37. COMMISSION DES AMAS STELLAIRES ET DES ASSOCIATIONS

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INTRODUCTION

This report is based partly upon the information received by the writer in response to a circular letter distributed in July 1960 amongst 120 astronomers, and partly upon the evaluation of an almost complete list of all papers dealing with clusters and associations which have been published after the Moscow meeting in 1958. It has been attempted to condense the huge amount of information into the tight form of a few tables, but obviously a certain kind of research work does not fit into the framework of such tables. It will be reported in the following text. The report is divided into four sections referring to associations, galactic clusters, globular clusters, and dynamical problems. Clusters and associations belonging to the Magellanic Clouds or other external galaxies are not included in this report. The number of papers devoted to such objects is steadily increasing from year to year; they are reported on in Sub-Commission 28*a*.

Catalogues and monographs

At the Moscow meeting the forthcoming publication of the card catalogue of clusters and associations compiled by G. Alter, J. Ruprecht and V. Vanýsek had been announced. This catalogue proved to be a very powerful tool for any astronomer engaged in cluster research. Both the authors and the Czechoslovakian Academy of Sciences may be sure to be shown the highest appreciation by a large multitude of astronomers for the work invested in this catalogue. To keep its value, it will be necessary from time to time to publish supplements which quote briefly the content of recent publications in such a form that it can be readily inserted into the card catalogue. Two supplements have been distributed in the meantime (**1**). Supplement no 3 (**2**) is expected to be published early in 1961. It will be exceptionally well received, for it contains more than 180 new objects (among them nearly 150 southern clusters recorded by J. Ruprecht). The catalogue is also enlarged by two new sections: the stellar groups newly brought into consideration and extra-galactic objects containing clusters. The catalogue will now comprise altogether 973 objects. Supplement no. 3 is concluded by a complete list of new galactic co-ordinates l^{I}, b^{I}. Furthermore it should be noted that the Czechoslovakian Academy of Sciences is kind enough to deliver new blank cards on order whenever the cards added to the card catalogue are used up.

On the other hand, to facilitate the continuation of this catalogue, workers in the field of clusters are urgently requested to send reprints of their published work to the Astronomical Institute, Ondrejov, C.S.R.

The Czechoslovakian astronomers have recently initiated the difficult project of producing a collection of maps of all galactic clusters. Obviously, this atlas will have an enormous value for cluster research. It is expected to be published in the middle of 1961.

Here mention should be made of three summarizing reports:

1. H. Sawyer Hogg, Star clusters. *Handb. Phys.* **53,** 129-207, 1959;
2. H. C. Arp, The Hertzsprung-Russell-Diagram. *Handb. Phys.* **51,** 75-131, 1958;
3. E. M. and G. R. Burbidge, Stellar Evolution. *Handb. Phys.* **51,** 195-238, 1958.

Mrs Sawyer Hogg's article is exclusively devoted to clusters and associations, whereas the other two articles deal with certain aspects of cluster research only. Each of them gives a very comprehensive and useful introduction to selected topics of modern cluster astronomy.

ASSOCIATIONS

Recent results and work in progress are summarized in Table 1 which is self explanatory. A certain amount of confusion still exists regarding the definition and nomenclature of associations. These problems will have to be discussed at Berkeley. At present several lists of associations have been set up; apart from the basic lists of W. W. Morgan, A. E. Whitford and A. D. Code (3) and of B. E. Markarian (4)—the latter has been used as a standard in the card catalogue of Alter, Ruprecht and Vanýsek—some new lists have been compiled recently. The most comprehensive one is due to K. H. Schmidt (5). It enumerates 62 objects within galactic longitudes 27° and 354° based upon W. A. Hiltner's (6) catalogue of early-type stars. P. N. Kholopov (7) published a revised list of T-associations containing 29 real and 12 possible T-associations and their members. Co-ordinates, diameters, and the composition of groups are given. A new classification of the objects belonging to T-associations is proposed.

Table 1—Associations

Name	Observer and reference	Photometry, method and limiting magnitude			Other data obtained, remarks
Per I	Chalonge	—	pg	—	3 dimens. class., 15 stars
	van Woerden	—	—	—	21 cm line profiles
Per II	Bappu	Hγ	pe	9	
= ζ Persei ass.	Crawford, *Ap.J.* **128,** 185, 1958.	*UBV*, Hβ	pe	6	
	Hardie, Seyfert, Grenchik *Ap.J.* **132,** 58, 1960	*UBV*	pe	11	s.t.
	Kiladze, *Bull. Abastumani Astrophys. Obs.* **24,** 35, 1959	—	—	11	r.v.
	Petrie, Odgers and Richardson	—	—	—	r.v., s.t.
Orion I	Meurers	—	—	—	p.m.
	Bappu	Hγ	pe	9	
	Haro	*UBV*	—	—	*UBV* phot. on T Tauri stars
	Crawford, *Ap.J.* **128,** 185, 1958	Hβ	pe	9	
	van Woerden	—	—	—	21 cm line profiles
	Mc Namara, *A.J.* **65,** 493, 1960	—	—	—	rotational vel. of B stars
Gem I	Hardie, Seyfert, Gulledge, *Ap.J.* **132,** 361, 1960	*UBV*	pe	11	s.t.
Pup I	Fernie, Kraft, Hiltner, *A.J.* **64,** 331, 1959	*UBV*	pg+pe	13	s.t., r.v.
Vel I	Fernie (planned)	*UBV*	pg+pe	—	
Car I	Fernie (planned)	*UBV*	pg+pe	—	
Cru I	Westerlund	—	—	—	p.e. photom. of OB stars
Sco II	Hardie (study in preparation)	—	—	—	
	van Woerden	—	—	—	21 cm line profiles
Ara-Nor	Whiteoak	*UBV*, Hβ	pe	12	s.t. and lum. (MK)

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Name	Observer and reference	Photometry, method and limiting magnitude			Other data obtained, remarks
Sco-Cen	Bappu	Hγ	pe	9	
	Bertiau, *Ap.J.* **128**, 533, 1958	—	—	8	absolute magnitudes
	Buscombe and Morris, *M.N.* **121**, 263, 1960	—	—	7	r.v., s.t., 120 OBA stars
	Crawford, *Ap.J.* **128**, 185, 1958	*UBV*, Hβ	pe	7	
	Hardie, Crawford, *A.J.* **65**, 527, 1960	*UBV*, Hβ	pe	—	phot. of brightest stars in Scorpius region
Cyg I	Barbier (under way)		pg		
Cyg II	Schulte, *Ap.J.* **128**, 41, 1958	*UBV*	pe	12	12 additional members, s.t.
	Serkowski		pe	12·5	pol., λ=450, 540
	Reddish	*UBV*	pg	15	1000 stars
	Herbig, Mendoza, *A.J.* **65**, 534, 1960	—	—	—	3 faint WR stars
Lac I	Blaauw, Delhage, Roemer (in press)	—	—	—	p.m., r.v.
	Crawford, *A.J.* **65**, 487 and 527, 1960	Hβ	pe	—	revised list of members
	Chalonge	—	pg	—	3 dimens. class., 25 stars
	Eggen, *Observatory* **78**, 149, 1958	—	—	—	reality of expanding motions
	Hardie, Seyfert, *Ap.J.* **129**, 601, 1959	*UBV*	pe	11	s.t.
	Krzeminski and Oskanjan *Acta astron.* **10** (in press)	—	pe	9	pol., λ=540
	Petrie, Odgers, Richardson	—	—	—	r.v., s.t.
Cep III	Blaauw, Hiltner, Johnson, *Ap.J.* **130**, 69, 1959	*UBV*	pe	12·5	s.t.
	Serkowski, *Acta astron.* **10** (in press)	—	pg	11·5	pol., λ=450
Cass V	Reddish	*UBV*	pg	13	180 stars
Cep	Blanco, Williams, *Ap.J.* **130**, 482, 1958	*UBV*	pg+pe	11	s.t., unusual reddening, new ass.
Taurus	Haro	*UBV*	—	—	*UBV*—phot. of T Tauri stars
Cas-Tau group	Petrie, *M.N.* **118**, 80, 1958	—	—	—	r.v., s.t., space mot. and lum.
Per-Cas-And	Hack, van Woerden, *B.A.N.* (in press)	—	—	—	21 cm line profiles

N. H. Dieter (**8**), in a paper on the connection of neutral hydrogen and OB-associations, lists distances and radial velocities of 35 associations. He points out that serious differences exist between the photometric distances of associations and those calculated from H I observations on the basis of the usual model of galactic rotation.

Similarly, P. Pismis (**9**) shows that the spiral arms in the solar neighbourhood as represented by 23 associations are receding from the galactic centre at the rate of 4 km/sec with respect to the Sun.

J. Sahade (**10**) gives a list of 7 clusters and 9 associations containing Wolf-Rayet stars and a second list of 5 associations connected with O *f*-stars. A. Blaauw, apart from his investigations on associations III Ceph, Sco-Cen and I Lac listed in Table 1, comments on his extensive radial velocity programme (McDonald 82-inch). Details with regard to the new spectroscopic binaries found have been communicated to the relevant commissions. The material will supplement the basis for an improved determination of the incidence of binaries among the massive stars of recent formation, as well as to a study of possible differences in this respect between different associations. A by-product will be the improved determination of the internal velocity dispersions.

The I Lac association according to Blaauw and his collaborators consists of

(*a*) the sub-group around 10 Lacerta;

(*b*) the chain-like distribution of stars extending north-east with respect to this sub-group;

(*c*) the scattered stars in the region north of the sub-group around 10 Lac and this chain.

The internal velocity dispersion is found to be small ($< \pm 3$ km/sec) in the sub-group around 10 Lac and in the chain. The latter appears to be moving away from the 10 Lac sub-group.

Special attention was given by Blaauw to the problem of the so-called run-away stars. A paper on this subject is in press. Data for 19 objects were collected. A theory has been proposed to explain the origin of these objects as a consequence of the disruption of the primary component of massive proto-binaries. Basic facts are:

(*a*) the percentage of binaries among the run-away stars is very low or zero, as contrasted to the normal O- and B-type stars, where it well exceeds 50% (including all separations);

(*b*) the percentage of run-away stars among the O-type stars is about 20% as contrasted to about 2% among the B-type stars.

P. N. Kholopov (**10a**) obtained the spectrum-luminosity diagrams for the following 10 T-associations: T Ori, S Mon, T Tau, RY Tau, UZ Tau, RW Aur, CO Ori, IC 348, R CrA and ρ Oph. The investigation shows that the RW Aurigae-type stars are mainly distributed in the spectrum-luminosity diagram above the main sequence and are, thus, sub-giants. Further, by studying the apparent and space distribution of T-associations he concluded (**10b**) that they constitute a flat system and are present in almost all groups of hot stars within 500 pc of the Sun. No principal difference between the O- and T-associations was found by the author. G. A. Manova (**10c**) revealed 32 new emission stars in the region of λ Ori cluster, apparently connected with the T-association T 4 Ori. M. V. Dolidze and M. A. Arakelian (**10d**) discovered 88 Hα-emission stars near the dark nebula ρ Ophiuchi. By comparing the data for these stars with the known T-associations the authors concluded that the discovered stars form a T-association. M. V. Dolidze (**10e**) revealed many faint stars in the regions of Cep I and II associations with H-emission lines. N. M. Artiukhina (**10f**) determined the proper motions of 20 RW Aur stars (9 to 13 mag.), half of which belong to the T-association Tauri-Aurigae. The mean distance of these stars is in good agreement with the distance of the association determined from the luminosity-spectrum diagram.

GALACTIC CLUSTERS

An attempt has been made to condense as much information on galactic clusters as possible into the following Table 2. Only those clusters which have been actively investigated since 1958 are quoted in the table. Clusters which according to our information have been 'put on programme' only, without indication of any material so far collected, have been omitted from the table, except in a few cases in which information on planned programmes seemed to be justified. Mentioning too many cluster projects was felt misleading by some astronomers in the past. Thus, a blank line in the last column of Table 2 means that work is definitely progressing. Mere projects are reported in the following text, besides other information which does not fit into Table 2.

Table 2. Galactic Clusters

NGC and type	Observer and references (see end of table)	Photometry, method and limiting magnitude			Other data obtained, remarks
103	Hardorp (11)	*UBV*	pg	17	
	Hiltner (11)	*UBV*	pe	17	
129	Arp, Sandage, Stephens *Ap.J.* **130**, 80, 1959	*UBV*	pg+pe	16	
	Franz, *A.J.* **65**, 559, 1960	—	—	—	p.m. (Yerkes 40-in.)
	Hardorp (11)	*UBV*	pg	17	
	(5)	*UBV*	pg+pe	16	
	Lavdovski (12)	—	—	—	p.m.
	Mavridis (7)	—	—	(*I*) 13·5	Search for M-, S-, C-types
136	Hardorp (11)	*UGR*	pg	17	
146	Hardorp (11)	*UGR*	pg	17	
K 14	Hardorp (11)	*UGR*	pg	17	
188	Barkhatova, *Circ.* **191**, 1958	m_{pg}, m_{pv}	pg	15·5	*m*, *C*
	v. d. Bergh (4)	—	pg	20	Luminosity function
	Mavridis (7)	—	—	(*I*) 13·5	Search for M-, S-, C-types
	Sandage (18)	*BV*	—	18	
225	(5)	*UBV*	pg+pe	16	
K 16	Hardorp (11)	*UGR*	pg	17	Perhaps no cluster
436 1–2b	Becker, Stock (3)	*UGR*	pg	15·5	
	v. d. Bergh (4)	—	pg	20	Luminosity function
457 1b	v. d. Bergh (4)	—	pg	20	Luminosity function
	Franz	—	—	—	p.m. (Yerkes 40-in)
	(5)	*UBV*	pg+pe	16	
	Lavdovski (12)	—	—	—	p.m.
	Pesch, *Ap.J.* **130**, 764, 1959	*UBV*	pe	14	
559	v. d. Bergh (4)	—	pg	20	Luminosity function
	Kruspan (13)	*UGR*	pg	17	Provisional zero point
581 1–2b =M 103	v. d. Bergh (4)	—	pg	20	Luminosity function
	(5)	*UBV*	pg+pe	16	
	Kruspan (13)	*UGR*	pg	16·5	Provisional zero point
	Lavdovski (12)	—	—	—	p.m.
	Oja	*BVR*	pg	—	p.m. of 1000 stars
Tr 1	v. d. Bergh (4)	—	pg	20	Luminosity function
	Kharadze, Bartaya, *Circ.* **192**, 11, 1958	—	—	12	Spectra
	Kruspan (13)	*UGR*	pg	17	
637	Kruspan (13)	*UGR*	pg	16	
654	Hopmann-Haidrich	—	—	—	p.m.
	(5)	*UBV*	pg+pe	16	
	Pesch, *A.J.* **65**, 577, 1960	*UBV*	pe	—	
659	Hopmann, Haidrich	—	—	—	p.m.
	Kruspan (13)	*UGR*	pg	17	
663 1b	v. d. Bergh (4)	—	pg	20	Luminosity function
	Hopmann, Haidrich, *Mitt. Wien* **10**, 129, 1959	—	—	14	p.m.
	(5)	*UBV*	pg+pe	16	
Stock 2	Krzeminski and Serkowski	—	pe	12	pol., $\lambda = 540$
	Krzeminski and Serkowski	*UBV*	pe	14	

NGC and type	Observer and references (see end of table)	Photometry, method and limiting magnitude			Other data obtained, remarks
Stock 2	Larsson-Leander and Serkowski (19)	—	pe	11	pol.
744	(5)	*UBV*	pg+pe	16	
752 2f	Burbidge, Burbidge, *Ap.J.* **129**, 513, 1959	—	—	11	s.t. of red giants
	Lavdovski (12)	—	—	—	p.m.
	Mavridis (7)	—	—	(*I*) 13·5	Search for S-, M-, C-types
869 1b	Walker	*UBV*	pg+pe	19	Faint T Tau, RW Aur stars
869 1–2b	Bappu	Hγ	pe	9	
884 =*h*+χPer	Lavdovski (12)	—	—	—	p.m.
	Meurers, *Z. Ap.* **49**, 221, 1960	—	—	10	Exp. of surrounding groups
	Meurers, *Naturwiss.* **46**, 573, 1959	—	—	—	Rel. motion of *h* and χ
	Petrie, Odgers and Richardson	—	—	—	r.v., s.t.
	Serkowski	—	pe	11·5	pol., λ=540
	Wildey	*UBV*	pg+pe	18	Individual reddening for supergiants, main sequence in contracting region
IC 1805 1–20	(5)	*UBV*	pg+pe	16	
	Kirillova, *A.Zh.* **37**, 327, 1960	m_{pg}, m_{pv}	pg	17	Distribution in *m–C*
	Underhill	—	—	10	r.v., s.t. of 17 stars
	Vasilevskis, Balz	—	—	13·5	p.m.
	Walker	*UBV*	pg+pe	16	Faint T Tau, RW Aur stars
957	(5)	*UBV*	pg+pe	16	
	Larsson-Leander	*BV*	pe	16·5	+s.t.
Tr 2	(5)	*UBV*	pg+pe	16	
1027 1–2b	(5)	*UBV*	pg+pe	16	
1039 1b–a	Becker and Stock (3)	*UGR*	pg	14	
	Mathews (6)	*V*	pg	13	
IC 1848	(5)	*UBV*	pg+pe	16	
1245	(5)	*UBV*	pg+pe	16	
αPer cl.=	Bappu	Hγ	pe	9	
Per mov. cl.	Crawford, *Ap.J.* **128**, 185, 1958	Hβ	pe	8	
	Heckmann and Lübeck, *Z. Ap.* **45**, 243, 1958	*UBR*	pg	12	
	Mitchell, *Ap.J.* **132**, 68, 1960	*UBV*	pe	12	
	Mitchell, *P.A.S.P.* **69**, 392, 1957	*BV*	pe	12	
1342	(5)	*UBV*	pg+pe	16	
IC 348	Walker	—	—	—	Faint T Tau, RW Aur stars
Pleiades=1b	Bappu	Hγ	pe	9	
M 45	Mavridis (9)	—	—	13	Mass to luminosity
	Pels	—	—	12	p.m.
				14·5	p.m. in selected fields
	Walker	—	—	—	Faint T Tau, RW Aur stars

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NGC and type	Observer and references (see end of table)	Photometry, method and limiting magnitude			Other data obtained, remarks
M 45	Abt, *Ap.J.* **128**, 139, 1958	—	—	—	Spectroscopic binary HD 23642
	Chalonge	—	pg	—	3-dimens, classif., 18 stars
	Johnson and Mitchell, *Ap.J.* **128**, 31, 1958	*UBV*	pg+pe	16	
1444	(5)	*UBV*	pg+pe	16	
1502 1b	Becker and Purgathofer	*UBV*	pg+pe	14	
	Hopmann, Haidrich, *Mitt. Wien* **9**, 181, 1958	—	—	13·3	p.m., 146 stars
	(5)	*UBV*	pg+pe	16	
1513	Barkhatova, Driakhlushina, *A.Zh.* **37**, 332, 1960	m_{pg}, m_{pv}	pg	16·5	
	Becker and Stock (3)	*UGR*	pg	14·5	
	Bronnikova (20), **72**, 77, 1958	—	—	15	p.m., 664 stars
1528 1–2b–a	Becker and Stock (3)	*UGR*	pg	14	
	(5)	*UBV*	pg+pe	16	
	Larsson-Leander	*BV*	pe	16·5	s.t.
	Mathews (6)	*V*	pg	13	
IC 361	v. d. Bergh (4)	—	pg	20	Luminosity function
1545	(5)	*UBV*	pg+pe	16	
Hyades	Mavridis (9)	—	—	10	Mass to luminosity
	Treanor, *M.N.* (in press)	—	—	—	Rotational velocities
	Pels	—	—	12	p.m.
				14·5	p.m. in selected fields
	Ruprecht (21)	—	—	—	Dynamics, structure, age
	Perraud	—	—	—	r.v., with objective prism some plates taken
	Eggen, *Obs.* **77**, 229, 1957, **79**, 143, 1959 *M.N.* **118**, 65, 1958	—	—	12	New members of moving cluster
	Fernie, *M.N.A.S.S.A.* **19**, 94, 195	—	—	—	Convergent point
1582	Barkhatova (22)	m_{pg}, m_{pv}	pg	16	*m*, *C*
1605	Barkhatova, Tchentsov, *A.Zh.* **37**, no. 5, 1960	m_{pg}, m_{pv}	pg	17	
1647 1b–a	(5)	*UBV*	pg+pe	16	
	Roberts, Weaver, *A.J.* **65**, 529, 1960	—	—	—	Luminosity function
1662 2a	(5)	*UBV*	pg+pe	16	
1664	Barkhatova, Driakhlushina, *A.Zh.* **35**, 491, 1958	m_{pg}, m_{pv}	pg	15·5	
	Becker and Purgathofer	*UBV*	pg+pe	17	
	(5)	*UBV*	pg+pe	16	
1778	(5)	*UBV*	pg+pe	16	
1807 2a	Becker and Purgathofer	*UBV*	pg+pe	14	
1817	Becker and Purgathofer	*UBV*	pg+pe	14	
1893	(5)	*UBV*	pg+pe	16	
1907	Becker and Purgathofer	*UBV*	pg+pe	16·5	
	v. d. Bergh (4)	—	pg	20	Luminosity function
	(5)	*UBV*	pg+pe	16	
	Lavdovski (12)	—	—	—	p.m.

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NGC and type	Observer and references (see end of table)	Photometry, method and limiting magnitude			Other data obtained, remarks
1912 2b–a	Becker and Stock (3)	*UGR*	pg	15	
	(5)	*UBV*	pg+pe	16	
=M 38	Lavdovski (12)	—	—	—	p.m.
	Mathews (6)	*V*	pg	13	
1960 1b	v. d. Bergh (4)	—	pg	20	Luminosity function
=M 36	Bronnikova (20), **72**, 77, 1958	—	—	15	p.m., 1634 stars
	Meurers, *Z.Ap.* **44**, 203, 1958	—	—	10	Stellar aggregate in M 36
	Meurers, *Veröff. Bonn.* no. 49, 1958	—	—	15	p.m., 809 stars
Orion Neb.	Walker	*UBV*	pe	14	Also faint variables
	Johnson *P.A.S.P.* **73**, 147, 1961	—	—	18	Space distrib. of stars and gas
Cluster	Meurers	—	—	—	p.m.
	Strand, *Ap.J.* **128**, 14, 1958	—	—	14	p.m., expansion
1996	Barkhatova, *A.Zh.* **35**, no. 3, 1958	m_{pg}, m_{pv}	pg	17	
2099 2a	Artiukhina, Kholopov, *A.Zh.* **35**, 524, 1958	—	—	—	Distrib. of stellar density
=M 37	Arp	*UBV*	pg+pe	—	
	v. d. Bergh (4)	—	pg	20	Luminosity function
	Bronnikova (20), **72**, 77, 1958	—	—	15	p.m., 2532 stars
	Brosterhus	*UBV*	pg	17	
	(5)	*UBV*	pg+pe	16	
2129	Becker and Stock (3)	*UGR*	pg	17	
	(5)	*UBV*	pg+pe	16	
2141	v.d. Bergh (4)	—	pg	20	Luminosity function
Tr 4	Becker and Stock (3)	*UGR*	pg	17	
2158	Arp and Cuffey	*UBV*	pg+pe	—	Cluster similar to NGC 7789
	v.d. Bergh (4)	—	pg	20	Luminosity function
2168 1–2b	(5)	*UBV*	pg+pe	16	
=M 35	Lavdovski (12)	—	—	—	p.m.
	Meurers, *Z.Ap.* **49**, 221, 1960	—	—	10	Expans. of surround. groups
	Wackernagel, *Z.Ap.* **47**, 121, 1959	*UGR*	pg	16·5	Distance
2169	Becker (2)	$U_c BV$	pe	12	
	Grubissich, *Z.Ap.* **47**, 24, 1959	*UGR*	pg	16	
	(5)	*UBV*	pg+pe	16	
	Krzeminski, *Acta astr.* **10** (in press)	—	pe	11	pol., $\lambda=540$
2175	Kirillova (14)	m_{pg}, m_{pv}	pg	17	Distribution in $m-C$
2194	v.d. Bergh (4)	—	pg	20	Luminosity function
2215	Becker (2)	$U_c BV$	pg+pe	14	
2243	v.d. Bergh, *Z.Ap.* **46**, 176, 1958	—	—	—	Brightest stars: old cluster
2244 1–2o	Chalonge	—	pg	—	3-dimens. classif., 12 stars
	Grigorian, Smak (in press)	—	pe	—	pol.
	Kirillova (14)	m_{pg}, m_{pv}	pg	17	Distribution in $m-C$
	Lodén	—	pe	—	pol.

NGC and type	Observer and references (see end of table)	Photometry, method and limiting magnitude			Other data obtained, remarks
2244 1–20	Lodén	m_{pg}	pg	12·5	s.t.
	van Schewick (15)	—	—	14	p.m., 161 stars
	Walker	*UBV*	pg+pe	16	
2251	(5)	*UBV*	pg+pe	16	
2252	van Schewick (15)	—	—	14	p.m., 33 stars
Anon (CV Mon)	Arp, *Ap.J.* **131**, 322 1960	*UBV*	pe	18	
2264 1 0	Bappu	Hγ	pe	9	
(S Mon)	Underhill	—	—	10·8	r.v., s.t. of 25 stars
	Underhill, *Ap.J.* **131**, 524, 1960	—	—	—	Contracting F and G stars
	Uranova, *Stern. Ann.* **29**, 71, 1958	m_{pg}, m_{pv}	pg	17	
	Vasilevskis, Balz	—	—	16	p.m.
	Walker	—	—	—	Faint T Tau, RW Aur stars
2281 1 a	Vasilevskis, Balz, *A.J.* **64**, 170, 1959	—	—	13·5	p.m. 127 stars
2287 2 a =M 41	(5)	*UBV*	pg+pe	16	
2301	(5)	*UBV*	pg+pe	16	
2323 1 b–a	Becker (2)	U_cBV	pg+pe	13	
= M 50	(5)	*UBV*	pg+pe	16	
2324	Becker (10)	*UBV*	pg+pe	15	
	(5)	*UBV*	pg+pe	16	
2354	Dürbeck, *Z.Ap.* **49**, 214, 1960	*UBV*	pg+pe	15·5	
2360	Becker (10)	*UBV*	pg+pe	14	
2362 1 0	Bappu	Hγ	pe	9	
	Becker (10)	*UBV*	pg+pe	15	
	v.d. Bergh (4)	—	pg	20	Luminosity function
	Walker	—	—	—	Faint T Tau, RW Aur stars
Mel 66	Eggen and Stoy	*UBV*	pg+pe	16	Intergalactic glob. clusters?
2420	Arp	*UBV*	pg+pe	—	Cluster suspected, very old
	v.d. Bergh, *Z.Ap.* **46**, 176, 1958	—	pg	20	Lumin. funct., old cluster
2422 1–2 b	(5)	*UBV*	pg+pe	16	
	Lyngå and Smyth	*UBVR*	pg	14	s.t.
	Lyngå (16)	*UBV*	pe	14	Photometric sequences
2423	Lyngå and Smyth	*UBVR*	pg+pe	—	
Ha 13	Haffner	*UBV*	pe	15	
2437 1 a	Lyngå and Smyth	*UBVR*	pg+pe	—	
	Meurers	—	—	—	p.m.
2439	Becker (1)	*UGR*	pg+pe	13·5	
2447 2 a	Becker (1)	U_cBV	pg+pe	13	
2451 1–2 b	Smyth	*UBVR*	—	—	Plates taken only
2467	Pismis	*UBV*	pg+pe	16	Plates taken only
2477	v.d. Bergh (4)	—	pg	20	Luminosity function
	Eggen and Stoy (17)	*UBV*	pg+pe	16	Contains at least one M giant
	Smyth	*UBVR*	—	—	Plates taken only
2482	Pismis	*UBV*	pg+pe	18	Plates taken only
Tr 9	Pismis	*UBV*	pg+pe	18	Plates taken only
2506	v.d. Bergh (4)	—	pg	20	Luminosity function
	Becker and Purgathofer	*UBV*	pg+pe	17	
2516 1–2 b	Becker (2)	U_cBV	pe	11	
	Stoy	—	—	—	r.v.; 3-col. mag., 15 stars

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NGC and type	Observer and references (see end of table)	Photometry, method and limiting magnitude			Other data obtained, remarks
2539 1–2a	v.d. Bergh (4)	—	pg	20	Luminosity function
	Hogg	*UBV*	pe	14	
2546 1b	Fernie	U_cBV	pg+pe	13	+cluster Cepheid
2547 1b	Fernie, *M.N.A.S.S.A.* **18**, 57, 1959; **19**, 120, 1960	U_cBV	pe	11	Star counts to $V=13$; r.v., p.m.
	Stoy	—	—	—	r.v.; 3-col. mag., 10 stars
2632 2a	Bappu	Hγ	pe	9	
= Praesepe	Bidelman, *P.A.S.P.* **68**, 318, 1956	—	—	—	s.t. of 62 stars, $V<9{\cdot}7$
	Bouvier	—	—	—	Cond. of stat. equilibrium
	McDonald	—	—	—	r.v. of 50 stars somewhat distant from the centre, 12 new members
	Markarian, Arakelian (in press)	—	—	13	Luminosity function
	Markarian, Oganesian (in press)	—	—	—	Blue dwarfs
	Mavridis (9)	—	—	15	Mass to Luminosity
	Meurers	—	—	—	p.m. in outer regions
	Treanor, *M.N.* (in press)	—	—	—	Rotational velocities
IC 2391 1b	Buscombe and Morris	—	—	—	s.t.
	Hernández and Feinstein	—	—	—	s.t., r.v. of brightest stars, 3 pe. stars
	Hogg, *P.A.S.P.* **72**, 85, 1960	*UBV*	pe	14	Very young cluster
	Lyngå (16)	*UBVR*	pg+pe	11·5	s.t., p.m.
IC 2395 1b	Lyngå (16)	*UBVR*	pg+pe	12·5	s.t. p.m.
Tr 10 1b–a	Lyngå (16)	*UBVR*	pg+pe	11	s.t., p.m.
2682 2–3a	Artiukhina, Kholopov	—	—	—	Distrib. of stellar density
= M 67	v.d. Bergh (4)	—	pg	20	Luminosity function
	Burbidge, Burbidge, *Ap.J.* **129**, 513, 1959	—	—	11·5	s.t. of 13 red giants
	Reddish, *Obs.* **78**, 255, 1958	—	—	13	Luminosity function
	Wallerstein, *P.A.S.P.* **71**, 451, 1959	—	—	—	s.t. and r.v. of Fagerholm 81, brightest main-sequence star
2818	Tifft	*UBV*	pg+pe	16	
2910	Becker (10)	*UBV*	pg+pe	14	
2925	Steinlin, *Z.Ap.* **50**, 233, 1960	U_cBV	pg+pe	13·5	
3114 2a	Lyngå (16)	*UBVR*	pg+pe	12	s.t., p.m.
3228 1–2b–a	Hogg	*UBV*	pe	13	
Westerlund 1	Westerlund	*UBVRI*	pg	14	See table 'New Clusters'
		UBV	pe	14	
IC 2581	Fernie and Ellis	U_cBV	pg+pe	13	+ poss. cluster Cepheid
	Smyth	*UBR*	—	—	Plates taken only
3293 1b	Feast, *M.N.* **118**, 618, 1958; Obs. **78**, 186, 1958	—	—	—	s.t., r.v., dep. of r.v. on mag.
	Haffner	*UBV*	pe	15	
	Smyth	*UBR*	—	—	Plates taken only
3330	Becker (2)	U_cBV	pg+pe	13·5	

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NGC and type	Observer and references (see end of table)	Photometry, method and limiting magnitude			Other data obtained, remarks
IC 2602 1–2b	Feinstein	—	—	—	r.v.
	Gollnow, Przybylski	—	—	—	r.v., s.t.
	Whiteoak	*UBV*, Hβ	pe	12	
	Whiteoak	—	—	—	s.t. (MK) and luminosity
	Wood	—	—	—	p.m.
Tr 14	Becker (10)	*UBV*	pg+pe	13	
Tr 15	Becker and Fischer	*UBR*			
Tr 16	Becker (10)	*UBV*	pg+pe	11·5	
3532 2b–a	Koelbloed, *B.A.N.* 489, 1959	U_cBV	pg+pe	11·5	p.m.
3572	Haffner and H. Schmidt	*UBV*	pg+pe	15	
Tr 18	Fernie	U_cBV	pg+pe	13	+poss. cluster Cepheid
	H. Schmidt	*UBV*	pg+pe	15	
3590	H. Schmidt	*UBV*	pg+pe	15	
IC 2714	Becker (10)	*UBV*	pg+pe	14·5	
	Tayzir	*UBV*	pg+pe	15	
3766 1b	Koelbloed	—	—	—	p.m. mat. collected only
	Smyth and Ahmed	*UBVR*	pg+pe		
IC 2944	Thackeray and Wesselink	—	—	—	Spectroscopy, photometry
IC 2948	Haffner	*UBV*	pg+pe	15	
4052	Engver	*UBV*	pg+pe	15	
	Westerlund	—	—	—	Contains one Be star
4103	Becker (1)	U_cBV	pg+pe	13·5	
4349	Fernie	U_cBV	pg+pe	13	+cluster Cepheids
	Haffner and Lohmann	*UBV*	pg+pe	15	
	Tifft	*UBV*	pg+pe	16	
Mel 111	Bappu	Hγ	pe	9	
=Coma	Stephenson, *A.J.* **65**, 56, 1960; *Sky Tel.* **19**, 339, 1960; *P.A.S.P.* **72**, 42, 1960	—	pg	17	Search for white dwarfs
4609	Rodgers, *M.N.* **120**, 165, 1960	*UBV*	pe	14	
4755 1–2b	Arp, Van Sant, *A.J.* **63**, 341, 1958	U_cBV	pg+pe	14	+distance 830 pc
	Bidelman, *P.A.S.P.* **72**, 1960	—	—	—	s.t. distance 2100 pc
	Feast	—	—	—	s.t. and r.v.
	Hernández	—	—	—	r.v.
	Hogg	*UBV*	pg+pe	17	
	Koelbloed	—	—	—	p.m., Plates taken only
	Westerlund	—	—	—	2 Be stars in cluster, 2 Be stars immediately outside
4852	(Boyden)	*UBV*	pg+pe	15	Material collected only
	Westerlund	*UBV*	pe	14	3 emission stars in region
		UBVRI	pg	14	
Stock 16	Westerlund	—	—	—	WR star in region
5281	Hogg	*UBV*	pe	14	
	Smyth	*UBR*	—	—	Plates taken only
5316 1–2b–a	Rahim	*UBV*	pg+pe	15	
5460 1–2b–a	(Boyden)	*UBV*	pg+pe	15	Material collected only
5470	Eggen	*UBV*	pe	15	A very young cluster
5617 2a	Haug	*UBV*	pg+pe	15	

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NGC and type	Observer and references (see end of table)	Photometry, method and limiting magnitude			Other data obtained, remarks
Cr 285 =UMa mov. cl.	Meadows	—	—	—	rot. vel. of A0–A7 stars
5666	Haug	*UBV*	pg+pe	15	
Anon (Hogg)	Hogg, *Obs.* (in press)	*UBV*	pg+pe	15	See 'New Clusters'
5822 1–2b–a	Haffner	*UBV*	pe	15	
	Smyth	*UBR*	pg	15	
5823	Haffner	*UBV*	pe	15	
	Smyth	*UBR*	pg	15	
5925	(Boyden)	*UBV*	pg+pe	15	Material collected only
6025 1b	Hogg	*UBV*	pg+pe	14	
	Wood	—	—	—	p.m.
6031	Hogg	*UBV*	pg	15	
6067	Haffner and Engver	*UBV*	pg+pe	15	
	Thackeray and Wesselink	—	—	—	Spectroscopy, photometry
6087 1–2b	Fernie, *Ap.J.* (in press)	U_cBV	pg+pe	13	+S Nor
	Irwin, *A.J.* **63**, 197, 1958	*UBV*	pe	14	+S Nor
6124 2b–a	Haffner	*UBV*	pg+pe	15	
	Koelbloed, *B.A.N.* 489 1959	U_cBV	pe	12	
6134	Haffner	*UBV*	pe	15	
	Smyth	*UBR*	pg	15	
6152	(Boyden)	*UBV*	pg+pe	15	Material collected only
6167	Haffner	*UBV*	pe	15	
	Smyth	*UBR*	pg	15	
6193	Westerlund	*UBV*	pe	14	
		UBVI	pg	14	
Anon (Westerlund 2)	Westerlund			19·3	Preliminary investigation (see 'New Clusters')
6242 1–2b	Haffner	*UBV*	pg+pe	15	
6322 1b	Haffner	*UBV*	pg+pe	15	
6383	Eggen (17)	*UBV*	pe	13·5	Young cluster, 2 eclipsing binaries, V 701 and V 702 Sco
6405 1–2b	Eggen	*UBV*	pe	15·5	
	Stoy (17)	*BV*	pg	—	Contains the long-period super-giant var. BM Sco
	Rohlfs, Schrick, Stock, *Z.Ap.* **47**, 15, 1959	*UBV*	pe	5	s.t.
IC 4665 1–2b	McCarthy	*BV*	pg+pe	—	Faint variables
	Vasilevskis, Balz	—	—	13·5	p.m.
6469	Johnson, *A.J.* **65**, 577, 1960	*UBV*	pe	—	
6475 1b	Buscombe and Morris	—	—	—	s.t.
	(5)	*UBV*	pg+pe	16	
	Koelbloed, *B.A.N.* 489, 1959	U_cBV	pg+pe	11·5	
6494 2a	(5)	*UBV*	pg+pe	16	
6530 10	Pik Sin The, *Ap.J.* **132**, 40, 1960; *A.J.* **65**, 57, 1960	—	—	16	Study of foreground stars
	Walker	—	—	—	Faint T Tau, RW Aur stars
	Blanco and Grant, *P.A.S.P.* **71**, 194, 1959	*VI*	pg	16	*C* and s.t. of red giants

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NGC and type	Observer and references (see end of table)	Photometry, method and limiting magnitude			Other data obtained, remarks
6531 1b	(5)	*UBV*	pg+pe	16	
6604	Kharadze, Bartaya, *Circ.* 192, 11, 1958	—	—	12	Spectra
6611 10	(5)	*UBV*	pg+pe	16	
	Walker, *Ap.J.* (in press)	*UBV*	pg+pe	16·7	Faint T Tau, RW Aur stars
6618	Kirillova (14)	m_{pg}, m_{pv}	pg	16	Distribution in $m-C$
6633 1–2b–a	Hiltner, Iriarte, Johnson, *Ap.J.* **127**, 539, 1958	*UBV*	pe	15	
	Mathews (6)	*V*	pg	13	
	Vasilevskis, Klemola, Preston, *A.J.* **63**, 387, 1958	—	—	13·5	p.m. 207 stars
6639	Johnson, *A.J.* **65**, 577, 1960	*UBV*	pe	—	
IC 4725 2b	Irwin, *A.J.* **63**, 197, 1958	*UBV*	pe	14	+ *U* Sgr
= M 25	Mavridis (7)	—	—	(*I*) 13·5	Search for S, M, C types
	Serkowski	—	pe	12	pol. λ=450, 540
	Wallerstein, *Ap.J.* **132**, 37, 1960	—	—	—	r.v. of brightest stars
6664	Arp, *Ap.J.* **128**, 166, 1958	*UBV*	pg+pe	17	
Tr 34	Becker and Stock (3)	*UGR*	pg	15·5	No cluster
Tr 35	(5)	*UBV*	pg+pe	16	
6694 1–2b–a	(5)	*UBV*	pg+pe	16	
	Becker and Stock (3)	*UGR*	pg	16	
6705 2b–a	Becker and Stock (3)	*UGR*	pg	16·5	
= M 11	Bronnikova, (20), **72**, 77, 1958	—	—	15	p.m., 1097 stars
	Bidelman and Walker, *P.A.S.P.* **72**, 50, 1960	—	—	—	s.t. of 2 red giants
	Burbidge, Burbidge *Ap.J.* **129**, 513, 1959	—	—	—	s.t. of 1 red giant
	Mavridis (7)	—	—	(*I*) 13·5	Search for S, M, C types
6709 1–2b–a	(5)	*UBV*	pg+pe	16	
	Mathews (6)	*V*	pg	13	
6755	(5)	*UBV*	pg+pe	16	
	Mathews (6)	*V*	pg	13	
Cr 399	Hopmann, Haidrich	—	—	—	p.m.
6802	(5)	*UBV*	pg+pe	16	
6823	Grubissich, *Z.Ap.* **50**, 14, 1960	*UGR*	pg+pe	15	
	(5)	*UBV*	pg+pe	16	
	Mathews (6)	*V*	pg	13	
	Serkowski	—	pe	12	pol., λ=450, 540
	Walker	*UBV*	pg+pe	16	Material collected only
6830	Grubissich, *Z.Ap.* **50**, 14, 1960	*UGR*	pg+pe	15	
	(5)	*UBV*	pg+pe	16	
6834	(5)	*UBV*	pg+pe	16	
Mel 227 2a	Hogg	*UBV*	pg+pe	14	
6866 2a	(5)	*UBV*	pg+pe	16	
6871 10	Becker and Purgathofer	*UGR*	pg+pe	15	
	(5)	*UBV*	pg+pe	16	
	Mathews (6)	*V*	pg	13	

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NGC and type	Observer and references (see end of table)	Photometry, method and limiting magnitude			Other data obtained, remarks
	Serkowski	—	pe	12	pol., $\lambda = 450$, 540
6882 1–2b–a	(5)	*UBV*	pg+pe	16	
	Mathews (6)	*V*	pg	13	
6883	Becker and Purgathofer	*UGR*			
	Lavdovski (12)	—	—	—	p.m.
	Mathews (6)	*V*	pg	13	
6885 2–3a	(5)	*UBV*	pg+pe	16	
	Lavdovski (12)	—	—	—	p.m.
	Mathews (6)	*V*	pg	13	
	Meurers, *Veröff. Bonn.* no. 49 1958	—	—	13	p.m., physical cluster?
IC 4996 1b	Becker and Purgathofer	*UGR*	pg+pe	14	
	Hopmann, Haidrich, *Mitt. Wien* **9**, no. 57	—	—	—	p.m.
	(5)	*UBV*	pg+pe	16	
	Underhill	—	—	12	r.v., s.t. of 8 stars
	Walker	*UBV*	pg+pe	16	Material collected only
6910	(5)	*UBV*	pg+pe	16	
	Mathews (6)	*V*	pg	13	
	Tifft, *A.J.* **63**, 127, 1958	*UBR*	pg+pe	14·5	
	Underhill	—	—	11·4	r.v., s.t. of 7 stars
	Walker	*UBV*	pg+pe	16	Material collected only
6913 1b	(5)	*UBV*	pg+pe	16	
	Kharadze, Bartaya, *Circ*, 192, 11, 1958	—	—	12	Spectra
	Tifft, *A.J.* **63**, 127, 1958	*UBR*	pg+pe	14·5	
6939 3a	Meurers, Scharf, *Veröff. Bonn.* no. 48, 1957	—	—	15·5	p.m., 739 stars
	M. Schmidt	*UBV*	pg+pe	18	
6940 2a	Arp	*UBV*	pg+pe	—	
	Grigorjeva, *A.Zh.* **35**, 936, 1958	m_{pg}, m_{pv}	pg	14·5	
	(5)	*UBV*	pg+pe	16	
	Larsson-Leander, *Stockh. Ann.* **20**, no. 9, 1960	*BV*	—	16	s.t.
	Vasilevskis, Rach, *A.J.* **62**, 175, 1957	—	—	13·5	p.m.
	Walker, *Ap.J.* **128**, 562, 1958	*UBV*	pe	13	
Barkhatova 1	Barkhatova, *A.Zh.* **35**, 448, 1958	m_{pg}, m_{pv}	pg	15	
6996	Barkatova, *A.Zh.* **35**, 448, 1958	m_{pg}, m_{pv}	pg	15	
7023	Walker	—	—	—	Faint T Tau, RW Aur stars
Cr 428	Barkhatova, *A.Zh.* **35**, 448, 1958	m_{pg}, m_{pv}	pg	15	
7031	(5)	*UBV*	pg+pe	16	
IC 1369	Dibai, *A.Zh.* **35**, 938, 1958	m_{pg}, m_{pv}	—	17·5	
7062	(5)	*UBV*	pg+pe	16	
7063	(5)	*UBV*	pg+pe	16	
7067	(5)	*UBV*	pg+pe	16	
7086	(5)	*UBV*	pg+pe	16	
7092 1a	Chalonge	—	pg	—	3-dimens. classif., 8 stars

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7092 1a	Lavdovski (12)	—	—	—	p.m.
= M 39	Meadows	—	—	—	Rot. vel. (for A 0–A 7)
	van Schewick, *Veröff. Bonn.* no. 47, 1957	—	—	13·2	p.m., 151 stars
IC 1396 1–2o	Kirillova (14)	m_{pg}, m_{pv}	pg	17	Distribution in m − C
7128	(5)	*UBV*	pg + pe	16	
7142	(5)	*UBV*	pg + pe	16	
IC 5146	Walker, *Ap.J.* **130**, 57, 1959	*UBV*	pg + pe	17	Faint T Tau, RW Aur stars
7160	(5)	*UBV*	pg + pe	16	
7209 1–2a	(5)	*UBV*	pg + pe	16	
	Lavdovski (12)	—	—	—	p.m.
IC 1434	Larsson-Leander	*BV*	pe	16·5	+ s.t.
7235	(5)	*UBV*	pg + pe	16	
7243 1b	Mathews (6)	*V*	pg	13	
	van Schewick, *Veröff. Bonn.* no. 47, 1957	—	—	13·2	p.m., 133 stars
7261	(5)	*UBV*	pg + pe	16	
7380 1b	(5)	*UBV*	pg + pe	16	
	Mathews (6)	*V*	pg	13	
	Underhill	—	—	11·4	r.v., s.t. of 7 stars
7510	(5)	*UBV*	pg + pe	16	
	Mathews (6)	*V*	pg	13	
7654 1b–a	(5)	*UBV*	pg + pe	16	
	Pesch, *A.J.* **65**, 577, 1960	*UBV*	pe	—	
7686	(5)	*UBV*	pg + pe	16	
7788	Becker and Fischer	*UBR*			
	Franz, *A.J.* **65**, 559, 1960	—	—	—	p.m. (Yerkes 40-in)
	Mathews (6)	*V*	pg	13	
7789 2–3a	v.d. Bergh (4)	—	pg	20	Luminosity function
	Bidelman and Walker, *P.A.S.P.* **72**. 50, 1960	—	—	—	s.t. of 1 red giant
	Burbidge, Burbidge, *Ap.J.* **129**, 513, 1959	—	—	11	s.t. of 4 red giants
	Burbidge E. N. and Sandage *Ap.J.* **128**, 174, 1958	*UBV*	pg + pe	16·5	
	Mavridis (7), (8)	—	—	—	Membership of M, S, C stars
	Ozsvath (23)	*UGR*	pg	16	Luminosity function
	Reddish, *Liège coll.*, 1959, 113	—	—	—	Small amplitude variables
	Rohlfs	—	—	—	Mass of red giants
	Weber, *Astronomie* **72**, 80, 1958	—	—	—	1 var. (Küstner no. 468)
7790	Mavridis (8)	—	—	—	Membership of 1 M3 star
	Franz, *A.J.* **65**, 559, 1960	—	—	—	p.m. (Yerkes 40-in)
Blanco	Bidelman	—	—	—	s.t. of all HD stars < A2
	Westerlund	*UBV*	pg + pe	—	

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Abbreviations and References

The following abbreviations are used.

p.m. = proper motions	pol. = polarization
s.t. = spectral types	pe = photo-electric
r.v. = radial velocities	pg = photographic

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18. Quoted by O. Struve, *Sky and Telesc.* **20,** 142, 1960.
19. *Ark. Astr.* **2,** 295, 1959 = *Stockholm Medd.* no. 113.
20. *Publ. Pulkovo Obs.* II.
21. *Publ. astr. Inst. Czech. Acad. Sci.* 37, 1959.
22. *Scientific Notes of the Ural State University* no. 22, 1958.
23. *Abh. d. Hamburger Sternwarte* V No. 6, 1960.

In addition the following abbreviations are used:

Circ. = *Astronomical Circulars, U.S.S.R.*
Mitt. Wien. = *Mitt. Univ. Sternw. Wien.*
Veröff-Bonn. = *Veröff. Sternw. Bonn.*

New galactic clusters

By application of modern telescopes and techniques the number of known galactic clusters has been considerably increased. The new objects belong to two different groups:

1. Spectral clusters of medium or even large diameter discovered on objective prism plates. C. Roslund (**11**) announces 7 such clusters. C. B. Stephenson (**12**) described a possibly new galactic cluster involving δ Lyr.

2. Faint clusters with small diameters, discovered on Palomar 48-inch plates or on plates taken with other far-reaching telescopes. The largest list of such clusters is due to J. Ruprecht (**13**) who found 147 southern clusters brighter than magnitude 15 on 152 Boyden Metcalf plates covering the southern Milky Way, with declination less than $-15°$. A search for galactic clusters based on the Palomar Observatory Sky Survey was undertaken by A. F. Setteducati and H. F. Weaver (**14**); 91 new clusters were found. 46 of these are regarded as obvious and 45 as probable clusters. Furthermore, 42 NGC and IC objects not included in recent catalogues of clusters have been tentatively identified as clusters. The publication contains blue and red

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photographs (×8 enlargements of the Palomar prints) of the new clusters and some others which were recently discovered. P. Pismis (**15**) published a list of 23 small galactic (No. 9 should be crossed out) and two very faint globular clusters.

S. G. Iskudarian (**16**) discovered five new clusters on Palomar Sky Survey maps:

No.	h m	° ′
7	6 54·9	+8 22 (1950)
8	6 55·4	+6 30
9	6 55·1	+3 17
10	6 49·6	+3 00
11	6 48·6	+5 50

Westerlund is working, *inter alia*, on two anonymous clusters, at positions $10^h\ 23^m$, 57° 30′ (1950) and $16^h\ 45^m{\cdot}3$, 45° 46′·3 (1950). The latter is highly reddened. It does not show any star brighter than $V=14{\cdot}5$ mag. and no star appears on blue plates reaching $B=19$ mag. On infra-red plates the brightest stars appear to be of about $I=10$ mag. The total visual absorption averages about 11 mag. There are about 80 stars in the cluster brighter than $V=19{\cdot}3$ mag.; the cluster diameter is 2′. As all the stars measured so far appear to have the same colour, $V-I=+4{\cdot}5$ mag., it seems likely that we have here a very young cluster, possibly well embedded in dust.

Hogg reported on photometric work on an anonymous cluster near $14^h\ 47^m{\cdot}2$, −52°03′ (1950) in a region of 8′ diameter around HD 130 534 (B 3). The distance of the cluster is estimated to be 1050 pc, the number of members brighter than 17·5 mag. being 51.

Luminous and variable stars

The possible membership of bright luminous and of variable stars in galactic clusters has attracted much attention in recent years. The field of research may be divided into four sections: I a and I b stars of intermediate and late spectral type, S- and C-type stars, Cepheids, and other variables.

(*a*) Th. Schmidt (private communication) has searched for coincidences of F I to K I stars and galactic clusters in the same way as J. B. Irwin and R. P. Kraft did for Cepheids several years ago. He sub-divided his list into three sections according to the apparent distance d from the cluster centre (diameter a):

I. $d<a$	HD	7927	NGC 457	F 0 Ia ζ Cas	
		10494	NGC 654	F 5 Ia	
		20902	III Per	F 5 Ib α Per	
		50877	Cr 121	K 3 Iab	
		62058	NGC 2439	G 0 Ia	
		90772	IC 2581	F 0 Ia	
		97534	NGC 3572	F 0 Iap	
		A	NGC 129	F 5 Ib	*Ap.J.* **130,** 80
		B	NGC 6664	K 3 II	*Ap.J.* **128,** 162
		C	NGC 6664	G 8 II	
II. $d<2a$		12399	Stock 5	G 5 Ia	
		49068	NGC 2287	K0 Ib	
		+60°·2532	NGC 7654	F 7 Ib	
		AA	NGC 129	K 2 Ib	*Ap.J.* **130,** 80
		AB	NGC 129	M 0 IIp Ib	*Ap.J.* **128,** 163

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III. $d<3a$	17971	IC 1848	F 5 Ia
	59067	NGC 2396	G 8 Ib-II
	101947	IC 2944	G o Ia
	187299	Rosl. 2	G 5 Iab

(*b*) L. N. Mavridis (**17**), in collaboration with J. J. Nassau, has started a programme which aims at the discovery of M-, S- and C-stars connected with NGC 129, IC 4725, NGC 7790, NGC 188, NGC 752, M 11, NGC 7789. As a first result he describes two M-stars (M 1, II-III, $M_v = -1{\cdot}2$ and M 5, $M_v = +2{\cdot}3$) near NGC 7789 and one C-star near NGC 7790 as possible members of these clusters. Further tests of membership are badly needed.

At Warner and Swasey Observatory (**18**) objective prism plates are being examined for identification of previously unkown clusters around known M-type giants. Such clusters presumably would be old and, hence, possibly quite loose and hard to detect. The M-type giants may be considered as possible tracers for locating old clusters.

(*c*) The physical membership in galactic clusters of 6 Cepheids has been established since 1958 by Arp, Feast, Irwin, Johnson, Kraft, Sandage, and Stephenson. A few other cases are still questionable. These stars are summarized in the report of Sub-Commission 27*b*.

(*d*) A list of 26 eclipsing binaries, possibly belonging to galactic clusters on account of probability reasons, is given by R. P. Kraft and A. U. Landolt (**19**). The number of eclipsing binaries which are in optical coincidence with OB-associations is extremely large ($\sim$600). Due to incomplete data on both the eclipsing binaries and the associations it is impossible to ascertain the physical connection of these objects.

Stellar clusters may also contribute to the problem of evolution of W UMa-stars. Having this in view J. Sahade and H. Frieboes (**20**) investigated W UMa-stars possibly belonging to clusters. A list of 16 such variables has been set up, but in all but two cases the membership of clusters has still to be proved.

Proper motions

In recent years more and more observatories have started active work on proper motions in galactic clusters by taking second-epoch plates and measuring them together with early plates. These endeavours, it is true, are very tedious and, in respect of the probable errors of the final proper motions, perhaps do not pay in all cases. But, on the other hand, further data on proper motions are so important for detailed studies of many clusters that any reasonable effort in this field is very welcome. Hence, a special summary on present proper-motion work in clusters appears justified.

N. M. Bronnikova (**21**) has published absolute proper motions for 664 stars in NGC 1513, 1634 stars in NGC 1960, 2532 stars in NGC 2099, and 1097 stars in NGC 6705, limiting magnitude = 15. The proper motions are based on pairs of plates (average difference of epochs 53 years) taken with the Pulkovo normal astrograph.

The same instrument has been used by V. V. Lavdovski (**22**). He prepared for printing the catalogue of photographic magnitudes and proper motions of 14 165 stars in 13 clusters (see Table 2) NGC 129, 457, 581, 752, 869, 884, 1907, 1912, 2168, 6883, 6885, 7092, and 7209 and their surroundings. Systematic photography of the first epochs of numerous clusters was started in Pulkovo by means of the normal astrograph and the 26-inch reflector.

N. E. Wagman has compiled a draft copy of a catalogue of cluster plates taken at Allegheny Observatory. Data concerning dates, exposure times, centre of plates, image quality, and limiting magnitude are given for over 100 clusters. This information will be supplied on request and early plates will be duplicated for anyone who wishes to measure motions.

Duplication of early plates of 26 clusters listed in the Moscow report (**23**) is being continued by the Allegheny observers. Allegheny plates have been measured by S. Vasilevskis and his collaborators up to 13·5 mag. for NGC 2281 and 6633 (published in the *Astronomical Journal*, see Table 2) and for NGC 2264, IC 1805 and 4665 (in progress, see Table 2).

S. Vasilevskis (**24**) has nearly completed the first-epoch plates of galactic clusters in the series begun five years ago with the Lick 20-inch Carnegie astrograph.

For the proper-motion work carried out at the U.S. Naval Observatory over many years the list given in the Moscow report should be consulted (**23**). At Tonantzintla a proper-motion programme has been started by P. Pismis. The list of clusters comprises NGC 2345, 2353, 2360, 2374, 2396, 2422, 2423, 2437, and 2539. First-epoch plates had been taken between 1902 and 1912. The taking of second-epoch plates has started in 1960 and 1961.

By repeating old Küstner plates at Bonn ($f = 513$ cm), J. Meurers and H. van Schewick (**25**) have determined proper motions in NGC 7092, 7243, 6939, 6885, 1960, 2244, and 2252. Other clusters (NGC 457, 654, 663, 1528, 1912, 2194, 2323, 2539, 2548, 6811, 6838, 6871, 6940, 7086, 7380, 7654) are on the programme for second-epoch plates.

At Vienna J. Hopmann and collaborators are engaged in proper-motion work on NGC 663, 1502 and IC 4996 (published, see Table 2) and on Coll. 399, NGC 654 and 659 (in progress). Astrographic-zone plates (Specola Vaticana) and plates taken with the Vienna normal astrograph are being used. F. Bertiau is partaking in the measurements of NGC 654 and 659. At the Specola Vaticana it is planned to determine proper motions for all galactic clusters situated in the Vatican astrographic zone, wherever measuring seems to be sensible.

A. K. Das (Nizamiah Observatory) plans to take second-epoch plates for NGC 1912, 2099 and 2287 (epoch differences 66, 66 and 41 years respectively) with the Hyderabad Grubb refractor ($f = 490$ cm).

From Sydney Observatory H. Wood reports on proper motion work in star clusters of the Sydney astrographic zone for which old-epoch material exists. Apart from IC 2602 and NGC 6025, on which work is in progress, the following clusters have been put on programme for measurement: NGC 3532, 3766, 4103, 4755, and 5662.

Luminosity and density function

Several authors investigated the luminosity functions of galactic clusters, because they promise to throw some light on various problems of stellar origin and evolution. The most comprehensive study of this kind is due to S. van den Bergh and D. Sher (**26**). Using the 48-inch Schmidt telescope, the luminosity functions of 20 galactic clusters (old and young ones, see Table 2) have been obtained down to $B = 20$. The authors find that striking differences exist between the main-sequence luminosity functions of individual clusters. Also it appears that the faint ends of the luminosity functions of galactic clusters differ systematically from the van Rhijn-Luyten luminosity function for field stars in the vicinity of the Sun in the sense that (with one exception) all the clusters which were investigated to faint enough limits, had luminosity functions which either decreased or remained constant below $M_{pg} = +5$. The differences between individual clusters and the differences between the luminosity functions of clusters on the one hand and field stars on the other show that the luminosity function of star creation is not unique. This result is taken to indicate that the luminosity function with which stars are created probably depends on the physical conditions prevailing in the region of star creation.

N. M. Artiukhina and P. N. Kholopov (**27**) arrived at the conclusion, on the basis of a study of stellar density distribution in the region of the double cluster h and χ Per, that the double

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nucleus (12 pc in diameter) is surrounded by an extensive halo (50 to 70 pc in diameter) the density of which is almost constant.

Photometric work

K. A. Barkhatova (**28**) published an atlas of colour luminosity diagrams for open star clusters (Moscow 1958), as was announced already at the Moscow assembly of the IAU.

H. L. Johnson and his collaborators have been working on the joint Lowell Observatory—U.S. Naval Observatory cluster programme. All 70 clusters of the final list have been observed photo-electrically and photographically in the *UBV* system, with about 30 stars observed photo-electrically and carefully tied in with the *UBV* system, and on the average 200 stars observed photographically. In general, the limiting magnitude is $V=16$, but several clusters were observed up to $V=17\cdot5$. The observational data will be published in the *Publications of the U.S. Naval Observatory*, while the discussions of the data will be published in the *Lowell Observatory Bulletins*. Both publications will be in press early in 1961.

The unusual main sequence, found by M. Walker (**29**) in clusters like NGC 2264 and 6530, has stimulated some criticism. Pik Sin The and V. M. Blanco (**30**) concluded from star counts in the surroundings of NGC 6530 that the majority of the faint 'above main sequence' stars are highly reddened background stars of early type. Similarly A. B. Underhill (**31**) criticized Walker's conclusion by referring to the incompleteness of his survey.

M. Walker (**32**) is mainly concerned in a study of faint T Tau or RW Aur variables (see Table 2). More details will be found in the report of Sub-Commission 27*b*. His observations of NGC 6611 indicate that it is younger than all the other O-star clusters investigated previously. The colour-magnitude diagram consists of a main sequence extending from O 5 to about B 5, beyond which point stars above the main sequence are encountered. The location of the turn-off point of stars from the main sequence cannot be very well established, but it appears to be near $(B\text{-}V)_0=-0\cdot17$, from which the age of the cluster is $1\cdot8\times10^6$ years. In addition, the cluster sequence for $(B\text{-}V)_0<-0\cdot27$ lies to the left of the sequence in NGC 6530 and the Orion Nebula cluster, suggesting that the brightest stars in NGC 6611 are less evolved than those in the two other clusters. The fact that the cluster sequence extends from O 5 to at least B 5 supports the theory of Schwarzschild and Härm that very massive stars remain on the main sequence until they have burned about two-thirds of their hydrogen instead of the 12% previously assumed. Like the O-star clusters studied previously, NGC 6611 contains a number of faint (presumably T Tau or RW Aur) variables.

M. Golay (Geneva) reports on his programme of a photo-electric photometry of clusters in seven wave-length regions. Three are identical with the *UBV* system, the others are at $\lambda_1=4089$ Å, $\lambda_2=4517$ Å, $\lambda_3=5420$ Å, $\lambda_4=5889$ Å. The photometric system is chosen so as to permit a calibration in Chalonge's parameters. It is intended to measure the Pleiades, Praesepe, Coma Berenice, h and χ Per within the 1960/61 season at Jungfraujoch. In addition Golay has studied in detail the relation between large-band photometric systems and Chalonge's parameters.

Th. Walraven is observing pe-magnitudes in 5 colours of southern OB-stars. In general, when stars of this programme are situated in a cluster, a number of stars in this cluster are measured, too.

B. Westerlund is carrying out an infra-red spectral survey of the southern Milky Way. Red stars that may be members of clusters will be noted. Further on, he surveyed a region of about 100 square degrees between R.A. $11^h\ 40^m$ and $13^h\ 20^m$; Dec. $-56°$ and $-66°$ for emission objects and OB-stars. About 200 emission objects and 150 OB-stars have been identified.

Photo-electric photometry is being carried out. Most of the OB-stars may belong to the Crucis association (Houck's thesis). Priority in the photometry is given to stars in or near clusters.

As a result of a comparison of the gravitation curves with the spectrum-luminosity diagram of the Pleiades cluster E. V. Kotok (**33**) arrived at the conclusion that the widening of the lower part of the diagram can be explained in terms of the compression process in stars belonging to the late spectral classes.

A systematic search for white dwarfs in the region of the Coma cluster was initiated by C. B. Stephenson (**34**). 5 bright ultra-violet stars were found on a Coma plate taken with the Cleveland Schmidt and reaching magnitude 17. Comparison plates of some nearby fields, however, revealed comparable numbers of stars. The question of membership of white dwarfs remains, therefore, undecided. The cluster turns out to be not a suitable one in which to compare theoretical and observed white-dwarf population.

B. E. Markarian and E. Oganesian (in press) discovered 28 white-blue dwarfs in the surroundings of NGC 2632 (Praesepe).

Criteria for finding old galactic clusters were described by S. van den Bergh (**35**). Using one of them, *i.e.* the intrinsic faintness of the fifth brightest cluster star together with the z co-ordinate, he finds NGC 2420 and 2243 to be probably old clusters (apart from the known cases of NGC 188 and M 67).

Although outside of the special scope of this report a paper of L. Mavridis (**36**) should be noted here because of its bearing on cluster photometry. It deals with two inter-connected problems, *i.e.* the reddening paths of early-type stars in the two-colour diagram and the intrinsic colours of O- and B-stars of different luminosity classes. The ratio E_{U-B}/E_{B-V} turns out to be nearly independent of spectral type, between 0·68 and 0·76. The latter figure is valid for a linear reddening path, the former for the maximum amount of curvature of the reddening path. By applying these results to the bright stars of the Perseus double cluster and of M 29 intrinsic values of $(U\text{-}B)$ and $(B\text{-}V)$ are determined for the range O 5 to A 0 and luminosity classes I, III and V.

Before his untimely death, C. Seyfert was engaged in studies of methods to obtain spectra of faint stars with objective-prism equipment. After experimenting with glass and liquid filters, he found the most encouraging results with a multi-layer interference filter made by Baird-Atomic. With this filter, a band between 3900 and 4000 Å was admitted with sufficient efficiency to permit obtaining spectra one magnitude fainter, before being limited by sky brightness. The technique is intended primarily for the identification of A-stars in the nearby associations.

Spectrographic work

A. Feinstein and C. Hernández (La Plata) report on spectroscopic observations of the brightest stars in IC 2391. The cluster has 2 peculiar stars: HR 3466 (Si$-\lambda$4200) and HD 74169 (metallic line). Another star HD 73340 classified by M. Jaschek and C. Jaschek (**37**) as Si$-\lambda$4200 at a distance of 2° from the centre of the cluster is quite probably a member of it. Its radial velocity is the same as that of the cluster. C. Hernández has observed, furthermore, the radial velocities of the 11 brightest stars in NGC 4755. Three of them, CPD$-59°$ 4551, $-59°$ 4564 and $-59°$ 4557, were found to be spectroscopic binaries. After accounting for a reddening of 0·44 mag. the distance turns out to be 2200 pc. This value is in disagreement with the 830 pc derived by H. Arp and C. T. van Sant (**38**).

H. Weaver reports (**39**) that the catalogue of radial velocities of galactic clusters observed by R. J. Trumpler has been completed and, except for an introductory statement, is now ready for the press.

A number of statistical studies based on Trumpler's extensive file of unpublished data on galactic clusters have been made by M. Roberts (**39**). One such study allowed a check to be made of the hypothesis that, as a result of significant mass loss, early-type stars evolve down the main sequence. The observational data do not confirm this prediction.

P. J. Treanor (**32**) is determining the rotational velocities in the Hyades, Praesepe and II Per association. He concludes that the stars of common age in a cluster also show the sudden fall in rotational velocity near type F 5 V previously found in field stars. The ratio of Be to B stars in 10 galactic clusters was compared by A. J. Meadows (**40**) with the corresponding ratio for the galaxy as a whole. It is suggested that the considerably higher abundance of Be stars in clusters (all clusters are young) is due to higher than average rotational velocities for all the B stars in clusters. In continuation of this work Meadows determined rotational velocities of 11 stars in the UMa cluster and of 18 stars in M 39 (A 0 to A 7). The average value agrees well with Treanor's values (**32, 41**) for the Hyades and Praesepe and with Slettebak's values for field stars. This work is in press. This result is contradicted by a recent paper of D. H. McNamara (**42**) who has investigated 28 B 0·5- to B 3-stars in the Orion association. He found the average value of $v \sin i$ for these stars remarkably smaller than the corresponding value for field stars of the same spectral class.

H. A. Abt (**43**) contributed to the interesting problem of the frequency of spectroscopic binaries in galactic clusters by a paper in which the spectroscopic orbit of the cluster member HD 23642—Hertzsprung no. 540, a hitherto unknown spectroscopic binary, is determined.

Stellar groups

Among the high-velocity stars several physical groups have been discovered and investigated by O. J. Eggen. One of the most interesting of these is the γ Leo group (**44**). Eggen selected 31 stars as possible members on account of their common space motion and found a typical old-cluster *C-m*-diagram. Similar groups are the Hyades group (46 members) (**45, 46, 47**), the Groombridge 1830 group (**48**), the *Sirius* group (68 members) (**46**), the ζ Her group (23 members) (**49**), the ϵ Ind group (15 members) (**49**), and the 61 Cyg group (16 members) (**49**).

Another phenomenon, intermediary between Eggen's stellar groups and multiple stars, is described by J. Hopmann (**50**). The members of what he calls 'stellar troops' are selected on account of their common proper motion. The diameters of the 'troops' are 1 to 2 parsec. So far, 6 'troops' have been discovered by Hopmann.

Space distribution of galactic clusters and associations

Extending his previous investigations (**51**) on space distribution of galactic clusters which had been based on photometric distances of 40 clusters W. Becker has now studied 85 clusters for a similar purpose. Their space distribution shows sections of three spiral arms, especially if clusters of early type are used. They have exactly the same distribution as have the H II regions and the OBA associations. There is no coincidence between the spiral arms of the galactic clusters and those of H I as determined by radio astronomy. At the Basle Observatory the determination of the distances of galactic clusters will be continued, especially with regard to clusters which, according to Trumpler, are situated between the spiral arms as delineated in the present picture of space distribution.

B. E. Markarian (**52**) investigated the distribution of 200 clusters in the galactic plane using their Trumpler distances. He found that the clusters containing O-B 2 types of stars are strongly concentrated in spiral arms. Clusters which contain only stars of types equal to or later than B 3 are distributed almost uniformly. Since the distribution of clusters is intimately inter-connected with the occurrence of H II, mention should be made here of a catalogue of H II-regions compiled by S. Sharpless (53). Positions and brief descriptions of 313 objects with declinations greater than $-27°$ are given on the basis of the *Palomar Sky Atlas*. A list of 308 early-type stars associated with these regions is also given.

GLOBULAR CLUSTERS

The most comprehensive and modern survey on observational facts regarding globular clusters has been edited by A. Sandage (54). It represents the summary of a symposium held in Toronto on 31 August 1959 with contributions from H. Sawyer Hogg, Kron and Mayall, Morgan, Thackeray, and Arp. There is no sense in reporting here on this report in full detail, but one of Mrs Sawyer Hogg's main points should be stressed, *i.e.* the physical differences that exist between any two globular clusters. Due to these differences the globular clusters form a group of cosmical objects inhomogeneous in physical parameters, perhaps even more than the galactic clusters.

Mrs Sawyer Hogg has completed the supplement to her 'Bibliography of Individual Globular Clusters' for the literature up to 1960. It is expected to be published well before the IAU meeting. The catalogue numbers 121 clusters, but this number seems to vary by one or two almost from month to month.

Table 3 lists, in a similar manner to Table 2, the globular clusters which have been photometrically studied in recent years.

Table 3. Globular Clusters

NGC	Observer and references	Photometry, method and limiting magnitude			Other data obtained, remarks
104 =47 Tuc	Feast and Thackeray *M.N.* **120**, 463, 1960	—	—	—	r.v., s.t., mass determ.
	Feast, Thackeray and Wesselink, *M.N.* **120**, 64, 1960	—	—	—	RR Lyrae stars
	Gaposchkin, *A.J.* **65**, 518, 1960	—	—	—	Luminosity function
	Tifft	*BV*	pg+pe	19·5	Soon to be published
	Wallenquist	—	—	—	Space distrib. of stars
	Westerlund	—	pg	—	Spectral class. of red giants in infra-red and red; photom. of red variables
	Wildey, *Ap.J.* (in press)	—	pg	—	*C-m* diagram
4372	Tifft	(*U*) *BV*	pg+pe		
5024=M 53	Cuffey, *Ap.J.* **128**, 219, 1958	*PV*	pg+pe	19	*C-m* diagram
5053	Johnson, *A.J.* **65**, 577, 1960	*UBV*	pe		
5139 =ω Cen	Belserene, *A.J.* **64**, 58, 1959	*BV*	pg+pe	19·5	*C-m* diagram, lum. funct.
	Eggen	3-col. phot.	pe	17·2	
	Gaposchkin, *A.J.* **65**, 518, 1960	—	—	—	Luminosity function

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NGC	Observer and references	Photometry, method and limiting magnitude			Other data obtained, remarks
= ω Cen	Wallenquist	—	—	—	Space distrib. of stars
	Woolley and Alexander	2-col. phot.	pg	—	Plates being measured
5466	Cuffey	—	—	—	Col.-mag. diagram
5904	Arp, *A.J.* **64**, 441, 1959	—	—	—	
=M 5	Arp	—	—	—	Cols., mags., main sequence
6205 =M 13	Baum, Hiltner, Johnson, Sandage, *Ap.J.* **130**, 749, 1959	*UBV*	pg+pe	22	Lower main sequence
	Markarian. See note (1)	—	—	—	Luminosity function
6229	Mayer (Prag), *B.A.C.* (in print)	—	—	—	Periods of 10 variables
6341 = M 92	Markarian. See note (1)	—	—	—	Luminosity function
6356	Arp	—	—	—	*UV*-excess, reddening in field
	Sandage and Wallerstein *Ap.J.* **131**, 598, 1960	*BV*	pg+pe	19·2	
6397	Eggen, *MNASSA* **19**, 115, 1960	*UBV*	pe	18	
	Gascoigne	*BV*	—	17	
	Woolley and Alexander	2-col. phot.	—	—	Plates being measured
6522	Arp	—	—	—	Distance to galactic centre and reddening in field
6637	Arp	—	—	—	Upper col.—mag. diagram
6656 = M 22	Arp and Melbourne *A.J.* **64**, 28, 1959	*BV*	pg+pe	15	Col.—mag. diagram
6838	Arp	—	—	—	Col.-mag. diagram, down to and including main sequence
	Cuffey	—	—	—	Col.-mag. diagram
7006	Wildey and Sandage	—	pg+pe	—	Col.-mag. diagram
7078 = M 15	Markarian. See note (1)	—	—	—	Luminosity function
7089	Arp, *A.J.* **64**, 441, 1959				
= M 2	Arp, in progress				
	Markarian. See note (1)	—	—	—	Luminosity function
7492	Cuffey	—	—	—	Col.-mag. diagram

Note (1): *Burakan Observatory Communication* **28**, 1960 (in press)

Special investigations

At Bonn J. Meurers is planning to repeat Küstner plates of globular clusters in order to determine *proper motions*. The clusters in question are NGC 4147, 5024, 5272, 5904, 6205, 6218, 6254, 6341, 6779, 6981, 7078 and 7089. The taking of the second-epoch plates has started.

Various problems of globular clusters have been treated by T. D. Kinman in several papers. After determining *radial velocities* of 30 southern globular clusters a catalogue of radial velocities of 70 southern and northern clusters was compiled (**55**). Later, Kinman (**56**) published a catalogue of integrated spectral types of clusters taken from various sources and reduced to a homogeneous system. Analysing the radial velocities (**57**) led to some important

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conclusions as to the kinematical properties of the system of globular clusters. Finally, Kinman (58, 59) deduced revised distance moduli of 75 clusters. For each cluster he gives the individual values of the moduli based upon various methods and the finally adopted mean value.

Using Kinman's revised moduli of the clusters within 15 kpc from the centre of the Galaxy, J. M. A. Danby (60) advocated H. Johnson's (61) suggestion that the Galaxy is a barred spiral, the bar being seen almost end-on, slightly preceding the Sun.

Various solutions have been given in the past for solving the problem of the determination of *space densities* of stars in stellar clusters. A brief summary of these solutions has recently been given by A. Wallenquist (62). He also describes some numerical methods which are based on studies of the areal density of stars in concentric rings or in parallel strips through the cluster region. Applying these methods Wallenquist (63) has calculated areal and space densities for 67 well-studied clusters. The distribution of the stars is used firstly to determine a homogeneous system of apparent diameters of clusters and secondly to derive a certain parameter c of concentration. From the diameters individual distances are deduced. The reliability of the c-values is proved by the fact that the concentration does not show any dependence on distance, but there is a strong tendency for intrinsically large clusters to show greater concentration. Furthermore, the degree of concentration seems to decrease with age, whereas the average space densities tend to increase with age. From this Wallenquist reaches the conclusion that younger clusters are fairly unstable systems of low densities and short life-times. Clusters with large densities are more stable systems and may therefore have long life-times. H. Wilkens (64) has found a linear relation between the *diameters* of globular clusters and their integrated magnitudes. This result is contradicted by the conclusions drawn by R. Kurth and F. Holden (65) in a note on the diameters of globular clusters. The authors find only a small correlation between linear diameters and absolute magnitudes. On the other hand, they confirm the close correlation between linear diameters and distances which had been already dealt with by W. Lohmann (66) in 1952.

The possible existence of *dark material* in globular clusters, frequently disputed in the past, has been investigated again by several authors contributing new material. Mrs Sawyer Hogg in her *Handbuch*-article describes the possible interpretations according to the facts known up to 1958. G. M. Idlis and G. M. Nikolski (67) discovered dark lanes on the Palomar charts in the central part of NGC 6121 (M 4). From star counts the authors concluded that the lanes must probably be clouds of diffuse matter. O. Struve (68) reports on unpublished work of M. S. Roberts. Roberts has prepared a list of 12 globular clusters out of 32 studied, that have one or more dark regions in them. He gives some reasons for believing that the dark matter is due to the remains of fairly massive population II stars explosively converted into white dwarfs (perhaps by super-novae processes). Finally we mention a paper of P. Hodge (69) in which he discusses absorbing material apparently present in NGC 2209, a globular cluster situated at the very border of the Large Magellanic Cloud. The nature of the object under discussion remains doubtful, but a simple projection effect of material lying far in front of the cluster does not seem impossible. R. M. Dzigvashvili (70) determined the parameters of the *velocity distribution* function of globular clusters. W. Lohmann has in press a paper on the determination of the mass of the Galaxy from radial velocities of globular clusters. B. E. Markarian (71), using the data of the six-colour photometry, determined the partial luminosity distribution (total luminosities of the individual star classes) for the globular clusters M 2, M 13, M 15, and M 92.

The problem of *inter-galactic globular clusters* is dealt with by S. van den Bergh and by E. M. Burbidge and A. Sandage. The former author (72) referring to G. Abell's (73) *Palomar Sky Survey* estimates the number of inter-galactic globular clusters within the local group (radius 500 kpc) to be of the order of 250. Thus about one third of all globular clusters would be of the inter-galactic type. E. M. Burbidge and A. Sandage (**74**) have studied two very distant globular clusters (1·2 and $1{\cdot}3 \times 10^5$ pc). The diameters (90 and 83 pc) are unusually large compared with other clusters having 10 times more population. They may be explained by small tidal forces of the Galaxy, if the clusters have never passed closer than 9 kpc to the galactic centre. Possibly the clusters are escaped members of M 31.

A new faint globular cluster, discovered by S. van den Bergh in 1958, has been briefly described and measured by H. Arp and S. van den Bergh (**75**). A modulus of $m-M \approx 20$ is suggested, which makes this object an inter-galactic cluster.

G. E. Kron and N. U. Mayall report (**32**) that their analysis of photo-electric observations of globular clusters is now completed and has been submitted for publication. In all, 187 star clusters, mostly globular, were observed, the majority of them in three colours: *P-V-I* system. Galactic and globular clusters in the Galaxy prove to be well separated on a *P-V*, *V-I* diagram. Other conclusions refer to globular clusters contained in M 31.

W. W. Morgan (**76**) continued the investigation of the properties of integrated spectra of globular clusters. A discussion of new material, added to that used earlier, resulted in the segregation of a group of 13 globular clusters of later spectral type. 10 of these are concentrated in the region of the galactic nucleus and the other 3 are located close to the galactic plane. Two globular clusters (NGC 6528 and 6533) appear to have metallic line strengths greater than any of those observed earlier. Their spectra in the green region match closely those of relatively transparent areas of the galactic nucleus and of the nuclear region of M 31.

Colours of 21 globular clusters have been measured by J. Dufay and J. H. Bigay (**77**) in Johnson's *BV* system. H. C. Johnson himself (**78**) determined integrated magnitudes and colours of 27 globular clusters in the *UBV* system. Both authors found the dispersion of the intrinsic colours to be remarkably small.

A. Sandage and G. Wallerstein (**79**) investigated the *C-m* diagram of the strong metallic-line, disk globular cluster NGC 6356. The position of the giant branch is below that of M 3 (halo, weak to normal metal lines) and well below that of M 92 (halo, very weak metal lines). From a study of 16 globular clusters the authors conclude that globular clusters with high metal-abundance have giant branches which are at least 0·8 mag. fainter than those of clusters with weak lines. This feature shows how unreliable distances are which are based on constant absolute magnitude of brightest stars in clusters.

The *C-m* diagram of 47 Tuc has been extended by R. L. Wildey (**80**, see Table 3) about one magnitude fainter than the stubby horizontal branch. There are no stars left of the RR Lyr gap. The horizontal branch is heavily populated. The absolute magnitude of the red-giant branch is fainter than that of any geometrically globular cluster published to date. Also the junction of the horizontal branch and the giant branch is redder than in any previously published cluster.

G. H. Herbig (**32**) obtained the spectrum of a relatively bright O-type star in M 3. From the radial velocity the membership of this star is beyond reasonable doubt. N. J. Woolf (**32**) has studied the relative central condensation of red giants, RR Lyr stars and blue and red horizontal branch stars in M 3. In a brief note on the population II Cepheid region in the *C-m* diagram of globular clusters G. Wallerstein (**81**) pointed out that 5 non-variable stars located in the Cepheid region of 5 globular clusters have proved to be non-members on account of both their spectra and their radial velocities. He corroborates earlier conclusions that the region of population II Cepheids (at least above $M_{pv} = -1{\cdot}0$) is a region of instability. V. C. Reddish (**82**) has corrected earlier conclusions of A. Sandage (**83**) regarding the relative position of AB-type and C-type Cepheids in the B-V, log P diagram. He showed that there is no evidence for differences in Q.

R. L. Wildey in association with Mrs E. M. Burbidge, G. R. Burbidge, and A. Sandage (**84**) has determined blanketing corrections for the Sun, 50 And, ξ Peg, and the sub-dwarf HD 19445 in order to get information necessary for constructing composite cluster C-m diagrams. The application of the corrections reduces the above group to one sequence in the two-colour diagram. The corrections were obtained by planimetry of micro-photometered spectrograms taken with the Mount Wilson reflectors.

4. DYNAMICS OF CLUSTERS

L. Spitzer jr. (**85**) investigated the effect of tidal forces of passing inter-stellar clouds on the stability of clusters. He concluded that all galactic clusters with mean densities between 0·5 and 5 solar masses per pc^3 will be completely disrupted by successive tidal disturbances in 10^8 to 10^9 years.

S. von Hoerner (**86**) approached the theory of stellar dynamics by integrating the equations of motion of a random cluster with 4, 8, 12, 16 stars. The observed relaxation times agree closely with Chandrasekhar's formula; the density and the velocity distributions show remarkable deviations from theoretical values.

I. King has systematically investigated the various processes and influences that determine the rate of escape of stars from clusters. The results have been published in a series of papers (**87**) entitled 'The Escape of Stars from Clusters'. The sub-titles are: Calculation of a centrally condensed model; A simple theory of the evolution of an isolated cluster; Expansion versus contraction in the evolution of a star cluster; The retardation of escaping stars; The basic escape rate. King is working now on the shape of a rotating cluster and the influence of tidal forces on clusters (**87a**). Another project is the determination of density distributions in 15 globular clusters. The material consists of (*a*) photo-electric surface brightnesses, (*b*) star counts on Mount Wilson and Mount Palomar reflector plates, and (*c*) star counts on 48-inch Palomar Schmidt plates.

J. Ruprecht in a paper (**88**) entitled 'Dynamics and Structure of Open Star Clusters' studied the dynamics and structure of the Hyades. He estimated the age of this cluster to be $1{\cdot}1 \times 10^9$ years.

Several papers dealing with dynamics of clusters have been published at the Astronomical Institute of the University of Ghent: H. L. Vanderlinden and F. Bossaert (**89**), Dynamics of globular clusters; R. Bouciqué (**90**), Relation between the radial distribution laws of stars of different mass in a spherical stellar system; W. Moerdyk (**91**), The age of a stellar association determined from the observed space velocities; H. L. Vanderlinden (**92**), The velocity of escape in globular clusters. Four other papers devoted to dynamical problems in galactic clusters (influence of the galactic rotation, ratio of mass and luminosity, age of clusters, escape of gas from clusters) will be published in the near future.

The gravitational contraction times of stars in very young clusters have been reconsidered by C. M. Varsavsky (**93**) in order to explain certain discrepancies between theory and observations which had been discussed by A. Sandage (**94**) when treating Walker's anomaly in the main sequence of young clusters like NGC 2264. Varsavsky concluded that there are no serious discrepancies at all, if the correct relationship between $B-V$ and Te, valid for T Tau variables, is used. P. B. Bouvier (**95**) has studied the influence of inter-stellar clouds on the stability of galactic clusters and the perturbations of internal stellar motions by the general galactic field. Present work refers to the conditions of a potential statistical equilibrium in the

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Praesepe cluster. R. W. Michie (**96**) attempted to study both the stationary structure as well as the changes the cluster undergoes as it evolves due to stellar evaporation. The basic assumption is that the continuous evolutionary process can be approximated by a series of successive equilibrium states. The results show, *inter alia*, a flow of stars inward within one parsec from the centre and an expansion beyond twenty parsecs. K. A. Barkhatova investigated also the motion of the system of open star clusters. The Oort constant A for the system is 20 km/sec/kpc, and the K-effect constant K is $-5{\cdot}9$ km/sec/kpc. V. K. Abalakin investigated the periodical motions of stars in the ellipsoidal star clusters.

M. Hénon (**97**) derived the special form of the potential $U(r)$ in a spherical globular cluster which makes the period of any star independent of its angular momentum. The resulting cluster is called an 'isochronic cluster'. This model resembles the actual cluster in many, but not all, essential ways. In a second paper (**98**) the author calculated particular stellar orbits existing in the isochronic model.

An attempt has been made by J. H. Oort and G. van Herk (**99**) to understand the observed structure of M 3. In the region up to 8 pc from the centre stellar encounters have set up an approximate Maxwellian velocity distribution. In the outer regions of the cluster from 10-100 pc the effect of stellar encounters is almost negligible. A satisfactory dynamical representation can be obtained by a prolate spheroidal velocity distribution, the major axis increasing outwards. The velocity distribution has been cut off at the velocity of escape. Relative masses of the stars of the cluster NGC 7789 have been determined by K. Rohlfs (**100**) with the help of cluster models from the sedimentation of the stars. The masses obtained for the cluster stars—the red giants included—fit the mass-luminosity relation of van de Kamp (1954). They are not consistent with those masses that are obtained from the current theory of stellar evolution, if a mass-luminosity relation $L{\sim}M^4$ is assumed for the zero-age main sequence. Assuming the velocity distribution to be Maxwellian, four cluster models were computed; no cut off for the velocities has been applied. It is shown that these assumptions are fulfilled with good approximation for the observed parts of the cluster.

VARIA

W. Becker (Basle) will have three fast-working iris-photometers in 1961 the use of which is kindly offered by him to astronomers who need such a photometer for cluster work.

A. D. Thackeray points out that the Radcliffe Observatory is in a position to undertake observations, down to magitude 12 for radial velocities, of selected stars whose distances can be accurately determined through membership of associations etc. It is felt that there is scope for co-operation between observatories concerned with accurate determination of distances of associations, Cepheids etc., and other observatories concerned with radial velocities.

RECOMMENDATIONS FOR DISCUSSION

A. Blaauw points out that there is no uniquely adopted nomenclature of the associations at present. He suggests a small working committee to define criteria for the selection of associations as distinguished (if possible) from clusters, to draw up a list of objects and to propose a system of nomenclature which may be universally adopted.

Various astronomers urge the necessity of adopting a uniform photometric system for cluster work according to previous recommendations. The *UBV* system lends itself as suitable in many respects. The most serious objections against its present status arise from the problem of how to reproduce its zero-points amongst fainter and reddened stars. An alternative proposal aims at adopting the fundamental system of stellar magnitudes which is being established by R. H. Stoy on the recommendation of Commission 25 (Moscow). It is hoped to discuss these far-reaching problems in a joint meeting with Commission 25 at Berkeley.

R. T. Matthews raises the question as to whether duplication of work on various clusters is necessary in view of the fact that H. L. Johnson has now picked most of the clusters available. It might be worthwhile to draw up a list of clusters which need observing, but which have been completely neglected to date.

The writer wants to thank all those astronomers who have kindly contributed to this report by sending various kinds of information. Particular thanks are due to J. Hardorp who has arranged the large amount of material on individual clusters into the form of three tables.

H. HAFFNER
President of the Commission

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ADDITION TO REPORT OF COMMISSION 40 (see p. 451)

REPORT, BY A. P. MOLCHANOV, OF WORK IN THE FIELD OF RADIO ASTRONOMY IN U.S.S.R. IN 1958–1961

Radio-emission from the Sun

Electronic inhomogeneities in the solar corona were discovered at distances up to 30 solar radii, and their characteristics were evaluated (**1, 29**).

The solar observations at centimetric wave-lengths are consistent with the assumption that the emission from localized sources on the Sun is thermal (the height of the sources is the same as for corona (condensation); the emission is very stable and partially polarized (**6, 8-12, 19-22**), but leads to the supposition that either high kinetic temperature and strong magnetic fields are present or that the emission from these regions has not only a thermal, but also for example a synchrotron, component (**11, 19**).

Spectra of the bursts called "pips" were obtained (**30**). Some peculiarity of the spectra of the bursts on the shorter wave-lengths near $\lambda = 3{\cdot}04$ cm, can be explained by the influence of the hydrogen line (**4**). Theoretical investigations are related to the propagation of radio-waves in the plasma and to conditions for the generation of bursts in the solar corona (**7**).

Radio-emission from the Moon and planets

Measurements were carried out with the large radio telescope with high resolving power (**16, 17**). Radio-location studies of the Moon ($\lambda = 3$ cm, $\lambda = 10$ cm) give the value of the integral coefficient of reflection (**14**). The connection between the effective temperature emission from the centre of the Moon and the phase was obtained (**31**).

The temperature of the radio-emission from Venus was determined as $T \approx 315° \pm 70°$ K (**13**).

Radio-emission from the galaxy and metagalaxy

Measurements on a wave-length of $\lambda = 21$ cm show some changes of profile in the direction to Cygnus X (**27**); measurements on $\lambda = 91{\cdot}7$ cm give negative results (**5**).

Observations of the emission from the discrete sources have allowed the composition of a catalogue of 40 sources including 24 which had not been observed before (**15**), the determination of the brightness distribution for some sources (**18, 23**); a great absorption was found in the western part of the source Omega (**23**).