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27*a*. SOUS-COMMISSION DE COORDINATION DES RECHERCHES GALACTIQUES (ÉTOILES VARIABLES)

MEMBRES: MM. Baade, Blaauw, Kukarkin, Oosterhoff.

27*b*. SOUS-COMMISSION DES ÉTOILES VARIABLES D'AMAS GLOBULAIRES

PRÉSIDENT: Mme H. B. Sawyer-Hogg.

MEMBRES: MM. Arp, Kholopov, Rosino, Thackeray.

INTRODUCTION

The writer must regretfully begin with the sad information of the death of Sergei Nikolaevitch Blazhko, late Professor of Moscow University, the oldest member of the Commission, who died on 11 February 1956. Though during his last years he was unable to take an active part in the work of the Commission he was to his last days interested in variable star studies. He paid particular attention to the variation of the light curves of RR Lyrae type stars discovered by him about forty years ago (the so-called 'Blazhko-effect').

Many important investigations have been carried out during the period covered by this report. Data on variable stars were used in a number of astronomical fields and it is quite impossible even to mention all of them here. This account will inevitably reflect the personal convictions and interests of the author; he requests his readers to excuse him in advance for any lack of objectivity from their point of view.

According to the author's opinion, a summary of all essential studies in the domain of variable stars that have taken place during the last three years should be given in the report. A number of problems, raised by different astronomers in the course of preparation of the report, have to be put before the next meeting during the Moscow Assembly.

During the last three years the author has tried to maintain close contact with members of Commission 27, as well as of Commissions 29, 33 and 42, some of whose tasks are inseparable from those of Commission 27. Six circular letters were sent to members of Commission 27 and to some members of the other three commissions. The first contained a request to communicate new data on variable stars for inclusion in the second edition of the *General Catalogue of Variable Stars*. The second related to the study of all variables brighter than 12^m at maximum. The third letter was devoted to the problem of the investigation of bright Mira Ceti type variables, which are not included in the programme of the Amateur Associations. A request to support photo-electric photometry of ν Eridani was made in the fourth letter. Letter five contained information about the progress of the second edition of the *General Catalogue of Variable Stars*. Finally letter six contained a request to send data for the preparation of the present report. Numerous answers were received to these letters and many have been utilized in the present report. The writer did his best to support and help various works in variable star studies. Thus the recommendations of C. de Jager and M. Walker on the organization of continuous photo-electric observations of variable stars 12-DD Lacertae and HD 217050 were supported, as well as the initiative of M. Petit concerning observations of flare stars. An animated exchange of letters took place in connexion with a number of special problems.

The activity of the Sub-Commission on the co-ordination of galactic research was conducted in the form of private correspondence and an animated exchange of opinions in the course of the Stockholm Conference in June 1957. The main problems will be mentioned in corresponding places of the report.

The Sub-Commission for variable stars in globular clusters has begun its activity in the period under report. A separate report has been prepared by Dr H. Sawyer-Hogg, President of the Sub-Commission.

INTERNATIONAL COLLABORATION

In the course of 1955–57 several international symposia directly connected with problems of stellar variability were held.

A colloquium on the problems of stellar variability was held in Budapest during 24–28 August 1956. About thirty scientists from Hungary, Italy, Netherlands, Germany, Poland, Czechoslovakia, China, Belgium and the U.S.S.R. took part in the work of this colloquium [1, 2]. Besides the general methodical questions, particular attention was paid to the problems of variable stars in globular clusters and the variability of light curves of RR Lyrae type stars (Blazhko-effect). The Hungarian astronomers headed by Dr L. Detre, Director of the Konkoly Observatory, did their best to make the Symposium both interesting and fruitful.

A symposium devoted to the problems of non-stable stars was held on 20–22 September 1956 in Burakan (Armenian S.S.R.). Scientists of a number of the U.S.S.R. Republics and from China, Yugoslavia, Mexico, U.S.A. and France took part in it [3]. At the symposium were discussed problems connected with flare stars, the classification of T Tauri and UV Ceti type stars, T-associations and their relations with diffuse nebulae, of continuous emission and the origin of emission lines, questions connected with Herbig-Haro objects, close duplicity of flare stars, and also some theoretical problems. The hospitality of the Armenian astronomers under Prof. V. A. Ambartsumian's direction exceeded all expectations.

The second Conference for the co-ordination of galactic research took place in Stockholm during 17–22 June 1957. Scientists from Sweden, Germany, France, U.S.A., U.S.S.R., Netherlands, Great Britain, Union of South Africa, Australia, Mexico and Czechoslovakia were present [4]. Problems were discussed on the distribution and peculiarities of cepheids in the nucleus disk and the spherical component of our Galaxy, the evidence for the presence of globular clusters and RR Lyrae type variables in the flat component, problems of red stars in general and Mira Ceti type stars in particular, general problems of cepheid investigations, problems connected with the study of variable stars in Magellanic Clouds and other galaxies. An animated exchange of opinions led in some cases to definite recommendations. The organization of the Conference was faultless and the participants of the Conference will never forget the hospitality of Swedish astronomers headed by Prof. B. Lindblad.

The traditional astrophysical Colloquium was held on 8–10 July 1957, in Liège. It was devoted to the study of stars with bright emission lines. Scientists of Belgium, Germany, Austria, U.S.A., France, Great Britain, Netherlands, Hungary, Italy, India, Japan, Lebanon, Poland, Saar, Sweden, Czechoslovakia and U.S.S.R. were its participants [5]. Problems were discussed connected with the study of Be, Ae, P Cyg and T Tauri type stars, R Coronae Borealis and flare stars, the emission lines of cepheids, spectra of long-period variables, emission of eclipsing variables with a particular study of the interesting star W Serpentis, questions of symbiotic stars and general questions on the dependence of emission lines on the types of stellar variability. As usual the Colloquium was perfectly organized by our Belgian colleagues under Prof. P. Swings.

During the past period, three co-operative studies devoted to continuous observations of several variable stars by means of photo-electric photometers have been carried out. Astronomers of many countries participated in systematical observations of 12-DD Lacertae, suggested by C. de Jager. M. Walker requested observations of the variable star HD 217050, and E. K. Kharadze of ν Eridani. These three proposals were supported by Commission 27 and the response was very good; in spite of unfavourable weather conditions numerous observations were obtained. This experience shows that such co-operative works should be continued.

The activity of M. Petit deserves special mention. He has done much to unite the efforts of flare star investigators and to maintain permanent contact with them. Papers containing recommendations for international collaboration in the investigations have been published [6].

About 600 letters from more than 100 variable star investigators, and astronomers in adjoining branches, have been received in connexion with the preparation of the second edition of the *General Catalogue*. These letters contained information about certain variables, proposals concerning classification, and matters of organizational character. It deserves mention that astronomers of twenty-three countries and six U.S.S.R. republics communicated new data and took part in the discussion of the catalogue. After the Dublin meeting of Commission 27 questions concerning the classification of variable stars were discussed at the international Symposium in Budapest and in part during the Burakan Conference.

REFERENCE BOOKS, CATALOGUES, YEAR-BOOKS, MONOGRAPHS, MAPS AND TABLES

It is expected that the fourth volume of the second edition of *Geschichte und Literatur der Veränderlichen Sterne* compiled by H. Schneller will be issued before the end of 1957. This volume contains references up to 1954 on variable stars discovered and designated before 1938, lacking in the preceding volumes. Schneller is preparing the next volume, which will contain references on 1220 more stars. He hopes to complete his work for the remaining 5000 stars during the following four years. In future it is intended to prepare only supplements and to publish them either annually, or simultaneously with the issue of the *General Catalogue*.

The annual issue of the ephemeris for eclipsing variable stars, prepared by Krakow University Observatory, has been continued. It is very welcome that from the beginning of 1957 these ephemerides are again accompanied with the latest data on the observed epochs of minima for a number of eclipsing variables.

The Astronomical Council of the Academy of Sciences of the U.S.S.R. and the Sternberg Astronomical Institute have prepared and issued the seventh, eighth and ninth Supplements to the *General Catalogue of Variable Stars* (1st ed. 1948). These supplements contain corresponding information about 261, 629 and 337 newly designated variables. New data about 358 stars designated earlier are also given in Supplement no. 7. The compilation of the second edition of the *General Catalogue* has been completed, in which the information about variables has been completely revised. As mentioned above details of the new edition of the catalogue were discussed at a number of international meetings. More than a hundred astronomers from about thirty countries communicated to the compilers information about approximately 6000 variables.

Besides the main table containing information about 14 708 variable stars, auxiliary and nomenclature tables are given. As a result of a thorough analysis of numerous recommendations and several discussions, the authors of the new edition of the catalogue accepted a new classification of variable stars, which is given below.

All variable stars may be subdivided into three main classes—pulsating, eruptive and eclipsing variables. This division into three classes according to the cause of variability is not reflected in the type symbols, but will be applied in the present preface to statistical calculations, etc. The following short description of the types is given according to these three main classes.

Pulsating variable stars

C—*long-period* (*classical*) *cepheids*. Periodically pulsating variables of high luminosity with periods from one to fifty-seven days, light-variation amplitudes ranging from $0^m.1$ to 2^m (being larger in photographic than in visual wave-lengths). The period and the form of the light curve are, as a rule, constant, but cases are known when apparently sudden changes of period, from 0·001 to 0·1 % take place after the elapse of several hundred or thousand periods. The curve of radial velocity V_r is almost a mirror-reflexion of the light curve, the maximum of V_r coinciding practically with the light minimum and the minimum of V_r corresponding to the maximum brightness. Spectral classes at light maxima are late F, at minima G–K, being later the greater the period of light variation.

Cδ—*long-period cepheids* belonging to the *flat* component of the Galaxy. They are characterized by small z-coordinates, moderate velocities relative to the Sun and the presence of a definite correspondence between the form of the light curve and the length of the period. The periods and luminosities of these stars are mutually connected by the well-known period-luminosity relation. A typical representative is the star δ Cep.

CW—*long-period cepheids* belonging to the *spherical* component of the Galaxy. They differ from the cepheids of the flat component mainly by the peculiar light curves, considerable z-coordinates and large radial velocities relative to the Sun. The form of the period-luminosity curve is similar to the one of the corresponding curve for the flat component cepheids, but the zero-points of the two curves are different. The spherical-component cepheids are $1^m.5$–2^m fainter than the cepheids of the flat component for the same period. A typical representative is W Vir.

It must be taken into account that at present it is practically impossible to distinguish a flat-component cepheid from one of the spherical component, if the radial velocity of the latter relative to the Sun is small, and if the latter is located near the galactic plane and possesses a period at which the light curves of the two kinds of cepheids differ quite insignificantly. It is not excluded, therefore, that among cepheids referred in the catalogue to the category Cδ some stars belonging in reality to the CW group may be met.

I—*irregular variable stars*. Variable stars with light-variations void of any trace of periodicity, or possessing an extremely faint periodicity which appears only at times. Some variables are included in this class only as a result of insufficient knowledge. The majority of them are in reality semi-regular variables, or variables of other types.

Ia—*irregular variable stars* of early spectral classes. It must be kept in mind that in this also some eruptive variables may be included, particularly the RW Aurigae type stars of early spectral classes.

Ib—*slowly varying irregular variables* of late spectral classes (K, M, C and S)—giants, as a rule. A typical representative is CO Cyg.

Ic—*irregular variable super-giants* of late spectral classes. A typical representative is TZ Cas.

M—*Mira Ceti type stars*. The long-period giant variables with amplitudes over $2^m.5$ (up to 5^m and even larger), with well-expressed periodicity, with periods ranging from about 80^d to 1000^d and with characteristic emission spectra of late type spectral classes (Ne, Ce, Se). A typical representative is *o* Cet.

Long-period variables with uncertain but, judging by observational data, sufficiently large amplitudes (reaching minimum brightness beyond the range of visibility) are also included in this class. When, for amplitudes exceeding 1^m–$1^m.5$, there is no certainty that the actual amplitude of light-variation exceeds $2^m.5$, symbol M is accompanied by a question mark, or the star is referred to the class of semi-regular variables, the symbol of this class (SR) being also accompanied by a question mark.

SR—*semi-regular variables*. The giant or super-giant stars possessing an appreciable periodicity accompanied, or at times disturbed, by various irregularities in the change of brightness. The periods of semi-regular variables cover a wide range—from about 30^d to 1000^d and even more. The forms of the light curves are extremely diverse, and the amplitudes usually do not exceed 1^m–2^m.

SRa—*semi-regular variable giants* of *late* spectral classes (M, C and S), which retain periodicity with comparative stability and possess, as a rule, small (less than $2^m.5$) light-variation amplitudes. Amplitudes and forms of light curves are usually liable to strong variations from period to period. Many of these stars differ from the Mira Ceti type stars only owing to the smaller amplitude of light variation. A typical representative is Z Aqr.

SRb—*semi-regular variable giants* of *late* spectral classes (M, C and S) with a poorly expressed periodicity, i.e. with a different duration of individual cycles (which leads to the impossibility of predicting the epochs of maximum and minimum brightness), or with the replacement of periodical changes by slow irregular variations, or even by the constancy of brightness. Some of them are characterized by a certain mean value of the period, given in the catalogue. Typical representatives are RR CrB, AF Cyg.

The majority of semi-regular variables denoted by the symbol SR, for which the elements of light variation are given in the catalogue, can probably be referred to the type SRa. Many semi-regular variables denoted by the symbol SR, for which only the value of the cycle is given, may apparently be referred to the type SRb. However the symbol SR is accompanied in the catalogue by the letters a or b, only if the compilers are quite sure that the star belongs to the late spectral class (this can be justified in the absence of the spectrum by a large colour index).

SRc—*semi-regular variable super-giants* of *late* spectral classes. Typical representatives are μ Cep, RW Cyg.

SRd—*semi-regular variable giants and super-giants* belonging to spectral classes F, G, K. Typical representatives are S Vul, UU Her, AG Aur.

RR—*variable stars of RR Lyrae* type (short-period cepheids, or stars of the type of variables in globular clusters). Pulsating giants possessing cepheid properties, with periods ranging from $0^d.05$ to $1^d.2$, of spectral class A (and rarely F) and amplitudes of light variation not exceeding 1^m–2^m; they belong mostly to the spherical component of the Galaxy. The period and form of the light curve are constant as a rule, but cases of variability both of the form of the light curve and of the period are known. These variations are in many cases periodic (Blazhko-effect).

RRa—*RR Lyrae type variables* with very *asymmetrical* light curve (a steep ascending branch). It must be kept in mind that along with the typical variables of this kind characterized by large amplitudes of light variation (up to $1^m.5$) and sharp maxima, we refer to this group the RR Lyrae type variables with asymmetric light curves, but with smaller amplitude of light variation (about $0^m.5$) and almost flat maxima (usually denoted by the symbol RRb according to Bailey's classification). Though the mean periods of stars belonging to these two groups are somewhat different ($0^d.5$ for RRa and $0^d.7$ for RRb), between the light curves of the typical representatives of these groups a number of transitory forms are known. The existence of some correlations between their characteristics also suggests that these two groups should be considered together. A typical representative is RR Lyr.

RRc—*RR Lyrae type variables* with almost *symmetrical*, often sinusoidal, light curves. The mean period is $0^d.3$. It is very difficult to distinguish some of these from the eclipsing binaries of W UMa type, if their spectral properties and radial velocities are unknown. A typical representative is SX UMa.

RV—*RV Tauri type stars*. Variable super-giants characterized by the following properties: a comparatively stable periodicity of light variations, the total amplitude of which even reaches 3^m; light curve consisting of double waves with alternating main and secondary minima of variable depth; main minima being often replaced by the secondary and vice versa; the intervals between two successive main minima, usually regarded as the formal period, range from 30^d to 150^d (this is the period given in the catalogue); spectral classes range from G to late K (rarely M), being earliest near the maximum brightness.

RVa—*RV Tauri type variables* with *constant* mean brightness. A typical representative is AC Her.

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RVb—*RV Tauri type variables* with periodically *varying* mean brightness. Typical representatives are RV Tau, R Sge.

β C—*β Cephei type variables*, or (as they are often called) β Canis Majoris type stars. A very homogeneous group of pulsating giants with brightness variations within about $0^m.1$. The periods of radial velocity and light variations range from $0^d.1$ to $0^d.3$. Spectral subclasses are B 1–B 3, classes of luminosity are III–IV. Contrary to cepheids, the maximum brightness corresponds with the pulsation hypothesis to the phase of maximal compression of the star. A typical representative is β Cep.

δ Sc—*δ Scuti type stars*. Pulsating variables of spectral class F with amplitudes of light variation not exceeding $0^m.25$ and periods less than 1^d. The form of the light curve varies usually very much. According to their physical characteristics, particularly to the phase relation between the brightness and radial velocity, these stars are very similar to RR Lyrae type variables and must perhaps be considered in reality as a variety of the latter. A typical representative is δ Sct.

α^2CV—*α^2 Canum Venaticorum type variables*. Stars of spectral type Ap, in the spectra of which anomalously intense lines of silicon, strontium, chromium and rare-earth elements are observed, varying in intensity with period equal to that of light variation. Periods of light variation range from 1^d to 25^d, amplitudes usually do not exceed $0^m.1$. Some of these stars possess powerful variable magnetic fields, the period of variation of which is equal to the period of light and spectrum variations. A typical representative is α^2CVn.

Eruptive variable stars

N—*novae*. Hot dwarfs with spontaneous increase of brightness ranging from 7^m to 16^m in the course of one to a hundred days, decreasing slowly in the course of several years or decades until the initial brightness is reached. Some novae show small light-fluctuations in minimum. Near maximum brightness an absorption spectrum is usually observed similar to that of class A or F giants. After the maximum brightness has been attained wide emission bands of hydrogen, helium and other elements with absorption components appear in the spectrum. Along with the decreasing brightness of the star bright forbidden lines, inherent to the spectra of gaseous nebulae, appear in the complex spectrum. After the novae return to their initial stage the spectra of novae usually become continuous or similar to the spectra of the Wolf-Rayet stars.

Na—*rapidly developing novae*, characterized by a rapid increase of brightness, followed by a decrease of 3^m after the maximum during 100 or fewer days. A typical representative is GK Per (Nova Per 1901).

Nb—*slowly developing novae*. These are Novae for which the decrease of 3^m takes 150 and more days after the maximum. In this case no account is taken of the well-known 'dip' in the light curves of such novae as DQ Her and T Aur; the velocity of the light-decrease is estimated according to the smooth curve drawn through the portions before and after the 'dip'. A typical representative is RR Pic.

Nc—*novae with particularly slow development*, retaining their maximum brightness for many years and then becoming fainter extremely slowly. A typical representative is RT Ser.

Nd—*recurrent novae*. They are distinguished from the typical novae only by the fact that one, two and more flares were recorded for them. A typical representative is T CrB.

Ne—*nova-like variable stars*. A very heterogeneous class of objects similar to the novae according to the character of light variation or the spectral properties. Many members of this group probably bear no relation to novae. Typical representatives are Z And, P Cyg, BF Cyg.

SN—*super-novae*. Stars that suddenly increase their brightness by 20 and even more magnitudes and then slowly fade. According to their general appearance their light curves are similar to those of novae. Their spectra are characterized during an outburst by extremely wide emission bands the width of which exceeds several times that of the bright bands observed in the spectra of novae. A typical representative is CM Tau (SN 1054), as a result of the outburst of which the Crab nebula originated.

RCB—*R Coronae Borealis type variables.* Stars of high luminosity belonging to spectral classes F–K and R characterized by slow non-periodic drops in brightness of different amplitudes (from 1^m to 9^m) and different duration (from over ten to several hundred days), during the minimum brightness of which emission lines of metals usually appear in the spectra. A typical representative is R CrB.

RW—*RW Aurigae type stars.* Numerous irregular variables of spectral classes from B to M (both with and without emission in their spectra) located on the spectrum-luminosity diagram in the main sequence region and in the sub-giant region and characterized by irregular, mainly rapid, light variations of highly various character. The amplitudes of light variation may reach a few magnitudes; periods of light constancy, which take place occasionally, may be regarded as a characteristic property of many RW Aurigae type stars. The overwhelming majority of these stars are evidently connected with bright or dark diffuse nebulae. In such cases a small letter n is added to the symbol for the type; a detailed classification of stars of the above type does not yet exist. However, it is possible to select a number of stars, which are similar in some respects; thus, for example, stars of this type possessing characteristic emission spectra of spectral classes G–M, in which bright fluorescent lines of Fe I and forbidden lines of S II and Fe II are present may be considered as belonging to the sub-type of T Tauri. In these cases symbol (T) is added to the spectral class in the column 'spectrum'. Finally, RW Aur type variables, showing outbursts analogous to the outbursts of UV Ceti type variables and located in diffuse nebulae, are designated by the symbol RWnf. Typical representatives are BW Aur, T Tau, BO Cep, T Ori.

UG—*U Geminorum, or SS Cygni type variables.* Dwarf stars usually showing only small light fluctuations, the brightness of which increases now and then by several (from 2 to 6) magnitudes during 1^h–2^h, after which they return to their former brightness in the course of several days, or several dozens of days. The intervals between two successive outbursts of a given star can change over wide limits, but every star is characterized by some mean value of such intervals—the mean cycle. The mean cycles of the U Gem type variables are within the limits of 20^d to 600^d. Between the value of the mean cycle and the amplitude of the outburst there exists a certain statistical relation. The greater the amplitude, the less frequent are the outbursts. The spectrum is continuous at minimum brightness with a superposition of wide bright lines of hydrogen, helium, and ionized helium and calcium. These lines disappear almost completely at maximum brightness, or are even transformed into shallow absorption lines of the same width. A typical representative is U Gem.

UV—*UV Ceti type variables.* Dwarf stars of spectral classes dM3e–dM6e characterized by rare and very short flares with amplitudes from 1^m to 6^m. Maximum brightness (usually sharp) is attained in a few, or several tens of seconds after the commencement of the flare, total duration of the flare being equal to about ten to fifty minutes. A typical representative is UV Cet.

Z—*Z Camelopardalis type variables.* Stars similar to the U Geminorum type variables according to their physical characteristics and spectral properties, showing cyclic light variations similar to the outbursts of the U Geminorum type variables interrupted now and then by periods of light constancy, during which the star retains its intermediate magnitude (between minimum and maximum) for several cycles. The values of the mean cycles are within the limits of 10^d–40^d, and the amplitudes of light variation within 2^m–5^m. A typical representative is Z Cam.

Eclipsing binaries

E—*eclipsing variable stars.* Binary systems whose orbital planes are so close to the line of sight of the observer on the Earth that the two components (or one of them) mutually eclipse each other. These eclipses are recorded by the observer as changes of the apparent total brightness of the system. The period of these changes coincides with the period of the orbital motion of the components.

EA—*eclipsing variables of the Algol type.* Eclipsing binaries with globular or slightly ellipsoidal components, and light curves permitting the fixing of times of beginning and end of the eclipses. In the intervals between eclipses there is, as a rule, almost no change of light. For some stars a secondary minimum may be absent. The periods are contained in very wide limits (from $0^d.2$ to 10 000^d or more), the amplitudes of light variation also vary greatly and may reach several magnitudes. A typical representative is β Per.

EB—*β Lyrae type eclipsing variables.* Eclipsing binaries with ellipsoidal components, possessing light curves which do not permit the fixing of times of beginning and end of eclipses (owing to the continuous variation of the apparent total brightness of the system in the intervals between the eclipses). A secondary minimum is always observed, the depth of it being, as a rule, essentially smaller than the depth of the main minimum. The periods mostly exceed one day, the components are usually of early spectral classes. Amplitudes of light variation are usually less than 2^m. A typical representative is β Lyr.

EW—*eclipsing variables of W Ursae Majoris type.* Eclipsing binary systems with periods less than one day, consisting of ellipsoidal components which almost touch each other, and having light curves which do not permit of fixing the times of beginning and end of eclipses, the main and the secondary minima being almost equal in depth. The spectral classes of the components are usually F–G and later. The amplitudes of light variation are usually less than $0^m.8$. A typical representative is W UMa.

Ell—*ellipsoidal variables.* Binary systems with ellipsoidal components, the apparent total light of which varies with the period of the orbital motion as a result of the change of the visible area of the luminous surface, but without eclipses. These stars are included in the class of the eclipsing binaries because there is no real difference in the causes of light variation and the properties of these systems. A typical representative is *b* Per.

The table of the distribution of variable stars according to their types is also given.

DISTRIBUTION OF VARIABLE STARS ACCORDING TO TYPE

Type		No.
	Pulsating variables	
C	Long-period cepheids	610
I	Irregular variables	1 370
M	Mira Ceti type stars	3 657
SR	Semi-regular variables	1 675
RR	RR Lyrae type variables	2 426
RV	RV Tauri type stars	92
βC	β Cephei type stars	11
δ Sc	δ Scuti type stars	5
α^2CV	α^2 Canum Venaticorum type stars	9
	Total of pulsating variables	9 855
	Eruptive variables	
N	Novae	146
Ne	Nova-like variables	35
SN	Super-novae	7
RCB	R Coronae Borealis type stars	39
RW	RW Aurigae type stars	590
UG	U Geminorum type stars	112
UV	UV Ceti type stars	15
Z	Z Camelopardalis type stars	15
	Total of eruptive variables	959
E	*Eclipsing variables of all types*	2 763
*	Unique variables	10
?	Unstudied variables	982
cst	Constant stars	142
	Total of variables	14 711

The difference between the total number of variables of different types and that given in the catalogue is explained by the fact that three stars were included in the type lists twice: these are η Gem (contained in the SR and E lists), DQ Her (contained in the N and E lists) and AR Pav (contained in the Ne and E lists).

C. Payne-Gaposchkin published an interesting monograph *Variable stars and galactic structure* in 1954 [7] and *The Galactic Novae* in 1957 [8].

Z. Kopal together with M. Shapley published a very important 'Catalogue of elements of eclipsing binary systems' [9].

A valuable catalogue of spectra of red variables was compiled and published by J. J. Nassau and D. Cameron; spectral classes of 723 red variable stars were determined [10].

Surveys describing certain types of variables have been published; I mention only O. Struve's survey of β Cephei type stars [11], the survey on flare stars by P. E. Roques and M. Petit [12, 13], and that of P. W. Merrill on red stars [14].

Transactions of the fourth Cosmogonical Conference (editor V. A. Ambartsumian) organized by the U.S.S.R. Academy of Sciences in Moscow were published in 1955 [15].

A collection of papers entitled *Non-stable stars*, editor G. Herbig, containing the material of the Symposium held in Dublin in September 1955 [16] and *The Non-stable Stars*, containing the results of the Burakan conference held in September 1956 [17] was issued. Interesting summaries giving a great deal of new data and ideas can be found in the two volumes of *Vistas in Astronomy* [18, 19].

An extensive work connected with the issue of maps of the surroundings of variable stars was carried out. The vast labour of the Sonneberg astronomers under C. Hoffmeister deserves special mention. Maps of surroundings were prepared and published by them for about 3000 stars discovered at Sonneberg [20].

A. Brun and M. Petit compiled an atlas of the surroundings of U Geminorum type stars [21].

The issue of the special bulletin 'Variable Stars' has been continued by the Academy of Sciences of the U.S.S.R.; ten issues were published, a total of 600 pages. The issue of *Mitteilungen über Veränderliche Sterne* (*M.V.S.*) was also continued at the Sonneberg Observatory; over 100 pages have been published.

VISUAL OBSERVATIONS

Associations and sections of variable star observers proceeded with their work.

The American Association of Variable Star Observers continued intense observations. Fifty to sixty thousand observations of about 800 variables are obtained by this association yearly. The results are published, most regrettably, only in the form of 10-day means (with the exception of variables with rapid light variations) in the Quarterly A.A.V.S.O. Reports. By the middle of 1958 it is hoped to prepare for print all observations of 1955. Mrs M. W. Mayall, A.A.V.S.O. Recorder, published the important volume, prepared by the late L. Campbell, containing epochs of maxima and minima, magnitudes and mean light curves for more than 400 Mira Ceti type variables [22]. The preparation of the next volume containing the epochs of maxima and minima for recent years is planned. Light curves of long-period variables with small amplitudes were published. These curves embrace a period of about fifty years. Further extension of the observational programme faces the lack of good sequences of comparison stars for some hundreds of bright Mira Ceti type variables [23]. Indeed more than two hundred stars of this type reaching 9th and even 8th magnitude in their maximum cannot be included in the observational programme owing to the absence of sequences.

The work of the Variable Star Section of the British Astronomical Association has been actively progressing, as communicated by W. M. Lindley, its director. A manuscript containing observations of long-period variable stars has been prepared. Increasing attention is paid to variables of U Gem and Z Cam types. It is proposed to extend the programme of observations in the near future by adding RW Aur and flare type variables. G. Herbig supplied the Section with maps of the surroundings of these types of variable [23]. L'Association Française des Observateurs d'Etoiles Variables has begun to publish observations regularly in the *Journal des Observateurs*.

The Variable Star Section of the Nordisk Astronomisk Selskab continued its activity under the direction of A. V. Nielsen; the observers of this section are amazingly constant.

These observers study scrupulously from year to year a small number of variables of different types. Unfortunately the number of constant observers gradually decreases, and there are practically no new observers.

The Variable Star Section of the New Zealand Astronomical Society under the direction of F. M. Bateson was as active as before. The Section publishes systematically in its 'Circulars' observations of the southern Mira Ceti type stars and a number of interesting flare stars. Several issues of the Circulars are devoted to a detailed investigation of some U Gem type stars.

V. P. Tsesevich, G. A. Lange and G. S. Stejman (Odessa) observed about a hundred eclipsing and unstudied variables, mainly short-period ones. As a result, types and elements were determined for several dozens of stars [23].

C. Hoffmeister observed fifty-five southern short-period variables of RW Aur type [24].

V. Oskanjan in Belgrade, D. Elias in Athens and other observers directed by M. Petit [23] carried out systematic observations of flare variables of UV Ceti, T Tau and RW Aur types. A. Dermul prepared for print an important series of observations of RW Aur. Miss R. Szafraniec reported a very remarkable event: 110 262 light estimates of 429 eclipsing variables were prepared for print. These estimates were obtained in 1920–50 by the collaborators of the Krakow University Observatory in Poland [23].

A. A. Batyrev and his collaborators in Rostov-on-Don systematically observed several dozens of RR Lyrae type variables.

Numerous observations of eclipsing variables were conducted by Chis from Kluj, Rumania [23]. Numerous visual observations of variable stars have been carried on by Wroblewski and other members of the Polskiego Towarszystwa Milosnikow Astronomii under the direction of Gadomski [23], and by S. Kanda, S. Kaho and Koshiro in Japan.

Visual observations of some interesting variable stars were also conducted by M. Lavrov at the Engelhardt Observatory near Kazan, W. Zonn and his collaborators at the Warsaw University Observatory.

Members of the Berliner Arbeitsgemeinschaft fur veränderliche Sterne observed selected variable stars, mainly eclipsing ones [23].

PHOTOGRAPHIC OBSERVATIONS

Systematic photography of the accessible stellar sky was carried out at the Sonneberg, Stalinabad and Odessa observatories. Collections of plates accumulated there continued to be extensively used for variable star investigations. Systematic photography of separate sky regions by means of short-focus cameras was continued at a number of observatories (Moscow, Sonneberg, Tartu, Tashkent, Tokyo, etc.). The concentrated work of R. Weber in Paris and G. Romano in Treviso (Italy), who obtained at their private observatories during the last years hundreds of photographs of a number of sky regions, deserves particular mention. These photographs are extensively used by them for variable star studies. The activity of B. Whitney and his collaborators at the Oklahoma University should also be mentioned. Since 1942 systematic photography of thirty-eight sky regions has been carried on there, mainly for the study of eclipsing variables. These photographs are extensively used for the discovery of new, and the study of interesting, variables. J. Ashbrook continues his variable star studies on plates of the Harvard Observatory Sky Patrol. Systematic sky patrol was started by G. Lacchini (Faenza, Italy) by means of a small 33 mm aperture Zeiss Tessar covering an area of $30^\circ \times 45^\circ$; the magnitude limit is 13^m.

Investigation of unstudied variable stars brighter than 12^m in maximum was very successful. This work will permit definite conclusions to be drawn concerning the distribution of variable stars of various types surrounding the Sun. Vasiljanovskaya, Erleksova, Filatov, Filin, and Shakhovskoi estimated at the Stalinabad observatory over 190 unstudied variables [25]. W. Götz, H. Huth, G. Richter and others (Sonneberg Observatory) investigated seventy-four stars, mainly those discovered at that observatory [23, 27]. Tsesevich, Grigorevsky and others (Odessa Observatory) investigated about 70 variables [25]. 20 variable stars were investigated at the Moscow Observatory [23]. Individual bright variable stars were studied elsewhere.

The systematic search for bright variables by the Bamberg Observatory is interesting. Using more than 6000 plates, obtained with the 'Ernostar' object lens from 1929 to 1939, W. Strohmeier, R. Kippenhahn, E. Geyer and others searched and partially investigated a number of variable stars. These plates cover the sky from the North pole to declination $-15°$. Three pairs of plates were used usually for the discovery of new variables. One hundred and seventy-two new bright variables were discovered as a result [26]. These stars seem to avoid the Milky Way, which can be explained simply by the fact that most variables in this region of the sky have already been discovered. Approximately 40% of the variable stars newly discovered at Bamberg belong to the types of variables with slow light-variations and small amplitudes (semi-regular and irregular variables), 30% to the eclipsing variables, and 20% to variables with rapid changes of brightness (cepheids, RR Lyrae type stars, eclipsing stars). This shows that even the bright variable stars of all types in solar surroundings are not yet discovered, but only four Mira Ceti type stars (2%) were discovered, all fainter than 11^m in maximum. Practically all stars of the latter type in solar vicinity are known to us. Searching for bright variable stars was continued at the Sonneberg, Moscow and some other Observatories.

Systematic estimations of the poorly investigated Mira Ceti type stars were carried on at the Stalinabad, Sonneberg, Moscow and Odessa Observatories. More than 700 epochs of maxima for about 200 Mira Ceti type stars were published as a result of these investigations [25, 27]. R. Weber (Paris) obtained, according to our request, the light estimates of 116 Mira Ceti type stars using his own plates of 1942 for this purpose [23]. The author together with Li Tsin and Shen Liang-tzao at the Purple Mountain Observatory (near Nanking, China), and together with P. Kulikovsky at the Uccle observatory (Belgium) attempted to use the plate collections obtained for Minor planets, for a study of the Mira Ceti type stars. The results of these attempts were positive: about forty Mira Ceti type stars were studied [28, 23].

Intense investigation of fainter stars in selected areas of the sky was continued.

H. Shapley continued his study of variable stars in the direction of the galactic anticentre. Together with Mrs Kloss investigations of variable stars were started in VSF 235 situated less than 20° from the galactic centre. The study of variable stars in the Magellanic Clouds [29] was continued, with Mrs V. McKibben Nail.

Miss Margaret Harwood, former Director of the Maria Mitchell Observatory, continued the study of variables in the stellar cloud in Scutum. Data concerning 325 variables in this region are ready for printing. At Lick G. Kron carried out photo-electric observations of stars in the same cloud. This will make possible a reliable magnitude scale for the studied variables [23].

Miss D. Hoffleit, new Director of the Maria Mitchell Observatory, continues her investigations of variable stars in VSF 193 at a distance of 10° from the centre of the Galaxy. Hundreds of new variable stars of Mira Ceti type were discovered and a number of known, but unstudied, variable stars were investigated. Interesting conclusions were drawn from the discovered statistical regularities [30, 23].

S. I. Gaposchkin published the results of his investigation and observation of 285 variables, discovered by W. Baade in the galactic nucleus [31]. E. Pavlovskaya has shown that some periods of short-period cepheids suggested by S. I. Gaposchkin are only apparent ones and are equal to $0^d.5$ but not $0^d.3$ [32].

C. Hoffmeister, P. Ahnert, H. Huth, W. Götz and W. Wenzel (Sonneberg Observatory) continue the valuable studies of variable stars in selected areas of the Milky Way and in special regions of the sky [33, 23].

F. Zwicky (Mount Wilson and Palomar observatories) discovered many variables fainter than 14^m in maximum near the North pole of the Galaxy on plates taken by means of 18-inch, 48-inch and 200-inch telescopes [23].

Investigations of variable stars in the Milky Way clouds in Cygnus, Cepheus and

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Lacerta have been made at the Astronomical Laboratory of Fordham University under the guidance of W. J. Miller. This investigation is based on more than 3000 plates, obtained at the Vatican, Harvard, Mount Wilson and Palomar observatories. Light variations of eighteen variable stars were studied in detail [34].

J. Ponsen (Leiden Observatory) investigated faint variable stars near the galactic centre. These stars were discovered on plates obtained with the 74 inch refractor of the Radcliffe Observatory. The distribution of these variables according to their types is as follows:

Field 1: $\alpha = 17^h\,53^m$, $\delta = -29°\,04'$ (1900)		Field 2: $\alpha = 18^h\,09^m$, $\delta = -28°\,02'$ (1900)	
RR Lyrae	30	RR Lyrae	23
Long-period	22	Long-period and semi-regular	20
Semi-regular	17	Eclipsing	1
Eclipsing	4	Unstudied	4
Unstudied	8		

The majority of long-period variables have periods less than 250, mostly even less than 150 days. RR Lyrae type stars have periods of both $0^d\!.3$ and about $0^d\!.5$ [23]. J. Ponsen investigated also the field of $10° \times 10°$ centred at $\alpha = 18^h\,19^m$, $\delta = -31°\,49'$ on plates obtained with the Franklin-Adams camera. The limiting magnitude of stars on these plates is 16^m. The first pair of the compared plates gave 146 long-period variables, nine-tenths of which have magnitudes $13^m - 14^m$ in maxima [23]. The number of RR Lyrae type stars is comparatively small but most are probably inaccessible for research, being below the stellar magnitude limit of these plates.

L. Rosino (Asiago) commenced systematic photography of four sky regions in Cygnus, Cassiopeia, Scutum and Orion with the 120-cm reflector. The limiting magnitude of stars on these plates is about 20^m pg. The diameter of each field is 20′. At least 100 plates will be obtained for each field, which will enable a reliable classification of variables according to types and the study of the dependence of population from galactic longitude [23].

L. Plaut from the Kapteyn Laboratory in Groningen works at Mount Palomar with the 48 inch Schmidt telescope, in order to obtain extensive material in different regions of the sky, and to be able to investigate variable stars in the galactic halo, in accordance with plans developed at the Groningen Conference in 1953. Plaut obtained in 1956 photographs of four fields: $l = 327°$, $b = +28°$; $l = 331°$, $b = +12°$; $l = 327°$, $b = -12°$; $l = 48°$, $b = +10°$. For each of these fields 100 photographic and twenty photo-visual plates were obtained. These plates are being investigated in Groningen using the Borgman television-scanning technique [23].

The studies of Ponsen, Rosino and Plaut will give plenty of valuable data connected with the problem of galactic structure.

C. Grubissich started, at Asiago Observatory, systematic photography of rich Milky Way regions with the aid of a 33-cm Schmidt telescope, aimed at the study of variable stars brighter than $16^m\!.5$ [23].

About 300 variables including 130 newly-discovered ones were investigated by A. A. Wachmann (Hamburg-Bergedorf) on 300 plates centred at $19^h\,37^m$, $+30°$ and with limiting magnitude $16^m\!.5$–17^m. Part of this study was carried out with W. J. Miller (see above). Thirty new variables were found in the region $6^h\,50^m$, $\pm 0°$ [23].

Systematic photography of all Kapteyn Selected Areas (S.A.) of the North sky was continued at the Moscow Observatory on $10° \times 10°$ plates embracing stars to $16^m\!.5$–17^m. N. E. Kurochkin studied variables in the surroundings of S.A. 19, 42 and 110 [35, 23]. Using the plates obtained at the Engelhardt Observatory (near Kazan) with the 38-cm Schmidt telescope, D. Ya. Martynov studied the stars in S.A. 40 and N. B. Perova in S.A. 57 [23]. About 100 variable stars were discovered and investigated.

Systematic photography of S.A. 23, 24, 31, 37 and 39 continued at Engelhardt with the Schmidt telescope. A study of variable stars in S.A. 24 was started [23]. Bright variable stars are estimated on plates obtained with a short-focus camera.

G. Horn d'Arturo and J. Lacchini are studying faint variables discovered by them on plates, obtained at the Bologna Observatory by means of a reflector with a composite mirror of about 160 cm in diameter. The stars are studied in the declination zone $+43^\circ 50'$ to $+45^\circ 10'$ [36, 23].

At Mount Palomar F. Zwicky, together with the collaborators of the Lick, Steward and Bern Observatories, continued the search for super-novae. Two or three super-novae a year are discovered. These stars are photographed in ultra-violet, blue, green-yellow and red light by Zwicky with the 48-inch and 200-inch telescopes [23]. Photographic observations of super-novae were also carried out at the Sonneberg, Nanking and other observatories.

L. Detre, J. Balázs and other collaborators of the Konkoly Observatory in Budapest continue intense photographic observations of all the RR Lyrae type stars of the northern hemisphere brighter than 13^m5 in minimum, mainly for the study of the Blazhko-effect. L. Detre enclosed the following list of RR Lyrae type stars with secondary periods (Blazhko-effect). P_o and P_b are the main and the Blazhko-effect period, respectively. P'_b is the apparent period of the light curve variation.

LIST OF RR LYRAE STARS WITH SECONDARY PERIODS

	P_o	P_b	P_b/P_o	P'_b	P'_b/P_b	References
AC And	0^d525	0^d711	1·354	2^d04	2·9	Guman, unpublished
RV Ari	0·093	0·316	3·397	—	—	Broglia, Pestarino, *Mem. Soc. Astr. Ital.* **26**, 429; Detre, *Bp. Mitt.* 40
AI Vel	0·112	0·379	3·398	—	—	Walraven, *B.A.N.* **11**, 421, 1952
SX Phe	0·055	0·193	3·508	—	—	Walraven, *B.A.N.* **12**, 57, 1953
VZ Cnc	0·178	0·716	4·016	?	?	Guman, *Bp. Mitt.* 36; Fitch, *Ap. J.* **121**, 690
δ Sct	0·194	0·838	4·325	—	—	Walraven, unpublished
DQ Cep	0·079	0·375	4·754	—	—	Sahade, Struve, Wilson, Zebergs, *Ap. J.* **123**, 399
RW Cnc	0·547	29·6	54·7	91·1	3·05	Balázs, Detre, *Bp. Mitt.* **2**, 23
V 674 Cen	0·494	29·5	59·7	—	—	Hoffmeister, *Sonneberg Veroff.* **3**, 1, 1956
Y LMi	0·522	33·4	63·7	89·2	2·67	Balázs, *Bp. Mitt.* 39
AR Her	0·470	31·6	67·3	?	?	Balázs, Detre, *Bp. Mitt.* **8**; Oosterhoff, *B.A.N.* **10**, 123, 1946
RR Lyr	0·567	40·7	71·8	122·1	3·00	Walraven, *B.A.N.* **11**, 17, 1949; Balázs, Detre, unpublished
DL Her	0·592	49·2	83·1	—	—	Tsesevich, *Odessa Izv.* **3**, 257
SW And	0·442	36·8	83·3	—	—	Balázs, Detre, *Bp. Mitt.* 33
RZ Lyr	0·511	43·0	84·0	122·1	2·85	Detre, Guman, unpublished
S 4186 Ret	0·492	45·0	91·0	—	—	Hoffmeister, *op. cit.*
RW Dra	0·443	41·64	94·0	121·4	2·92	Balázs, Detre, *Bp. Mitt.* 27
RR Gem	0·397	48·3	121·5	?	?	Detre, unpublished
XZ Cyg	0·467	57·25	122·7	153·8	2·69	Muller, *B.A.N.* **12**, 11, 1953
RV Cap	0·448	?	?	222	?	Tsesevich, Ustinov, *Publ. Sternb. Astr. Inst.* **3**, 257
UV Oct	0·543	80·0	147·0	—	—	Hoffmeister, *op. cit.*
XZ Dra	0·476	76·0	160·0	—	—	Balázs, Detre, *A.N.* **271**, 231, 1941
RV UMa	0·468	91·1	195·0	—	—	Balázs, Detre, *Bp. Mitt.* 42 (in preparation)
RS Boo	0·377	537·0	1424·0	—	—	Oosterhoff, *B.A.N.* **10**, 101, 1946

[Editor's note: Bp. = Budapest.]

Studies of eruptive variables of RW Aur type, particularly those connected with the young stellar clusters, developed rapidly during the reported period. The studies of M. Walker, who investigated a number of such stars in the clusters NGC 6530, 6611, IC 5146 and particularly in NGC 2264, deserve to be mentioned in the first place [37]. L. Rosino and his collaborators investigated at Asiago more than eighty stars of the latter cluster [45]. About the same number of stars were investigated in this cluster by W. Wenzel at Sonneberg [27]. L. Rosino investigated over 180 variables in the Orion nebula (sixty-one of them were discovered by Rosino himself), in which (as in NGC 2264) he discovered several stars with extremely rapid light variations [46]. Eighty-eight variables of the Orion nebula were investigated at the Zô-Sè (Shi-Shang) Observatory by Li Tsing, Schen Liang-tzao and the author [38]. A number of stars with Hα-emission (more than fifty) in the Orion nebula were tested for variability by W. Götz in Sonneberg [23], Li Tsing, Schen Liang-tzao and the author at the Shi-Shang Observatory [47]. The majority of these stars were found to be variables. L. Rosino continues on photography of the regions near ζ and δ Ori, NGC 1999 and in Cassiopeia, Sagittarius and Scorpius for the study of RW Aurigae type stars [23]. G. Herbig at Lick and G. Haro at Tonantzintla, along with spectral investigations, discover and study RW Aurigae and T Tauri type stars, connected with young clusters and dark nebulae [23]. P. N. Kholopov in Moscow carried out systematic studies of stars with Hα-emission, discovered by G. Herbig in the IC 5070 nebula. V. P. Fedorovitch studies in Moscow similar stars in the region of ζ Ori [23]. A detailed investigation of the light curves of three typical and six non-typical RW Aur type stars of the southern sky was carried out by C. Hoffmeister [23]. Götz carries on photographic observations of stars in the clouds of dark nebulae in Taurus [23]. G. S. Badalian (Burakan) carried out investigations of colour variations of some T Tauri type stars [3, 38]. P. N. Kholopov obtained a summarized light curve of RW Aur [39]. J. Duncan published interesting material concerning the variable comet-like nebula NGC 2261 [40].

I. F. Alania (Abastumani) compiled a catalogue of colour-indices of 102 RR Lyrae type stars from photographic observations in two spectral regions and arrived at interesting conclusions [41]. G. S. Badalian continued the study of colour excesses of long-period cepheids [42].

J. J. Nassau, B. Westerlund, A. G. Velghe and M. S. McCarthy (Warner and Swasey Observatory) continued variable star studies in some regions of the Milky Way, 20 square degrees each. A number of new variables were found in these regions. It was shown that all stars of spectral classes M 7 and later are variables [23].

At the Cordoba Observatory Dessy continued photographic observations of variable stars in the Magellanic Clouds. About a thousand new variables were discovered, for a number of which the types and periods were determined. The identification of the newly discovered variables with former ones involves some difficulties [23]. A. Wesselink discovered at the Radcliffe Observatory a few new faint cepheids in the small Magellanic Cloud [23].

Ch. Bertaud continued a systematic search of new variables in different sky regions [23].

An extremely interesting study of novae in the Andromeda nebula was carried out by H. Arp at the Mount Wilson and Palomar Observatories [43]. W. Baade and H. Swope continued their extremely valuable studies of variable stars along the large axis of the Andromeda nebula [44, 23]. Systematic studies of novae and bright variables in Andromeda nebula are conducted in Asiago by L. Rosino.

PHOTO-ELECTRIC OBSERVATIONS

As mentioned earlier, co-operative two-colour photo-electric observations of three interesting stars—12 Lac = DD Lac, ν Eri and HD 217050 = EW Lac, initiated by C. de Jager, M. F. Walker and E. K. Kharadze, were successfully organized in the reported period. This is an indication that such co-operative works are possible and rational. The problem before us is to choose the most interesting objects and to try to organize such observations in the very near future.

As before, the greatest interest and attention of observers working with photo-electric photometers was paid to the eclipsing variables, belonging to the field of Commission 42. But nevertheless the most active observers of eclipsing variables deserve to be mentioned here: C. M. Huffer at Washburn; K. K. Kwee, who observed at Leiden fifty-seven total

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minima of seventeen variables of W UMa type; R. A. Bozula and M. I. Lavrov, who obtained a few thousand observations of eclipsing variables at Engelhardt; N. L. Magalashvili and J. J. Kumsishvili at Abastumani; M. Huruhata at Tokyo; G. Larsson-Leander at Stockholm; J. Rumz at Donnemara; M. W. Ovenden at Glasgow; G .Kron, with collaborators, at Lick; F. B. Wood, L. Binnendijk, W. Blitzstein at the Flower and Cook observatories; R. N. Koch at the Steward Observatory; F. B. Wood, who studies southern stars at the Mount Stromlo; H. Schneller in Potsdam; F. Lenouvel at Pic-du-Midi; E. M. Lindsay at the Boyden Station; A. Fresa in Naples. I am quite sure that this enumeration is not complete. I should like to underline particularly the publication of the numerous and valuable series of photo-electric observations of Nova DQ HER by M. F. Walker [48]. As a result of intense observations of eclipsing variables in various spectral regions F. B. Wood and his collaborators discovered evidence of intrinsic variability of components [23].

It would, perhaps, be true to say that during recent years particular interest has been paid to photo-electric observations of intrinsic variable stars of very different types. This fact is particularly agreeable to me, because I attempted for many years to draw the attention of all observers working with the photo-electric photometers to the necessity for these investigations.

O. J. Eggen continued his observations of numerous intrinsic variables. Several interesting stars were discovered by him during recent years [49]. M. F. Walker investigated the variability of red giants in globular clusters M 3 and M 92 [5]. By using the spectral observations of O. C. Wilson he studied the complicated changes of light curves of SX Phe and CC And [51]. C. E. Worley, together with O. J. Eggen, paid attention to the wonderful changes of the light curve of the cepheid TU Cas [52]. An explanation of these changes was found as a result of investigations by P. Th. Oosterhoff [53]. R. H. Hardie, on one hand, and W. S. Fitch, on the other, carried on three-colour photo-electric photometry in U, B, V systems of short-period cepheids RR Lyr, EH Lib and DY Her, which is very essential for the realization of the place of short-period cepheids among different stellar sequences [54, 55]. Systematic photo-electric observations of the RR Lyrae type stars are carried on by L. Detre, J. Balázs, A. Guman and others at the Konkoly Observatory in Budapest [56, 23]. At Lick G. E. Kron, S. N. Svolopoulos, and A. Balz commenced systematic observations of the magnitudes and colours of 18 RR Lyrae type stars: SW And, SW Aqr, AA Aql, SW Boo, RZ Cep, RR Cet, UY Cyg, XX Cyg, XZ Cyg, SU Dra, RX Eri, CE Her, VX Her, VZ Her, RR Lyr, RZ Lyr, RV CrB and ST Oph. Observations of var. N. 1 in M 92 are carried on besides and Svolopoulos carries on six-colour photometry [23] of FF Aq 1 and TVu 1. Numerous series of observations of short-period cepheids with variable light curves have been made by T. Walraven.

Much attention was paid to the β Cep and σ Sco type variables. Apart from the co-operative study connected with observations of variable stars DD-12 Lac and ν Eri, mentioned twice in this report, O. J. Eggen and A. R. Hogg at Mount Stromlo [57] and M. Huruhata in Tokyo, and some others, obtained observations of stars of this type.

Long-period cepheids attract at present much attention. P. Th. Oosterhoff with the aid of the photo-electric photometer mounted on the 74-inch reflector of the Radcliffe Observatory, obtained the magnitudes in maximum and the colours of 186 cepheids in the photometric system S. Practically all southern sky cepheids brighter than $12^{m}5$ were studied [23]. In 1955 J. B. Irwin obtained 1700 three-colour observations of 145 cepheids by means of the 24-inch refractor of the Cape Observatory and of the 74-inch reflector of the Radcliffe Observatory. Six-colour photo-electric photometry of northern cepheids is intended by M. Mianes at the Saint-Michel Observatory [23]. J. Bigay proposes to determine at the same observatory the magnitudes and colours of some northern cepheids in S.A. over 13^{m} in maxima [23]. S. C. B. Gascoigne, O. J. Eggen, E. J. Burr (Mount Stromlo) obtained the light curves of fifteen southern cepheids [58].

R. Jaschek (Lick) obtained observations of five northern cepheids, belonging to the spherical component of our Galaxy. S. C. B. Gascoigne carries on observations of a number of cepheids in the small and large Magellanic clouds and also of three cepheids in the globular cluster ω Cen [23]. A. J. Wesselink (Radcliffe Observatory) made photo-electric observations of super-super-giants ($M = -9^m$) in the Large Magellanic Cloud. These stars show slight light variations [23]. Observations of the stars S Dor [59] and HV 814 (RR Lyrae type) near the globular cluster 47 Tuc = NGC 104 [23] were also conducted.

K. A. Grigorian and R. K. Shakhbasian (Burakan) carried on three-colour photo-electric observations with simultaneous polarimetric measurements of μ, VV, RW Cep and AG Dra. The degree of polarization of the stars μ and VV Cep is variable [23]. Two-colour photo-electric observations of μ Cep were begun from November 1955 by G. Larsson-Leander in Stockholm. No rapid fluctuations were observed [23]. N. L. Magalashvili and E. K. Kharadze in Abastumani published photo-electric observations of the magnitude and colour of P Cyg in 1951–55 [60]. F. Lenouvel (Pic-du-Midi) published observations of several short-period cepheids, flare stars and two T Tauri type stars [61]. Flare stars were also the object of investigations of other photometrists. G. Jackisch (Sonneberg) started systematic observations of 150 constant stars aimed for micro-variability tests [23]. Study of the photo-electric magnitudes and colours of RV Tau type variables and yellow semi-regular variable stars was undertaken by F. E. Kameny [62].

Systematic photo-electric observations are intended at the Bamberg Observatory (RR Lyrae type stars, eclipsing variables and T Tauri type stars) and at the Wroclaw Observatory (short period variable stars) [23]. Systematic observations of 18 classical cepheids have been carried out at Heidelberg since 1956 by K. Bahner and L. Mavridis.

SPECTRAL INVESTIGATIONS

Detailed account of the results and achievements of spectral investigations of variable stars is the aim of Sub-Commission 29*b*. However, it is difficult to pass in silence the numerous investigations of variable star spectra. It was, therefore, decided to mention shortly some of them, not pretending of course to be exhaustive or objective.

J. J. Nassau, V. M. Blanco, D. Cameron continued at the Warner and Swasey Observatory their interesting classification of red stars in the Milky Way by means of photographs taken with an objective prism in the infra-red. Regularities of the distribution of M, C and S stars were studied [10, 63, 64, 65]. J. J. Nassau is constantly observing spectra of the following fifty-one red variable stars to study the changes of their spectra with phase:

List of fifty-one red variables

R And	RX Boo	GS Cas	AD Cyg	R Gem	W Per
W And	R Cam	T Cep	AF Cyg	R Hya	RZ Per
X And	T Cam	SZ Cep	AT Cyg	W Hya	R Ser
UX And	V Cnc	*o* Cet	BG Cyg	R Leo	U Ser
BG And	V CVn	R Cyg	CN Cyg	R UMi	R Tau
T Ari	R CMi	S Cyg	LX Cyg	R Lyn	R UMa
RY Ari	T Cas	W Cyg	V 449 Cyg	S Lyr	S UMa
U Aur	VY Cas	TW Cyg	χ Cyg	U Per	T UMa
R Boo	WY Cas	AA Cyg			

V. M. Blanco obtains infra-red spectra of stars by means of an objective prism. The classification of M, C and S stars from $16^m.5$ to $19^m.5$ (depending on colour) in fields studied by L. Plaut on the 48-inch telescope at Mount Wilson (see under Photographic Observations) has been begun by him.

P. C. Keenan, with collaborators, continues at the Perkins Observatory observations and investigation of spectra of Mira Ceti type stars (Moe-M5e) and semi-regular and irregular variables of spectral classes K–M. His purpose is a study of the effects connected with the luminosity and temperature [23]. Yoshio Fujita (Tokyo) investigated the spectra of several semi-regular variable stars and Mira Ceti type stars [23, 66]. Spectra of a number of carbon stars were obtained by Mannino at Asiago with a dispersion of 40 Å/mm near Hγ in order to classify and study the ratio C 12:C 13. Investigations of the peculiarities of the spectra of long-period variable stars were carried out by W. I. Iwanowska in Torun [23]. F. D. Miller investigated the infra-red spectrum of S UMi [67]. P. W. Merrill and J. Greenstein prepared a revised list of absorption lines in the spectrum of R And [68]. P. W. Merrill continued his remarkable work on Mira Ceti type and other low temperature stars. He studied in particular the existence of technetium in the spectra of some stars [69, 70]. W. P. Bidelman obtained eighteen spectrograms of bright Mira type stars for spectral classification [23]. W. S. Adams studied the shell-lines in α Ori spectrum [71], and A. J. Deutsch the circumstellar envelope of α Her [72]. M. W. Feast and A. D. Thackeray studied the spectra and radial velocities of red super-super-giants in the Large Magellanic Cloud [73]. M. W. Feast studied the spectra of three Me-stars in the globular cluster 47 Tuc = NGC 104 [23]. Dessy obtained at Cordoba several hundred spectra of long-period variables of the southern sky [23]. Systematic spectral investigations of μ Cep and ρ Cas were carried out by G. Larsson-Leander [23]. The work by W. P. Bidelman and A. McKellar is devoted to the double lines of ρ Cas spectrum [74]. R. F. Sanford published a detailed investigation of the AC Her spectrum obtained on the basis of coudé-spectrograms [76]. The spectral investigations of another RV Tau and U Mon star published by H. A. Abt [77] are of no less interest.

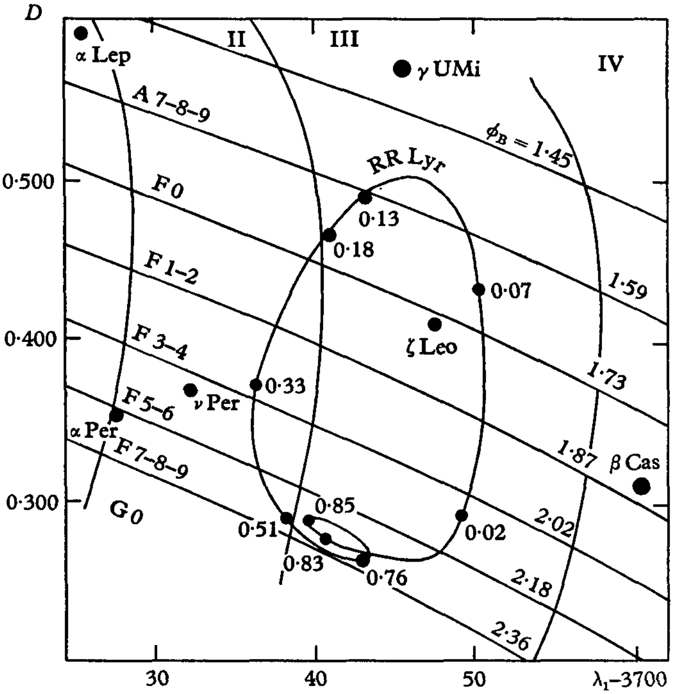
Much attention was paid to the spectral studies of long-period cepheids. Thus, a number of works were devoted by R. P. Kraft [78, 79] and M. and C. Jaschek [80, 23] to the study of H and K Ca II emission lines. About a third of the long-period cepheids show, at definite phases, emission components in the profiles of H and K lines. Probably, the percentage of emission stars is even greater in reality, because spectral observations of far from all cepheids studied in this respect fully embrace all the phases of radiation changes. M. W. Feast obtained spectra of several bright long-period cepheids in the Magellanic Clouds [81]. W. N. Abbott studied the behaviour of the ionized and neutral calcium in the spectra of bright cepheids, η Aql and ζ Gem [82]. R. F. Sanford obtained precise curves of radial velocity changes of T Mon and SV Vul [84].

The magnetic field of RR Lyrae was studied by H. W. Babcock. It was found to be variable ranging from +1170 to −1580 gauss [85]. H. A. Abt investigated the spectrum of VZ Cnc [87]. L. Gratton, Platzeck and Lavagnino obtained hundreds of spectrograms of AT Vel [23]. M. W. Feast obtained the spectrum of a RR Lyrae type variable in the globular cluster 47 Tuc = NGC 104 [23]. D. Chalonge, together with Miss A. M. Fringant, applied to RR Lyrae the three-dimensional spectral classification developed by the French astronomers [88]. Interesting conclusions about the peculiarities of spectral changes during the whole cycle of light variations of this star were obtained as a result. The projection of the spectral changes of RR Lyrae on the plane λ_1, D is given in the figure (the legend is due to D. Chalonge) [23].

Much work was devoted to spectral studies of β Cep and β CMa type stars. Curves of radial velocity changes of a number of this type of stars were published and continue to be studied by O. Struve and his collaborators J. Sahade, V. Zebergs and others [89-94, 23]. During the co-operative observations of DD-12 Lac spectrograms of this star were obtained by J. Sahade and his collaborators. J. F. Heard (David Dunlap Observatory) obtained more than 200 spectrograms of the star during the reported period [23]. A. van Hoof measured over 300 spectrograms of θ Oph obtained at McDonald, David Dunlap, Radcliffe and La Plata observatories. It was established that this star belongs to the β Cep type with period $3^h\,23^m$ and is besides a spectral binary with an eccentric orbit [23]. R. Wilson and H. Seddon [95] and O. Struve and J. Sahade [23] investigated the Hα emission in the spectrum of β Cep. Investigation of bright β Cep type stars of the southern sky was made by B. E. J. Pagel [96]. W. Buscombe and H. H. Gollnow determined at Mount Stromlo radial velocities of θ Oph and β Cru [23].

O. Struve, J. Sahade and others continued their spectral investigations of δ Sct type stars [97, 98, 99]. A detailed survey of modern knowledge about the spectra of α CVn type stars was published by A. J. Deutsch [100]. Besides a detailed description of the observational results some ideas are expressed connected with studies of the nature of these interesting objects.

Spectral investigations of novae were continued. Thus the spectrum of the slow Nova V 356 Aql (1936) was investigated by D. B. McLaughlin [101]. M. W. Feast investigated the spectrum of Nova V 1275 Sgr (1934) [102]. The high luminosity of Nova CP Pup (1942) was confirmed by R. F. Sanford and J. L. Greenstein by spectral investigation of this star [102]. Eight slit spectrograms of Nova DQ Her (1934) at light maximum (22 December 1934) obtained at Simeis by late G. A. Shajn are studied by E. R. Mustel and M. E. Bojartchuk. The curve of growth is constructed. The turbulent velocities do not exceed 10 km/sec, and the density of gases in the expanding nova estimated according to the width of hydrogen absorptions $H\beta$, $H\gamma$, $H\delta$ is found to be very low [23]. Emission contours in



Variation de RR Lyrae, en projection sur le plan λ_1, D. La figure représente, en projection sur le plan λ_1, D, la partie supérieure de la surface Σ (région des classes de luminosité II et III). Le long des courbes de séparation des sous-classes spectrales sont inscrits les ϕ_B.

the spectra of Nova DQ Her (1934) obtained by G. A. Shajn and V. A. Albitsky after light maximum are studied by E. R. Mustel and R. N. Kumajgorodskaya. The development of several contours is investigated from the point of view of the mechanism of excitation of atoms producing these contours. This investigation confirms the hypothesis suggested earlier by E. R. Mustel, that during the first phase after light maximum emission bands are the result of the continuous emission of atoms from the nova [23].

The work by W. S. Adams and P. W. Merrill [103] was devoted to the description of Mount Wilson spectrograms of the nova-like star P Cyg. On the basis of spectral studies of a nova-like star RR Tel in 1953 and 1954 A. D. Thackeray expressed his views on the evolution of slow novae [104]. The spectrum of this extremely interesting star and nova-like stars AG Car and GG Car are systematically investigated by Dessy and Sahade at the Cordoba Observatory. GG Car is at the same time an eclipsing variable [23]. L. Gratton (La Plata Observatory) carried on continuous spectrographic observations of the remarkable nova-like star η Car. During recent years some activity was revealed in the behaviour of this star [23]. L. H. Aller investigated the spectra of CI Cyg, AX Per [105], Z And and BF Cyg [23]. Ch. Bertaud (Saint-Michel) studies systematically the spectra of P Cyg and AG Peg [23]. Numerous investigations are devoted to Be-stars, for which the relations between spectral changes and light variability are not yet studied. A. B. Underhill (Dominion Astrophysical Observatory) paid particular attention in this respect to stars γ Cas, ξ Tau, *Pleione* and 48 Lib [23]. E. Vandekerkhove in Uccle, Mlle M. Bloch and Prof. Tcheng Mao-Lin in Lyon continued intense spectral investigations of nova-like Be and carbon stars.

Extremely interesting is the discovery made by A. Joy during the spectral study of the well-known nova-like star SS Cyg, which together with U Gem is the prototype of one of the most interesting groups of eruptive variables. It is found that SS Cyg is a spectral binary with a period of 0·276 days and the mass of its components is only a small fraction of the solar mass [106]. Joy's discovery and the detection of close duplicity of the classic nova DQ Her and the nova-like star AE Aqr are doubtlessly opening a new page in the study of this class of objects.

More and more attention is being paid to the T Tau and RW Aur type and flare stars. It is impossible to give here a detailed description of the numerous investigations by G. Herbig, G. Haro and their collaborators. We shall refer you to the Transactions of the Burakan Conference on Non-stable Stars [17] and its description by E. Schatzman [3]. Spectral investigation of XX Oph carried out by L. H. Aller and his numerous collaborators must also be mentioned [108]. Systematic spectrographic observations of R Mon, T Tau and RY Tau are carried on by L. H. Aller at the Michigan University Observatory [23]. High-power ultra-violet spectrographs to be used for intense spectral studies of T Tau type stars and associated nebulae are being designed by Th. Stecher at the same Observatory [23]. L. V. Mirzoyan (Burakan) studied the spectrum of AG Dra [109]. Spectro-photometry of several RW Aur type stars is conducted by E. K. Kharadze and R. E. Bartaya [23]. Ch. Bertaud systematically obtains since 1956 spectrograms of a number of nova-like stars and RW Aur type stars [23]. It is quite impossible to mention here all papers and notes devoted to spectral investigations of flare stars, novae and so on.

The description of numerous spectral studies of eclipsing variables is of no less difficulty and is beyond the domain of Commission 27. It is desirable to mention only the numerous papers devoted to the variable star W Ser, observations of which reveal most interesting physical processes besides the eclipsing effect [110].

OBSERVATIONS OF MOTIONS OF VARIABLE STARS

In accordance with the recommendations of the conference on co-ordination of galactic studies (Groningen, 1953) L. Plaut prepared a list of variable stars. It is desirable to determine their proper motions by comparing new plates with the old ones obtained for the International 'Carte du Ciel'. The same work was also started at the Observatories in Toulouse (as communicated by E. Paloque) [23] and in Catania, where according to P. Tempesti's communication a determination of proper motions of sixty-one long-period, twenty-two semi-regular variables and seven RR Lyr type stars on plates with a mean epoch difference of fifty-five years [23] has been conducted. Proper motions of a number of variable stars are determined at the Sternberg Astronomical Institute in Moscow by a comparison of plates obtained with a 38-cm reflector (focal length 6·6 m), with epoch difference of more than twenty years, and the positions in the 'Astrographic Catalogue'.

Determination of proper motions of 337 long-period variables is being made at the McCormick Observatory under the guidance of H. L. Alden and A. N. Vyssotsky. Plates obtained at McCormick and at the Yale Southern Station more than twenty years ago are compared with recently obtained ones [23]. Determination of proper motions of numerous cepheids is also planned by H. Eichhorn at the Georgetown Observatory [23].

M. W. Feast (Radcliffe Observatory) determined the radial velocities of practically all southern Mira Ceti type stars brighter than 10^m in maximum [23]. D. W. N. Stibbs (the same observatory) carried out radial velocity measurements of more than fifty long-period southern sky cepheids [83]. The radial velocities of fifteen RR Lyr type stars were determined by A. Joy at Mount Wilson [86], and of nine S stars by P. C. Keenan and R. G. Teske at Perkins Observatory [75].

GENERAL STUDIES, THEORETICAL AND STATISTICAL WORKS

It is hardly possible to give an exhaustive survey of such works in the field of variable star studies, because it is almost impossible to separate studies devoted to variable stars from those where they are only used as data or illustrations. Therefore I request readers once more to excuse the incompleteness of this survey.

Studies devoted to probability and to new methods of variable-star discovery have been made during recent years. First of all I should like to mention the investigation of J. Borgman; it is devoted to a description of the principle and the application of television technique for a comparison of two plates of the same region of the sky. Though the selection of a comparable pair of plates appears to be a very difficult task, further development seems to be very promising. At the same time J. Borgman worked on the problem of probability of discovery [111]. Some modification of the 'negative-positive' comparison method was suggested by N. E. Kurochkin. He advises the comparison of the positive copies of a pair of plates, because the difference of light streams from the star and background against a dark background is comparatively more noticeable, than that against a bright one. N. E. Kurochkin's method implies automatization of the comparison process by recording the photo-stream from the images of a given star on two compared positives [112]. A theoretical method for the calculation of the probability of discovery of various type variables was developed by Z. Kvíz [113].

An interesting investigation of the dependence of the period from the moments of minima for eclipsing variable stars was published by Z. Kopal and R. Kurth [114]. Z. Kopal prepared a monograph devoted to the theory of close binary systems, in which he proposes to give a theory of the period variation, to examine the light—and velocity-changes due to precession, to study the non-linear darkening at the limb and to give a theory of determination of the contact binary system elements [23]. M. A. Svechnikov published an interesting investigation of the period variations of eclipsing variables [115]. The question of gas streams in close binaries was investigated by V. A. Krat [116]. M. I. Lavrov published his investigation of a physical interpretation of some statistical regularities of eclipsing variable stars [117]. J. Mergentaler is calculating the limb darkening in reflected light, taking into consideration the turbulence of gases with high-temperature gradients. His results are much less as compared with those calculated by means of usual methods [23].

The detailed papers by D. A. Frank-Kamenetsky [118, 119] and S. A. Zhevakin [120] are devoted to a survey of our knowledge in the field of pulsation theory and to a description of new theoretical ideas. L. Gratton studied the general hydrodynamical problem of wave-motions in cepheids. A solution for the outer envelope in terms of the confluent hypergeometric function was obtained by him [23]. A. van Hoof analyzed all the known facts about β CMa type stars and came to the conclusion that they could be explained by the existence of an overtone pulsation next the fundamental one [23]. Interesting suggestions about the origin of possible sequences of unstable stars as a result of evolution of close binary systems were given by Su-Shu Huang [121]. Important ideas concerning masses of RR Lyr type stars were stated by A. Sandage [122].

The question of the zero-point of the 'period-luminosity' relation for cepheids continued to attract attention of scientists. W. Baade published a survey devoted to this problem, in which he gave a number of his own important ideas [123]. A detailed revision of a number of cepheid regularities, including the period-luminosity relation, was published by P. P. Parenago [124]. A series of investigations are devoted to the study of cepheid

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radii and the zero-point determinations on the basis of stellar radiation. Papers by C. Whitney [125] and A. Opolski and J. Krawiecka [158] must be mentioned in the first place. Critical opinion was expressed by J. C. Pecker [126]. Important ideas concerning the period-luminosity relation for cepheids of the spherical component and of its possible dependence from stellar composition were put forward by V. C. Reddish [127, 128]. A. W. Rodgers investigated the dependence of the radius variation from the type of galactic population to which a cepheid belongs. It was found that, contrary to cepheids of the flat component, those belonging to the spherical one show a rapid increase of the relative amplitude of radius variation with period, reaching the order of the radius at a 20^d period [129, 23].

A number of investigators expressed their idea of the existence of short-period cepheids in the flat component of our Galaxy. These were found to be dwarf cepheids (see for instance [130]). Few works were devoted to the study of period-luminosity relation of β CMa type stars (see for instance [131]).

The use of cepheids in the studies of the structure and dynamics of our Galaxy was continued. D. W. Stibbs carried out an extremely important and convincing work devoted to the study of the differential rotation of the Galaxy based on the analysis of radial velocities of about 200 cepheids [132]. L. Perek studies the short-period cepheids (RR Lyrae type stars) with hyperbolic galactocentric velocities [133]. P. Notni published quite recently an extremely detailed study of absolute magnitudes and kinetic properties of RR Lyrae type stars subsystem [134].

L. Gratton communicated that the study of amplitudes of light- and radial-velocity curves leads to the discovery of different dependences for cepheids of different origin. Thus the amplitudes of the flat component cepheids are connected by the relation $\Delta V(\text{km/sec}) = 3{\cdot}6 + 31{\cdot}7\,\Delta m$ and of the spherical component cepheids by the relation $\Delta V(\text{km/sec}) = 3{\cdot}6 + 48{\cdot}9\Delta m$ [23]. L. Gratton established also that the 'period-luminosity' relation is different for each of the two groups of long-period cepheids and is quite different for that of RR Lyrae type stars [23]. A number of important ideas about the galactic population were given by W. Iwanowska [156].

S. van den Berg investigated the distribution of cepheids according to their periods in the galactic field, in some globular stellar clusters and in the nucleus of the Galaxy [23]. Landi found that the distribution of cepheids in the Magellanic Clouds and our Galaxy is different, which he explained by different stages of their evolution [23]. Special distribution of cepheids was studied by R. Jaschek [135]. Studies by P. P. Parenago [136] and the present author [137] were devoted to the search for regularities in the period variations of cepheids and RR Lyrae type stars. They arrived at the conclusion that the O–C values are best represented by means of separate straight lines. A definite relation between the value which characterizes the period instability and the lengths of the period was discovered. This dependence is different for cepheids belonging to different components of the Galaxy [135]. Properties connected with the Blazhko-effect in RR Lyrae type stars were studied by L. Detre [138] and L. A. Klepikova [139]. O–C diagrams of about 200 RR Lyrae type stars were studied by L. Detre. These diagrams are very simple for stars with stable curves (RRa) and complicated for stars with the Blazhko-effect and with RRc type light curves [23].

An important investigation of cepheids was carried out by R. Canavaggia. She developed a method for the determination of the relative reddening of cepheids belonging to the flat component by comparing their light curves obtained by six-colour photometry. If we consider the absorption of some cepheids to be known, absolute values of absorption and reddening can be obtained. This method allows consideration of the light absorption not only statistically, but individually for each cepheid [23, 140].

D. W. N. Stibbs published an important study about the real colours of galactic cepheids [141]. In accordance with P. Parenago's and R. Canavaggia's conclusions it was found that the real colour of cepheids deduced by O. J. Eggen contained a systematic error.

A detailed comparative study of colours and magnitudes of cepheids in the Galaxy and in the Magellanic Clouds was carried out by S. C. B. Gascoigne and O. J. Eggen. They deduced improved colour excesses and light absorption values for fifty-five cepheids, revised the value of rotational constant A, and obtained a correction of -1.7 magnitudes for the 'period-luminosity' relation of Shapley [23].

An interesting work on the zero-point determination of spectro-photometric gradients of stars by a reference to cepheids was accomplished by O. A. Melnikov [142].

D. H. McNamara and A. D. Williams investigated the colours of β CMa type stars [143].

G. S. Badalian investigated the connexion between spatial distribution of interstellar neutral hydrogen and long-period cepheids and found that it was a genetical one [144].

V. S. Safronov carried out a detailed investigation of the kinematics of Mira Ceti type variable star sub-system [145]. W. Osvalds and Risley (McCormick Observatory) began a determination of secular parallaxes, absolute magnitudes and spatial distribution of 337 Mira Ceti type stars, for which proper motions were deduced [23]. P. W. Merrill noticed that a more or less durable light constancy in minimum brightness is characteristic of some Mira Ceti type stars. He explains this phenomenon by the presence of a close satellite [146].

P. N. Kholopov studied the problem of the presence of variable stars in open clusters. He came to the conclusion that contrary to the present opinion, irregular and semi-regular variables, eclipsing variables, α^2 CVn type stars and perhaps long-period cepheids are met in open clusters [147]. The latter conclusion was confirmed by G. Wallerstein [148], S. van den Berg, R. P. Kraft [23] and others.

The spatial distribution of irregular variables was studied by J. Stohl (Czechoslovakia) who concluded that they belong to the intermediate component of our Galaxy [155].

C. Payne-Gaposchkin expressed a number of interesting ideas about the relation between different types of variable stars and their emission [110].

The investigation of the Crab nebula—remnant of the 1054 A.D. super-nova—is extremely important. Many investigations were carried out in this field and a sufficiently full critical survey of them can be found in the papers by L. Woltjer [149]. W. Baade, G. R. Burbidge, F. Hoyle, E. M. Burbidge, R. F. Christy and W. A. Fowler expressed their interesting ideas about the probable significance of Californium 254 in the phenomenon of super-nova stars [150].

E. R. Mustel investigated the magnetic fields of novae; he showed that magnetic fields explain the following features observed in the envelopes ejected by novae: (*a*) 'polar caps' in the envelopes and generally the so-called 'doubling' of new stars. (*b*) Equatorial belts and rings observed in these envelopes (Nova Her 1934, Nova Aql 1918, etc.). These belts and rings are the result of continuous ejection of gases from novae after light maximum. Gases ejected in all directions are deflected towards the equator by the magnetic field of the nova [157].

On the basis of observational data E. R. Mustel investigated the chemical structure of the interiors of novae. The gases producing the Orion spectra of novae are ejected from more inner parts of the star than the gases forming the principal envelope. Therefore comparing the chemical composition of the polar caps and of the equatorial rings (or equatorial belt in those cases where there is no bifurcation of the belt) we can establish a possible difference between the inner and outer parts of the nova. This problem is discussed in application to Nova Aql 1918 and Nova Her 1934. The principal result of this investigation is that such a difference does exist, the nitrogen is more abundant in the inner parts of the nova than in the outer ones. The existence of this difference may be explained if we again introduce noticeable magnetic fields. The latter suppress the convective motions inside the star [23].

Interesting ideas concerning the physical processes in novae and super-novae were published by Z. Kopal and W. H. Ramsey [151].

A revision of the dependence of the absolute magnitude of a nova in maximum and the degree of its light decrease was undertaken by W. Buscombe and G. de Vaucouleurs. They show that practically all novae reach absolute magnitude of $-5^{m}.2$ by the fourteenth day after their maximum [152].

V. A. Ambartsumian carried out calculations confirming the explanation of the continuous emission of non-stable stars as a result of radiating relativistic electrons in magnetic fields [153].

A number of important ideas on the nature of galactic radio emission and on supernovae as sources of radio emission were given by I. S. Shklovsky (see, for instance, his monograph, [154]).

RECOMMENDATIONS

Letters connected with the preparation of the second edition of the *General Catalogue of Variable Stars* and the Report of the Commission contained a number of suggestions. As a result of their analysis the following recommendations can be formulated:

(1) Taking into account the success of co-operative photo-electric observations of DD Lac, ν Eri and HD 217050 it is recommended that Commission 27 assists such work in future. In the first place attention must be paid to flare stars, β CMa, T Tau and also variables of well-studied types, but particularly of those deserving special attention. The President of Commission 27 is recommended to prepare: a list of observatories and observers who desire to participate in such observations, with an indication of the average number of 'photometric nights' per year; and a list of stars for co-operative observations (suggested by M. Huruhata, A. V. Nielsen, A. A. Opolsky, M. Petit, V. P. Tsesevich and M. F. Walker).

(2) It is recommended that systematic photographic or visual observations of RR Lyrae type stars brighter than 13·5 be organized to obtain at least one epoch of maximum per year. The participation of observers and observatories in the southern hemisphere is particularly desirable. The aim of this work is the collection of mass information on the character of slow changes of the periods of RR Lyrae type stars (recommended by A. Batrev, L. Detre, A. Soloviev, V. Tsesevich).

(3) The large work connected with the publication of maps of variable star surroundings has already been carried out, but a number of requests are still being received. It is suggested that, besides maps, the co-ordinates of new variable stars be given (V. M. Blanco). Publication of photographic (half-tone) charts rather than drawings is recommended (M. F. Walker). For future photo-electric observations it is desirable to show even the faintest stars in the closest vicinity of variables (M. F. Walker). To simplify identification of faint variable stars it is recommended that sky-survey maps be published (A. A. Wachmann).

(4) For a more exhaustive study of the phenomena of spectral changes it is recommended that: accurate photo-electric determinations of magnitudes and colours of representative Of and Be stars with variable bright line spectra be organized (P. Swings); systematic observations be made of the red variables for which spectral observations of these stars are being conducted (see list above) (J. J. Nassau); systematic observations of peculiar A stars be continued (D. Hoffleit); closer contact with Commission 29 be established (suggested by a number of members).

(5) It is recommended that, together with Commission 25, a closer contact be established with professional observatories in the determination of photo-visual magnitudes of comparison stars for variables not included into the programmes of observations of amateur associations. Many observers, for instance those who enter the A.A.V.S.O., will gladly extend their programmes (M. Mayall).

(6) It is recommended that more use be made, in variable star studies, of large plate collections such as that of the Harvard patrol, Milky Way Survey, attracting visiting astronomers to this work as much as possible (D. Hoffleit, B. Kukarkin).

(7) It is recommended that interested observatories be requested to organize a possibly uninterrupted observation of flare stars, for example, by means of photography of star traces. Bright flare stars AD Leo, DO Cep and EV Lac may be recommended in the first place (D. M. Popper, M. Petit).

(8) The attention of Commission 42 to be drawn to the necessity of observing eclipsing variables, possibly always in two spectral regions (D. M. Popper).

(9) As the total number of works connected with the discovery and study of variable stars is becoming unmanageably large, it is recommended that the discovery of new variables be undertaken for certain specific purposes rather than at random. These works should be directed in the future to:

(*a*) the discovery of extremely rapid variables, both intrinsic and eclipsing binaries;

(*b*) the discovery of variables for the purpose of the study of galactic structure, such as the Palomar-Groningen survey of RR Lyrae stars;

(*c*) systematic search for variables related to problems of stellar evolution, such as T Tauri variables;

(*d*) systematic multi-colour photo-electric observations of selected variables from all parts of the H–R diagram (M. F. Walker).

(N.B. It should be noted that variable star studies are progressing in the directions pointed out by M. F. Walker, which is supported by Commission 27. Studies of variables brighter than 12^m must not in our view be curtailed. Restriction of the initiative of variable star observers unable to follow the directions indicated by M. F. Walker seems to be premature.)

(10) It is desirable that systematic multi-colour (three-colour for example) photographic observations of selected regions of the sky, of interest for the studies of the Galaxy, be organized in order to obtain the physical properties of different types of variables (D. Hoffleit, F. J. Heyden). The colour systems of all published series of variable star observations should be determined with possibly higher precision (I. M. Istchenko).

(11) It is recommended that efforts be applied to obtain, in some variable-star fields, infra-red spectra such as J. J. Nassau has been obtaining at the Warner and Swasey observatory (D. Hoffleit).

(12) When publishing lists of newly discovered variables, data should be given indicating precisely the degree of completeness of the search (D. Hoffleit).

(13) A published initial epoch of a variable star should be an observed epoch rather than an E_0 chosen for convenience of machine calculation, plus a fraction of the period (B. S. Whitney).

(14) To request the publishers that personal copies of the following publications be mailed to all members of Commission 27; (*a*) *General Catalogue of Variable Stars* with supplements and their English versions, (*b*) Bulletin 'Variable Stars', (*c*) *Geschichte und Literatur der Veränderlichen Sterne* (W. J. Miller).

(15) It is desirable to resume publication of the ephemeris of RR Lyrae type stars (V. P. Tsesevich).

(16) It is desirable to publish new tables for the conversion of geocentric to heliocentric time (V. P. Tsesevich).

B. V. KUKARKIN
President of the Commission

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27 *b*. SUB-COMMISSION ON VARIABLE STARS IN GLOBULAR CLUSTERS

This is the first report of the Sub-Commission which was formed at the ninth General Assembly of the I.A.U.

The study of variable stars in globular clusters has proceeded along the following main lines: (1) discovery of new variables; (2) derivation of periods; (3) determination of period or light-curve changes; (4) determination of light curves of high precision; (5) spectroscopic investigations; (6) relation of variable star branch to main branch in colour-magnitude diagram.

At the Dublin meeting, 'A Second Catalogue of Variable Stars in Globular Clusters, comprising 1421 entries' by H. B. Sawyer [1] was just off the press. This summary showed that seventy-two out of the 107 clusters then recognized as globular had been studied for variables. Periods were known for 843 stars in thirty-eight clusters. About 90% of the

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Among the more significant features noted since 1955 in published material, or unpublished, communicated to this Sub-Commission are:

(1) and (2) *Discovery of new variables, and derivation of periods*

The number of clusters searched has increased to seventy-eight, with 119 clusters now recognized as globular. About 100 new variables have been added, of which thirty-two are published. The southern clusters NGC 5824 and 6715 have been found by Rosino to be especially rewarding, with twenty new variables found in the former and more than thirty in the latter. Discovery of two slow variables by Rosino at Asiago in Hubble's cluster (Abell no. 4) with an assumption of their absolute magnitude, leads him to derive a distance of 98 kpc for this cluster, the most distant cluster associated with the Galaxy known to contain variable stars. In the faint cluster Abell no. 13, Rosino has found four RR Lyrae stars of median magnitude 18·0, and notes a peculiar absence of red giants. In the important distant cluster NGC 7006 in which variables have been known for years, for the first time actual RR Lyrae periods have been determined, by Rosino and associates [2]. New variables and periods have also been found in the long-neglected cluster NGC 4147, by Sandage and Walker [3] and Newburn [4].

(3) *Period changes*

For many years the cluster Messier 3 has been most intensively investigated for period changes. Further determinations by Roberts and Sandage [5] confirm earlier results, while M 15 has been similarly studied by Mannino [6].

(4) *Light curves of high precision*

Arp at Mount Wilson in his study of the more important slow variables [7] has done especially long and consecutive work in following variables in two colours over a period of months. The determination of the period-luminosity relation in globular clusters faces the problem of the small number of requisite variables in any single cluster (except ω Centauri). Attempts to add up material from cluster to cluster involve assumptions of an important nature. Sandage, Arp and collaborators at Mount Wilson and Palomar are working on light curves in different colours for NGC 7006 and 5272, while ultra-violet light curves in NGC 5272 have been published by R. H. Baker and H. V. Baker [8].

(5) *Spectroscopic investigations*

Of particular importance are those by Thackeray on the spectra of the three long-period variables in 47 Tucanae, which prove that these are actually members of the cluster, but that their absolute luminosities are considerably fainter than Shapley's earlier estimates. Studies by Wallerstein at Mount Wilson of the two 26-day cepheids in M 5 show that no. 84 has alternating behaviour in its radial velocity curve.

(6) *Relation of variable star branch to main sequence*

Schwarzschild's results in 1940 for M 3 [9] have been confirmed in all other clusters so far examined, namely, that the RR Lyrae variables fall in a certain gap in the colour-luminosity diagram. For a star in a globular cluster to become unstable and oscillate, its radius, luminosity and probably chemical composition must lie within certain limits. The boundaries of this variable star gap are shown to be sharp in M 3 by Roberts and Sandage [5] and in M 92 by Walker [10]. The position of the cluster gap with respect to the main sequence is one of the more important problems of clusters. The Hercules cluster, M 13, differs from some of the others [11], but there is a scarcity of well-determined RR Lyrae stars for a firm comparison. Sandage suggests that the difference in mean period for RR Lyrae stars in different clusters is caused by the horizontal branch in those clusters being at a different absolute magnitude.

Related investigations

(a) Variables in globular clusters in external systems

Although the intent of this Sub-Commission was the study of variables in the globular clusters belonging to the Galaxy, we wish to note the valuable and interesting expansion of this subject in the work of Thackeray and Wesselink at Radcliffe Observatory in discovering variables in globular clusters associated with the Magellanic Clouds [12], and in determining periods. In NGC 121 in the Small Cloud, Thackeray has derived light curves for eight variables [13]. Those for three RR Lyrae variables conform to the pattern in globular clusters, rather than in the galactic nucleus. Near the Large Cloud, Wesselink now has a total of thirty-seven variables in NGC 1466, while NGC 2257 is proving moderately rich in short-period variables.

(b) Variables in galactic clusters

For years galactic clusters have been cited as systems which lack variables, in contrast to globular clusters which contain large numbers of them. An interesting development since 1955 has been the proof by Irwin [14], Stibbs [15], Feast [16] and Kraft [17], following the early suggestions of P. Doig thirty years ago [18], that galactic cepheids are present in some galactic clusters, as U Sgr in M 25 and S Nor in NGC 6087. This, with the presence of large numbers of T Tauri variables in some nebulous clusters [19] means that variables are present in galactic clusters. However, the type of variable most frequent in globular clusters—the RR Lyrae stars—does seem to be absent in the galactic. A worthwhile project would be to co-ordinate the variables in galactic clusters in a manner similar to the catalogues of variables in globular clusters.

Miscellaneous

(*a*) Unpublished work by H. Wilkens of La Plata indicates a linear relation between the diameter of a cluster defined by variables and the luminosity of the clusters.

(*b*) Arp suggests that workers concerned should reconsider the classification of variable star types, to modify or redefine the groupings. He states the terminology of cepheid, classical, RV Tauri, RR Lyrae, W Virginis means different things to different people.

(*c*) A new catalogue of globular cluster variables will be published by the writer when sufficient new material has accumulated to warrant it.

Clusters under intensive investigation at present

The appended table gives an overall picture of these clusters, indicating places and observers. It should be used as a supplement to Table 3*a*, *Trans. I.A.U.* **9**, 548, 1955, as material given in detail there is not repeated. Some work is going on in a number of other clusters which are not listed here.

Globular clusters currently under investigation for variables

NGC		NGC	
104	Wilkens, Stoy and Arp, Thackeray	6229	Asiago
3201	Wilkens	6273	Pretoria and Asiago
4147	Mannino, Sandage, Walker, Newburn	6304	Asiago
4372	Wilkens	6397	Wilkens
5024	Wachmann	6402	Sawyer
5139	Wilkens, Stoy and Arp	6426	Asiago
5272	Budapest, Moscow, Arp	6541	Wilkens
5824	Asiago	6544	Sawyer
5904	Wilkens, Wallerstein	6558	Asiago
5986	Asiago	6569	Asiago
6093	Sawyer	6656	Wilkens, Arp, Sawyer
6121	Wilkens	6712	Asiago, Sawyer, Harwood
6205	Arp	6715	Pretoria

Globular clusters currently under investigation for variables (cont.)

NGC		NGC	
6717	Sawyer	7006	Rosino, Sandage
6752	Wilkens	7078	Budapest, Asiago, Connelley and Sandage
6779	Asiago, Roberts	IC 1276	Sawyer
6838	Sawyer	Abell 4	Rosino
6864	Pretoria and Asiago	5	Asiago
6934	Sawyer	13	Rosino
6981	Asiago		

At Asiago (Padova), Rosino, Mannino, Grubissich, Nobili; at Bergedorf, Wachmann; at Cape, Stoy; at David Dunlap, Sawyer; at La Plata, Wilkens; at Lick, Roberts; at Maria Mitchell, Harwood; at Mount Wilson and Palomar, Arp, Sandage, Wallerstein, Walker, Newburn, Connelley; at Radcliffe (Pretoria), Thackeray, Wesselink, Rosino.

HELEN SAWYER-HOGG

President of the Sub-Commission

Supplement

Dr Kukarkin has requested that the following information, which he was not able to communicate to Dr Sawyer-Hogg in time for inclusion in her report, be added.

Dr van Agt (Leiden) is working on plates for NGC 4590 and 6266, obtained in 1950 by P. Th. Oosterhoff with the Radcliffe 74-inch refractor.

Li Tsing, with Schen Liang-tzao, of the Purple Mountain Observatory, near Nanking, obtained over eighty photographs of NGC 7078 = M 15 with the 60-cm reflector; and has started magnitude measurements.

P. N. Kholopov (Moscow) investigated the distribution of the density of variable stars in globular clusters M 15 (*Variable Stars*, no. 5, 1955) and M 4 (*Astr. J. Moscow*, **33**, no. 1, 1956).

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COMMISSION 27

Report of Meeting. 15 August 1958

PRESIDENT: B. V. Kukarkin.

SECRETARY: P. N. Kholopov.

TRANSLATORS: S. Gaposchkin and E. Rybka.

The President asked members to stand for a few moments in memory of the late Prof. S. N. Blazhko.

DISCUSSION OF THE DRAFT REPORT

Dr H. Shapley suggested that the Report as a whole should be adopted. Some small corrections to the Report had been forwarded in writing and would be incorporated.

The *Draft Report* was accordingly adopted.

FINANCIAL MATTERS

(1) The President asked Commission 27 to support the recommendation that a sum of $500 be allocated for the preparation of the English version of the Remarks to the second edition of *The General Catalogue of Variable Stars*. There being no objection, the Commission supported the recommendation (resolution no. 46).

(2) Dr W. Strohmeier had applied to the Commission for financial aid for the work of systematic searches for bright variable stars at the Bamberg Observatory. There are many photographs of different areas of the sky, obtained at the Observatory in 1932–9. A number of bright variable stars had been discovered by workers of the Bamberg observatory on these plates, but the projected programme cannot be completely realized at Bamberg. Repeated photography of all areas is needed. For the purchase of plates and increasing the number of observers the Observatory needs an additional allocation of $450 a year. Prof. V. P. Tsesevich said that the investigations conducted at the Bamberg Observatory are extremely interesting and recommended supporting Dr W. Strohmeier's application.

The recommendation was accepted and incorporated into Resolution no. 51.

DISCUSSION OF THE PRELIMINARY RESOLUTIONS

(1) No objections.

(2) Prof. V. P. Tsesevich raised the question of by whom the work would be carried out, and stated that the Odessa Observatory could undertake the recording of the organized work, its planning and co-ordination.

Dr H. Shapley pointed out the necessity for an analysis of the period-variations of RR Lyrae-type variables. Therefore at least three, and not one, epoch of maximum should be determined for every star. Dr Shapley seconded Prof. Tsesevich's suggestion.

Prof. Tsesevich stated that about 200–300 observations will be received for each star each year. It will therefore be possible to investigate the Blazhko effect for any star. Dr M. Walker wished to know how many such stars there are up to $13^{m}_{\cdot}5$, and Prof. Tsesevich answered, about 400; thus only the co-operation of many observers can solve the problem.

Prof. B. V. Kukarkin provided the information that observations of the RR Lyrae-type variables are carried out in Budapest, Odessa, Rostov-Don and Peking Planetarium. The suggestion by Prof. Tsesevich on the co-ordination of their activity in this field was much to be welcomed. Dr P. Ahnert said that he would be able to take part in this work at the Sonneberg Observatory.

Prof. Tsesevich asked all observatories taking part in this work to inform the Odessa Observatory about their plans.

All the suggestions were accepted.

(3) No objections.

(4) Prof. Tsesevich stated that it is very difficult to observe the red variables, discovered by J. J. Nassau and contained in the Catalogue of Stars suspected of variability, if their photographic magnitudes are not known. The President explained that in this respect the resolutions concerned only the old variable stars and suggested that the point be introduced in a further recommendation.

Prof. Tsesevich asked that attention be given to RZ Psc—the mysterious star, probably of the *Algol* type; continuous observations of this star in the course of a whole season are needed. Prof. C. Hoffmeister said that this star probably belongs to the BO Cep type. Prof. Kukarkin said that, according to Dr G. Herbig, its spectral type is G 8 V without emissions; the photometric behaviour of this star is very similar to that of BO Cep and BH Cep (the RW Aur-type stars) which could be regarded as stars similar to Algol.

(5) Mrs M. Mayall said that some stars cannot be observed by the A.A.V.S.O. members, because of the lack of identification maps and magnitudes of the comparison stars, and stated that such maps had already been prepared by her for six stars, which were not observed previously. The President thanked Mrs Mayall for her activity in this field.

Dr S. Gaposchkin announced that he has many sequences for different variable stars, and intends to prepare photographically sequences for faint variable stars, both photographic and photovisual. Mrs M. Mayall said that Dr F. M. Bateson (Cook Islands, South Pacific) is also preparing such sequences. Co-operation with him would be very useful.

(6) Prof. C. Payne-Gaposchkin explained her plan to use personally the Harvard collection of photographs for the study of faint variable stars. To realize this plan about two million estimates are needed. She added that every visitor who would like to use the Harvard collection of plates to estimate the brightness of variable stars will be welcomed. The President thanked Prof. Payne-Gaposchkin for this information.

Dr D. M. Popper said that it would be desirable to obtain information about the behaviour of a given variable in a definite time. Such information is not only needed by the variable star observers, but also by astronomers working in other fields. Prof. Payne-Gaposchkin considered that such information could be given by Harvard Observatory, but that the small staff of the Observatory would not permit a sufficiently prompt answer to all questions to be given. Prof. Kukarkin mentioned that this work is organized rather efficiently in the Soviet Union.

The recommendation was accepted.

(7) Dr Popper wished to know further details of the suggestion made by Dr M. Petit. In reply, Prof. Kukarkin said that a small group for systematic observations of flare stars had been organized by Dr Petit. Dr M. Mayall said that flare stars are also observed by A.A.V.S.O. members.

Dr V. Oskanian said that observations of the light-polarization of these stars are very desirable and recommended that this point be added to the resolutions; the suggestion was accepted.

(8) No objections.

(9) The President said that a discussion of this recommendation would probably give no positive results. Dr Walker's doubts are quite clear. However, it is necessary to distinguish between problems of the investigation of bright variables, the variables in the Selected Areas, and problems connected with Dr Walker's suggestion (that is, preferably, an investigation of the special types of variables). Prof. Payne-Gaposchkin agreed with this opinion; investigation of a large variety of variable stars must not be restricted.

(10) No objections.

(11) Dr W. Bidelman said that he would like to know the purpose of this recommendation. The President explained that such observations must be made not only in the Nassau's fields, but also in other fields where variable stars are studied, for the completeness of the data about the possible number of late-type variables in the given fields. Dr V. Blanco announced that such work is already being done.

(12) No objections.

(13) Prof. Tsesevich supported this recommendation.

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(14) The President announced that *The General Catalogue of Variable Stars*, the Supplements to them and the Bulletin *Variable Stars* are being distributed now and will be distributed henceforth to all members of Commission 27. As far as it is known all members of Commission 27 also receive the issues of the *Geschichte und Literatur des Lichtwechsels der Veränderlichen Sterne*. Therefore the inclusion of this point in the resolutions is unnecessary.

(15) Dr K. Kordylewski suggested that the ephemerides of the RR Lyrae-type stars be combined with the ephemerides of eclipsing variables edited by the Krakov observatory and agreed to carry out this work. The precision of the ephemeris will be up to $0^{d}01$. There was no objection. The question whether the epoch of maximum brightness, or the epoch of some point on the ascending branch of the light-curve, should be given will be solved by the authors of the ephemerides.

(16) The President suggested that the realization of this proposal be referred to the Variable Star Commission of the Academy of Sciences of the U.S.S.R., the latter already having definite plans on this question. There being no objection, this was agreed.

MISCELLANEOUS

Dr L. Gratton announced that the Córdoba observatory owns two large-field cameras and might start a programme for the discovery of new variables in the southern hemisphere. The main difficulty consists of obtaining government permission for importing the plates. Dr Gratton considered that a vote by Commission 27, stating that these observations are of importance, might help to obtain general permission for import, like the one given for the I.G.Y. scientific materials.

The President stressed the high importance of variable-star discovery in the southern hemisphere and supported the suggestion by Dr Gratton.

(These recommendations are incorporated in Resolutions nos. 46 to 52.)

Report of Meeting of Sub-Commission 27b. 15 August 1958

PRESIDENT: H. Sawyer-Hogg.

SECRETARY: L. Rosino.

The discussion opened at $12^{h}\,00^{m}$. The *Draft Report* was approved after correction of certain misprints. The President said that there have been in the past three years several interesting developments in the field of variable stars in clusters, namely (1) discovery of very distant intergalactic globular clusters, and variables in them; (2) study of variable stars in globular clusters of the Magellanic Clouds; (3) discovery of cepheid variable stars in galactic clusters.

L. Rosino spoke on the work on variable stars in globular clusters carried out at Asiago, and on photographic material taken at the Radcliffe Observatory at Pretoria in June and July 1956. Of many clusters under investigation (as noted in the report) three appear to be very rich in variables, NGC 5824, NGC 6715 (M 54) and NGC 6864 (M 75). In M 54, in addition to the twenty-eight variables previously announced, fifty-four new variables have been found. There is little doubt that many undiscovered variables are still present in the unresolved central part of the cluster, so that this cluster in Sagittarius is one of the richest in variable stars. Of eighty-two variables, fifty-nine belong certainly to the RR Lyrae type; one is a cepheid with period of $1^{d}35$; four are semi-regular and two (certainly field stars) are eclipsing variables. The distribution of the median photographic magnitudes shows that the majority of the RR Lyrae stars belong to the cluster. Preliminary elements have been derived for 34 RR Lyrae variables and light curves are given for twenty-seven of them. The periods fall in the interval $0^{d}5$–$0^{d}6$. It may be interesting to remark that the two clusters M 69 and M 70 very close to M 54 appear poor in variable stars.

Rosino also reported on the current work with the 120-cm reflector at Asiago on NGC 4147 and NGC 6229 (Mannino), NGC 6712 (Nobili and Rosino) and several faint clusters of the Abell list. He called attention to the work in the inter-galactic globular cluster Abell no. 4 with two slow variables (noted in the *Draft Report*) with a modulus of 20·2, and in Abell no. 13 with four bright RR Lyrae stars, which is remarkable in a complete absence of giant components and a very peculiar luminosity function. The faint cluster of Shakhbazian at R.A. $10^h\ 52^m\!.0$, Dec. $+40°\ 44'$ (1950) is also under investigation at Asiago.

Feast reported on the radial velocity observations and spectroscopic work on stars of 47 Tucanae at the Radcliffe Observatory. Six long-period variables have been studied. Three are regular, with periods about 200 days and luminosity classes I*b*–II; three are irregular with luminosity classes II–III. The spectra are M 2–M 3 and spectroscopically the regular variables appear indistinguishable from galactic Me variables of about the same period. The regulars and one irregular show H emission. Two short-period variables quite close to the centre of the cluster are shown to be RR Lyrae stars and cluster members. In answer to a question by Dr Shapley, Feast replied that their magnitudes are consistent with the distance modulus 13·5–14·0 adopted at Pretoria for 47 Tucanae. In reply to a question by Mrs Gaposchkin, Feast stated that the spectra and radial velocities of the three long-period variables are normal.

Feast also reported on RR Lyrae stars in the globular clusters of the Magellanic Clouds, describing Thackeray's work in NGC 121 (see *Draft Report*) and noting that two short-period variables have been found in NGC 1978 and forty-five variables are now known in NGC 1466, both clusters belonging to the Large Cloud.

Feast further commented on the radial velocity work at Pretoria which identified the classical cepheids U Sgr and S Nor as members of M 25 and NGC 6087 respectively, and stated that while various workers have suggested other clusters with cepheids, radial velocity work is very desirable to form a definite conclusion.

Jaschek of La Plata reported that in a search of NGC 4372, credited with three unpublished and eleven suspected variables, Dr Hubert Wilkens had found no variables. In ω Centauri, six new variables had been found at considerable distance from the centre.

The President recommended that co-ordinates as well as charts be given for the new variables in globular clusters. She proposed that, in view of the increasing number of variable stars in galactic clusters, the name of the Sub-Commission 'Variable stars in globular clusters' be changed to: 'Variable stars in star clusters', with the approval of the President of Commission 27, and the executive of the I.A.U. Dr Alter suggested the question be raised in a general meeting of Commission 37, Star Clusters (see Resolution no. 53).

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