27. COMMISSION DES ETOILES VARIABLES

PRÉSIDENT: Professor P. Th. Oosterhoff, University Observatory, Leiden, The Netherlands.

VICE-PRÉSIDENT: Dr G. H. Herbig, Lick Observatory, Mount Hamilton, California, U.S.A.

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INTRODUCTORY REMARKS

This Draft Report consists of three sections, each with its own references, and each written by a different author. The first, prepared by the President of Commission 27, has a rather general character. The second section, written by Dr G. H. Herbig as President of the Working Group on the Spectra of Variable Stars, deals with spectrographic observations and studies of variables, while the third section gives a summary of the work on variable stars in clusters. This last report has been prepared by Mrs Dr H. B. Sawyer Hogg, who is the President of the Working Group on Variable Stars in Clusters. Both sections 2 and 3 are printed hereafter as appendices 1 and 2 of the general report. Our thanks are due to the members of the organizing committee of Commission 27, who have assisted in collecting the material for this report.

It should be emphasized that the present report should not be considered as a complete survey of all the work done since the last General Assembly. Not all the members of the Commission have reported on their work. Furthermore in the first section all papers dealing with the discovery, new observations, determination of type or period, etc. of individual variable stars have been omitted. It also should be mentioned that eclipsing binaries of which a component is intrinsically variable have been omitted as a rule.

CATALOGUES, SYMPOSIA, ETC.

At the Berkeley meeting, Commission 27 decided to issue an 'Information Bulletin on Variable Stars'. In just over two years 34 such bulletins have been published, with announcements of discoveries, with requests for special observations and the like. Prof. L. Detre, who has been responsible for the publication of the Bulletin, has suggested, that also newly started programmes be announced in the future. It seems that the new bulletin serves a useful purpose and Commission 27 is grateful to Prof. Detre, who issues the Bulletin and distributes it gratuitously.

Some volumes of general interest to Commission 27 have been published or are nearly ready for distribution. In the first place, Dr Schneller should be complemented with the completion of the second edition of *Geschichte und Literatur des Lichtwechsels der veränderlichen Sterne.* The second part of volume V appeared in 1961, the third in 1963. These last two volumes contain information about all variables nominated between 1938 and 1958 in the constellations from Delphinus to Vulpecula.

Astronomers of the Astronomical Council of the U.S.S.R. Academy of Sciences and of the Sternberg Astronomical Institute have prepared two important publications for the press. The first is a supplement to the 'Catalogue of Stars suspected of Variability', which will contain about 3000 stars with probable variability and nearly 2000 stars of a more doubtful character. The second publication will present for 15 514 stars the galactic co-ordinates in the new system. These co-ordinates were computed by the Groningen Astronomical Laboratory under the supervision of Dr L. Plaut. Work has also been started on the second supplement to the *General Catalogue of Variable Stars.*

Ahnert at the Sonneberg Observatory has computed a table for the reduction of light time from the Sun to the barycentre (**54**).

For the new edition of Landolt-Börnstein, Dr M. Beyer of the Hamburg-Bergedorf Observatory has prepared the sections on variable stars, novae and super-novae.

A number of symposia have been held in the years covered by this report. In 1962, Dr W. Strohmeier organized a symposium on variable stars in Bamberg. The lectures and discussions have been published (**1**). In 1963, symposia were organized on Magnetic Stars at Rottach-Egern near Munich and on Novae and Super-novae at the Observatoire de Haute-Provence. Also in the Soviet Union several meetings took place. In 1961 a seminar was held at the Odessa Observatory on pulsating and eclipsing variable stars (**2**). In 1962, the Astronomical Council organized a symposium on non-stationary stars at the Crimean Astrophysical Observatory. Special attention was paid to flare stars and to nova-like and RW Aurigae type stars (**3**). Later in the same year and at the same observatory a symposium was held on the techniques of photo-electric observation of variable stars (**4**). At its 14th plenary meeting in 1963 the Variable Star Commission of the Astronomical Council devoted its time to problems connected with eruptive stars and with the period-luminosity relation for cepheids and RR Lyrae stars. This meeting was held at the Lwow Observatory.

Finally attention should be drawn to some articles of a general character: by H. C. Arp on Intrinsic Variables and Stellar Evolution, by G. Haro on the Problems of the T Tauri and UV Ceti Stars (**5**) and by R. P. Kraft on the Absolute Magnitudes of Classical Cepheids (**6**, p. 421).

VISUAL OBSERVATIONS

The various Variable Star Sections have been very active again. In New Zealand the headquarters of the section are now: Mount John University Observatory, Lake Tekapo. The director, F. M. Bateson, has reported that 400 variables are under regular observation. The work on charts for southern variables has continued in accordance with the 1961 report. Reports have been received from several sections. Also the Dutch working group has started with the publication of the observations. Two members of the Commission have been very active in this field: Mr de Kock at the Cape and Mr Peltier at Delphos, Ohio. The latter has made nearly 3000 observations per year of U Gem, Z Cam and R CrB type stars. In his search for novae he discovered Nova Herculis 1963. In the Soviet Union the Astronomical and Geodetical Society at Kuibyshev collected many observations of bright irregular and semi-regular variables. Under the guidance of Prof. Tsesevich numerous observations have been made at the Odessa Observatory of RR Lyrae type stars. More than 20 000 observations were obtained in 1962 and charts have been completed for 1500 variables. Visual observations of RR Lyrae variables were also made by Wenske at Hamburg-Rahlstedt and by Ahnert at the Sonneberg Observatory.

PHOTOGRAPHIC OBSERVATIONS OF SPECIAL FIELDS

Sky patrol observations have been made at the Odessa and Dushanbe observatories. The

thousands of plates obtained are used, together with the old plate collections of the Moscow and Simeis observatories, by numerous investigators for the study of individual variable stars of different types. Istchenko (**7**) is using photographic star-trails for the discovery of flare stars. Strohmeier at Bamberg is continuing his patrol service for the discovery and study of bright variables. This programme will be extended to the southern sky. Geyer has already started the observations at the Boyden Observatory with a special instrument (**1**, p. 126).

Many investigations concerning special fields are in progress. Plaut reports that the work on the Palomar-Groningen search for faint variable stars in four selected regions is still going on steadily. The blinking of 10 pairs of plates for each of the four fields will be finished probably before the summer of 1964. Results on the fields one and two are expected to be ready for publication during 1964. De Kort at Nijmegen is collaborating on field 4.

At the Leiden Observatory work on the southern Milky Way fields is being continued. The magnitudes of the variables published in the course of this work are not very accurate and do not form a homogeneous system. For 901 variables in four fields near the galactic centre Kwee has derived improved magnitudes with the aid of photographic and photo-electric photometry (**8**).

At the Crimean station of the Sternberg Astronomical Institute the areas of some T— associations are systematically photographed. The far surroundings of some globular clusters are also being observed. Results so far, have been published by Kuročkin for regions around NGC6171 (**9**) and M15 (**10**).

At the Lyon Observatory the search for red variables in the direction of the galactic centre has been continued. The photographic observations are made in the red. New discoveries have been announced by Cailliatte (**11**) and Terzan (**12**).

Wachmann and W. J. Miller have continued and nearly finished their work on the variables in the southern part of the Cygnus Cloud (**13, 14**). At the Fordham University 3500 plates are now being studied, in loan from Bergedorf, Vatican, Harvard and Mount Wilson and Palomar Observatories. Recently plates have also been obtained with the 40-cm quadruplet at Heidelberg. Miss Harwood published the main results of her investigation of variable stars in the Scutum Cloud (**15**). The work is being continued. At the Maria Mitchell Observatory Miss Hoffleit has carried on her work on the variable stars in VSF193 in Sagittarius. She published three contributions (**16**).

At the Sonneberg Observatory the Sky Patrol equipment was improved and is working now with 14 lenses in two colours. The plates were used by Huth for long period and other variables (**17**). Richter investigated the material of the Felder Plan for a study of the structure of the Milky Way system. Götz and Wenzel published two lists of spectral types of 149 variables obtained with the objective prisms of the Schmidt camera (**18**). Ahnert is observing several Milky Way fields with the Twin Schmidt camera in order to check short period variables for changes of period. Hoffmeister continued the investigation of plates taken in 1959 with the Metcalf Astrograph of the Boyden Observatory, bringing the number of new variables to 2083 (**19**), most of them in moderate and high southern galactic latitudes. He found 121 new variables on southern sky patrol plates, 207 on several northern fields, and 164 in the surroundings of the northern galactic pole (**20**).

At the public observatory at Hartha, Germany, Busch and co-workers took 800 short focus plates for an investigation of short period variables.

At the mountain station of the Konkoly Observatory, Lovas has started a search of faint variables in the galactic halo. The plates, 5 degrees in diameter, were taken with the 90/60-cm Schmidt telescope and have a limiting magnitude near $m_{pg} = 18$. The observed fields have the following centres (1900):

	α h m	δ ° ′
1.	11 45·0	+55 50
2.	13 39·0	28 30
3.	16 33·4	59 48
4.	16 34·7	57 57
5.	16 34·7	55 00
6.	17 14·5	57 36

Romano discovered new variable stars in a field centred at BD + 67° 1283 (**21**). Further he investigated a field centred at $1^h\ 10^m$ and + 51°. He also investigated variable stars near the Pleiades (**22**). These investigations were carried out in co-operation with Rosino.

At the Bonn Observatory, Van Schewick has measured proper motions of variables in Selected Areas, brighter than 13^m5. The time interval of the plates is 33 years.

RR LYRAE TYPE VARIABLES

Kordylewski has continued the annual publication of linear ephemerides for RR Lyrae variables (**23**). These linear elements were obtained in co-operation with Tsesevich and his co-workers at Odessa, who also studied the variation in period of these variables.

Plaut and Soudan reinvestigated the density distribution of the RR Lyrae variables (**24**). They confirmed the results derived by Perek. In a following article Plaut has derived their velocity and space distribution (**25**).

Geyer investigated the relation between the strength of metallines and the z co-ordinates. Variables with small z values have the larger metalcontent (**1**, p. 121).

That the periods given, cannot always be relied upon was shown by Wenzel (**26**) who investigated 16 variables with periods near 0·3 days and found that for 8 stars the period proved to be erroneous.

Many new photo-electric observations have become available. Kinman published a list of 22 southern RR Lyrae variables (**27**) for which he derived V magnitudes and $(B-V)$ and some $(U-B)$ colours at the Cape Observatory. He also gives the radial velocities and spectral types, observed at the Radcliffe Observatory. Lourens has measured the proper motions for these stars (**28**).

At the Leiden southern station in Africa, Ponsen and Walraven observed several long and short period RR Lyrae variables with the five colour photometer. Results are being prepared for publication. Also at Skalnate Pleso in Czechoslovakia and at Cluj in Roumania photographic and photo-electric observations of RR Lyrae variables are being continued. A great number of these variables are under observation in the U, B, V system at the Konkoly Observatory by Detre and his co-workers. Szeidl and Barlay will observe photo-electrically in two or three colours all RRc stars in the northern hemisphere brighter than magnitude 13.

In the last Draft Report Van Herk's work on the proper motions of many RR Lyrae stars has been mentioned. This work is nearing completion now.

Hoffmeister derived periods of RR Lyrae stars for a study of the intergalactic absorbing clouds. He investigated a region near ι Mic and derived 55 periods (**29**). He concluded that absorbing material exists at very large distances (**30**). He also investigates a region around ε Cha (**31**) and found a faint RR Lyrae star in a window near the galactic anticentre with a distance from the centre of the Galaxy of at least 25 kpc (**32**).

The study of periodic light curve variations is being continued at the Konkoly Observatory. Kanyó made U,B,V observations of RV UMa extending over the whole secondary period. He also made some polarization measurements at Burakan. The correlations between changes

in the fundamental and secondary periods have been discussed by Detre and Balázs-Detre for RR Lyr and RW Dra (33). Almár published a comprehensive study of AR Her (34), while Szeidl found the correct value of the secondary period of DL Her to be 32·5 days (35).

In the Soviet Union Alania carried on spectrophotometric observations of a number of RR Lyrae stars (36). Frolov at Moscow devoted some papers to a thorough analysis of the morphological peculiarities of these stars. He found criteria which permit to refer RR Lyrae type variables to the different components of our Galaxy (37–39). By means of a modified Wesselink's method values for the radii and absolute magnitudes were derived. It was shown that the resulting period-luminosity relations vary in zeropoint and shape for the different groups of variables (40). Pavlovskaya studied the period-luminosity relation for the RR Lyrae stars on the basis of mean parallaxes.

Miss Fringant obtained 250 spectra of RR Lyr from which she derived the four Chalonge parameters. She has studied the behaviour of these parameters in the course of the secondary period. She improved Wesselink's method for the determination of the radius and computed the mean absolute magnitude (41).

Kopal and co-workers have been studying radial oscillations of main sequence stellar models, taking into account the effects of viscosity. Preliminary results will be published before the General Assembly.

Mrs Balázs-Detre is working on a modified theory of RR Lyrae variables, in which, following Huang, the phenomena are considered as periodic mild outbursts, the source of instability being looked for in the convective layers of the stars.

A considerable amount of new material has been collected for the δ Scuti and ultra-short period variables.

A new star of this type has been discovered and observed by Churms and Evans. They determined light and colour curves and measured also radial velocities (42).

Fitch has reanalyzed Fath's photometric observations (43). Besides the fundamental period he found the second overtone and one resonance-excited period. In a second paper (44), Fitch discussed in a similar way more than two thousand new observations of CC And. For this star he found two resonance-excited periods.

McNamara and Augason have studied δ Sct and four other variables of this type by means of narrow-band photometry. They measured Strömgren's c and l values and in addition measured the strength of the K-line. They concluded that these stars form a homogeneous group with little spread in absolute magnitude and colour (45).

McNamara has also applied the method of narrow-band photometry to CY Aqr (46), whereas Sanwal has studied the variations in period of this variable (47).

At Merate Observatory, Broglia made many photo-electric observations of RV Ari, YZ Boo, DY Her and DY Peg (48).

An extensive series of U, B, V measures of VZ Cnc was published by Spinrad (49), and of DY Her by Hardy and Lott (50). The observations of this last variable can be represented by a single period.

Finally five-colour photometry by Ponsen of V703 Sco and ρ Pup should be mentioned (51, 52). It seems that the apparent period of the first star is due to an overtone, the fundamental pulsation having the smaller amplitude.

Results on RR Lyrae type variables in extra-galactic systems have been published by Baade and Swope. They made a thorough study of these variables in the Draco system (53). At the Leiden Observatory, Van Agt has investigated RR Lyrae stars in the Ursa Minor system on plates taken by Dr Baade. It is hoped that results will be published in a year or so.

β CANIS MAJORIS STARS

A short paragraph on β Canis Majoris variables follows here, because the problems of multiple periodicities is very similar to that of the ultra-short period variables of the preceding section.

The known variables of this type have been listed by Van Hoof (**1**, p. 68). In this article Van Hoof demonstrates his theory of multifold coupling between various modes on the light variation of ν Eri and ξ' CMa.

At the Wroclaw Observatory, Opolski and Ciurla have studied 12 (DD) Lac. They conclude that the light variation can be explained by one short variable period and one long period (**55**). In a second paper (**56**) they showed that the mean brightness of this variable is not constant, but changes with the long period.

During the summer and autumn of 1956 seventeen observatories have co-operated in an observing campaign of 12 (DD) Lac. A large number of photo-electric and spectrographic observations were secured. These observations have now been reduced and published by De Jager (**57**). A discussion of the observations will be given by De Jager in a subsequent paper. In the mean time Barning has made a numerical analysis of the photometric observations and obtained four periods (**58**).

At the Kiel Observatory, Mrs Böhm-Vitense has investigated the influence of rotation on the beat phenomena in this type of variable (**59**). Her discussion leads to the conclusion that pulsationally unstable early B stars can be detected as β CMa stars only, if we happen to look at them nearly pole-on.

At the Mount Stromlo Observatory, Rodgers and Bell have analyzed high dispersion spectra of α Lupi. Although the light seems to be constant, they confirm Pagel's suggestion that the star belongs to the β CMa group.

CEPHEIDS

Several series of new photo-electric observations have been published. Many southern cepheids were observed in three colours by Irwin (**60**). Many northern cepheids, also in three colours, by Bahner, Hiltner and Kraft (**61**) and by Weaver, Steinmetz, Mitchell at the Lowell Observatory (**62**). Svolopoulos at Lick has published photometry in six colours for 10 cepheids (**63**), whereas Walraven has observed about 30 southern cepheids in five colours at the Leiden southern station. His observations have been completed and publication can be expected soon. Also Mianes has observed more than 30 cepheids in five colours (**64**).

Working at the Lick Observatory Smak has observed population II cepheids. During a stay in the United States Kwee has carried out a similar programme. Bahner and Mavridis have continued the discussion of their two colour observations of 18 cepheids, made at Heidelberg. Miller has communicated that the faint cepheids discovered in the Cygnus cloud are being observed photometrically by Eggen. Finally it should be mentioned that Rodgers and Bell have concluded from a study of high dispersion spectra that the peculiar cepheid κ Pavonis belongs to the disk population (**65**).

Several studies have been devoted to the problem of intrinsic colours and period-luminosity relation. Work on cepheids in galactic clusters is very important in this respect. Fernie investigated S Nor (**66**), while Mitchell, H. L. Johnson and Iriarte published a note on U Sgr (**67**).

Westerlund identified the long period cepheid RS Puppis, which is surrounded by a small reflection nebula (**68**), as a physical member of the OB association Pup III. Results are in press for the *Mon. Not. R. astr. Soc.*

Kraft published (**69**) a revision of the period-colour and period-luminosity relations, which

he derived in earlier papers. Miss Canavaggia and Mianes are studying the discrepancy found by Mianes between his intrinsic colours for the cepheids and Kron's colours for the supergiants.

Since Oosterhoff discovered that TU Cas and AW Per probably have a blue companion, Mianes proved from his photometric observations that also W Gem and RW Cam have a blue companion, whereas a red companion was found in the case of BF Oph and may be RX Aur (**64**). Schneider at the Institut d'Astrophysique in Paris is studying cepheids spectrophotometrically in search of possible companions.

Bahner and Mavridis (**1**, p. 12) have confirmed Oosterhoff's analysis of the variations in the light curve of TU Cas. Jansen at the Leiden Observatory has shown (**70**) that the classical cepheid U TrA behaves in exactly the same way and that the ratio between fundamental and secondary periods is identical with the value derived for TU Cas.

An extensive study of galactic structure and galactic rotation derived from cepheids was published by Kraft and Schmidt (**71**).

Several astronomers have studied cepheids in the Magellanic Clouds. In the Small Cloud Arp has derived light and colour curves for several cepheids (**72**). Other plates which he took, are now being investigated by Van Genderen and Jansen at the Leiden Observatory. Arp showed that the SMC cepheids differ in some respects from the cepheids in the solar neighbourhood. Together with Kraft (**73**) he made a thorough study of these differences. The period-frequency, period-amplitude and period-colour relations are not the same for the two groups of cepheids. On the other hand the period-luminosity relations are shown to be quite similar. Mrs Payne-Gaposchkin has confirmed their conclusion as far as the period-amplitude relation is concerned (**74**). Woolley has described work on cepheids in the Large Cloud (**75**). He proved that the period-luminosity relation of the LMC is considerably steeper than that for the SMC. Results have been published by Woolley, Eggen, Sandage, Alexander and Miss Mather, Miss Epps and Miss Jones (**76**). In co-operation with Hodge, Miss F. W. Wright is working on cepheids in the northern portion of the Large Cloud. Their goal is the period-luminosity relation as well as a statistical study of the types and periods found. These two authors have investigated cepheids in the vicinity of globular clusters (**77**). For several reasons they assume these variables to belong to population II, but they find them nearly one magnitude brighter than they are in the Galactic system. Badaljan showed that in the Magellanic Clouds a close relation exists between the distribution of cepheids and of neutral hydrogen, similar to our Galaxy (**78**).

Baade and Swope have investigated a region in the Andromeda galaxy 96′ south preceding the nucleus. They found and discussed 20 cepheids. The slope of the period-luminosity relation proved to be similar to that for our Galaxy and for the Small Magellanic Cloud. Also Gaposchkin has discussed a large number of variables in the Andromeda Nebula (**79**).

Finally a number of theoretical investigations should be mentioned. Zhevakin developed a theory on the auto-oscillations of the pulsating stars in the zone of critical He II ionization and derived a theoretical period-luminosity relation with its dispersion (**80**). The instability of stars in the cepheid region of the H-R diagram was investigated by Baker and Kippenhahn (**81**). In their models for outer layers of these stars they found negative dissipation in the second helium ionization zone sufficient to overcome damping, as predicted by Zhevakin. In a more detailed calculation (**1**, p. 49), they derived the theoretical cepheid strip in the H-R diagram. It turns out that the theoretical models have an effective temperature about 600 degrees below the observed temperature. Also Cox has come to the conclusion that He II ionization is probably the basic source of the instability in the classical cepheids and RR Lyrae variables and also (but less certainly) in the W Virginis and δ Scuti stars (**82**).

Hoffmeister, Kippenhahn and Weigert have computed theoretical evolutionary tracks for a star of seven solar masses. The track starts on the main sequence and goes through hydrogen

and helium burning and crosses the cepheid strip five times. Results are in press for *Mitt. astr. Ges.*

Mrs Böhm-Vitense showed that the strong increase in brightness at the time of maximum velocity may be caused by a strong convective transport of energy in the hydrogen convection zone (**83**).

Takeuti has studied the pulsation equations in the outer layers of the star (**84**). Kopylov has studied the evolutionary tracks of main sequence stars. According to him B2-B6 stars become cepheids with periods less than 10 days and O9-B2 stars cepheids with periods from 10 to 50 days. Efremov has shown that cepheids with the greatest steepness of the ascending branch for a given period, show the smallest deviations from the period-luminosity and period-colour relations (**85**). Smak discussed a theoretical period-frequency function for classical cepheids (**86**).

RV TAU, LONG-PERIOD AND RED VARIABLES

Feast has derived radial velocities for 114 southern Me variables. These results have been combined with the northern observations to study the galactic motions of these stars. Feast found among other things that most of the Me variables with periods less than 150 days are probably pulsating in the first overtone (**87**).

Plaut published a study concerning the dependence of the periods of long-period variables on the galactic position (**88**), and confirmed results derived formerly by Miss Hoffleit. He also investigated the velocity and space distribution of this type of variable (**25**).

At the Warner and Swasey Observatory, Miss Houk determines spectral types of variables in VSF193 and examines the frequency distributions and completeness of discovery of variables with late M-type spectra. She has published an important paper on long-period variables with secondary periods (**89**). Westerlund is continuing his work on the red variables in the southern Coalsack and in a region in Carina.

A very interesting investigation of the RV Tauri stars has been published by Preston, Krzeminski, Smak and Williams (**90**). On the basis of a spectrographic study of 48 variables classified as RV Tau or yellow semi-regular variables the authors propose a division of the RV Tau stars into three groups. For a number of the variables also photometric results in the *U*, *B*, *V* system have been published. During his stay at the Lick Observatory, Smak also obtained photo-electric measures of Mira variables.

Henize published a list of emission-line stars in an obscured region in Chamaeleon (**91**). From his H-alpha survey of the southern sky he discovered a number of variable stars of spectral types M, S and C. A list of nearly a hundred of such stars is nearly ready for press. Henize intends to measure spectral types (M, S and C) of known variables for which no spectrum is given in the *General Catalogue of Variable Stars* and for which he noted variation on his plates. In the course of this H-alpha survey he discovered about 150 new S stars. Plates were taken by him at the Mount Stromlo Observatory for a study of the character of the light variation.

Gyldenkerne at the Brorfelde Observatory reports photo-electric observations of some bright semi-regular variables: ρ Cas, μ Cep and ρ Per. Interference filters with maxima at 4050 and 4500 Å are used. A series of two-colour photo-electric observations of μ Cep was made by Larsson-Leander at the Stockholm Observatory from November 1955 until May 1960. Results have been published (**92**).

At Castel Gandolfo, McCarthy published a list of fifty Carbon stars in the Cygnus region (**93**), while O'Connell investigated some stars in Centaurus (**94**). Eggen studied some southern variables in three colours (**95**).

T TAURI STARS AND FLARE STARS

At the Asiago Observatory, much work has been done on photometric spectroscopic research on variables associated with diffuse nebulae. Rosino and Cian (**96**) discovered 105 new variables around the Orion trapezium and they studied many more. Rosino and Romano investigated a dozen variables around NGC6023 (**97**). Maffei (**98**) studied 48 variables in two colours around NGC1999, while Petit found 29 new variables in the neighbourhood of NGC2264 (**99**). Maffei further found new variables near 49 Orionis (**100**) and in the Rosette Nebula (**101**).

Haro, Chavira and Mendoza discovered and studied 50 new flare stars in the Orion region. They found that these flare stars have nearly the same distribution as the T Tauri variables (**102**). Roques concluded from a study of YZ CMi that no simple relation exists between amplitude and duration of the flares (**103**).

McCarthy at the Vatican Observatory is planning photo-electric observations of the brighter T Tau stars. At the Sonneberg Observatory Wenzel has made a comprehensive study of low-luminosity stars with rapid and irregular variations and developed a model to explain the observed phenomena (**104**). Hoffmeister finished his work on variables in the obscured regions near ϵ Cha (**31**). Götz continued his work on Hα stars in Taurus and Orion. He also took many spectra of RW Aur. Wenzel and Fürtig are observing photo-electrically in two colours: RW, SU and AB Aur, UV Boo, SV Cep, RY Tau and WW Vul. This programme will be extended to include: HH Aur, SY Cep, CO Ori, T and CQ Tau.

Badaljan studied variables in the dark clouds in Taurus in two colours (**105**). He investigated the amplitude ratio in blue and yellow light. Lukatskaya, Gorazdo-Lesnykh and Pugatch have applied statistical methods for an analysis of the variations in brightness of some eruptive variables (**106**). Istchenko and Kuročkin have analysed the light variations of RW Aur stars and introduced a 'characteristic time' (**107**). Tchugainov and Zaitseva obtained in the years 1961–63 a long series of three-colour photo-electric observations of RW Aur. Many U.S.S.R. observatories co-operated in this campaign. Rapid light variations in the course of a night were discovered and the amplitude in the infra-red proved to be larger than expected from the hypothesis of purely thermal variations (**108**). Chugainov observed 14 flares of EV Lac and found a relation between the rate of light increase and decrease (**109**).

Slee, Higgins and Patston have published a list of suspected southern flare stars. They also made simultaneous visual and radio-astronomical observations of some of these objects. So far the radio measures did not yield a positive result (**110**).

U GEMINORUM STARS

After Joy had shown in 1956 that SS Cyg is a spectroscopic binary, Kraft has now proved that this is also the case with U Gem, RX And, RU Peg and SS Aur (**111**). The periods are all shorter than nine hours. The blue component is probably a white dwarf, while the red component seems to be strongly underluminous. Kraft presents different arguments to suggest that the U Gem variables are descendants of the W UMa stars. Wallerstein has made a study of these variables at maximum light and their position in the two-colour diagram (**112**).

Romano has reported that he has started a systematic search for faint U Gem variables and that he discovered five new ones.

At the Bonn Observatory, Schmidt-Kaler has determined brightness and colour-index for more than 100 faint variables of this type, using the Palomar Sky Atlas. He derived a correlation between range and period and an absolute visual magnitude of $+ 7{\cdot}2 \pm 0{\cdot}3$ (**1**, p. 109). Hoffmeister found many new variables of this type and he observed UV Per with the 2-meter telescope of the Karl Schwarzschild Observatory. The nebulosities reported by d'Esterre in 1911 have not been confirmed (**113**).

Chuvayev at the Crimean Observatory observed SS Cyg photo-electrically in the *U*, *B*, *V* system. He found that slowly increasing maxima are preceded by a minimum with large light fluctuations, whereas the steep maxima follow minima with small fluctuations (**114**).

At the Institut d'Astrophysique in Paris, Mme Lortet-Zuckermann has made a statistical study of the outbursts of SS Cyg (**115**). She gave a new classification of the outbursts and drew attention to the peculiar class of very faint outbursts. Also Martel made a study of the light curve of this variable between 1896 and 1958 (**116**). He found that the character of an outburst depends only on the character of the directly preceding outburst and not on the character of the other prior ones. Mme Lortet-Zuckermann has made a further analysis of this problem and reported on it at the colloquium at the Observatoire de Haute-Provence. Results will be published in the *Annales d'Astrophysique*.

Petit published a comprehensive study of U Gem stars (**138**).

NOVAE AND SUPER-NOVAE

A list of all galactic novae and super-novae, observed until the end of 1960, has been published by Bertaud (**117**). The search for novae has been continued by several professional and amateur astronomers. Saveljeva (**118**) and Apriamashvili (**119**) discovered several novae, while Elis Dahlgren of the Swedish Variable Star Section discovered Nova Herculis 1963.

The search for super-novae is being continued by Zwicky and his group. The results will be reported in the Draft Report of Commission 28. Also the Abastumani, Budapest, Burakan observatories and the Crimean station of the Sternberg Institute have started a search for super-novae. An effort is made to find new super-novae as early as possible. Two such variables have already been found (**120**). At Asiago Romano has found a super-nova.

At the Bonn Observatory, Schmidt-Kaler investigated the light curve-luminosity relation for novae. He measured brightness and colour index for more than 40 old novae on the Palomar Sky Atlas (**1**, p. 109). At Meudon, Eskioglu has studied the light curves of the recurrent novae WZ Sagittae and RS Ophiuchi. The explosions of 1946 and 1958 were compared with earlier explosions. Results will soon be published in the *Annales d'Astrophysique*. Artjukhina determined the proper motions of six novae (**121**). At the Crimean Observatory, Bartash, Boyarchuk and Mustel studied Nova Aquilae (1918) and found that its present light resembles black body emission with a temperature of 30 000°K (**122**).

After a new discussion (**123**) of the binary nature of DQ Her, Walker proved that also T Aur is an eclipsing binary (**124**), while Krzeminski proved the same for WZ Sagittae (**125**).

Efremov (**126**) and Kukarkin (**127**) consider it likely that Nova UMi (1956) is a super-nova, while Ahnert believes that it might have been a normal galactic nova (**128**). Börngen determined its magnitude and two colour indices from which he derived the spectral type B3 for this nova in 1963 (**129**).

Many observations have been reported on Nova Her 1960. Bertaud has derived a light curve from all available observations (**130**). Prokofjeva and Beliakina determined on the basis of multicolour photometry the electron density and mass of the envelope of this nova (**131**). G. Richter has observed the praenova on 40 Sonneberg plates. He found strong variability similar to that of an RW Aur star (**132**). Clemert and Ekedahl have determined radial velocities (**133**).

Also Nova Her 1963 is being observed by many. Bertaud reports photometric and spectroscopic work. Ahlmark and Clemert report a determination of the expansion velocities (**134**). Löchel has studied a star in the position of the nova on Sonneberg plates taken between 1941 and 1962. The star did not vary until 1961 and after that increased in brightness gradually by 1·5 magnitude (**135**). Bloch and Chalonge studied the spectrum in the visible and ultraviolet region (**136**), while Andrillat and Bloch studied the spectrum in the near infra-red (**137**).

At the Asiago Observatory, Bertola, Romano and Rosino have studied several super-novae. Results have been published in the Contributions of Asiago and in the Memoirs of the Italian Astronomical Society.

MAGNETIC VARIABLES AND MISCELLANEOUS INVESTIGATIONS

Abt and Golson have made *U*, *B*, *V* photometry of 70 magnetic stars (**139**). They found that all magnetic stars are slightly variable in visual light and also in the two colours. However, they have not found any correlation between the photometric dispersions and the magnetic or spectral peculiarities.

Jarzebowski has continued his fine series of photometric observations of magnetic stars. He found variations in brightness with a period of 2·0357 days and an amplitude of $0^{m}.07$ for HD215038 (**140**). He made a detailed study of α^2 CVn. In the irregular magnetic variable HD215441 he found variations in the degree of polarization (**1**, p. 95).

Rakosch published a thorough photometric study of nine magnetic stars (**141**) from observations made at the Lowell Observatory. He further studied the star HD71866 for which he derived a short period superimposed on the normal variation (**142**). In another paper he has treated SX Ari (**143**).

Ross has studied the variations in brightness of some Wolf-Rayet stars (**144**). He found variations as large as 0·05 magnitude. Lynds investigated the variations of the shell star HD183656 (**145**). C. and M. Jaschek report that they found some new spectrum variables: HD128775, 133652, 133792 and βScl. The symbiotic stars Z And, BF Cyg, AG Dra and AG Peg have been investigated by astronomers of the Crimean Astrophysical Observatory (**146**). Many investigations on individual variables could not be mentioned in this report. But it should be reported that Shakhovskoy and Dymov have determined the degree and plane of polarization of different variable stars (**147**); that Rogati at the La Plata Observatory is visually inspecting all variables south of the equator and brighter than $11^{m}.0$ for duplicity with the refractor of the observatory; that the amateur astronomer Weber at his station in Mainterne has been very active and that he published his results in the *Journal des Observateurs* and in the *Information Bulletin* of our Commission and finally that the variable radio-source 3C273 has been observed by Szeidl at the Konkoly Observatory and by Huth at Sonneberg (**148**). The radio stars 3C48 and 3C273 were observed by Harlan Smith and Miss Hoffleit (**149, 150**).

P. TH. OOSTERHOFF,
President of the Commission

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APPENDIX I—REPORT OF THE COMMITTEE ON THE SPECTRA OF VARIABLE STARS

(prepared by G. H. Herbig, Chairman)

The province of this committee is not entirely distinct from that of Commission 29 (Stellar Spectra) insofar as variable stars are concerned. In a rough way, it might be said that the committee is concerned with all spectroscopic work on variable stars that falls short of detailed astrophysical analysis. As a result, we tend to consider here (with certain exceptions) those spectroscopic results that are of a qualitative nature, or are intended mainly as an aid to the classification of variable stars.

In the latter regard, mention should be made of the extensive Sonneberg program for the spectral classification of variables with an objective prism, on the Bergedorf Spektral Durchmusterung system. Five lists by Götz and Wenzel (**1**) have appeared, giving types for 368 stars. Schaifers (**2**) has separately determined types for red variables. Many stars of emission, M, S, and C types have also been classified by Perraud (**3**) and by Nassau and Stephenson (**4**). Such information is most valuable, but it might be pointed out that at least another dimension can be added to spectral classification by the use of a slit spectrograph of modest dispersion on a relatively small reflector. The design and construction of such a spectrograph of high efficiency