsay will make the star-counts between $m_{pg}=10{\cdot}0$ to $16{\cdot}5$, which should yield accurate information on the stellar distribution for this part of the sky. The measurement of objective-prism radial velocities for at least 1000 stars will be carried out at Harvard. In collaboration with Dr and Mrs Gaposchkin a programme has been made up which should yield colour indices for all stars of known spectral type and many fainter stars. Dr Shapley and his associates will derive the number of faint nebulae in course of the general survey in intermediate latitudes. Miss Cannon has offered to determine the spectral types of numerous faint stars as part of the Henry Draper Extension. We hope that a concentrated attack on one of the most critical regions of the southern Milky Way will shed further light on the stellar distribution and dynamical properties of our galactic system. Similar surveys have been planned for the region of the galactic centre and for the Milky Way in Monoceros and Orion.

Bok further points out that the programme is only a particular phase of the large series of investigations on the structure of the universe that have been undertaken at Harvard under the direction of Dr Shapley. The work on photometry, with Dr and Mrs Gaposchkin in charge, Miss Cannon's classifications of stellar spectra and Shapley's studies on variable stars and the distribution of faint nebulae are intimately related to the work on galactic structure and stellar motion.

On the importance of certain studies of the distribution of external galaxies for problems in stellar statistics Dr Shapley writes as follows:

One observational research in the department of galaxies here at the Harvard Observatory should eventually have considerable importance in the study of galactic structure and the distribution of distant stars. That is the systematic survey we are making with long exposure plates along the borders of the Milky Way. In the galactic latitude zones from $+20°$ to $+30°$ and from $-20°$ to $-30°$—a ten-degree strip on each side of the Milky Way—we are making a complete coverage with exposures of three hours on fast plates, using the Bruce 24-inch telescope of the Boyden Station for southern declinations and the 16-inch Metcalf telescope at Oak Ridge for northern declinations.

Galaxies to the eighteenth magnitude (photographic) are recorded on these plates. To the extent that irregularities in surface and spatial distribution of galaxies can be ignored, the final material of this survey in the 20° to 30° zones will be valuable in outlining the irregularities in space absorption throughout all longitudes. These zones are more important than those of lower latitude because the number of recorded galaxies is sufficient to give statistical stability to the conclusions; in higher latitudes irregularities in space absorption are relatively unimportant.

We are paying special attention to the South Galactic Cap as a region for the investigation of surface and spatial irregularities in the distribution of galaxies. The distribution of galactic stars over the Cap from $-60°$ to $-90°$ galactic latitudes appears to be remarkably uniform. Unevenness of residual space absorption can probably be ignored. The South Galactic Cap is preferable to the North Galactic Cap because in the latter the distribution of galaxies is seriously disturbed by the clouds of bright galaxies that extend from Virgo through Coma into higher declinations. The distribution of stars to the fourteenth magnitude, the distribution of galaxies to the fifteenth magnitude, and the distribution of galaxies to magnitude 18·2 in the South Galactic Cap are now under study at the Harvard Observatory.

Photometric and spectral investigations of faint stars. Among recent works in this field should be mentioned especially the completion of the *Bergedorfer Spektral-Durchmusterung** of the northern Selected Areas. The photometric magnitudes were

* Band 1 (1935), 2 (1938).

determined at Groningen on plates from Harvard. Together with Humason's* spectral classification at Mount Wilson and the Potsdam Durchmusterung† of the southern areas by Becker this work is a most important contribution to our knowledge of the spectra of faint stars.

Concerning the spectrographic work in selected Milky Way fields at present performed at Upsala the director, Prof. Bergstrand, reports as follows:

Dr Å. Wallenquist is investigating short objective prism spectra for about 9000 stars brighter than m_{pg} 11·5 to 12·0 in an area situated in the Sagittarius region and covering 200 square degrees containing the great star cloud in Sagittarius as well as parts of the dark regions in Ophiuchus.

Studies of selected regions in the Northern Milky Way inaugurated at the Upsala observatory some years ago are continued by Dr E. Johansson who is investigating a region from Cygnus to Cepheus (R.A. 20^h to 22^h, Decl. $+50°$ to $+55°$) and by Dr G. Wernberg whose investigations embrace an area in Cepheus (R.A. $21^h\,30^m$ to $23^h\,0^m$, Decl. $+55°$ to $+66°$). Dr G. Dyfverman has started a study of the North America nebula and its surroundings. All these investigations are based on objective prism spectra of stars to about m_{pg} 10·5 to 11·0 and include also measurements of photographic magnitudes and colour equivalents.

Dr E. Stenquist has published an investigation "A spectrophotometric study of the Cambridge proper motion stars" (*Upsala Medd.* No. 72).

The work carried out at the Stockholm Observatory may be summarized as follows:

Malmquist‡ has completed and published his catalogue of photographic magnitudes and colour indices of 4500 stars in the field at the northern galactic pole between R.A. $12^h\,6^m$ and $12^h\,50^m$, Decl. $+29°$ and $+38°$. For 2800 of these stars, to about the photographic magnitude 13·5, he has classified the spectra and carried out a spectrophotometric analysis enabling an accurate division of the late-type stars into giants and dwarfs. The work serves as basis for statistical investigations of the decrease of star-density with the distance from the galactic plane.

The work on selected regions of the Milky Way has been concentrated about the bright region in the neighbourhood of the stars π^1 and π^2 Cygni. In addition to the work with the 40-cm. astrographic telescope, it is planned to observe smaller areas in the Milky Way structure and the accessible Kapteyn areas with special focal-plane spectrographs at the 40-inch reflector. The limiting magnitude will be about 14·0 or slightly fainter.

A spectrophotometric investigation of the Pleiades region has been completed by Gratton. Ramberg has performed a spectrophotometric study of the Praesepe and Hyades clusters. Two stars among the Hyades members, of m_{pg} 13·6 and 14·1, resp., have been identified as white dwarfs of early A type.§

Proper motions. Proper motions of 18,000 stars determined at the McCormick Observatory by van de Kamp and Vyssotsky‖ have been published. At the Mount Wilson Observatory van Maanen, Willis and Oosterhoff¶ have completed their investigations of large proper motions in 139 Selected Areas. With the completion of Luyten's Bruces proper-motion survey of the southern hemisphere, new and

* *Mt Wilson Contr.* Nos. 458, 560; *Aph. J.* **76**, 224 (1932); **85**, 14 (1937).
† *Potsdam Publ.* **27** (1931); **28**, Heft 1 (1935); Heft 2 (1938).
‡ *Stockholm Annals*, **12**, No. 7 (1936).
§ *A.N.* **265**, 111 (1938); *Stockholm Medd.* No. 37.
‖ *Leander McCormick Publ.* **7** (1937).
¶ *Mt Wilson Contr.* No. 412 (1930), No. 542; *Aph. J.* **83**, 340 (1936).

extensive material has become available for statistical discussions. Among the sets of data obtained may be mentioned:

(1) A list of large proper motions actually complete down to photographic magnitude 14·5, and statistically completed down to 16·5.
(2) A catalogue of proper motions for about 24,000 stars south of declination $-55°$.
(3) A catalogue of more than 1000 double stars with common motion in the southern hemisphere.

The first of these may be used for a new derivation of the luminosity function, and it is hoped that its conclusions may be published before the meeting of the I.A.U. is held.

Statistics of stellar motions. Van de Kamp and Vyssotsky have performed a very extensive statistical discussion of the McCormick proper motions. Oort* has discussed in great detail the Radcliffe proper motions in the northern Kapteyn areas, developing new methods for determining mean parallaxes. Instead of the parallactic motion, the dispersion of the proper motions is used as the distance criterion, assuming the dispersion of the linear velocities to be independent of distance near the galactic plane. In support of this Oort shows that the dispersion in the linear velocities is approximately identical in different parts of the galactic plane. On the basis of the statistical excess in the proper motions, an attempt is made to isolate the nearer stars (inside a radius of 560 parsecs) and to obtain mean parallaxes valid for the more distant stars separately. Stenquist† has discussed the proper motions determined by Smart in the Cambridge regions. By means of the distances inferred from the spectrophotometric criteria, the proper motions are transformed into linear tangential velocities. In the statistical discussion due attention is paid to the influence of the absorption of light in space, and methods of correcting the proper motions for errors in the parallactic motions employed in the reduction from relative to absolute proper motions are developed. The uniformity of the ellipsoidal distribution of stellar velocities within a very wide region surrounding the sun is confirmed.

In the treatment of the 18,000 McCormick proper motions, van de Kamp and Vyssotsky discuss the solar motion, the secular parallaxes, and the velocity ellipsoid for all stars together, as well as for different spectral types. They give also a re-determination of the constants of the differential rotation, together with corrections to the constant of precession and the motion of the equinox. The derivation of these quantities from the same material has been further discussed by Oort.‡

A very extensive statistical investigation of stellar motions on the basis of the present material of radial velocities has been given by H. Nordström.§ The solar motion, the K term, the velocity ellipsoid, and the constants of the differential rotation for different spectral types have been determined in a very careful statistical discussion of the material available. A comparative study of the solar motion from radial and transverse velocities gives corrections to various systems of spectroscopic parallaxes.

Smart‖ has discussed the mean parallaxes from proper motions, the methods of determining the solar motion, and the determination of the drift constants on the two-stream theory from radial velocities. Smart and Green¶ have investigated the determination of solar motion and galactic rotation from radial velocities.

* *B.A.N.* **8**, 75 (1936).
† *Upsala Medd.* No. 72 (1937).
‡ *B.A.N.* **8**, 149 (1937).
§ *Lund Medd.* Ser. II, No. 79 (1936).
‖ *M.N.* **96**, 132, 165, 461, 568 (1936).
¶ *M.N.* **96**, 471 (1936).

Ambartsumian* has developed interesting methods for the derivation of the frequency function of the space velocities of the stars from the observed radial velocities.

The differential rotation of the B type stars has been investigated by Mohr, who reports as follows:

Using the space velocities of B stars, I examined whether it would be possible to decide the question of the supplementary rotation of the local cluster around the centre placed at the galactic longitude $l = 237°$. It was apparent that the recent material of space velocities of B stars did not show any supplementary rotation. Nevertheless it would be necessary to know the space velocities of B stars in the southern hemisphere, which in all present statistical considerations are lacking.

The velocity-ellipsoid of the B stars is variously deformed in different galactic longitudes, which causes the K term of the B stars to be considerably positive. If these deformations are removed and an ideal velocity-ellipsoid is considered (given by all B stars together), there still remains a K term of approximately $+1{\cdot}5$ km./sec. If we consider the displacement of the centres of the velocity-ellipsoids arising through the rotation of the Galaxy around the centre distant 10,000 parsecs, there still remains for the K term the value $+1{\cdot}3$ km./sec.

The preponderant part of the positive value of the K term arises therefore from dynamical reasons. Whether the residual value of the K term is caused by Einstein's gravitation-effect or not is at present impossible to decide.

Dziewulski has made an investigation of the motions of stars of spectral type A based on the material collected by Bertaud including stars with known parallaxes, proper motions and radial velocities, in all 407 stars, excluding the members of the Taurus and Ursa major streams. The vertex of the velocity ellipsoid was found directed towards the point $l = 4°{\cdot}2$, $b = -3°{\cdot}9$. Dividing the stars into four groups according to rectangular galactic coordinates and applying corrections for normal differential galactic rotation, he finds certain residuals in the velocities which suggest a strong, local whorl of rotation of the group of A stars close to the sun.

Mineur presents the following remarks concerning the problem of galactic rotation:

Jusqu'à présent on a étudié la rotation galactique principalement au moyen d'étoiles relativement proches du soleil constituant un domaine de quelques centaines de parsecs d'étendu. J'ai repris ce problème en utilisant cette fois des astres répartis dans des domaines plus étendus:

1° Les amas globulaires englobent toute la galaxie, l'étude de leurs vitesses radiales (*M.N. of R.A.S.* **96**, 61, 1936; *ibid.* **97**, 150, 1936; *B.A.* **10**, 91, 1937) révèle les circonstances de la rotation galactique dans un domaine de 20,000 parsecs de rayon et d'épaisseur; le résultat le plus net est la décroissance de la vitesse de rotation quand on s'éloigne du centre.

2° Les amas galactiques et les céphéides nous renseignent sur un domaine de 6000 parsecs d'étendue dans le plan galactique, intermédiaire par conséquent entre celui des étoiles proches et celui des amas globulaires.

L'étude de leurs vitesses radiales permet de préciser la variation de la vitesse angulaire de rotation avec la distance au centre galactique (*Annales d'astrophysique*, **1**, 2, 1937).

Mais ces études ne sont basées que sur un petit nombre de données: 24 pour les amas globulaires, 42 pour les amas galactiques et 150 pour les céphéides.

La connaissance d'un plus grand nombre de vitesses radiales de ces objets est donc désirable pour préciser les circonstances de la rotation galactique.

* *M.N.* **96**, 172 (1936).

Mineur further requests that observers possessing the necessary instrumental means extend the determinations of radial velocities of globular and open clusters and of faint Cepheid variables.

An important contribution to the problems of galactic rotation and galactic structure has been given in Berman's* extensive study of the differential rotation of the planetary nebulae, which is based mainly on radial velocities determined at the Lick Observatory. Berman finds the centre of rotation at galactic longitude $333°{\cdot}0 \pm 1°{\cdot}3$. The distance to the centre is found to be 9360 ± 760 parsecs and the period of the sun's orbital motion $2{\cdot}1 \cdot 10^8$ years, in good agreement with previous estimates by Lindblad and by Plaskett and Pearce. The mass of the system is estimated at $2{\cdot}3 \cdot 10^{11}$ solar masses, approximately half of which is found to be concentrated within a region extending only 1000 parsecs from the centre. Though the planetaries form a "subsystem" more widely dispersed at right angles to the galactic plane than the stars in general, the velocity dispersion is still too small to give a very appreciable "asymmetrical drift" and Oort's coefficient A of the differential rotation is found, as might have been expected, in good accordance with the value derived from stellar data.

Density distribution and absorption of light in space. The density distribution in the direction perpendicular to the Milky Way for every spectral type separately has been investigated by van Rhijn and Schwassmann† on the basis of the Bergedorf spectral Durchmusterung. The same problem has been discussed by van de Kamp and Vyssotsky in their work mentioned above. A careful discussion of the density distribution in the galactic plane, in connection with a determination of the absorption of light from Joy's data concerning the differential rotation of faint Cepheid variables, has been given by van Rhijn.‡ As the most probable photographic coefficient of absorption van Rhijn adopts 1·1 mag. per kiloparsec. Van de Kamp and Vyssotsky derive in an entirely different way a coefficient of absorption for visual light amounting to 2 mag. per kiloparsec. Stenquist finds from his investigation of stellar velocities the value 2 mag. per kiloparsec for the average photographic absorption in the direction of Smart's regions.

New methods for the determination of the density distribution in space have been developed by Brill.§

The investigations of dark clouds in the Milky Way structure have been continued by numerous investigators. Seares‖ has investigated the colour-excess in Selected Areas in relation to the degree of obscuration as revealed by Hubble's counts of extra-galactic nebulae. The results suggest a correlation, though there are exceptions to the rule. The colour-excess seems to have an upper limit of about one magnitude. Schalén¶ has developed further the application of Mie's theory to interstellar absorption, and has given an important comparison between the selective absorption derived from the results of various investigators, as well as the corresponding absolute absorption for particles with diameters of $50\mu\mu$ and $100\mu\mu$. He has further investigated the influence of radiation pressure and gravitation on the development and form of the dark clouds. Wellmann** has investigated the influence of the form of the obscuring particles on their power of absorption. Further important contributions to our knowledge of the properties of the obscuring matter of interstellar space have been

* *Lick Bull.* **18**, 57 (1937).
† *Z. f. Aph.* **10**, 161 (1935).
‡ *Groningen Publ.* No. 47 (1936).
§ *Abh. Preuss. Akad. der Wiss., Phys. Math. Kl.* No. 2 (1937).
‖ *Mt Wilson Comm.* No. 119; *Wash. Nat. Ac.* **22**, 327 (1936).
¶ *Upsala Medd.* No. 64 (1936). ** *Z. f. Aph.* **14**, 195 (1937).

given recently by Schoenberg,* Jung,† Wilkens,‡ and Gleissberg.§ The absorbing power of individual dark clouds has been determined in recent years by Sticker‖ at Bonn, W. Becker¶ and von Klüber** at Potsdam, Mrs Lehman-Balanowskaja,†† Balanowsky and Hase,‡‡ Berg§§ and Shajn|||| at Poulkovo, and by Wallenquist¶¶ at Upsala. Further work of this kind in progress at Upsala has been reported above. Ogorodnikov at Poulkovo has developed further the theoretical analysis of star-counts in obscured regions.

Stebbins and Whitford* have continued their important investigation on the space reddening from the colour of the globular clusters. The differential absorption from pole to pole for the wave-lengths 4340 and 4670 A. is found to be $0^{m}\cdot08$. On the basis of Schalén's calculations for metallic particles of diameter $50\,\mu\mu$, this would agree well with the optical thickness 0·50 derived by Hubble. There is a close relation between the colour-excess and the space absorption as shown by the number of extra-galactic nebulae in the field of the cluster. An investigation by the same authors† concerning the selective absorption for extra-galactic nebulae, for clusters in high galactic latitude, and B stars comparatively far from the galactic plane gives a very much smaller coefficient of cosec b, indicating a far smaller selectivity of the effective absorption in the high galactic latitudes. An extensive treatment of the general selective absorption has been given by W. Becker,‡ who concludes that the sun is surrounded by a narrow strip of absorbing material stretching from Taurus to the opposite point of the sky.

The diffused light of absorbing clouds has been studied by Struve,§ Elvey and Roach,‖ and Henyey¶ at the Yerkes and MacDonald Observatories. The diffused light is found to be of the same order as the amount of direct star-light. The albedo of the scattering particles, including fluorescence in emission nebulae, is likely to be fairly high.

From the extensive literature of recent years concerning the diffuse matter giving rise to the "interstellar" lines in stellar spectra we may mention only the discovery of interstellar titanium and potassium by Adams and Dunham,** the calculations by Eddington†† concerning the influence of the differential rotation on the line profiles, the evidence given by Beals‡‡ concerning the existence of local condensations with considerable relative motions, the extensive observations of intensities and displacements of interstellar lines at Mount Wilson by Merrill, Sanford, Wilson, and Miss Burwell,§§ including the lines in the yellow and red discovered by Merrill, and the theoretical results derived by Swings|||| on the possible existence of molecules in the interstellar gas.

* *Breslau Mitteil.* **4**, 61 (1937).
† *Breslau Mitteil.* **4**, 61; *A.N.* **263**, 425 (1937).
‡ *Breslau Mitteil.* **4**, 1 (1937).
§ *Istanbul Publ.* Nos. 3, 4, 6 (1936), 7 (1937); *Z. f. Aph.* **13**, 255 (1937).
‖ *Bonn Veröff.* Heft 30 (1937).
¶ *Berlin-Babelsberg Veröff.* **10**, Heft 6 (1935).
** *Z. f. Aph.* **13**, 174 (1937).
†† *Poulkovo Bull.* **14**, 1 (1935).
‡‡ *Poulkovo Bull.* **14**, 2 (1935).
§§ *Poulkovo Bull.* **15**, 2 (1936).
|||| *Poulkovo Circ.* Nos. 22–23 (1937).
¶¶ *Upsala Medd.* Nos. 69, 71 (1937).

* *Mt Wilson Contr.* No. 547; *Aph. J.* **84**, 132 (1936).
† *Mt Wilson Contr.* No. 577; *Aph. J.* **86**, 247 (1937).
‡ *Z. f. Aph.* **11**, 98 (1936).
§ *Aph. J.* **85**, 194 (1937).
‖ *McDonald Obs. Contr.* No. 3; *Aph. J.* **85**, 213 (1937).
¶ *Aph. J.* **85**, 107 (1937); **85**, 255 (1937).
** *Publ. Astron. Soc. Pac.* **49**, 26 (1937).
†† *M.N* **95**, 2 (1934).
‡‡ *M.N.* **96**, 661 (1936).
§§ *Mt Wilson Contr.* Nos. 564, 569, 570, 573, 576, 582; *Aph. J.* **85**, 73, **86**, 28, 44, 136, 274 (1937); **87**, 9 (1938).
|||| *M.N.* **97**, 212 (1937).

Theoretical works. The application of dynamical theory to the general problems of stellar astronomy has received considerable attention in recent years. Heckmann has continued his work on dynamical systems, concerning which he writes as follows:

Seit mehreren Jahren haben mich die dynamischen Systeme mit in den Geschwindigkeiten linearen und quadratischen Integralen und die aus ihnen aufzubauenden statistischen Gesamtheiten, sofern sie sich unter ihrer eigenen Gravitation aufrechterhalten, beschäftigt. Das interessanteste Ergebnis ist ein den Raum gleichförmig erfüllendes System, das sich völlig isotrop ausdehnt oder zusammenzieht, also die Eigenschaften zeigt, die es für eine Theorie der Expansion des Systems der Spiralnebel geeignet macht. Unter hydrodynamischen Gesichtspunkten ist es identisch mit dem von Milne (*Quart. Journ. Math. Oxford*, **5**, 64, 1934) sowie Milne und McCrea (*a.a.O.* **5**, 73, 1934) angegebenen Modell. Eine Mitteilung darüber im Rahmen eines grösseren Referates über Kosmologie ist in Arbeit.

Mineur reports as follows regarding the statistical equilibrium in stellar clusters:

J'ai fait une théorie des amas d'étoiles en équilibre statistique, c'est-à-dire en tenant compte des passages mutuels des étoiles de l'amas; d'après cette théorie, les amas ont la forme d'ellipsoïdes allongés vers le centre galactique et aplatis suivant le plan galactique, tous les caractères d'un amas (longueurs des axes, vitesses résiduelles, etc....) dépendent de deux paramètres: le nombre des étoiles de l'amas et le rapport des axes dans le plan galactique.

J'ai étudié également l'évolution des amas; le phénomène le plus important pour celle-ci est l'échappement des étoiles à l'attraction de l'amas.

J'ai pu vérifier cette théorie au point de vue des ordres de grandeur, mais il serait important de la vérifier avec une précision plus grande et pour cela il faudrait établir des catalogues aussi précis et aussi complets que possible des amas ouverts.

Quelques catalogues ont déjà été établis (à Bonn par Küstner et Hopmann, à Upsal par Wallenquist, à Hambourg par Messow, Vanderlinden à Uccle, von Zeipel et Jungkvist), mais ils sont peu nombreux et parfois insuffisants.

De plus les amas pour lesquels on peut distinguer les étoiles de l'amas de celles du fond du ciel sont rares.

Theoretical researches have been made at Ghent under the direction of H. L. Vanderlinden by K. Cuypers, mainly on the changes of shape of Milky Way clouds and on the distribution of velocities and masses in the galactic system.

Milne's kinematical theory of differential motions has been carried out to terms of higher order by Edmondson.* Wellmann† has given a theoretical "hydrodynamical" treatment of Ogorodnikov's theory of the streaming of the B stars. Shiveshwarkar‡ and Clark§ have discussed stationary stellar systems. Lindblad‖ has extended the rotation theory of the galaxy to explain special effects of star-streaming in our neighbourhood, the one-sided distribution of high velocity vectors, and abnormal differential rotation. An attempt has also been made to connect certain galactic phenomena of stellar motions with the phenomenon of spiral structure in the nebulae interpreted on the basis of classical dynamical theory.

Catalogues. The importance of catalogues of trigonometric parallaxes, for instance in the form of a yearly supplement containing additions and corrections to Schlesinger's catalogue, is mentioned by Gratton. Luyten points out the importance of special classes of objects in the statistical derivation of the physical properties of the stars,

* *M.N.* **97**, 473 (1937).
† *Z. f. Aph.* **10**, 188 (1935).
‡ *M.N.* **96**, 749 (1936).
§ *M.N.* **97**, 182 (1937).
‖ *Stockholm Annals*, **12**, 4 (1936); *M.N.* **97**, 15 (1936); *Z. f. Aph.* **15**, 124 (1938).

such as, for instance, visual, spectroscopic and eclipsing binaries, white dwarfs, stars nearer than, say, five parsecs. Catalogues giving complete information on these types of stars should be published periodically, with a strict separation of the quantities that are definitely established by observation from those that are due merely to hypotheses or are purely computational results.

Monographs and textbooks. Among textbooks and monographs of the last few years giving extensive application to problems of stellar statistics may be mentioned *Ergänzungsband* of *Handbuch der Astrophysik* (Springer, Berlin, 1936), B. J. Bok, *The Distribution of Stars in Space* (in *Astrophysical Monographs* sponsored by the *Astrophysical Journal*, University of Chicago Press, 1937) and E. von der Pahlen, *Lehrbuch der Stellarstatistik* (Barth, Leipzig, 1937).

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