37. COMMISSION DES AMAS STELLAIRES

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INTRODUCTION

The following report consists of four parts: The first part is devoted to associations. According to a proposal of A. Blaauw, approved by the Executive Committee, this subject is now assigned to Commission 37. This arrangement not having been made until recently, only a fraction of the work done in this field can be reflected in this report. The second part is devoted to galactic clusters, and the third one to globular clusters. Each part gives tabular surveys of objects under observation, literature, and a list of instruments used. Tables 2 and 3 are followed by a short discussion of their contents and by special as well as general remarks on items not touched upon before.

These three sections are based on the answers to two circular letters each of which was accompanied by a questionnaire. The first was distributed by W. Becker and J. S. Hall in December 1952. It was sent to several members of Commission 37 and some other astronomers. The answers were collected by W. Baade and sent to O. Heckmann in December 1953. No answers arrived from the U.S.S.R. The material was examined at Bergedorf by H. Haffner. In July 1954 the results, together with a second and enlarged questionnaire, were communicated to all members of Commission 37 and, in addition, to all other astronomers who had received the first letter. Each addressee received two copies, the second one was to be given to any recognized station where cluster investigations were known to be carried out. The contents of the answers are condensed in the following tables. No other information was used, consequently the tables give a survey of cluster work only in so far as it was notified to the President. They cover the time since the Rome meeting till October 1954.

The fourth part reports on cluster work in the U.S.S.R. It was prepared by P. N. Kholopov, who had not used the questionnaire of the second circular letter. Its form could not well be worked into the tables of the foregoing parts. Therefore Kholopov's report is reproduced here with only slight condensations of the text.

ASSOCIATIONS

Table 1. *Associations*

Name	Morgan number[a]	Observer	Data observed[b]	Instrument[c]	Reference
II Per	23	W. Becker	pe mag. UBV	(*a*)	*Z. Ap.* **34**, 1, 1954
		Harris	pe mag. UBV	(*b*)	—
		Blaauw	r.v.	(*b*)	—
		Bertiau, Blaauw	s.t.	(*c*)	—
		Delhaye, Blaauw	p.m.	(*d*)	*B.A.N.* **14**, 448, 1953
I Lac	14	Harris	pe pag. UBV	(*b*)	—
		Blaauw	r.v.	(*b*)	—
		Blaauw, W. W. Morgan	p.m.	(*h*)	*Ap. J.* **117**, 256, 1953
		Delhaye	p.m.	(*d*)	—
III Cep	17	Blaauw	p.m.	(*e*)	—
		Münch	faint members	(*f*)	—
		Sawyer Hogg	r.v.	(*g*)	—
Sco-Cen	—	Bertiau, Blaauw	p.m.	(*h*)	—
UMa	—	Harris	pe mag. UBV	(*b*)	—
		Miczaika	pe mag. BV	(*i*)	—

Notes and References to Table 1

[a] The Morgan number is taken from W. W. Morgan *et al.*, *Ap. J.* **118**, 318, 1953.

[b] r.v. = radial velocities; s.t. = spectral types; p.m. = proper motions.

[c] Instruments used are: (*a*) 24 in. refl., Bergedorf; (*b*) 82 in. refl., McDonald; (*c*) 40 in. refr., Yerkes; (*d*) 7·6 merid. circle, Paris; (*e*) Ross 2 m.-astrograph, Yale; (*f*) 24 in. Schmidt, Tonantzintla; (*g*) 74 in. refl., David Dunlap; (*h*) different meridian circles; (*i*) 12 in. refr. Heidelberg.

Mrs Sawyer Hogg announces that the David Dunlop Observatory is observing radial velocities of stars brighter than 10·6 in the following aggregates listed by Morgan and collaborators (1): 9, 10, 11, 12, 13, 16, 17, 18, 19, 20, 21, 24, 27, II Cam.

Weaver reports that a Berkeley group is particularly interested in the motion of associations as regards Ursa Major and Perseus.

Galactic Clusters

Table 2*a*. *Galactic Clusters*

NGC	Type	Observer	$\bar{\lambda}$	Limiting magnitude	Method	Data observed and reference[a]
457	1b	W. Becker	370 470 640	14·5	pg	*Z. Ap.* **34**, 1, 1954 (with Stock)
		Hoag	435 530	14	pe	pe+pg pol. *Astr. J.* **58**, 42, 1953
		Walker	370 435 550	14·3	pe	s.t.
559		Miller, Becker	370 470 640	13	pg	—
581	1–2b	Miller, Becker	370 470 640	13	pg	—
		Hoag	435 530	14	pe	pe+pg pol. *Astr. J.* **58**, 42, 1953
		Wallenquist	419 536	11·5	pe	—
An. Tr. 1		Miller, Becker	370 470 640	13	pg	—
609, 637, 654, 659		Miller, Becker	370 470 640	13	pg	—
		Larsson-Leander	425 530 650	17	pg	—
		Larsson-Leander	425 530	15	pe	s.t.
663	1b	W. Becker	370 470 640	14·5	pg	*Z. Ap.* **34**, 1, 1954 (with Stock)
		Hoag	435 530	14	pe	pe+pg pol. *Astr. J.* **58**, 42, 1953
752	2f	Eggen	430 540	15	pe	—
		Haffner	370 427 470 640	15	pg	—
		H. Johnson	370 435 550	15	pe	*Ap. J.* **117**, 356, 1953
		Wallenquist	419 536	11·5	pe	—
		Westerlund	435 550 625	11·5	pg	—
		Roman	—	12·6	—	r.v.; s.t.
869	1b	H. Johnson	370 435 550	15	pe	—
		Dieckvoss, Kox	—	—	—	p.m.
884	1–2b	H. Johnson	370 435 550	15	pe	—
		Dieckvoss, Kox	—	—	—	p.m.
957		Larsson-Leander	425 530 650	17	pg	—
		Larsson-Leander	425 530	15	pe	s.t.
1039	1b–a	H. Johnson	370 435 550	15	pe	*Ap. J.* **119**, 185, 1954
		Wallenquist	419 536	11·5	pg	—
		Dieckvoss, Kox	—	13	—	p.m.
α Per	1–2b	Bahner	430 550	10·7	pe	—
		Harris	370 436 553	—	pe	—
		Heckmann	370 420 470 640	—	pg	p.m.
		Pels	—	12	—	p.m.
		Ponsen	3 colours	10·5	pe	—
IC 348		Harris, Morgan, Roman	370 435 550	13·4	pe	s.t. *Ap. J.* **119**, 622, 1954
		Walker	370 435 550	16·1	pe	s.t.
Pleiades	1b	Harris	370 436 553	16·5	pe	*Ap. J.* **117**, 469, 1953
		H. Johnson	370 435 550	15	pe	*Ap. J.* **117**, 313, 1953

Table 2*a*. *Galactic Clusters* (*cont.*)

NGC	Type	Observer	$\bar{\lambda}$	Limiting magnitude	Method	Data observed and reference
		Weaver	—	—	—	s.t.
1502	1b	Haffner	370 427 470 645	12	pg	pg pol.
		Hoag	430 530	14	pe	pg+pe pol. *Astr. J.* **58**, 42, 1953
		Blaauw	—	—	—	p.m.
		Hopmann	—	—	—	p.m.
1528	1–2b–a	W. Becker	370 470 640	14·5	pg	—
		Larsson-Leander	425 530 650	17	pg	—
		Larsson-Leander	425 530	15	pe	s.t.
		Reddish	440 640	15	pg	—
Hyades	2a	Bahner	430 550	10·7	pe	—
		Harris	370 436 553	14	pe	—
		Heckmann	427 588	12·5	pg	p.m. *Mitt. A.G.* 20, 1952; *Vistas in Astronomy*, in the Press; Osvalds, *A.N.* **281**, 193, 1954
		Miller	430 640	18	pg	—
		Pels	—	12	—	p.m.
		Weaver	—	—	—	s.t.
1605		Larsson-Leander	425 530 650	17	pg	s.t.
		Larsson-Leander	425 530	15	pe	—
1647	1b–a	Larsson-Leander	425 530 650	17	pg	—
		Larsson-Leander	425 530	15	pe	—
1664		Larsson-Leander	425 530 650	17	pg	—
		Larsson-Leander	425 530	15	pe	—
1907		Cuffey	430 550	14	pe	—
1912	2b–a	Cuffey	430 550	14	pe	—
		Wallenquist	419 536	11·5	pe	—
1936		Wallenquist	419 536	11·5	pe	—
1960	1b	H. Johnson	370 435 550	15	pe	*Ap. J.* **117**, 313, 1953
2099	2a	Cuffey	430 550	14	pe	—
2129		Miller, Becker	370 470 640	13	pg	—
An. Tr. 4		Miller, Becker	370 470 640	13	pg	—
2168	1–2b	Miller, Becker	370 470 640	13	pg	—
		Wallenquist	419 536	11·5	pe	—
		Dieckvoss, Kox	—	—	—	p.m.
2169		Cuffey	430 550	14	pe	—
2192		Larsson-Leander	425 530 650	17	pg	—
		Larsson-Leander	425 530	15	pe	—
2244	1–2o	H. Johnson	370 435 550	15	pe	—
2264	1o	W. Becker	370 470 585	11·5	pe	*Z. Ap.* **34**, 31, 1954 (with Stock)
		H. Johnson	370 435 550	15	pe	—
		Walker	370 435 550	16·5	pe+pg	s.t.
2287	2a	Cox	427 534	13	pe	*Ap. J.* **119**, 188, 1954
2362	1o	H. Johnson	370 435 550	15	pe	*Ap. J.* **117**, 313, 1954
2422	1–2b	Brück	350 430 630	15·5	pg	—
2423		Brück	350 430 630	15·5	pg	—
2437	1a	Brück	350 430 630	15·5	pg	—
		Cuffey	430 550	14	pe	—
2451	1–2b	Brück	350 430 630	15·5	pg	—
2477		Brück	350 430 630	15·5	pg	—
2516	1–2b	Cox	427 534	13	pe	—
Praesepe	2a	H. Johnson	370 435 550	15	pe	*Ap. J.* **116**, 640, 1952
		Dieckvoss, Kox	—	—	—	p.m.
		Weaver	—	—	—	s.t.
		Schrick	—	13	—	p.m. *Veröff. Bonn*, no. 40, 1954.
IC 2581		Brück	350 430 630	15·5	pg	—
3293	1b	Brück	350 430 630	15·5	pg	—

Table 2*a*. *Galactic Clusters* (*cont.*)

NGC	Type	Observer	$\tilde{\lambda}$	Limiting magnitude	Method	Data observed and reference
3532	2b–a	Houck	—	—	—	—
		Koelbloed	430 550	—	pg+pe	+p.m.
3766	1b	Brück	350 430 630	15·5	pg	—
		Koelbloed	—	—	—	p.m.
Coma	2a	Bahner, Miczaika	430 550	—	pe	*Z. Ap.* **31**, 236, 1952
		Thiessen	410 530	—	pe	—
		Westerlund	435 550 625	11·5	pg	s.t. *Ann. Uppsala*, **3**, no. 10, 1953
		Weaver	430 550	11	pe	*Ap. J.* **116**, 612, 1952
		Dieckvoss, Kox	—	—	—	p.m.
		Fehrenbach	—	—	—	r.v.
4755	1–2b	Koelbloed	—	—	—	p.m.
5281, 5316, 5999, 6005	1–2b–a	Brück	350 430 630	15·5	pg	—
6124	2b–a	Koelbloed	430 550	—	pg+pe	p.m.
6231	1o	Houck, Cox	427 534	—	pe	*Ap. J.* **118**, 165, 1953
6281		Koelbloed	—	—	—	p.m.
6405	1–2b	Koelbloed	—	—	—	p.m.
IC4665	1–2b	H. Johnson	370 435 550	15	pe	*Ap. J.* **119**, 181, 1954
		Weaver	—	—	—	s.t.
6469		Svolopoulos	430 550	13	pg	*Mon. Not. R. Astr. Soc.* **113**, 758, 1953
6475	1b	Koelbloed	430 550	—	pg+pe	—
6494	2a	Svolopoulos	430 550	14	pg	*Mon. Not. R. Astr. Soc.* **113**, 758, 1953
6523		H. Johnson	370 435 550	15	pe	—
6531	1b	H. Johnson	370 435 550	15	pe	—
		Svolopoulos	430 550	13	pg	*Mon. Not. R. Astr. Soc.* **113**, 758, 1953
6546		Svolopoulos	430 550	13	pg	*Mon. Not. R. Astr. Soc.* **113**, 758, 1953
6649		Cuffey	430 550	14	pe	—
6705	2b–a	H. Johnson	370 435 550	15	pe	—
		Meurers	—	14	—	p.m. *Veröff. Bonn*, no. 41, 1954.
6802		Larsson-Leander	425 530 650	17	pg	—
		Larsson-Leander	425 530	15	pe	s.t.
6811	2a–f	W. Becker	370 470 640	14·5	pg	*Z. Ap.* **34**, 1, 1954 (with Stock)
6823		W. Becker	370 470 640	14·5	pg	*Z. Ap.* **34**, 1, 1954 (with Stock)
6866	2a	Dieckvoss, Kox	—	—	—	p.m.
6910		W. Becker	370 470 640	14·5	pg	*Z. Ap.* **34**, 1, 1954 (with Stock)
6913	1b	W. Becker	370 470 640	14·5	pg	*Z. Ap.* **34**, 1, 1954 (with Stock)
		Harris	370 436 553	15·5	pe	—
6939	3a	Cuffey	430 550	14	pe	—
6940	2a	Larsson-Leander	425 530 650	17	pg	—
			425 530	15	pe	s.t.
7092	1a	W. Becker	370 470 640	14·5	pg	*Z. Ap.* **34**, 1, 1954 (with Stock)
		Haffner	370 427 640	14	pg	—
		H. Johnson	370 436 550	15	pe	—
		Weaver	430 550	11	pe	*Ap. J.* **117**, 366, 1953
7127		Svolopoulos	430 550	14	pg	*Mon. Not. R. Astr. Soc.* **113**, 758, 1953
7128		Svolopoulos	430 550	14	pg	*Mon. Not. R. Astr. Soc.* **113**, 758, 1953
7209	1–2a	W. Becker	370 470 640	14·5	pg	*Z. Ap.* **34**, 1, 1954 (with Stock)
IC1434		Larsson-Leander	425 530 650	17	pg	—
			425 530	15	pe	s.t.

Table 2*a*. *Galactic Clusters (cont.)*

NGC	Type	Observer	$\bar{\lambda}$	Limiting magnitude	Method	Data observed and reference
7243	1b	W. Becker	370 470 640	14·5	pg	*Z. Ap.* **34**, 1, 1954 (with Stock)
7380	1b	Hoag	430 550	14	pe	pg+pe pol. *Astr. J.* **58**, 42, 1953
7510		Miller, Becker	370 470 640	14	pg	—
7654	1b–a	Elvius	430 540	14	pg	—

[a] pol. = polarization; s.t. = spectral types; r.v. = radial velocities; p.m. = proper motions.

Table 2*b*. *Observers and Instruments*

Name	Instrument	Locality	Data observed
Bahner	12 in. refr.	Heidelberg	—
W. Becker	24 in. Schmidt	Michigan	—
	24 in. refl.	Bergedorf	—
	48 in. refl.	Asiago	—
Blaauw	30 in. refr.	Allegheny	proper motions
Brück	36 in. ADH-tel.	Bloemfontein	—
Cox	24 in. Victoria tel.	Cape	mag.
	82 in. refl.	McDonald	spectral types
Cuffey	40 in. refl.	Goethe Link Observatory	—
Dieckvoss, Kox	24 in. refr.	Bergedorf	—
	4⁷4 astrograph	Bergedorf	—
Eggen	12 in. refl.	Lick	—
Elvius	16 in. astrogr.	Stockholm	—
Fehrenbach	—	St Michel	—
Haffner	14 in Schmidt.	Göttingen	—
	14 in. astrograph	Göttingen	—
	32 in. Schmidt	Bergedorf	—
Harris	82 in. refl.	McDonald	—
Heckmann	14 in. Schmidt	Bergedorf	—
	12 in. astrograph	Bergedorf	—
Hoag	40 in. refl.	Washington	pe mag.+pe polarization
	26 in. refr.	Washington	pg polarization
Hopmann	14 in. refr.	Wien/Castel Gandolfo	—
Houck	—	Cape	—
	—	Bloemfontein	—
H. Johnson	13 in. refl.	McDonald	—
	82 in. refl.	McDonald	—
Koelbloed	24 in. Victoria tel.	Cape	—
Larsson-Leander	40 in. refl.	Saltsjöbaden	spectra
	24 in. refr.	Saltsjöbaden	pg+pe mag.
	20 in. refr.	Saltsjöbaden	pv+pr
Meurers	12 in. refr.	Bonn	—
Miczaika	12 in. refr.	Heidelberg	—
Miller	24 in. Schmidt	Michigan	—
Pels	13 in. refr.	Leiden	—
Ponsen	18 in. refl.	Leiden	—
Reddish	24 in. refr.	London, Mill Hill	pg mag.
	18 in. refr.	London, Mill Hill	pr mag.
Roman	82 in. refl.	McDonald	—
Schrick	12 in. refr.	Bonn	—
Svolopoulos	7 in. astrogr.	Norman Lockyer	—
	5⁷5 astrogr.	Norman Lockyer	—
Thiessen	24 in. refr.	Bergedorf	—
Trumpler	div.	Lick	—
Walker	100 in. refl.	Mt Wilson	pe mag., spectral types
	60 in. refl.	Mt Wilson	—
	20 in. refl.	Mt Palomar	—

Table 2*b*. *Observers and Instruments (cont.)*

Name	Instrument	Locality	Data observed
Wallenquist	16 in. refl.	Kvistaberg/Uppsala	—
Weaver	12 in. refr.	Lick	—
	36 in. refl.	Lick	—
	100 in. refl.	Mt Wilson	—
Westerlund	6 in. refr.	Uppsala	Spectral types
	12 in. Schmidt	Uppsala	—
	15 in. Schmidt	Uppsala	—

Discussion of Table 2a

Completeness

With regard to the names of the observers (column 3) one has to consider that:

1. Trumpler's name does not appear. He announced in December 1952 that about 100 galactic clusters, not communicated individually, had been observed from 9–14 pg. mag. 'Preliminary reduction completed. Will be published when radial velocities and spectral class determinations are completed.'

2. The report received from the U.S.S.R. is given on pp. 344 ff.

Effective wave-length

The data in column 4 are not in all cases exactly the authors' own data, remarks like 'pg, pv, B, V, P' were replaced by suitable wave-lengths. It is evident from column 4 that most astronomers have decided to measure stellar magnitudes in three wave-length ranges:

360–450–630 or 360–450–550.

There are remarkable differences in the effective wave-lengths of the blue, yellow or red spectral range, caused only partly by the difference of sensitivity of multiplier and emulsion (cf. column 6, *Method*). *A certain standardization of receivers and colour filters should be seriously considered.*

Present status

Because of the wide diversity of answers regarding the present status of work, no details are communicated. It is suggested that observers be asked for particulars.

Selection of objects

Table 2*a* comprises 84 galactic clusters (M 67, M 71, and NGC 7789 have been placed in the list of globular clusters). This total of 84 has to be compared with the total number of known clusters, 331 according to Trumpler, 471 according to Collinder.

The Trumpler spectral type of clusters (LOB 420) accounts for 50 clusters out of the 84. Most of the observations are devoted to the types 1 o, 1–2 o, 2 o, 1 b, 1–2 b and 2 b (27 compared with 51 in the Trumpler list) and to the rare 'late' types 3 a, 2 a–f, 2 f which are all under observation (2). Comparatively few of the intermediate types between 1 b–a and 2–3 a (Hyades and Praesepe type) appear (20, including Hyades, Praesepe and Coma, compared with 45 in the Trumpler list).

The main cause for the difference between the number of known and of observed clusters is the southern declination of many objects. Considering only the 100 clusters of Trumpler type, one finds that 40 clusters have $\delta < -15°$, but only 15 of these are contained in Table 2*a*. Comparing the Trumpler list with Table 2*a* it is easy to pick out clusters of special interest accessible to northern or southern observatories and hitherto unobserved with modern photometric methods.

Requests

Blaauw suggests that observatories having old series of cluster plates should make lists available with data of observation, scale, and magnitude limit. They should state whether they (*a*) are willing to repeat plates on request; (*b*) are not willing to repeat

plates. In case (*b*) new plates could be taken by similar instruments at other observatories.

Dieckvoss and Kox need radial velocities in NGC 1039.

Miczaika urgently desires proper motions and radial velocities of possible members of Ursa Major group to improve identification of membership.

Miss Roman wants to get improved proper motion and radial velocity data of Heinemann no. 209 (A0) in NGC 752 in order to check membership.

Svolopoulos needs spectral types for the clusters he has measured photometrically.

Special remarks

Motions

Dieckvoss and Kox (Bergedorf) are determining absolute proper motions in NGC 869, 884, 1039, 2168, 2632, 6866, and Coma. Their material consists of plate pairs either of 24 in. refr. or of 4$^{\prime\prime}$5 AG astrograph; limits are between 12 and 14 m_{pg}.

Heard is observing radial velocities in the α Per cluster.

Heckmann, Dieckvoss and Kox, by comparison of AGK1, CdC, AGK2, and new photographic positions, determined proper motions in the Hyades ($4^h\,4^m$ to $4^h\,34^m$; 12° to 23°5) in order to derive individual parallaxes and around α Per ($3^h\,6^m$ to $3^h\,36^m$; 46° 37′ to 51° 37′) where they found new faint members of the B star cluster. Results are to be published in 1955.

Oosterhoff reports that Pels is deriving proper motions in a field around the Hyades ($3^h\,0^m$ to $5^h\,24^m$; 0° to 32°), and, together with Blaauw, around α Per ($3^h\,0^m$ to $3^h\,56^m$; 44° to 52°). His method is comparison of astrographic catalogue positions with plates of Leiden 13 in. refr.

Osvalds (3) (Charlottesville, formerly Bergedorf) has derived proper motions in a $5° \times 5°$ field around θ^2 Tauri. His material is 3 pairs of old and new AG plates; Δ epoch 10–20 years. He has found some new faint Hyades.

Stoy reports that Koelbloed, besides his photometric work, is deriving proper motions with Cape plates of NGC 3532, 3766, 4755; Δ epoch 16 years.

Walker highly desires accurate proper motions in the area of NGC 2264, down to 19·5 m_{vis}.

Spectral types

Gratton together with Hernandez (La Plata) has determined spectral types and radial velocities of the brighter stars in the cluster near κ Crucis.

Miss Roman in NGC 752 has observed spectral types in MK system, 113 Å/mm. at Hγ, limit 12·6 m_{vis}, with the 82 in. McDonald. She also measured radial velocities on the same plates (material still incomplete). Her purpose is to obtain a H–R diagram, and luminosity standards for F subgiants.

Weaver has determined spectral types in Pleiades, Praesepe, Hyades, IC 4665, using the 36 in. Lick, and the 100 in. Mt Wilson; dispersion, 75 and 37 Å/mm., for a few Hyades 10 and 2·9 Å/mm. His purpose is to obtain spectral characteristics of clusters.

Miscellaneous

Miller (Michigan) has completed his observations for W. Becker. His Hyades programme consists of 20 min. exposures 103a–O without filter and 30 min. 103a–E with Wratten 22 (red). Luyten wants these plates for a search of abnormally blue and abnormally red stars.

Reddish has identified NGC 7789 as a population II object. It should therefore be rather classified as 'globular'.

Walker reports that he did not find in NGC 457 the abnormal Balmer discontinuity announced by W. Becker.

Table 3*a*. *Globular Clusters*

NGC	Name	Observer	Limiting magnitude	Purpose	Reference
104	47 Tuc	Gaposchkin	19	Var., ϕ (M)	—
		Wilkens	—	Var.	—
2158	—	Rosino	—	Var.	*Contr. Asiago*, no. 52, 1954
2682	M 67	W. Becker	14·5	C–m	—
		Eggen	15	C–m	—
		H. Johnson	15	C–m	—
		Reddish	15	C–m	—
		Rosino	18, 20[a]	Var., ϕ (M)	*Contr. Asiago*, no. 52, 1954
3201	—	Wilkens	—	Var.	—
4147	—	Rosino	18, 20[a]	Var., ϕ (M)	—
		Sandage	22	Main sequence	—
		Walker	18·4	C–m (UBV)	—
4372	—	Wilkens	—	Var.	—
4590	M 68	Oosterhoff	16	Var.	—
		Rosino	18, 20[a]	Var., ϕ (M)	*Publ. Bologna*, VI, no. 5, 1954
5024	M 53	Cuffey	18	C–m	—
5139	ω Cent	Gaposchkin	19	Var., ϕ (M)	—
		van Woerden	—	Var.	—
		Wilkens	—	Var.	—
5272	M 3	Arp	17	Var., C–m	*Astr. J.* **59**, 190, 1954 (Roberts and Sandage)
		Baum	23	C–m, ϕ (M)	*Astr. J.* **57**, 222, 1952; **58**, 4, 1953
		Hoag	—	Distribution of intensity	—
		H. Johnson	15	C–m (UBV)	—
		Walker	17	Var.	—
5466	—	Cuffey	18	C–m	—
5897	—	Sawyer Hogg	—	Var.	*Comm. David Dunlap*, no. 34, 1953
5904	M 5	Arp	17	Var., C–m	—
		Reddish	15	C–m	—
Anon.	$15^h\ 13^m + 0°1$	Rosino	18, 20[a]	Var., ϕ (M)	*Publ. Bologna*, V, no. 15, 1951
6093	—	Sawyer Hogg	—	Var.	—
6121	—	Sawyer Hogg	—	Var.	—
		Wilkens	—	Var.	—
6144	—	Rosino	18, 20[a]	Var., ϕ (M)	—
	—	Sawyer Hogg	—	Var.	*Comm. David Dunlap*, no. 34, 1953
6171	—	Sandage	22	Main sequence	—
6205	M 13	Arp	17	C–m, Var.	*Astr. J.* **59**, 192, 1954
		Baum	23	C–m, ϕ (M)	*Astr. J.* **59**, 183 and 353–4, 1954
		Hoag	14·5	C–m, distribution of intensity	*Astr. J.* **57**, 13, 1952
		H. Johnson	15	C–m (UBV)	—
		Sawyer Hogg	—	Var.	—
6218	—	Sawyer Hogg	—	Var.	—
6229	—	Sawyer Hogg	—	Var.	*Comm. David Dunlap*, no. 34, 1953
6235	—	Sawyer Hogg	—	Var.	*Comm. David Dunlap*, no. 34, 1953
6254	M 10	Sawyer Hogg	—	Var.	—
		Arp	17	Var., C–m	—
6266	M 62	Oosterhoff	16	Var.	—
6273	—	Sawyer-Hogg	—	Var.	—
6341	M 92	Baum	23	C–m, Var.	*Astr. J.* **57**, 222, 1952; **58**, 4, 1953
		Hoag	—	Distribution of intensity	—
		Walker, Sandage	16·5	Var., C–m (UBV)	—
6342	—	Sawyer Hogg	—	Var.	—
6356	—	Sawyer Hogg	—	Var.	*Comm. David Dunlap*, no. 34, 1953
6397	—	Wilkens	—	Var.	—

Table 3*a*. *Globular Clusters (cont.)*

NGC	Name	Observer	Limiting magnitude	Purpose	Reference
6401	—	Sawyer Hogg	—	Var.	—
6402	M 14	Sawyer Hogg	—	Var.	—
		Arp	17	Var., C–m	—
6535	—	Sawyer Hogg	—	Var.	*Comm. David Dunlap*, no. 34, 1953
6539	—	Sawyer Hogg	—	Var.	—
6541	—	Wilkens	—	Var.	—
6544	—	Sawyer Hogg	—	Var.	—
6558	—	Rosino	18, 20[a]	Var., ϕ (M)	*Contr. Asiago*, no. 52, 1954
IC 1276	—	Sawyer Hogg	—	Var.	—
6626	—	Sawyer Hogg	—	Var.	—
6637	M 69	Rosino	18, 20[a]	Var., ϕ (M)	—
6638	—	Sawyer Hogg	—	Var.	—
6642	—	Sawyer Hogg	—	Var.	—
6656	—	Sawyer Hogg	—	Var.	—
		Wilkens	—	Var.	—
6712	—	Rosino	18, 20[a]	Var., ϕ (M)	—
		Sawyer Hogg	—	Var.	*Comm. David Dunlap*, no. 34, 1953
6715	M 54	Rosino	18, 20[a]	Var., ϕ (M)	*Publ. Bologna*, v, no. 18, 1952
6717	—	Sawyer Hogg	—	Var.	—
6752	—	Wilkens	—	Var.	—
6760	—	Sawyer Hogg	—	Var.	*Comm. David Dunlap*, no. 34, 1953
6779	M 56	Sawyer Hogg	—	Var.	*Comm. David Dunlap*, no. 34, 1953
		Rosino	18, 20[a]	Var., ϕ (M)	—
6809	M 55	H. Johnson	15	C–m	—
6838	M 71	W. Becker	17·5	C–m	—
		Cuffey	18	C–m	—
		Rosino	18, 20[a]	Var., ϕ (M)	*Contr. Asiago*, no. 52, 1954
		Sawyer Hogg	—	Var.	*Comm. David Dunlap*, no. 34, 1953
6864	—	Rosino	18, 20[a]	Var., ϕ (M)	—
6934	—	Sawyer Hogg	—	Var.	—
6981	M 72	Rosino	18, 20[a]	Var., ϕ (M)	*Publ. Bologna*, VI, no. 2, 1953
		Sawyer Hogg	—	Var.	*Comm. David Dunlap*, no. 34, 1953
7006	—	Rosino	18, 20[a]	Var., ϕ (M)	—
7078	M 15	Arp	17	C–m, ϕ (M)	—
		Baum	23	C–m	—
		Hoag	—	Distribution of intensity	—
		Rosino	18, 20[a]	Var., ϕ (M)	—
7089	M 2	Arp	17	C–m	—
		Hoag	—	Distribution of intensity	—
7099	—	Rosino	18, 20[a]	Var., ϕ (M)	—
7492	—	Cuffey	18	C–m	—
		Rosino	18, 20[a]	Var., ϕ (M)	—
7789	—	Reddish	15	C–m	—

[a] See Table 3*b* (Rosino).

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Table 3*b*. *Observers and Instruments*

Name	Instrument	Locality	Effective wave-length	Method
Arp	200 in. refl.	Mt Palomar	430 540	pg+pe
Baum	200 in. refl.	Mt Palomar	360 430 540	pg+pe
W. Becker	See Table 2*b*		M 67: 370 470 640	pg
			M 71: 430 600	pg
Cuffey	36 in. refl.	Bloomington	430 630	pg
Eggen	36 in. refl.	Lick	430 540	pe
Hoag	40 in. refl.	Washington	430 530	pe
H. Johnson	82 in. refl.	McDonald	370 435 550	pe
Mayall	36 in. refl.	Lick	430 540	pe
Oosterhoff	74 in. refl.	Radcliffe	430	pg
Gaposchkin	60 in. refl. 36 in. ADH telescope 10 in. Metcalf	Bloemfontein	430 630	pg
Reddish	24 in. refr.	London, Mill Hill	440 640	pg
Rosino	24 in. refl.	Lojano (limit 18 mag.)	430	pg
	48 in. refl.	Asiago (limit 20 mag.)	430	pg
Sandage	200 in. refl.	Mt Palomar	430 540	pg+pe
	100 in. refl.	Mt Wilson	370 430 550	pg
Sawyer Hogg	74 in. refl.	David Dunlap	430	pg
	19 in. refl.	David Dunlap	430	pg
Walker	100 in. refl.	Mt Wilson	370 435 550	pe
	60 in. refl.	Mt Wilson	370 435 550	pe
Wilkens	14 in. refr.	La Plata	430	pg
van Woerden	74 in. refl.	Radcliffe	430	pg

Discussion of Table 3a

The data on globular clusters have been arranged in Table 3*a* in a similar manner to those on galactic clusters in Table 2*a*. They need little explanation. The effective wave-lengths are given in Table 3*b*, together with the instruments used. On account of the nature of globular clusters there is a greater diversity in the purposes of the authors than in the case of galactic clusters. Therefore the purposes are given individually in column 5 (*Remarks*).

Selection of clusters

The total number of known globular clusters belonging to the Galactic System is 109, Mrs Sawyer Hogg's last Catalogue being enlarged by ten recent additions (NGC 2158, 2682 (M 67), 6235, 6535, 6558, 6642, 6717, 7789, IC 1276 and Anon. $15^h\,13^m+0°.1$) among which there may still be some dubious cases. Fifty-nine out of these are under observation. The distribution in declination of the known (N_{tot}) and the observed (N_o) clusters may be seen from Table 4.

Table 4[a]

		N_{tot}	N_o
+70° to	+90°	0	—
+50	+70	1	1
+30	+50	5	4
+15	+30	8	7
0	+15	7	6
−15	0	13	10
−30	−15	32	19
−50	−30	25	8
−70	−50	11	2
−90	−70	7	2
	Sum:	109	59

[a] In most of the southern globular clusters now under observation only variables are investigated.

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Requests

Baum reports that the main series in M 13 and probably in M 3 and M 15 may be in the sub-dwarf region. He therefore suggests a more intensive study of sub-dwarfs in the general field, particularly towards determining their location and spread in the CMD.

Rosino recommends that observations of variable stars in clusters be made by observers working at different geographic longitudes.

Mrs Sawyer Hogg asks for radial velocities of bright variables in globular clusters in order to decide their membership.

Walker needs spectroscopic observations of red stars in NGC 4147 because of the photometrically established abnormally strong ultra-violet. Comparison with M 3, where H. L. Johnson found the same phenomenon, is suggested.

Miscellaneous remarks

Gratton, besides the data given in Table 3*a*, reports on investigations by H. Wilkens on diameters of globular clusters determined by the distribution of known variables.

Mrs Sawyer Hogg is preparing a second edition of the catalogue of variables in globular clusters, comprising 1421 entries. The catalogue will be published before the Dublin meeting of the I.A.U. In M 3 and M 92 Walker is investigating photo-electrically stars at either edge of the variable star gap for incipient variability.

Globular clusters in extragalactic objects

Kron and Mayall are determining pe magnitude of 60 globular clusters in M 31 for comparison of absolute magnitude in the galaxy. They want to study absorption in M 31, and intend to use globular clusters as distance indicators for nebulae in Virgo cluster having identified globular clusters.

Shapley (4) reports on photometry of 'Constellations' in the Large Magellanic Cloud and on the cataloguing and description of open and globular clusters in the Large and Small Magellanic Clouds; the instruments used were the Boyden Station ADH and 60 in. He hopes to complete this work in 1955 or 1956.

Work on Associations, Galactic Clusters, and Globular Clusters in the U.S.S.R.

Stellar associations

B.E. Markarian (5) published a revised list of O-type stellar associations containing data about nineteen reliable and six probable associations.

V. A. Ambartsumian (6) found a close connexion between irregular and semi-regular supergiants of late spectral classes and the O-associations. This may prove that these M-type supergiants are stars of a comparatively recent origin.

A number of papers were devoted to individual O-associations. B. E. Markarian (7) showed that the system of bright stars of early spectral classes in the Cep II association is expanding.

N. M. Artiukhina (8) derived proper motions of stars of the same association and confirmed the expansion found by B. E. Markarian.

I. M. Kopylov (9) investigated the association around the open cluster NGC 6231 in Scorpius. In the same papers he studied the instability of associations in Scorpius, Cep II, Per II and the Scorpio-Centaurus stream, and showed that the total energies of all these systems are positive.

P. P. Parenago (10) completed his investigation of the stellar system associated with the Orion nebula. In a region of 9 square degrees, with the nebula in its centre, magnitudes and colour indices of 3000 stars with magnitudes up to 14·5, the equatorial co-ordinates of 2200 stars, and the proper motions of 1500 stars were determined (the

latter by N. M. Artiukhina, in the majority of cases). In the same region 224 variable stars of RW Aurigae type were studied.

The colour magnitude diagram was found to be rather peculiar. It consists of the first part of the Main Sequence, extending from O-type stars to A5-type stars, only, and of a group of subgiants. Variable stars of RW Aurigae type are distributed in the same regions of the diagram.

Systematic motions of stars in different parts of the system were studied. The motions of the Trapezium stars confirm its expansion. The distribution in space of all the B stars belonging to the Orion association was also studied. P. P. Parenago concludes that this association is of a comparatively recent origin.

T. A. Uranova (11) completed a photographic study of the stellar system connected with the nebula NGC 2264 in the region of S Mon.

In a theoretical study, devoted to an interpretation of the observed peculiarities in the motion of stars of spectral classes O and B, A. F. Torondzhadze (12) showed that the system of bright stars in the neighbourhood of the Sun can be considered as a result of the expansion and disintegration (dissipation) of stellar associations, of a comparatively recent origin.

Open clusters

An *Atlas of Open Star Clusters of Different Types* by B. E. Markarian was published in 1952. It contains photographs of thirty-seven clusters of all types according to the author's classification, obtained at the Byurakan Astrophysical Observatory by means of a 12–8 inch Schmidt camera.

The colour magnitude diagram was photographically determined by means of the 15-inch Schmidt camera of the Engelhardt Observatory for the clusters NGC 188, 1528, 1545, 6811, 6823, 6830, 6996, 7086 and Col. 428 by K. A. Barkhatova and for the clusters NGC 1513, 1664 and 7039 by L. J. Melnikova.

Second-epoch plates of the open star clusters NGC 129, 457, 581, 752, 869, 884, 1513, 1907, 1912, 1960, 2099, 2168, 6705, 6885, 7092, and 7209 were taken with the normal astrograph of the Pulkovo Observatory.

V. V. Lavdovsky obtained the relative proper motions of the stars of twelve of these clusters and their surroundings (on the average about 1000 stars in each cluster), from three to five pairs of plates. The probable error of the proper motion of an individual star is $\pm 0''.001$ for the mean of four pairs of plates. Photographic magnitudes of all the stars up to 14–15^m were determined for five clusters with a precision of $\pm 0^m.2$. V. V. Lavdovsky (13) also published a paper on the determination of the magnitude equation in the proper motions of stars in NGC 6885.

P. A. Savizky investigated the proper motions of 820 stars in the region of NGC 7654 (14) and of 431 stars in the region of NGC 6885 (15).

N. M. Artiukhina (16) investigated the proper motions of 1100 stars up to the 15th magnitude in the region of the North Pole of the Galaxy in the field of Coma Berenices. A comparison of the luminosity functions of the Pleiades, Hyades, Praesepe and Coma Berenices was carried out. N. M. Artiukhina is also determining the proper motions of the cluster H 20.

On the basis of a study of the motions of the bright stars in IC 2602 B. E. Markarian (17) arrived at a conclusion about the expansion of this cluster (type O according to his classification). He suggests (18) that the majority of O-type clusters does not transform into B- and A-type clusters, but are rapidly dissociating, because of the fact that their energy is positive. I. M. Kopylov, in his above-mentioned studies, arrived at similar conclusions.

N. N. Gorokhova (19), by means of the Pulkovo mirror and lens camera with a direct-vision prism, completed the spectrophotometric investigation of thirty-two stars in the Coma Berenices cluster and of the eight brightest stars in the Pleiades. From spectrophotometric gradients and from other data she derived the absorption of light in the region of these clusters. She concluded that the Pleiades are the younger cluster.

K. A. Barkhatova and V. V. Syrovoi (20) studied the average colour indices depending upon the distance from the centre in twenty-four open clusters, and found an increase of the average colour indices towards the periphery of the latter. Such an effect is interpreted by the authors as a consequence of the preferential distribution of stars of lower luminosity at the periphery of the clusters, as a result of their departure from the clusters.

K. A. Barkhatova (21) showed that clusters with a large quantity of stars of various luminosities and with a weak concentration towards their centre, possess the largest galactic concentration.

I. M. Kopylov (22) determined the absolute integral magnitudes of 300 open clusters and obtained their luminosity function, which turned out to be close to the normal distribution with a maximum about $-3^{m}\cdot5$.

Globular clusters

Proper motions of the cluster M 13 were determined by N. V. Fatchikhin (23). N. M. Artiukhina is completing the determination of the proper motion of the cluster M 71. A series of studies by P. N. Kholopov (24), devoted to the investigation of the apparent and spatial distribution of different types of stars in a number of globular clusters, was published. It was discovered by the author that the globular clusters consist of a number of zones, each of them characterized by certain values of the average density gradient. The boundaries of these zones are rather distinct. Going from one zone to the next one, the gradient of the spatial density changes by one order of magnitude. The orientation of the ellipsoid of equal apparent density in the inner regions of some clusters differs from the corresponding orientation in the outer regions. Papers by I. N. Minin (25) on an application of the equations of stellar hydrodynamics to globular clusters, and by G. M. Idlis (26) on criteria of the tidal stability and the distribution of globular clusters in galaxies and of stars in globular clusters, are devoted to a theoretical analysis of the problems of the structure and development of globular clusters.

In conclusion, I wish to thank H. Haffner for his continuous and effective help in preparing this report.

O. Heckmann
President of the Commission

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Report of the meeting. 30 August 1955

PRESIDENT: Prof. O. Heckmann.

SECRETARY: Dr J. Cuffey.

The participants stood during some words by the President in memory of H. Mineur.

No comments were made on the published report.

After some general remarks, the Chairman suggested a discussion of the following points, which had already arisen in preparing the report.

(1) Blaauw's proposal (cf. p. 339) that lists of old cluster plates be published.

(2) Desirability of a uniform three-colour system to be applied to the photometry of star clusters.

(3) Extension of Trumpler's cluster classification to clusters of hitherto unknown Trumpler type.

(4) Desirability of MK spectral types in clusters.

(5) Discovery of new clusters.

(1) It is well known that a number of observatories possess old plates of star clusters which could be used with new exposures taken with the same instruments for the derivation of proper motions. Following a suggestion by A. Blaauw, these observatories are requested to prepare lists of such plate material in their files. It is further suggested that these lists be forwarded to the Chairman of Commission 37, who will collect and prepare them for publication. The lists should include the following necessary information regarding the plates:

(*a*) Instrument.
(*b*) Scale.
(*c*) Size of field.
(*d*) Object.
(*e*) 1950 co-ordinates of the plate centre.
(*f*) Date of observation.
(*g*) Exposure time.
(*h*) Limiting magnitude.
(*i*) Quality.

It should further be stated whether the observatory will be able to repeat exposures on request and whether it will be able to undertake the reduction of the plates or would be willing to turn them over to other astronomers for reduction. It is hoped that this procedure will result in a systematic evaluation of the galactic *and* globular cluster material which has not as yet been fully evaluated.

F. Becker (Bonn) and J. Hopmann (Vienna) reported in detail on the plate material available at their institutions for the derivation of proper motions in clusters. H. F. Weaver (Mount Hamilton) called attention to a series of plates taken some time ago by R. F. Trumpler at the Allegheny Observatory.

(2) Since the last meeting of the I.A.U., astronomers have come to closer agreement with regard to the usefulness of magnitudes of cluster stars in at least three, rather than

two, spectral ranges. According to the work of W. Becker and of H. L. Johnson three-colour photometry will yield distances and absorptions under the assumption that the relations between their intrinsic colours and absolute magnitudes are identical for different clusters. In order to facilitate the comparison of results of various investigators, the President suggests that all photometric work on clusters be done in the three-colour UBV system of Johnson and Morgan, if possible, since this is at present the most practical system. It was pointed out during the discussion that not only the effective wave-lengths but also wave-length ranges of the UBV system should be adopted. It was suggested that Commission 37 support the relevant resolutions of Commission 25 (Photometry).

(3) The selection of galactic clusters in most of the current investigations is based on Trumpler's type classifications (LOB 420), which characterize briefly the distribution of giant stars in the H–R diagram. However, these Trumpler types are known for only 100 clusters. It is therefore highly desirable to inaugurate investigations which will determine Trumpler types for additional clusters. In view of the existing plate material, this would be possible for a number of galactic clusters without the necessity of taking new plates.

For the southern sky in any case, this problem has only been studied very incompletely.

Naturally, the Trumpler types are no substitute for a more extensive spectral classification.

(4) A more extensive and extremely desirable task, though it would naturally be laborious, would be the establishment of spectral types on the MK system. In combination with colour indices, this would yield not only the cluster-type, but also a knowledge of the distance of the cluster and the absorption in front of it. This method does not depend on the same assumptions as that discussed under point (2). MK types are not yet available for many of the 100 clusters with known Trumpler types. This would require relatively high dispersion and therefore larger telescopes. Objective prism work will be possible only in certain cases. A. Underhill reports work of this nature in Victoria (with G. L. Odgers and R. M. Petrie). L. Gratton reports analogous work in Cordoba.

(5) The question of the discovery of new clusters leads to several useful points of view:

(*a*) The Franklin-Adams Charts have already been exhausted for this purpose by Collinder. The limiting magnitude in this case is 16.

(*b*) The limiting magnitude of 20 in the Palomar Sky Survey leads to such high star densities in the Milky Way, that clusters in which the brightest stars are of magnitude 16 or fainter could be found only under exceptional circumstances.

(*c*) A survey to a limiting magnitude of about 18 would be more desirable in many respects. It is probable that existing plate material could be used in part for this purpose.

(*d*) Even more important is the application of highly sensitive infra-red plates (for example, Eastman I–N), which would increase the probability of discovery of new clusters by virtue of being less affected by absorption.

The session ended with the forming of two resolutions:

Resolution 1: Identical in content with point (1) above.

Resolution 2: Commission 37 supports resolutions 1, 2 and 3 as approved by Commission 25.

Report of meeting. 1 September 1955

PRESIDENT: Prof. O. Heckmann.

SECRETARY: Dr J. Cuffey.

Agenda:
(1) Resolutions to approve.
(2) Additional reports (Weaver, Kholopov, Mrs Sawyer Hogg).
(3) Remarks on globular clusters.
(4) M. Schwarzschild: On the evolutionary tracks in the CM-diagram. Discussion.

(1) The Commission passed the two resolutions discussed at the first session.

(2) H. F. Weaver gave a short report on R. Trumpler's more recent work on galactic clusters. The extensive radial velocity observations are now complete. The publication is planned to include a catalogue of the radial velocity for each star (usually with three or more observations), magnitudes, colours, and a chart of each cluster with identification numbers on it. A discussion of the radial velocity material will be published later.

P. N. Kholopov read the following additions to the Draft Report:

T. S. Kirillova (Moscow) derived photographically (in photographic and red light) CM-diagrams for the open clusters NGC 2175, 2244, IC 1805, Tr. 37 and Col. 377.

N. M. Shakhovskoy in Moscow has completed his investigation of the Cep II association. He showed that a large number of B and A stars belong to that association.

N. M. Artiukhina (Moscow), as a continuation of her previous work, has derived and improved the proper motions of another forty B stars in the region of the Cep II association, which belong to that association according to Shakhovskoy. Proper motions of sixty O and B stars in the above region suggest that the expansion of this association originates at two centres: cluster Tr 37 and cluster NGC 7160.

In addition Mr Kholopov handed over to the Commission copies of a manuscript by A. I. Lebedinsky and O. B. Khorosheva entitled: 'On the Origin of the OB-type star associations'. This work will be published elsewhere.

(3) L. Rosino suggested that a survey for variable stars be made in all globular clusters north of $-20°$ declination. There are thirty-four clusters in Mrs Sawyer Hogg's catalogue in which no search for variables has been made.

Mrs Sawyer Hogg presented to the Commission a copy of the second edition of her catalogue of variables in globular clusters.

(4) M. Schwarzschild, on request of the President, was kind enough to give a report on his work on the evolutionary interpretation of the CM-diagrams of clusters. He summarizes his report as follows:

The Hertzsprung-Russell diagrams of Clusters as a Key Test of the Theory of Stellar Evolution

Before 1938 the theory of the stellar interior was badly handicapped by the fact that the nuclear processes which provide the energy sources within a star were unknown. In consequence, the equilibrium structure of a star of given mass and composition could not be derived uniquely, and comparison with observations was largely restricted to the mass-luminosity relation, which is fairly independent of the character of the nuclear processes.

Now that the necessary nuclear data are available, one can not only derive the initial structure of a star without arbitrariness, but one can even follow the star in its evolution, by computing at each evolution phase the changes in composition caused by the nuclear transmutations, and by constructing for each phase a new model of the star with due regard to the changed composition. From such model sequences one can then derive the luminosity and radius of the star as a function of time and thus obtain the evolutionary track of the star in the Hertzsprung-Russell diagram.

It appears likely that the stars of one cluster are essentially of the same age and initial composition. Accordingly, if we compute a family of evolutionary tracks for stars of the

same initial composition, but of different masses, and if we draw across these tracks in the Hertzsprung-Russell diagram the curves which connect points of equal age, then these curves should be identical with the observed Hertzsprung-Russell diagrams of clusters. It is for this reason that the Hertzsprung-Russell diagrams of clusters have recently gained the key role among the observational tests of the theory of stellar evolution.

The necessary theoretical work to compute evolutionary tracks is extensive. The use of large electronic machines is just now starting to speed up this work enormously. This far only the earliest evolution phases have been investigated in some detail. These investigations indicate that the well-known turn-off from the main-sequences of the brightest stars in each galactic cluster may be understood in terms of hydrogen depletion in the core of the stars. For globular clusters the analysis has been carried somewhat further, and it appears that the entire giant sequence in these clusters can be interpreted by the growth of hydrogen-exhausted, partially degenerate cores. The investigation of the latest evolutionary phases, which may well be represented by the horizontal branch in the globular clusters and by the yellow and red supergiants in galactic clusters, has hardly yet begun.

It is obvious that this theoretical development will be successful only if it will be guided phase by phase by the relevant observational data. The available data regarding the Hertzsprung-Russell diagrams of clusters have enormously increased in the last few years. Still, a good number of critical deficiencies are left. For example, the data on the supergiants in galactic clusters are still weak: very few clusters of intermediate age such as M67 have as yet been thoroughly investigated; only for a very small sample have the delicate differences between various globular clusters been determined accurately. The solving of such observational problems appears fully as necessary as the parallel theoretical investigations if we are to gain speedily a fuller picture of stellar evolution.

The discussion touched the following points: Influence of rotation on mixing of stellar material; relation of the variable-star content in globular clusters to the form of the red branches in CM-diagrams; possibility of classifying clusters by means of their variables.

W. W. Morgan called attention to the two-colour diagram in which U–B is plotted versus B–V as abscissa. This is available now for some galactic clusters. There is a tendency for Population II stars of type F2 to G0 to lie somewhat (some $0^{m}\cdot01$) above the stars of the Sun's neighbourhood. Accordingly the youngest clusters may lie lower and the oldest higher than those of intermediate age. For such diagrams photo-electric rather than photographic accuracy is required.

Schwarzschild emphasized that, irrespective of its theoretical interpretation, the two-colour diagram is important as a new means of sorting clusters in sub-groups.