parameters, its *mass* and its *content of heavy elements*. If the enrichment with heavy elements has occurred at the same rate in all parts of the Galactic System the heavy-element content of a star would also determine the epoch at which it was formed and, therefore, its age. If this were so and if the heavy-element content of a star could be determined with sufficient accuracy, we might in this way arrange the stars in age groups. In practice we cannot yet reach this ideal. In the first place we can as yet hardly measure the heavy-element content of an individual star except when it deviates drastically from normal, as in the case of the sub-dwarfs. In the second place it is likely that the enrichment of the interstellar material has depended on the amount of star formation and has therefore been much greater in the central parts than in the outer regions.

Attempts to determine the heavy-element content with greater precision must be considered to be of the greatest importance. It is probable, as Sandage has shown, that considerable progress in this line can be made by studying galactic clusters. The main difficulty *there* is that we know as yet so few clusters of ages intermediate between the primeval and contracting stage on one hand, and the youngest stage of the System on the other hand.

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[2] Schmidt, M. *Bull. Astr. Inst. Netherl.* **13**, 15, 1956.
[3] Weaver, H. F., unpublished.
[4] See the forthcoming report on the *Semaine d'Etude* on Stellar Populations, Vatican, 1957, now being edited by D. O'Connell.

(B) SOME PROPERTIES OF OTHER STELLAR SYSTEMS

This section deals with a few remarks on stellar systems outside the Galaxy which were considered to be of importance in the interpretation of galactic observations.

(1) *Integrated spectra and colours of galaxies*

Information on the general stellar population predominant in the light emitted by galaxies, may be obtained from a study of the integrated spectra. W. W. Morgan reported on such an approach, recently made by Morgan and Mayall [1], extending earlier work by Humason [2] and others.

The criteria used for the spectral classification, which necessarily are of the very low-dispersion variety, are mainly the appearance of the hydrogen lines and the cyanogen absorptions at $\lambda\lambda$ 3800 and 4200. In objects where the hydrogen lines are of maximum intensity the predominant

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stellar population is composed of stars of about spectral class A0, while in objects showing maximum strength of the CN absorption the predominant stars are of spectral classes somewhat later than K0. Composite spectra between these two extremes may be evaluated in about the same way as an unresolved binary is classified.

A number of the brighter galaxies have been classified and a marked correlation between the spectral class and the nebular type according to the Hubble classification appears. This was also indicated in the work of Humason. When making comparisons between various galaxies it is important, however, that only spectrograms covering the same wave-length region are used.

The red and infra-red regions of the spectrum of M 31 show strong TiO bands, indicating that a large proportion of the luminosity is due to M stars, which are probably similar to the many M stars found in our Galaxy by Nassau and his collaborators. In the blue region the CN absorption is prominent, indicating that also a large number of giant K stars is present. Other galaxies of the Sb type with a large central bulge have spectra of the same type as M 31. The irregular galaxies, such as NGC 4449, and the Sc systems, which have no marked central condensation, have spectra of early type; most of the luminosity is in this case due to stars around spectral class A0. The giant ellipticals, like M 87, have an almost pure K spectrum, while dwarf ellipticals, such as M 32, are of earlier spectral class and somewhat peculiar.

Observations of M 31 reveal no change of the population with distance from the nucleus. On the other hand, the colour indices as determined by Holmberg [3] show considerable variation from the inner to the outer regions. In the central part the colour index is always large, about +0·84, the same as for the elliptical galaxies, while in the outer parts of the spiral it amounts to between +0·40 and +0·50. The irregular galaxies according to Holmberg seem to belong to two different types, one having a mean colour index of +0·28, whereas the other is the same as for the ellipticals.

An especially interesting case is M 82, which exhibits a large colour index but a pure class A spectrum. It belongs to the turbulent type of galaxies which in a number of cases are radio sources. They have strong emission lines, as for instance NGC 4151. Perhaps the emission lines originate in a very large number of planetary nebulae, not in H II regions.

(2) *The rotation curve of M 31*

In order to compare the 21 cm rotation curve of the Andromeda nebula with that of our Galaxy van de Hulst and Raimond [4] have determined 21-cm profiles at various points on the major axis of M 31 out to 2° from the centre on either side. Westerhout reported on this work. Van de Hulst has computed the density distribution and the rotation curve fitting the observations. The resulting rotation curve, which shows very little asymmetry, does not drop as fast in the outer regions as does the rotation curve of our Galaxy based on Schmidt's model. This may indicate that the mass density in the outer regions of the Galaxy has been underestimated.

The mass density of the neutral hydrogen in M 31 shows maxima at about 1° from the centre, that is where the main spiral arms appear and where the super-giants are most conspicuous. Similar maxima are shown in the Galaxy at distances of about 7 kpc from the centre. There is a difference between the two systems in that M 31 shows a long tail of low density stretching out farther in the equatorial plane than is the case in our Galaxy, where the density drops fairly rapidly.

As mentioned above the radio measures of M 31 show very little asymmetry of the rotation curve, of the order of 15 km/sec. In contrast to this the emission nebulae have given a difference amounting to about 100 km/sec between the south preceding and the north following side. It was suggested by Lindblad that this might be due to M 31 being a barred spiral, but it is difficult to see why the neutral and the ionized hydrogen should then behave differently. Baade thought that the observed difference is due to tidal disturbances from M 32, and pointed out that part of it might be introduced if the emission nebulae are not all situated in the equatorial plane of the system. Fehrenbach stressed the difficulty of measuring exact radial velocities of emission nebulae and recommended the use of interference methods. He intends to use this method at Haute Provence to check the previous measurements.

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