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Discussion

Feast: Could Dr. Aller say where the spectral types he quoted come from? Are they unpublished data?

Aller: We collected them from the available literature. Of course we would like better classifications.

Eggen: The problem of accurate classification of weak-lined stars must be kept in mind.

Aller: The analysis of such a composite spectrum is very difficult in practice. One must select stars of different metal/hydrogen ratios and use the observed colour-magnitude arrays to construct a synthetic composite spectrum and energy distribution. Further, one must have a good description of the composite spectrum, obtained with as high resolution as practicable.

Rodgers: I agree with Dr. Aller that in the interpretation of the integrated scans of clusters the Hess diagram is most important. Differentiation between the intermediate-age clusters and halo clusters of intermediate abundances seems difficult.

Aller: We cannot interpret energy scans correctly without other data, such as adequate colour-magnitude diagrams. But when we have a colour-magnitude diagram with the correct number of stars in each interval of magnitude and colour, spectrograms from which line intensities may be measured, and energy scans, we should be able to get a result for the ratio of hydrogen to metals.

Heard: van den Bergh and Henry have studied 24 globular clusters visible in northern latitudes by means of spectrum scans, and have found several discriminants which correlate well with the Morgan line-strength classifications and serve to separate the clusters as to metal abundance.

Aller: The method must of course be calibrated; van den Bergh and Henry have suggested some leads that may be applied profitably to Magellanic Cloud clusters, when better spectral classifications are available.

As far as our cluster data suggest, as yet there is no evidence for a different metal/hydrogen ratio in the Magellanic Clouds than in the Galaxy.

74. SHORT-PERIOD VARIABLES IN THE MAGELLANIC CLOUDS

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Our knowledge of short-period variables in the Magellanic Clouds remains rather meagre despite the considerable effort that has been put into discovering them. Original failures to detect RR Lyrae variables at the expected magnitude of 17·5 led to a temporary belief that perhaps the Clouds contained virtually no Population II. However, the Radcliffe discoveries of RR Lyrae variables in the globular clusters NGC 121 (3), 1466 (44), 1978 (2), and 2257 (17+8), put the existence of a Population II component in both Clouds beyond doubt. Moreover, the published light curves and periods of variables in NGC 121 (Thackeray 1958) and NGC 2257

(Alexander 1960) showed the typical characteristics of Bailey types *a*, *b*, and *c*. Thus the comparison, so far as it goes, between the Population II of the Magellanic Clouds and the Galaxy shows no outstanding difference.

There remains the very difficult problem of accurate photometry of these variables. The Magellanic Clouds are still the only two systems in which it is possible to compare directly the luminosities of Population I and II variables. Tifft has made an exhaustive photometric study of NGC 121 and gives magnitudes that are several tenths fainter than those published by Thackeray and Wesselink. Wesselink is at present engaged in a new attack on this problem using a coarse grating which should give accurate magnitudes at 19^{m} despite the rather crowded fields in the Clouds.

Outside of globular clusters, our knowledge of short-period variables is still more meagre. Dessy (1959) has reported eight variables considered as cepheids with a mean apparent magnitude of 17·0, i.e. more than 2^{m} brighter than the RR Lyrae in NGC 121. At a fairly conservative estimate, not more than one of Dessy's eight variables can be attributed to the galactic foreground. This conclusion remains true even when taking into account Kinman's recent findings of faint RR Lyrae variables at high galactic latitude.

At a slightly fainter level, Wesselink (1962) has found five variables in the crowded central region of the Small Cloud whose periods are less than 1 day. But these, like the Dessy variables, are nevertheless considerably brighter than the variables in NGC 121.

Finally, a few faint variables lying outside NGC 121, but probably belonging to the SMC outskirts, have been observed by Thackeray and Tifft. These variables are about as faint as the cluster variables and at least one of them seems to be a true RR Lyrae variable with a period near half a day.

Variation of the Most Luminous Stars

In contrast to the very faint RR Lyrae variables in the Clouds, consider now the very brightest stars in the Clouds. Wesselink has found small changes in *V* in excess of $0\overset{m}{.}10$, and we ask ourselves the question: Do these small variations arise from the inherent instability of super-massive stars? Schwarzschild and Härm (1958) have predicted that such instability will lead to pulsations in periods of order 6 hr for the hottest stars.

It is already known from studies of B and A supergiants in both Magellanic Clouds and in the Galaxy that excessive luminosity is almost invariably accompanied by hydrogen emission and associated P Cygni absorption. This gives us direct confirmation of the concept that radiation pressure is probably winning the battle against gravitation in the enormously extended atmosphere (in particular, outward motion of CaII gas has been observed in the spectra of the brightest members of each Cloud, by Thackeray (1962)). But can any periods be detected? In the most famous case, S Doradus, with a large amplitude, no period has yet been found; in particular, Gaposchkin's 40-year period seems to be ruled out unambiguously.

One star in the Small Cloud received particular attention in 1962 because (*a*) it was already known to show variations in both light and spectrum, (*b*) as one of the hottest stars it might be expected to fulfil the Schwarzschild-Härm prediction of a very short period.

The star is the Wolf-Rayet object HD 5980 near the nebula NGC 346. On a night of fair photometric quality this star was observed photoelectrically by Mr. G. Harding and the writer semi-continuously for an interval of 5 hr. For comparisons Wesselink's standard HD 6005 and another blue Cloud member close by were used.

The extreme variation in HD 5980 was only $0\overset{m}{.}06$, half what Wesselink has observed as the range on separated nights. No convincing evidence of periodic variation was found.

In support of this result, many spectra were obtained in 1962, usually pairs of spectra separated by some 4 hr, and sometimes three in one night. The variations from night to night are confirmed, but no clear instance of a variation during the night has been found. On one night two spectra show double emission lines (separation$\sim$600 km/sec) but the general pattern of behaviour of the lines suggests intrinsic atmospheric changes in intervals of days rather than a true binary. It is possible that the star has no regular period, but a period of 6 hr or less appears to be most unlikely.

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Discussion

Eggen: What luminosity is this Wolf-Rayet star?

Thackeray: Apparent magnitude 11·6; that is, we believe brighter than −7 absolute.

Arp: What are the periods of Wesselink's new short-period variables in the central regions of the SMC? Are they close to 0·5 day period or closer to 1 day?

Thackeray: About 0·75 to 0·95 day. They are like the Landi Dessy variables but fainter.

Gascoigne: Are there any clusters in which there are no cluster-type variables?

Thackeray: Yes, though the negative result is not conclusive. If six plates or less failed to show RR Lyrae variables the cluster was dropped.

Tifft: Near NGC 121 one variable $<V>\sim 18\cdot 1$, $p=1\overset{d}{.}4$ is seen which appears to be a Type II cepheid. It might be interesting to know if this type of variable might relate to the Wesselink or Dessy variables.

It is likely that in the SMC it may be more practical to study cluster-type variables in the general halo field — as near NGC 121 and other possible areas — rather than in clusters.

Thackeray: A search for RR Lyrae variables in the general field would be very useful but time-consuming.

Aller: Variations in the intensities and profiles of emission lines in Wolf-Rayet stars (e.g. HD 45166) and in Of stars (observed by Oke) have been noted. They have also been suspected in Wolf-Rayet nuclei of planetary nebulae. The variation would appear to be correlated with atmospheric envelope instability rather than with luminosity.