35. GALACTIC CLUSTERS AND H II REGIONS

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The galactic clusters and the exciting stars of H II regions are powerful indicators of the spiral structure since these objects lie on or very close to the zero age main sequence (ZAMS). For clusters this behaviour can be confirmed by direct photometric observation. The exciting stars of H II regions are probably so young as not to have evolved from the ZAMS. The coincidence of these objects with the ZAMS indicates that there is little scattering in the absolute magnitudes and, as a consequence, little uncertainty in the determination of distance. This fact reveals itself very distinctly in the case of H II regions, whose exciting stars define the spiral structure considerably better than the stars of the same early spectral types but not connected with H II regions.

Within the last 3 years the contributions of various observatories have increased the number of galactic clusters with distances determined by three-colour photometric methods from about 150 to about 230.

Unfortunately the corresponding number of H II regions with distances determined by the Hβ- and Hγ- intensities of their exciting stars has not augmented in the same measure, namely from 55 to only 70. Some of these coincide with young clusters.

Even so, the total number of these objects has increased sufficiently to justify a new survey of their spatial distribution and, hopefully, stimulating new work in this field.

We have collected systematically the published results and combined them with our own. For the clusters it seems practical to determine the distances in a homogeneous way. Most authors use the B–V colour magnitude diagram (CMD) for the determination of age and distance modulus and the two-colour diagram (TCD) for the evaluation of the colour excess.

There are three reasons which lead us to the conviction that an other method is more practical, a method using both CMD's (B–V and U–B), but not the TCD. These reasons are:

(1) The apparent magnitude, necessary for the separation of physical and non-physical members of galactic clusters does not enter the TCD. The colour excess evidently should be determined only by the physical members. Since the B–V CMD alone in many cases allows no conclusive determination of the physical membership, both CMD's together complement each other and are the next best tool to proper motions.

(2) The colour excess can be more precisely determined by postulating the coincidence of the physical members of the cluster with the ZAMS of B–V *and* U–B CMD simultaneously and taking into account the fixed ratio of the excesses in U–B and B–V.

(3) The U–B CMD is often more reliable for the determination of the distance modulus, especially for young clusters, since the upper part of the ZAMS is much less steep here than in the B–V CMD, where it is almost vertical. In addition, the

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determination of age, i.e. of the colour index of the whitest stars, is more precisely done in the U–B CMD than in the B–V CMD, since an interval in U–B of 0.4 magn. corresponds to an interval of only 0.1 magn. in B–V.

Using our method we had to modify the published distances in some cases by 10 to 30%, but mostly by less than 10%.

Figure 1 shows the distribution of the young galactic clusters (●) with earliest type between O and B 2 to B 3. It does not diverge from the distribution of the H II regions (○), also shown in this figure. Not considering a few 'drop-outs', the distribution defines three lanes suggesting parts of spiral arms. This suggestion is supported by the fact that there exists a spiral galaxy, NGC 1232, whose spiral arms coincide with these parts of *our* spiral arms regarding their width and their mutual distance,

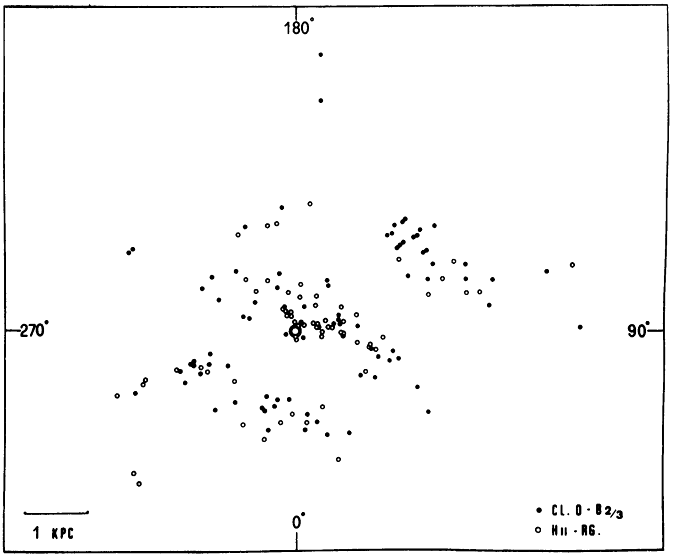

Fig. 1. Space distribution of young galactic star clusters (●) and H II regions (○) in the galactic plane. Parts of three spiral arms can be seen, the local arm (O), the Perseus arm (+I) and the Carina-Sagittarius-Scutum arm (−I). The position of the sun is (☉).

that is they agree even in pitch angle and distance from the respective nuclei (Figure 2). The total diameter of NGC 1232 is according to its expansion velocity (Hubble constant 100 km s^{-1} Mpc^{-1}) practically the same as the one of the Milky Way system.

Figure 3 shows the spatial distribution of the older clusters with earliest type later than B 3, which seems quite random. However the number of such intermediate age clusters is still too small to provide a basis for a successful investigation of the transition from spiral to random distribution.

The arrangement of the young clusters and the H II regions in the spiral arms is due partly to selection effects caused by the observation programs and partly by particularities of the spatial distribution.

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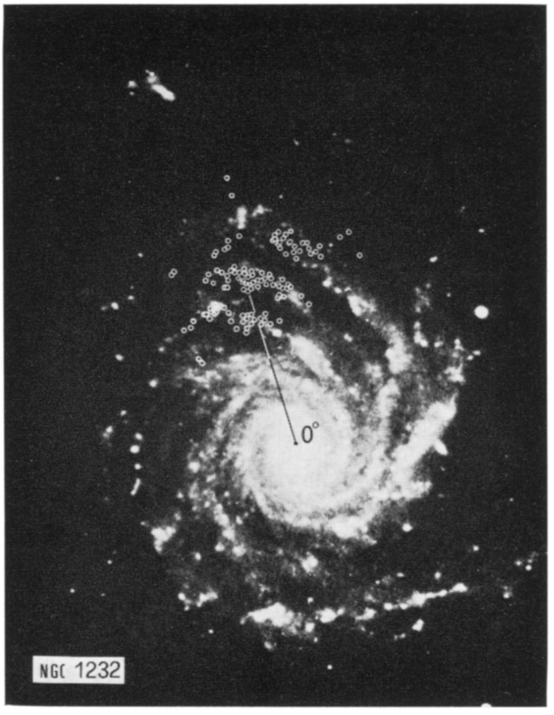

Fig. 2. Young galactic star clusters and H II regions as projected in a corresponding scale to the spiral galaxy NGC 1232, which has the same linear diameter as our Galaxy.

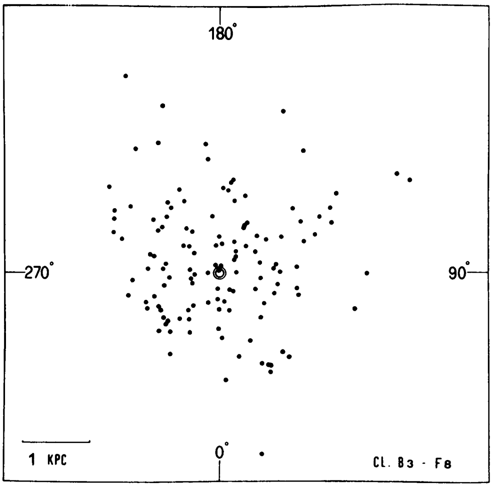

Fig. 3. Space distribution of the old galactic star clusters.

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If we permit ourselves to compare again the situation in NGC 1232 to our galaxy, we cannot expect to complete the picture in the directions $l^{\mathrm{II}}=200°$ to $250°$ substantially, because the spiral arms seem to dissolve in these directions. On the other hand, a completion of the spiral arm +I in the direction $l^{\mathrm{II}}<95°$ meets observational difficulties, since its clusters will have distances over 3 kpc and will be influenced by heavy absorption of the Cygnus bifurcation. Between $l^{\mathrm{II}}=140°$ and $180°$, young objects seem to be missing completely in the arm +I.

Most interesting and relatively easy to complete is the picture in the region between $l^{\mathrm{II}}=300°$ and $330°$, which will be of great importance for a resolution of the discrepancy in the interpretation between Bok and ourselves. A better definition of the inter-arm regions in the directions around $l^{\mathrm{II}}=50°$ (Aquila-Vulpecula) and $l^{\mathrm{II}}=255°$ to $285°$ (Puppis) might prove to be of equal interest. We plan to concentrate our activities mainly on these problems.

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