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CEPHEID DISTRIBUTION IN THE GALAXY

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Abstract. Space distribution of 363 cepheids in the Galaxy is examined. The galactic disc is widened at the periphery of the Galaxy. We identify 19 cepheid complexes. The cepheids with nearby periods fall in the same complex. The Cepheid distribution is compared with those in M31 and M33.

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1. Introduction

The distances of cepheids can be obtained based on the period-luminosity and period-colour relations. The cepheids have high luminosity and their distances reach several kpc. They are appropriate objects for the galactic structure. The investigations of cepheids distribution have started with the papers of R. P. Kraft and M. Schmidt [1] and J. D. Fernie [2]. G. R. Ivanov and N. S. Nikolov [3] have found that cepheids trace the Carina arm. Yu. N. Efremov et al. [4] identify 20 cepheid complexes with similar periods and radial velocities.

In the present paper we use the period-luminosity and period-colour relations and have determined the distances for 363 cepheids.

2. The Cepheid Distance Scale

The absolute magnitude of a star may be represented by the relation

$$M_V = S_V - 5\lg\frac{R}{R_\odot} + 16.16 \tag{1}$$

where

$$S_V = 1.93(B-V)_\mathrm{o} - 11.58$$

and the zero-point is obtained using the data for cepheids in open clusters. Using data for 33 classical cepheids (G. R. Ivanov [5]) the following period–radius relation was obtained

$$\lg\frac{R}{R_\odot} = 0.71\lg P + 1.11\,. \tag{2}$$

Replacing this value in Eq. (1) we have been obtained

$$M_V = -3.55 \lg P + 1.93(B - V)_o - 1.97\,. \qquad (3)$$

This relation is nearly the same as that obtained by M. W. Feast and A. R. Walker [6]. The period-colour relation was obtained using data for 231 cepheids from L. Berdnikov [7] and J. D. Fernie [8]

$$(B - V)_o = 0.34 + 0.395 \lg P\,. \qquad (4)$$

Replacing (4) in (3) have been obtained

$$M_V = -1.31 - 2.79 \lg P. \qquad (5)$$

This relation was used to determine absolute magnitudes of 132 cepheids which have not colour excesses in paper of J. D. Fernie [8].

3. The Cepheid Distribution

Figure 1 gives the distribution of 363 classical cepheids on the galactic plane. The Sun is in the center with coordinates $X = 0$ and $Y = 8.5$ kpc. Figure 2 shows Z coordinates of cepheids with galactocentric distance R. The galactic disc is 160 pc thick at $R = 6$ kpc and about 800 pc thick at $R = 13$ kpc. It seems that galactic disc is widened at the periphery of the Galaxy. This effect is observed on the plates of edge-on galaxies.

Cepheid complexes were identified using the criterion proposed by G. R. Ivanov [9]. This identification criterion assigned to one and the same complex if the stars form a group with a statistically significant peak of space density above the mean level of stars. Cepheid complexes are extensive regions with high space density of cepheids. Their characteristic length scale is about 600 pc. The name "star complex" was supposed by Yu. N. Efremov [10]. Figure 3 shows 19 cepheid complexes. The space density of cepheids in these complexes is one order greater than in vicinity of the Sun. About 80 % of them contain smaller subgroups but have higher stellar density. Yu. N. Efremov [11] suggests to call them stellar aggregates. The cepheids in the same star complex have close periods.

Figure 3 represents the hierarchical structure of cepheid distribution. There are two large regions which contain several star complexes with the same period, i. e. the same age. These regions are identical with spiral arms Car-Sgr and Per-Cas (Fig. 1). There are three hierarchical structures with characteristic length 250 pc, 600 pc and about 2 kpc. This hierarchy connected with the near ages of cepheids reflects the coherent formation of cepheids in different regions of the same molecular cloud about several 10^8 years ago.

4. Discussion

The distribution of spiral arm indicators is shown in Fig. 1. The stellar associations are concentrated in three regions known as spiral arms. The OB associations, giant molecular clouds (GMC) and cepheids fall in the same region of the Galaxy, namely

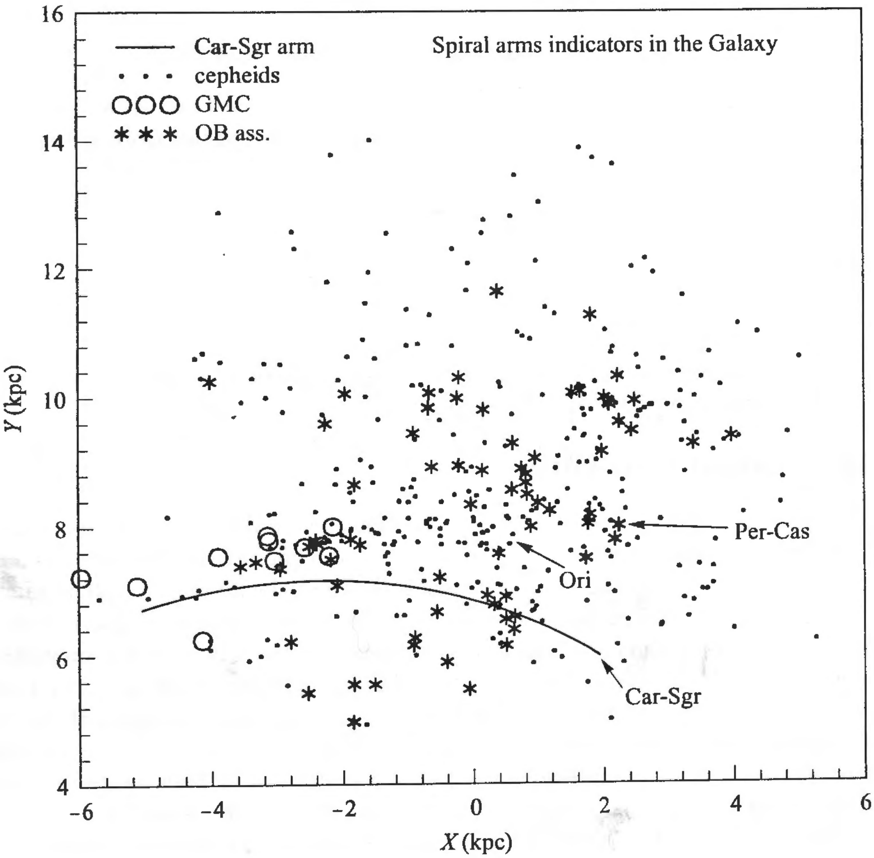

Fig. 1. Distribution of cepheids, giant molecular clouds and OB associations on the galactic plane The Sun has coordinates $X = 0$ and $Y = 8.5$ kpc

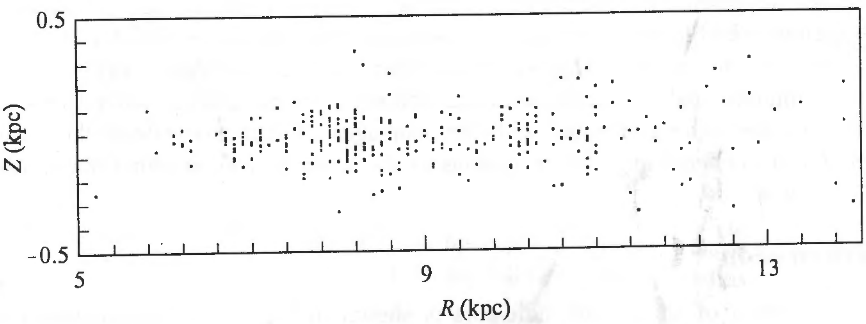

Fig. 2. Cepheid Z coordinates *vs.* galactocentric distance

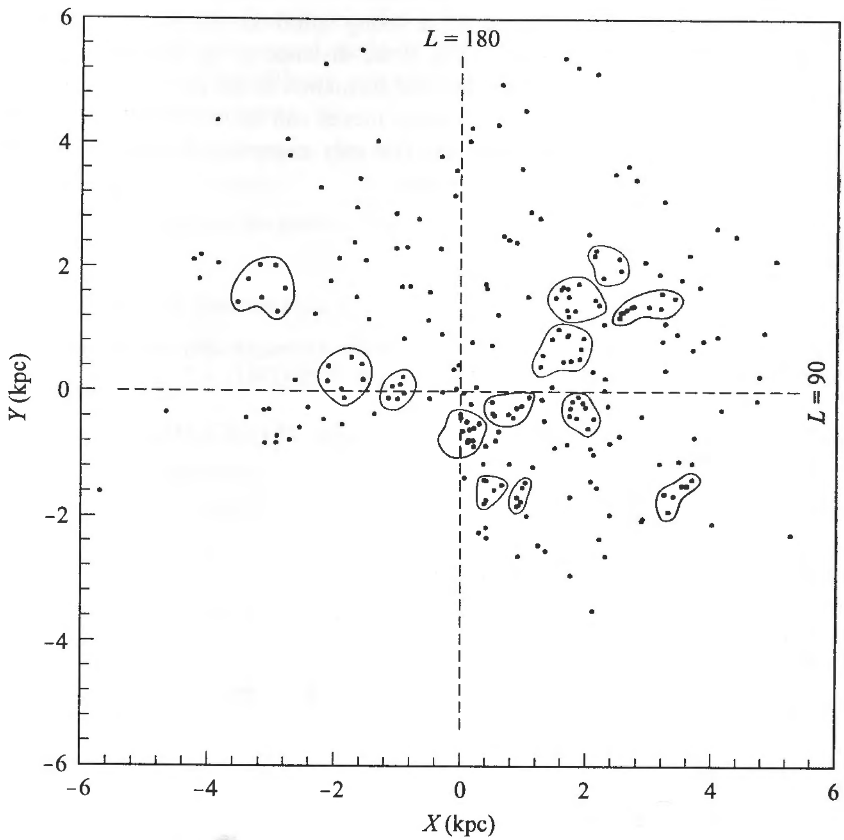

Fig. 3. Cepheid complexes on the galactic plane
The Sun has coordinates $X = 0$ and $Y = 0$

in the arm Car-Sgr. But even the youngest cepheids with the largest period are not confined in the Ori and Per arms which are well outlined by OB associations. This conclusion coincides with the earlier results of G. R. Ivanov and N. S. Nikolov [3] and Yu. N. Efremov et al. [4].

Yu. N. Efremov et al. [4] discuss the connection of cepheid distribution in the Galaxy with the dust complexes. They found that the distribution of cepheids beyond a distance 2 kpc from the Sun is strongly influenced by dust clouds. Therefore the cepheid concentration in the Carina spiral arm is real. It is important to compare the cepheid distribution in the Galaxy with that in nearby galaxies. It is unlike to the one in the Andromeda Galaxy. Yu. N. Efremov [12] pointed out that cepheids of all periods in the Andromeda galaxy are concentrated in the spiral arms which are well outlined by luminous stars. The cepheids practically absent outside the arms in M31. However the distribution of cepheids in the vicinity of the Sun in Fig. 1 does not resemble M31. This picture is quite different in M33 galaxy. Classical cepheids predominate outside arm regions while O stars outline well spiral arms.

There are observational evidences for a strong spiral density wave in M31 galaxy (Yu. N. Efremov [11], G. R. Ivanov [13]). If the distance of the Sun from the galactic centre is near to the corotation radius, the star formation is not governed by the density wave and, instead of a spiral arm, many short pieces can be formed (D. M. Elmegreen [14]) similar to the arms Ori and Per-Cas. The only exception is Carina spiral arm. It may be in connection with the density wave.

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