POPULATION OF THE GALACTIC DISC IN THE SOLAR NEIGHBOURHOOD

I. Parameters of Spatial Distribution for Stellar Groups of A–K Spectral and III–V Luminosity Classes

E. K. KHARADZE, R. A. BARTAYA
Abastumani Astrophysical Observatory, Academy of Sciences of Georgian SSR, U.S.S.R.

O. B. DLUZHNEVSKAYA, A. E. PISKUNOV
Astronomical Council of the USSR Academy of Sciences, Moscow, U.S.S.R.

and

E. D. PAVLOVSKAYA
Sternberg Astronomical Institute, Moscow, U.S.S.R.

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Abstract. Spatial density parameters of z-distribution and luminosity dispersion in the HR diagram for nine stellar spectral groups (A–K III, A–G IV, A–F V) were determined. It was shown that all stars considered can be divided into two subsets according to their scale-height β. For the younger stars β is of the order of 100–150 pc, and for older ones of 300–400 pc. The accuracy of the parameters derived was evaluated with use of numerical simulations. We found that for subgiants and dwarfs the relative error in the local density makes 10 to 15%, and for giants it is a little higher (20 to 25%). For other parameters the typical error is of the order of 20–30%.

1. Introduction

Determination of spatial, kinematic, and evolutionary characteristics of the galactic disk stars is one of the most important problems in the study of the Galaxy in a structural and evolutionary aspect. By this time many of investigations have been made. However, most of them are confined to the data on the stars located just near the galactic plane. They either refer to particular categories of stars, for instance, to the variables (Oort and Plaut, 1975), or to specific directions in the Galaxy (Fenkart and Karaali, 1984). Meanwhile from the standpoint of constructing the mass distribution model, it is necessary to have the data on a smoothed structure of the Galaxy as well as to use the data on the spatial distribution parameters for different stellar age groups.

A catalogue of spectral and luminosity classes compiled by R. A. Bartaya at the Abastumani Astrophysical Observatory – hereafter referred to as the Bartaya (1979) catalogue – presents reliable material for solving of this problem. The catalogue contains homogeneous observational data comprising the solar neighbourhood space and permitting the determination of photometric stellar distances with the accuracy satisfying a statistical analysis.

The present work opens a series of papers, where we intend – on the basis of the data from the catalogue – to discuss statistics of stellar populations in the solar neighbourhood. Below we shall consider local spatial distribution of various stellar age groups corresponding to different spectral and luminosity classes.

In the next paper we shall present results of determination of a luminosity function for disk stars. And, furthermore, involving accurate $UBV$ photometry of high luminosity stars we will study the large-scale structure of the disk. There is also planned (involving both published and new data on radial velocities and proper motions) an investigation of relation between a star position above the galactic plane, its age and velocity.

It should be noted that a further work on the two-dimensional spectral classification is under way at the Abastumani Astrophysical Observatory. We are going to apply the method, worked out by us, to new observational material as well.

The use of machine-readable version of the catalogue permits us to apply throughout the study a modern technique, e.g., the method of numerical experiments. In particular this method gives a possibility to estimate the accuracy of parameters of spatial distribution under study for different stellar groups in the HR diagram.

2. Observational Data

The Bartaya (1979) catalogue lists spectral and luminosity classes of about 10400 stars in the Kapteyn Areas (KA) Nos. 2–43. The fact that the classification is not made by the slit spectrograms, but by the objective prism plates, enabled us to perform a mass spectral classification of reasonably faint stars being very important in solving the problems of stellar statistics. The catalogue is complete up to 11$m^m$5 photographic magnitude. Apparent magnitudes of stars in the catalogue are borrowed from the Bergedorfer Spectral Durchmusterung (BSD). It should be noted that the size of the Bartaya (1979) catalogue areas is $4^\circ.5 \times 4^\circ.5$, meanwhile the BSD areas are smaller $3^\circ.5 \times 3^\circ.5$. Therefore, our sample contains only about 60% of stars available from the Bartaya (1979) catalogue. The absence of the photoelectric magnitudes prevents us from studying the spatial distribution of high-luminosity distant stars (supergiants, bright giants, and B-stars).

Unfortunately, the data on M-stars in the Bartaya (1979) catalogue are not complete. Therefore, a determination of spatial distribution of these stars and of a full stellar density in the solar neighbourhood is impossible; and we should restrict this study to the determination of local spatial densities for a number of spectral groups and investigate the distribution of stars of these groups along the $z$-coordinate. The latter is possible as much as about 40% of the areas studied are located at the high galactic latitudes $b > 30^\circ$. The galactic longitudes of the area centers are within $l \sim 70^\circ - 176^\circ$. Consequently, the catalogue allows to determine the spatial density in the Orion spiral arm, as the distances of all stars considered, do not exceed about 400 pc.