

THE GALACTIC DISTRIBUTION OF 60 YOUNG OPEN CLUSTERS

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The photometric distances of 60 young galactic clusters (with $sp < b3$), all observed in UBV or RGU, have been calculated or recalculated according to "method A" (Becker, 1963). The galactic distribution of these clusters, shown in Figure 1, confirms their role of being good spiral tracers.

20 years have elapsed since Becker and Stock (1958) published their catalogue of 40 three-colour photometrically observed galactic clusters. This was the first one in a series containing increasing numbers of clusters (i.e. 82, 156, 216) and published by the Basle Observatory (Becker, 1961; Becker, 1963; Becker and Fenkart, 1971).

The main aim of these compilations was to provide the given clusters with the best, homogeneously determined distances available. Covering distances up to 5 to 7 kpc from the sun with a mean error of not more than $\pm 10\%$, the three-colour photometric method turns out to be ideal for this purpose, yielding, together with the distance, reddening, absorption, probable physical members and earliest spectral type for the cluster in question. The last parameter is a good indicator of the relative age of the cluster and therefore it is important for the identification of those clusters which are young enough to be spiral tracers. Indeed, all clusters with an earliest spectral type not later than about $b2$ have a strong tendency to concentrate their positions along relatively well defined fragments of the local spiral arms, representing therefore the most reliable spiral tracers next to HII regions.

For these reasons, it seemed useful to extend the material contained in the previous catalogues by collecting all available three-colour photometric data of those galactic clusters which have been observed since the fourth Basle Catalogue (BC IV) (Becker and Fenkart, 1971), either in Johnson's UBV- or in Becker's RGU-system.

In view of their importance as potential spiral tracers, we have reconsidered all those young clusters, i.e. with $sp \leq b2$, whose distances had not been determined according to "method A" applied at the

Basle Observatory and consisting of the evaluation of both colour-magnitude diagrams, because it provides a better identification of probable physical members and a more precise determination of interstellar absorption and distance than "method B" which uses one colour-magnitude diagram only, together with the distance-independent two-colour diagram (Becker, 1963). Among the young clusters collected since BV IV and up to the deadline of the compilation in question (March 18th, 1978), there were 17 whose distances had to be redetermined according to method A. The resulting values differ, in some cases, quite considerably from those obtained by the corresponding authors according to method B.

Figure 1 shows all 60 young clusters of this last Basle Catalogue (BV C; Fenkart and Binggeli, 1978) containing totally 191 three-colour photometrically observed galactic clusters. They are projected upon the galactic plane, where the hatched regions give an idea of the approximate course of Becker's spiral arms -II, -I, 0 and +I which represent the local spiral structure as it is defined by previous plottings of reliable spiral tracers, as HII regions and young open clusters (cf. Becker and Fenkart, 1970).

The original distances (according to method B) of the 17 reconsidered clusters are indicated by the points of the radial arrows starting at the inverted triangles (\blacktriangledown) which represent their recalculated positions according to method A. None of these revised positions is outside a hatched region or a plausible extension of one of them.

Among the 43 clusters (\bullet) whose distances had been determined according to method A by the corresponding authors themselves, only five lie clearly in the inner arm regions between the hatched areas: 95 and 99 between arms 0 and -I, 120, 149 and 183 between arms -I and -II. 95, 120, 149 and 183, however, lie so close to neighbouring arms that even during their short lifetimes they could have withdrawn from there, provided they had been born sufficiently close to the corresponding edges of these arms and assuming sufficiently steep directions of their space motions with respect to them. In the cases of 149 and 183, even a distance correction by less than 10% (the mean error of three-colour photometrically determined cluster distances) would shift them into neighbouring arms. For 99, however, only an unusually large component of its space motion, perpendicular to arm 0, (13 km sec^{-1}) would reconcile the low age of this cluster with its extreme inner arm position.

The remaining 38 clusters lie either within the hatched arm regions or so far from them that it cannot be decided whether they would fall into their extensions, into inner arm regions or, in the cases of 32, 38, 44, and 45, even into +arms lying farther out from the sun.

The addition of 60 further spiral tracers overwhelmingly confirms the familiar local spiral structure defined by Becker's arms. The

clusters whose positions fall outside this system are not sufficiently crowded to give reliable hints for plausible extensions.

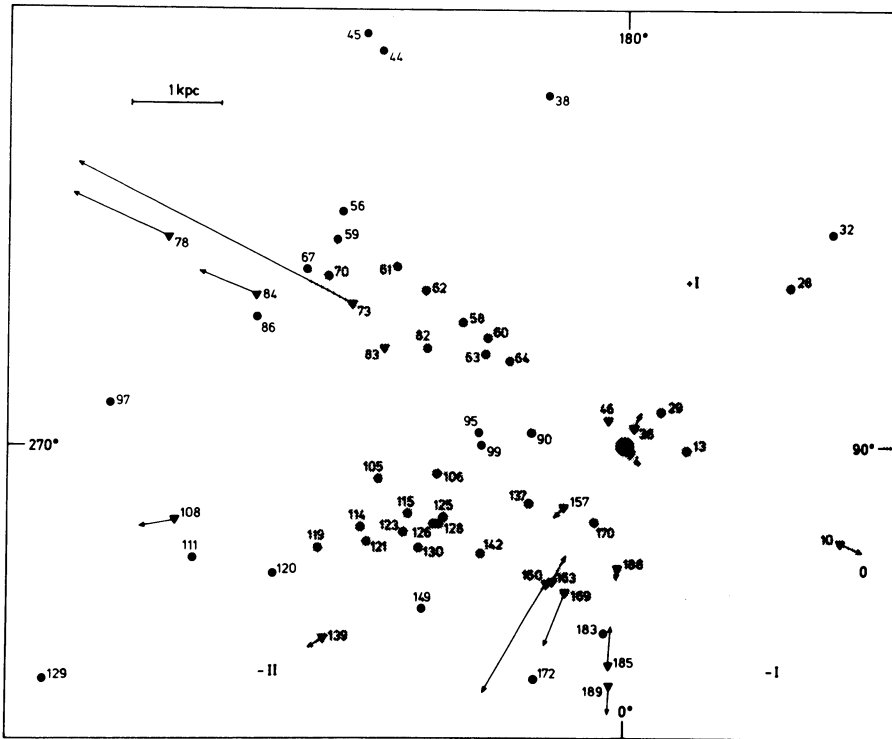


Figure 1. Galactic distribution of 60 young galactic clusters ($sp \leq b2$) contained in the Fifth Basle Catalogue (BC V).

Hatched regions: Approximate course of Becker's spiral arms -II, -I, 0 and +I.

- ⊙ : Sun
- ▼ : Redetermined positions according to method A (by F)
- ↓ : Original positions according to method B (determined by corresponding authors)
- : Positions according to method A (determined by corresponding authors)

Numbers corresponding to those in column 1 of table 1 (BC V).

REFERENCES

- Becker, W., Stock, J.: 1958, Z. Astrophys. 45, 269.
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DISCUSSION

Kaufman: What width did you adopt for the spiral arms? Whether you assign a cluster to arm or interarm depends on the assumed arm width.

Fenkart: The width of the hatched arm regions is given by the approximate range of spiral tracer positions given in earlier plots (see, e.g., Becker and Fenkart, 1970).

Jackson: In what you call the Arm-I and others call the Sagittarius-Carina arm, you are sure that you are seeing through it to the other side, and not just running into dust at different distances in different directions?

Fenkart: Yes.

de Vaucouleurs: Spiral arm "tracers" have been much discussed at this symposium. At the same time the confused picture of spiral structure in our solar neighborhood given by these "tracers" is a disappointment. Let me remind you that a similar situation is observed in many galaxies whose spiral structure almost disappears if one plots only the "tracers" (HII regions, etc.). In some galaxies, such as M101, the "tracers" are in many parts much displaced from the smooth, old spiral arms.

Bok: 1. What is the Carina Arm in your picture? 2. It seems very desirable always to print side-by-side with one diagram (like the one shown by Dr. Fenkart) showing the suggested spiral arms, a second diagram showing only the raw data. By having these diagrams side-by-side, it is easy for the readers to judge for themselves whether or not it makes sense to draw the spiral features as shown.

Fenkart: 1. The Carina fragment has not been fully hatched, because only very few new objects are found there. 2. I agree with your suggestion.