RGU THREE-COLOUR-PHOTOMETRY TOWARDS THE NORTH GALACTIC POLE: HALO-TO-DISK MASS RATIO

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The halo program of the Basel observatory, initiated by Becker in 1965, is based on a three colour photometry in test fields along the circle through the galactic centre and the galactic poles. The more favourable direction of the blanketing vector relative to the main sequence in the two colour diagram for RGU makes it possible to separate at least statistically the disk population and the halo populatior within the interval of absolute magnitudes $+3 \leqq M_G \leqq +8$. It is therefore possible to derive density functions for both populations and for different intervals in absolute magnitude for each test direction within the test plane defined above. This allows one to draw isodensity curves in the test plane and, assuming rotational symmetry of the halo, also isodensity surfaces. The last assumption is tested at least locally by test fields with different inclinations towards the test plane (Fenkart, R.P. and Wagner, R., 1975).

The investigations in Basel have led to two results which will be used here:

a) the combination of results in all eleven directions treated so far gives a determination of the local halo mass density in the solar neighbourhood;
b) the halo star density function in the direction of the galactic poles allows to calculate the halo-to-disk mass ratio (Fenkart, R. P., 1976).

1. The local halo mass density ρ_0. Since the classification with three colour photometry is only possible for stars with $3 \leqq M \leqq 8$ we get with those stars only a lower limit for ρ_0. But the luminosity function $\varphi(M)$ for the halo stars from our observation shows that

a) stars with $M < 3$ are very scarce and their contribution to the total mass can be neglected;
b) for stars with $M > 8$ we can extrapolate $\varphi(M)$ to faint magnitudes. It seems to extend at best horizontally rather far towards faint stars (a

Edith A. Müller (ed.), Highlights of Astronomy, Vol. 4, Part II, 53-54.

similar result was recently obtained by Eggen (1976) using a very different approach), and we can include these stars for an upper limit for ρ_O.

For the masses of halo stars the mass-luminosity relation for stars with low metal content by M. Schmidt (1975) is used. With this we obtain the local mass density of halo stars ρ_O:

lower limit: $3.0 \cdot 10^{-4} \mathfrak{M}_\odot \, pc^{-3}$; upper limit: $7.7 \cdot 10^{-4} \mathfrak{M}_\odot \, pc^{-3}$.

2. The halo-to-disk mass ratio. The program in three colour photometry gives the stellar density distribution D(r) for the halo and for the disk for different absolute magnitudes as a function of the distance r from the sun. In the case of the polar fields SA 57 and SA 141, r is equal to the distance z from the galactic plane. We can, therefore, obtain the total mass within a column piercing vertically the galactic plane at the position of the sun, separately for the disk population and the halo population. The densities for corresponding luminosity groups in the direction of the north galactic pole (actually SA 57) and the south galactic pole (actually SA 141) agree well enough to assume a north-south symmetry of both disk and halo structure and to restrict the calculations to the northern polar direction (Fenkart, R., 1969).

Assuming furthermore that the luminosity function does not change with z, we have to integrate over D(z) up to 2 kpc for the disk and up to 8 kpc for the halo to reach a density of about 10^{-3} relative to that in the solar neighbourhood. The assumption of a uniform luminosity function for all z can to a large extent be checked by the numbers of stars for different z and M, except for the faintest stars at large z (where they are beyond the limiting magnitude) and for the brightest stars at small z (where their number is too small to be statistically significant). An integration only to 1.5 kpc and 6 kpc, respectively, would reduce the masses of the two populations by little more than 1 %.

As a result we obtain a halo to disk mass ratio of 0.10 and of 0.25, for the lower and for the upper limit of ρ_O, respectively.

References

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