A large calculated value indicates the presence of expansion. Karachentseva (29-13503) analyzed the distribution of dwarf galaxies in three clusters and Zwiagina (29-11799) did the same for the groups in MCG, using the notes in that catalogue.

Radio observations of galaxies with discussions of the results, were carried out by Kurilchik and Lekht (29-485, -3515; 30-4362) and their colleagues. Esipov and collaborators (29-5008, -5009; 30-4343, -8552), using image converters, studied the spectra of faint QSS, etc., by means of a 125 cm telescope. Komberg (29-6500; 30-4361, -8560) discussed the nature of the broad emissions in the spectra of QSS and suggested that they may be due to binaries. Vorontsov-Velyaminov opines that QSS form groups and clusters of galaxies by repeated fragmentation. Gordon (29-11707) is producing models of the structure and masses of the envelopes of Supernovae, QSS and Seyfert galaxies. Shklovsky (29-13519) considered the nature of the standard absorption spectra of QSS on the basis of special relativity. He explains the variation of the optical spectrum of 3C 345 by the clearing of clouds of Mg II in the frequencies of the resonance lines due to the heating by the stream of particles ejected from the nucleus. Ozernoy and Chertoprud (29-3189; 30-4353) analyzed the light curves of the QSS using a magnetohydrodynamical model. Shklovsky (28-11055) showed the possibility of various causes for the X-ray emission. Ozernoy showed that the plasma ejected by a magnetoid can condense into stars. Jointly with Sazonov, he calculated the spectrum and polarization of a radio source produced by a relativistic fission of its components. Ozernoy and Chernin (29-11490; *Astr. Zu.*, **45**, 1137) formulated the hypothesis of a dynamical character of pregalactic "photon vortices" and on this basis they developed a theory of the origin of galaxies.

Zelmanov showed that the space volume, the quantity of particles and the energy in a cosmological model can be infinite in one system of reference and be finite in another. Grišcuk (29-7446) elucidated the difference between the group and differential criteria of a space non-uniformity. He has found all metrics satisfying the second criterion proposed by Zelmanov. Grišcuk also showed that for a dusty space the general solution of the equations of gravitation contains an essential non-simultaneous physical singularity. The solution containing a simultaneous singularity is not stable. Grišcuk, Doroshkevich and Novikov showed that the solutions could be made isotropic. They gave formulae for the anisotropic surviving emission in the models described by the solutions which were obtained. The team headed by Zeldovich, which includes Novikov, Doroshkevich and Sjunjaev studied a large number of problems of relativistic cosmology: the residual emission at different epochs, the expansion of anisotropic models, gravitational instability and collapse, and the formation of galaxies by different types of perturbations of a Friedman model. At the critical density of $2 \times 10^{-29}$ g cm$^{-3}$ for the intergalactic gas, the universe is open (infinite).

G. C. MCVITTIE
*President of the Commission*

## WORKING GROUP ON THE MAGELLANIC CLOUDS
(by A. D. Thackeray)

### 1. *General*

A Symposium* on the Magellanic Clouds was sponsored by E.S.O. in Santiago, Chile, in 1969 March in connection with the dedication of the E.S.O. Observatory at La Silla. Review papers on the Clouds have been written by Westerlund and Bok (*J. R. astr. Soc. Can.*, **63**, 105).

### 2. *Variables and the P-L relation*

Gascoigne (*Mon. Not. R. astr. Soc.*, **146**, 1) has prosecuted further his *P-L* work on Cloud

* Where no references are given, the reader should consult the Proceedings of this Symposium and also forthcoming issues of the *Mon. Not. astr. Soc. S. Africa.*

cepheids and finds

$$V = 17{\cdot}58 - 3{\cdot}072 \log P \quad (7 \text{ LMC cepheids}),$$
$$V = 17{\cdot}73 - 2{\cdot}879 \log P \quad (13 \text{ SMC cepheids})$$

while 25 SMC, 18 LMC and 13 galactic cepheids obey the Sandage relation

$$M_v = a - 3{\cdot}609 \log P + 2{\cdot}52(\langle B \rangle - \langle V \rangle).$$

This implies moduli of 18·73 (LMC) and 19·36 (SMC), but Gascoigne recommends, in the light of other evidence, adoption of moduli 18·75 (LMC) and 19·2 (SMC). The colours of SMC cepheids are 0.1 bluer than those in the Galaxy and they may be somewhat underluminous for their periods.

Arp's SMC sequence has been further tested at Radcliffe by Andrews and at Boyden by Butler.

Hodge and F. Wright have derived periods for 19 LMC cepheids on a 63-year baseline without finding changes in period. The slope of their *P-L* relation agrees well with that of Gascoigne and of the Herstmonceux group. They have also studied two W Vir, two long-period and two eclipsing variables. A peculiar R CrB variable (max. 16·2 $m_{pg}$) showed one minimum only over 63 years.

Two-colour photographic photometry of 100 SMC cepheids (central part) and 5-colour photoelectric photometry of 12 SMC cepheids has been completed by van Genderen (*BAN Suppl.*, No. 6). The Gaposchkins have continued their very extensive studies of Cloud variables. S Dor has still not recovered from its deep 1963 minimum. Martini has found that Cordoba spectra show that the variable was in minimum phase in 1945–46. Landi Dessy has found 222 variables in his SMC field '*f*' (away from the bar) of which 111 were discovered on blink-pairs with intervals 0·146–0·27 days. Christy has applied his theory of cepheid instability to Cloud cepheids. In particular his interpretation of secondary bumps in light-curves as internal echo phenomena has led to the conclusion that a single variable with clear bumps and period near 10 days can be used to determine a distance modulus. From one of Gascoigne's variables he derives 18·75 for the LMC modulus. Lloyd Evans is searching the Clouds for red variables. Several found in the LMC with $P \sim 200$ days are presumably genuine Mira variables. Meier (29-9920) reports 12 new Bamberg variables and one nova (1966) in the LMC.

### 3. *Gaseous components, radio, X-ray, etc.*

Faulkner (29-6460) has set up an upper limit of $5{\cdot}10^5\ M_\odot$ to the mass of 30 Dor from Balmer-line isophotes. Le Marne (30-4256) has studied 30 Dor at 408 MHz. The presence of non-thermal sources on rings surrounding supernova remnants has been pointed out by Matthewson and Westerlund.

OH has not been found in the Clouds with the Parkes reflector (29-1941). Of various attempts to observe X-rays from the Clouds (30-4365, 29-13461) only Mark *et al.* claim success with the LMC at a level of order 4 % the intensity of Tau X-1. H. M. Johnson suggests that localized X-ray sources might have non-thermal continua optically detectable.

Westerlund (30-13077) has summarized known data on the Cloud planetaries. Feast and Webster independently find the SMC to be relatively rich in low excitation planetaries. Miss Webster has measured absolute emission line-fluxes (H, [O III], [O II]) and continua photoelectrically in 30 Cloud planetaries. She has also combined measures of the central stars with H, He line strengths to yield temperatures and luminosities. Some similarities with Seaton's evolutionary track are found.

### 4. *Clusters*

(a) *Globular*

Gascoigne and Hearnshaw (*Astr. Soc. Aust.*, **1**, 208) are deriving *c-m* arrays of the clusters NGC 2010, 2136 which contain cepheids. P. J. Andrews and Lloyd Evans find in their work on integrated spectra of red globulars that LMC globulars match galactic counterparts with moderately large metal deficiency but, in the SMC, NGC 416 and Kron 3 have no galactic counterparts.

(b) *Associations and clusters*

Westerlund and P. J. Andre are independently investigating the wing of the SMC and agree in the dominance of a very young population here. Andrews finds NGC371 (SMC) to resemble *h* and $\chi$Per in its *c-m* array: in one of three nearby small clusters (20″ of arc) there is found a giant branch at $V \sim 16{\cdot}5$, $B-V$ from 0·45 to 0·95.

Van den Bergh (39-4399) has observed and discussed integrated *UBV* magnitudes of 39 LMC and 13 SMC clusters. G. Walker and S. Morris have published *UBV* photometry of two LMC associations. F. Wright and Hodge (*A.J.*, **73**, S184, S210) have discussed the distribution of ages of LMC clusters through the system.

## 5. *General field*

(a) *Stellar spectroscopy*

Sanduleak (30-6356) has applied the Michigan Schmidt at Cerro Tololo to list 169 probable SMC members through objective prism classification (580 Å $mm^{-1}$). Fehrenbach and Thackeray independently confirm the reliability of Sanduleak's list. Sanduleak's new members include only 6 brighter than 12·0 $m_{pg}$. Sanduleak has a similar list of 1200 LMC members in preparation.

Fehrenbach reports that the ESO group at La Silla have now completely examined 13 fields, covering the bulk of the LMC, that have yielded 469 high-velocity stars, 1765 foreground stars and 200 stars of intermediate or doubtful velocity, etc. Maurice *et al.* have measured and classified 150 LMC stars (72 Å $mm^{-1}$). Florsch is listing 150 SMC members, while Mme Carozzi, in studying the region between the Clouds and between LMC and Galaxy, has found a surprising number of high-velocity stars apparently belonging to the galactic foreground.

Walraven, Fehrenbach and Thackeray all find the LMC to be richer than the SMC in the brightest super-supergiants of type F-K. Wesselink has calculated radii for such stars by a method which circumvents questions of bolometric corrections, but not of intrinsic colour, and finds $R = 10{\cdot}3$ A.U. for HDE 268757. 5-colour photometry of 69 LMC supergiants has been completed by van Genderen. The state of evolution of such stars still poses considerable difficulties as indicated by Kippenhahn, Stothers (29-14531) and others.

Przybylski (30-624) confirms the close similarity of HD 33579 (LMC) in abundances of metals to $\alpha$Cyg. L. F. Smith (30-4393) in discussing absolute magnitudes and colours of W stars comments on the similarity of LMC objects to Pop. I in the solar neighbourhood, while the SMC Pop. I is compared with that of the outer parts of the Galaxy. Underhill (30-8489) has also discussed W stars in the LMC.

(b) *Kinematics*

Monnet and Courtès report measures of 300 radial velocities of H II regions over the whole LMC, yielding a rotation curve like that for 21-cm radiation. The Fehrenbach group are supplementing their stellar objective prism work with radial velocities from slit spectra (72 Å $mm^{-1}$).

Feast (30-2624) has published radial velocities of 25 LMC and 11 SMC planetaries. The LMC objects define a rotation curve very similar to that for young objects (centre displaced from the bar) but with a larger dispersion (22 km $s^{-1}$). A spread in ages is indicated. Webster's (30-13016, -13017, -13018) velocities suggest a centre nearer to the bar. The distribution of Feast's SMC planetary velocities shows a double maximum like Hindman's for the 21-cm velocities. There is some support for the SMC being regarded as a bar seen end-on with matter flowing out at the ends, just as may be occurring with the LMC bar as suggested by de Vaucouleurs.

(c) *Photometry*

Basinski, Bok and Bok (29-6491) have published photometry of stars down to $16^m$ in the core of the SMC, predominantly unreddened blue stars. The Boks have checked Tifft's LMC sequence from $V = 9{\cdot}4$ to 16·4. Mianes *et al.* have carried out 5-colour photometry of more than 300 LMC

members at La Silla. Walraven reported further results of his multicolour photometry of Cloud stars at the ESO Symposium, compared with model computations. Five-colour photometry by Wamsteker of 500 blue stars and two-colour photography by Velthuyse have been carried out in the inter-Cloud region at the Leiden Station.

(d) *Absorption and polarization*

Studies of absorption continue to emphasize local obscuration in many parts of the LMC as compared with the relative transparency over much of the SMC, including the core. Gascoigne has examined main sequence B stars and adopts locally in the SMC a reddening of $0^m.2$, most of which may be in the foreground, and $0^m.05$ in the LMC. Le Marne (*Astr. Soc. Aust.*, **1**, 97) and Faulkner's work on 30 Dor, which combines radio and optical measures, suggests $A_v/E = 3$ for foreground absorption, but $A_v/E = 7$ within the nebula. However, Gascoigne's photometry of the cepheid HV 2749, only 15′ of arc south of 30 Dor, yields $A_v/E = 2{\cdot}8 \pm 0{\cdot}25$.

## 6. *Tidal Action*

Tidal action between the Clouds and the Galaxy has been considered by a number of workers (29-5003), but it is still uncertain whether the Clouds are bound gravitationally to the Galaxy. Kerr (*A.J.*, **73**, S102) has pointed out that the bulk of the high-velocity HI clouds, with a total mass comparable to that of the Magellanic system, may be moving in an approximately opposite direction to the Magellanic Clouds.

## WORKING GROUP FOR RESEARCH ON SUPERNOVAE

(by F. W. Zwicky)

By October 1966, the number of supernovae in extragalactic systems which had been definitely identified was 184. During the following three years an additional 70 supernovae were discovered, bringing the total number by July 1969 to 254.

The search for and the investigation of supernovae has been engaged in by an ever increasing number of observatories and astronomers, the majority of whom strongly support the continuation of the working group on supernovae and, until further notice, of the writer as its chairman.

Circular letter No. 9 was issued to the members of the working group in June 1968, giving data on the supernovae Nos. 171 to 216. A catalogue-monograph on the supernovae found since 1885 is in preparation and should be ready for presentation at the 1970 IAU Assembly. In the meantime K. Rudnicki and A. Karpowiczowa have announced that the manuscript of their catalogue of supernovae, including all major bibliographic data has been sent to the printer.

Two new approaches to the search for supernovae are in the first stages of realization, namely (*a*) automated searches by Professors Hynek and Colgate, the first having already resulted in 40000 bright galaxy reductions, the second being expected to start operation in the fall of 1969 and (*b*) the endeavours by J. Strong and F. Zwicky to have full-size objective gratings built for large (up to 50″ apertures) Schmidt telescopes. With gratings of this type, supernovae to about $m_p = 16{\cdot}5$ may be discovered on single plates, the spectrum being observed at discovery.

The frequency of supernovae appearing in galaxies within about five absolute magnitudes of the brightest has been redetermined by several investigators using extensive material. The frequency found originally by Zwicky of about one supernova per galaxy per 300 to 400 years has been confirmed. It is estimated that most of the supernovae which have appeared in the central cores of the galaxies observed have been missed. Also, no estimate can as yet be made of the frequency of intrinsically faint supernovae such as Eta Carinae. As predicted already from the statistics made 30 years ago there are some special galaxies which produce supernovae at a far greater rate than normal. For instance four supernovae each have appeared in NGC 5236 and NGC 6946 during the past fifty years.

A most interesting issue arises with respect to the frequency of supernovae in quasars and in the