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V. STELLAR DISTRIBUTION IN LOW GALACTIC LATITUDES

General Surveys

To supplement the surveys noted in other Sections of this Report and in Dr Elvius' Report on Selected Areas, we list here briefly a few General Surveys otherwise not fully reported.

1. The Uppsala Milky Way Survey (**1**) is continuing. The results for the range $40° < l^{I} < 60°$ have been published as Part II of the series (**2**). Ljunggren is now investigating the adjoining sector at lower longitudes ($10° < l^{I} < 40°$) and Oja that at higher longitudes ($80° < l^{I} < 100°$). The limiting magnitude (m_{4400}) is now 10·5.

2. The extensive three-colour photometry undertaken at Basel which includes stars to $m = 19$, and which uses as a basis mostly 48-inch Palomar-Schmidt plates in the R, G, U system, includes in addition to the nine Selected Areas, fields as follows: Small and Large Sagittarius Cloud, and fields in Scutum, Aquila, Cepheus, Cassiopeia, Taurus, Lacerta and the region of the Hyades. The progress of the work has been slowed down by the unavailability of suitable photo-electric standards.

3. Boulon reports that at the Observatoire de Haute-Provence, ten fields are being investigated in the range $55° < l^{II} < 192°$, and that in each field spectral-luminosity classes and colours are being determined together with objective prism radial velocities; approximately 1000 stars are included in the survey. One result is that the width of the Orion arm is found to be of the order of 550 pc.

4. Useful compilations of radial velocities, magnitudes and colours and spectral-luminosity data have recently been published for OB stars. The work for the northern hemisphere was performed by Mrs Rubin and associates (**3**), that for the southern hemisphere by Buscombe (**4**). Iwanowska reports that a 'Spectral Sky Atlas', consisting of objective prism plates photometrically calibrated, is in preparation at Toruń Observatory.

5. Infra-red surveys are more and more coming to the fore. Westerlund (**5**) has completed an infra-red survey for M, S and carbon stars for the range $230° < l^{II} < 10°$, including the galactic centre, complete to infra-red magnitude 10·5. He finds that the M2 – M4 stars tend to cluster along spiral arms, and that the later M stars are more evenly distributed. The distribution of 1326 carbon stars and 87 S stars shows these stars to be connected with spiral

arms; see also Westerlund's infra-red study of the Southern Coalsack (**6**). At Warner and Swasey Observatory, several major infra-red studies are under way. Blanco (**7**) has investigated several young associations, where he has found a marked absence of stars later that M2 — which result has an important bearing on evolutionary theory. Mavridis and Nassau are studying the distribution of M, S and carbon stars in seven fields centered on galactic clusters — an objective prism survey that is complete to infra-red $m = 13{\cdot}5$. Velghe and Nassau are engaged upon a search and study of C, S and WR stars in three areas centered at $l^{II} = 77°$ and $0° < b^{II} < + 22°$ (Cygnus and Draco), covering about 74 square degrees of the sky. They are also studying the distribution of the M stars in six regions of different obscurations in these areas. All the M stars from M 2 to M 10 and up to infra-red $m = 13{\cdot}5$ have been classified; the determination of V and I magnitudes for these stars is in progress. H. M. Johnson reports on experiments performed with infra-red objective prism plates obtained at the Tonantzintla Observatory. He has developed high-contrast darkroom techniques of printing which permit extension of the known searches of Blanco (**7**) and Herbig and Kuhi (**8**) to fainter limits than previously reached.

6. Dr G Kuzmin reports as follows on current researches in the U.S.S.R.

The spectral surveys down to photographic magnitude 12·5 with the aid of the 16-inch astrograph and objective prism of the Crimean Astrophysical Observatory together with determinations of magnitudes and colour indices have been continued. The following eight Milky Way areas, 15 to 60 square degrees each and an $8° \times 7°$ area around the Orion nebula have been studied:

α 1950	δ 1950	
$18^h\ 10^m$	$-15°$	Pronik (**9**)
18 54	+ 5	Pronik (**10**)
20 04	+36	Numerova (**11**)
20 44	+45	Metik (**12**)
21 24	+58·5	Alksnis (**13**)
00 00	+66·5	Raznik (**13a**)
01 30	+61	Brodskaya (**14**)
02 30	+59	,,
05 32	−5·5	Kopylov, Straizis (**15**)

The distribution of stars of various spectral classes, as well as of obscuring clouds have been considered and some conclusions on the structure of the Galaxy in the solar neighbourhood have been made. For the first area the luminosity function has been found. For three areas the catalogue of spectra and photographic magnitudes of 5600 stars is published.

The spectral surveys down to photographic magnitude 12·5 have also continued at the Abastumani Astrophysical Observatory, using the 28-inch prismatic camera. Kharadze and Bartaya (**16**) have published the spectral classes and photographic magnitudes of 2400 stars in the following Milky Way fields:

α 1950	18^h15^m	20^h32^m	1^h32^m
δ 1950	−12°	+38°	+61°

each about 18 square degrees in size, and of 2310 stars in the following $4° \times 3°$ fields (**17**)

α 1950	20^h44^m	20^h28^m	20^h32^m	21^h10^m
δ 1950	+41°	+44°	+46°·5	+60°

A number of S and C stars has been discovered by Dolidze (**18**) using spectral surveys in red. The spectra of 855 M stars in red and infra-red have been classified in an area $\alpha = 21^h\,04^m$, $\delta = + 38°$ of about 30 square degrees (**19**). The results for Cas IV, Cas VII and Vul I are being prepared for publication.

In the limits of the Parenago plan, the spectra in four areas of Parenago's regions were classified at the Abastumani Observatory. A catalogue of photographic, photovisual and photored magnitudes down to photographic magnitude 13·5 of stars in Parenago's regions has been published by the Main Astronomical Observatory of the Ukrainian Academy of Sciences (**20**). An investigation of space distribution of stars in an area $\alpha = 18^h\ 50^m$, $\delta = +5°$, $6° \times 6°$, based on this catalogue, has been fulfiled by Voroshilov (**21**). Kolesnik (**22**) has studied the distribution of stars and dark clouds in the region of Selected Area 40 ($3° \times 3°$).

Dombrovsky (**23**) has analysed the structure of the Galaxy in Cygnus in connection with polarization observations. Area $\alpha = 19^h\ 12^m$, $\delta = +38°$, 40 square degrees in size has been studied.

Methods of studying dark clouds by means of star counts has been discussed by Uranova (**24**).

Regional Surveys

We shall not report here on the many important researches on galactic star clusters, which serve admirably as anchor points for studies of spiral structure. These are listed in the Report for Commission 37 and they are currently especially enriching our knowledge of the Southern Milky Way.

Before we begin the detailed summary, a few general comments are in order. W. Becker (**25**) has analysed the techniques of correcting colour-magnitude arrays for interstellar reddening and has recommended the use of a mean colour excess as the best means for deriving a corrected distance for the cluster. In a later paper, Becker (**26**) has commented at length on the proper application of three-colour techniques to the problems of stellar statistics. He discusses the methods for locating different varieties of stars in colour-magnitude arrays, the fixing of absolute magnitudes and the effects of interstellar reddening. Miss Seitter (**27**) has compared the effectiveness of the *R*, *G*, *U* and *U*, *B*, *V* systems and finds that the use of the latter is not advisable for regions of high reddening.

Zone $0° < l^{II} < 60°$ (Sgr, Scu, Aql, Sge, Vul). Albers (**28**) has used infra-red techniques to investigate the distribution of 1200 M stars in the Scutum Region. He concludes that the Scutum Cloud as such stands out from its surroundings principally because it is in a direction of low absorption. The *total* infra-red absorption for this direction may be no more than 1·0 mag. in the clear regions. There is a concentration of M stars for the direction of the Scutum Cloud at a distance of 2500 pc ($15° < l^{II} < 20°$), which may be part of the Sagittarius arm. There is also evidence for a concentration of late M stars associated with the galactic nucleus. Becker has applied his three-colour techniques to the Scutum Cloud (**26**) and he finds a density maximum for giant stars at a distance of about 1000 pc. He comments on the exceptionally large number of late-type giants for this section of the Milky Way. Roslund (**29**) has surveyed the distribution of O and B stars for the Milky Way in Scutum ($l^{II} = 25°$; $b^{II} = -1°$). He finds an average visual absorption of one magnitude in front of the Scutum Cloud, and some nearby regions of very great obscuration. The region beyond 1 kpc from the Sun is relatively clear. There is some indication of an excess space density for the OB stars at a distance of 1 kpc from the Sun, but the space densities drop at distances of the order of 1000 to 1500 pc, which suggests that the OB concentration is at a distance no more than 1500 pc from the Sun.

Kharadze reports that at the Abastumani Observatory, the two dimensional spectral classification and magnitude determinations to $m = 12$ has continued according to Parenago's Plan for two areas, one in Aquila ($l^{II} = 29°$). M stars have been classified to 18th magnitude. Most of the interstellar absorption within 9 kpc from the Sun occurs at distances between 150 and 500 pc from the Sun. OB stars appear to concentrate at discrete distances, presumably associated with spiral structure, one such feature being at 3800 to 5000 pc from the Sun. Two papers on the subject will appear shortly in Abastumani Observatory Bulletins nos. 30 and 31.

Iwaniszewski (**30**) has investigated one of three fields in Aquila-Sagitta ($l^{II} = 48°$) in the region of the Great Rift, with results agreeing closely with earlier ones by Weaver and by Calvert. Very strong absorption is present at distances less than 700 pc from the Sun. Similar results have been obtained by Lisicki (**31**).

Zone $60° < l^{II} < 120°$ (Cyg, Cep, Cas). Kharadze, Apriamashvili and Kotchlashvili have in press (Abastumani Obs. Bull. no. 31) a catalogue of 1000 stars for Parenago's Plan Area in Cygnus. Barbier (**32**) has published two papers on the stellar distribution in the region of P Cygni ($l^{II} \sim 75°$), where she finds two concentrations in depth, the first at distances in the range between 500 and 2200 pc, the second near 3000 pc, with a gap between them. This suggests two crossings by the line of sight of spiral arms. McCuskey, collaborating with Menges and Houk, has extended his work for LF 5 (**33**) with photometric studies for the known OB stars. Five OB clusters are at distances between 1800 and 2300 pc; these are presumably associated with the Perseus arm. The greatest density of B stars is at a distance of 1800 pc.

Zone $120° < l^{II} < 180°$ (Cas, Per, Aur, Gem). Brodskaya (**34**) has studied the space distribution of Ao stars in the Perseus—Cassiopeia section of the Milky Way. There appears to be a continuously decreasing space density for the Ao stars in these directions, which is indicative of the presence of an interarm region to 1000 pc from the Sun in this direction. Kalandadze is completing her work on the Parenago's Plan Areas in Taurus (4000 stars).

Zone $180° < l^{II} < 240°$ (Ori, Mon, CMa). There is little to report beyond the references already quoted.

Zone $240° < l^{II} < 300°$ (Pup, Vel, Car, Cru, Cen). Velghe has under way an extensive investigation of photo-electric colours and magnitudes for 196 OB stars in the region of the I Vela Association ($263° < l^{II} < 273°$; $-5° < b^{II} < +2°$). From data gathered at Boyden and Radcliffe Observatories, it appears that the so-called I Vel Association represents a spiral feature stretching from the Sun to a distance of 4 kiloparsecs in a direction not coincident with the Carina-Cygnus arm. The apparent absence of OB stars elsewhere in the area may be caused by heavy local obscuration at $l^{II} = 270°$.

Bok has described the work currently in progress at Mount Stromlo Observatory for the region of I Puppis ($l^{II} = 245°$), (**35**). There seems to be good evidence (*U*, *B*, *V*, H-beta, optical and 21 cm radial velocities) for a spiral feature at 5000 pc from the Sun. There are several nearby features in the Pup-Vel section, notably the Gum Nebula (175 pc) and several H II Regions within 2 kpc of the Sun. Westerlund reports a new association, Puppis III, at a distance of 1700 pc from the Sun (**36**); it contains 23 OB stars and the cepheid RS Puppis.

Much work is in progress for this sector $275° < l^{II} < 300°$, which is dominated by the η Carinae Nebula, at a probable distance of 2500 pc. (Faulkner (**37**), Graham). Recent work on this sector has been summarized by Bok (**35**) and reference to the relevant papers on OB stars and galactic clusters may be found there. We note that, in this sector, there are several features at distances greater than 3000 pc from the Sun, notably a cluster studied by Sher, NGC 3603, which may be at 5 kpc from the sun. The OB stars seem to occur at all distances between 1 and 5 kpc from the Sun. Basinski, Bok (B.J. and P.F.) report for Selected Area 193 a very high concentration of B8 – Ao stars at a distance of 1 kpc from the Sun (0·32 per 1000 pc^3, as against 0·08 near the Sun), whereas there are few OB stars within 1 kpc for this same direction. Lyngå and Graham report that they have in preparation a finding list of 460 faint OB stars in Carina. Westerlund has under way an infra-red survey for Selected Area 193 and surroundings The ratio of early M to late M stars is the characteristic one for spiral arm regions. He is also engaged upon multi-colour photometry in the Southern Coalsack.

Zone $300° < l^{II} < 0°$ (Cen, Cir, Nor, Sco, Sgr). Bok reports (**35**) that Mount Stromlo observers are paying special attention to the sector near alpha and beta Centaurii, $310° < l^{II} < 317°$, where the majority of OB stars is at an average distance of 1800 pc from the Sun.

Lyngå is engaged upon an extensive study of OB stars and galactic clusters in the same sector. A very different sort of galactic structure is found in the rich sector $325° < l^{II} < 355°$. A probable edge of the Sagittarius Arm is at $l^{II} = 325°$, where B.J. and P.F. Bok and Graham (**38**) find a marked concentration of OB stars at $l^{II} = 328°$, distance 2500 ± 300 pc. Ramberg reports that his study for the same sector is approaching completion. He finds strong indications for the presence of a southern spiral arm stretching from 1000 to 1800 pc from the Sun. Recent work at other longitudes in this sector has been summarized by Bok (**35**). Pik-Sin The (**39**) has located a possible new OB Association in Scorpius ($17^h\ 10^m$, $-33°$) at a distance of 1400 pc from the Sun; it is being investigated by C. Röslund.

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VI. STELLAR DISTRIBUTION IN HIGH AND INTERMEDIATE GALACTIC LATITUDES

During the past triennium much work has been done on the stellar distribution in the North Galactic Polar Cap. Special attention has been paid to the distribution of late-type stars. Very useful results have been reported on the basis of analyses of objective prism plates obtained with the Schmidt telescope of the Warner and Swasey Observatory and the Hamburg-Schmidt telescope. Upgren (**1**) has studied the distribution of stars of spectral types G5 to K5 and later, distinguishing between luminosity classes III, IV and V; he was unable to distinguish stars of higher luminosity from class III, nor could he, at the dispersions employed in this work, distinguish weak-line from strong-line stars. All classifications were made from plates extending into the ultra-violet. His catalogue covers 396 square degrees; it contains 4027 stars and appears to be complete to photographic magnitude 12·75. Density functions perpendicular to the galactic plane have been calculated and also percentages of giants and dwarfs at various apparent magnitudes. The Upgren paper provides much basic material for a study of the variation with height above the galactic plane, z, of the force per unit mass perpendicular to the galactic plane, $K(z)$, and certain inconsistencies are noted. The curve for $K(z)$ as a function of z derived by Upgren differs completely from the customary curves (Oort, Hill, Schmidt). Upgren finds at $z = 1000$ pc a value of $K(z)$ equal to one third or less of the average value for 100 to 400 pc, whereas the more traditional curves generally show a value of $K(z)$ at 1000 pc equal to twice the average for the range 100 to 400 pc. The importance of related density and velocity studies cannot be over-stressed. Upgren has recently reported (**2**) the results of an objective prism survey for stars of spectral class F2 to G5 (1127 stars to $B = 12{\cdot}5$). He finds that the density gradient for the main sequence F stars is considerably greater than for the early G stars. Blanco reports that Sanduleak has made a survey of faint M stars for an area of 120 square degrees near the North Galactic Pole, complete to $V \sim 17$. They estimate that less than 5% of the average number of M stars found (10 per square degree) can be giant M stars. Preliminary analysis indicates a marked upward revision of the mass density per pc^3 near the Sun.

Extensive researches on stellar distribution in the North Galactic Polar Cap are under way at the Uppsala Observatory. A paper not previously recorded in the Reports of Commission 33 is that of Malmquist (**3**), which contains spectrophotometric data for 3000 stars to $B = 13{\cdot}5$ (79 square degrees). In a preliminary note (**4**), Malmquist reports that he finds the interstellar absorption for the direction of the North Galactic Pole to be greater than hitherto estimated, about double the value of 0·25 mag. (blue) generally quoted. The problem is under investigation by Ljunggren.

Work on the brighter stars has also advanced considerably. Westerlund (**5**) is publishing U, B, V magnitudes and colours for 110 stars of early spectral type within 15° of the North Galactic Pole and for 110 stars within 12° of the South Galactic Pole. Reddening and blanketing effects are noted. Slettebak, Bahner and Stock (**6**) have obtained slit spectra to $m = 12$ for 84 stars of spectral type F2 and earlier for the purpose of obtaining spectral types, radial velocities and estimates of axial rotation. U, B, V magnitudes and colours are also available for these stars. The majority of these stars are 'Older Population I', but there are ten with decided Population II characteristics; sixteen new metallic line stars have been found. Klemola (**7**) has made a study of the mean absolute magnitudes for 205 stars of spectral type Bo to A5, all except 12 in the North Galactic Polar Cap. most of them in the range $9 < V < 12$. Proper motions are known for all stars and the τ-components have been used for the estimation of mean absolute magnitudes. The basic radial velocity material for the A1 to A5 stars is from Slettebak, Bahner and Stock (**6**) and for the Bo–Ao stars from Greenstein (**8**). Derived mean visual