THE COSMOGONICAL SIGNIFICANCE OF THE Z DISTRIBUTION OF STARS

L.G. Balazs

Konkoly Observatory, Budapest

INTRODUCTION

According to the consequences of the density wave theory of spiral structure a shock wave is triggered in the interstellar gas leading to the formation of new stars (Roberts, 1969). The space and velocity distribution of the newly born stars is similar to those of the diffuse material which they have been formed from, i.e. they are strongly concentrated to the Galactic plane and have nearly circular velocities and small velocity dispersions. The velocity dispersions could increase in course of time by different stellar dinamical processes: encounters with large clouds of stars and gas (Spitzer and Schwarzschild, 1953; Julian, 1967; Barbanis and Woltjer, 1967), cooperative phenomena (Lynden-Bell, 1967), effect of non periodic orbits (Wielen, 1975), etc. If some of this processes has a time scale comparable with the time the star streeming needs between two consecutive passages of the density wave one expects an observable effect in the space distribution of A and late B type stars perpendicular to the Galactic plane. The Δt time difference between two consecutive passages equals 2.5×10^8 years near the sun. If the lifetime of stars is greater than this value their space distribution is a superposition of newly born stars with small velocity dispersion and stars born earlier and having greater velocity dispersion already. (Fig. 1.)

OBSERVATIONAL DATA

The space density curve of A and late B stars perpendicular to the Galactic plane shows an inflection which can be explained by supposing a superposition of two kinematically distinct subsystems, each having Gaussian velocity distribu-

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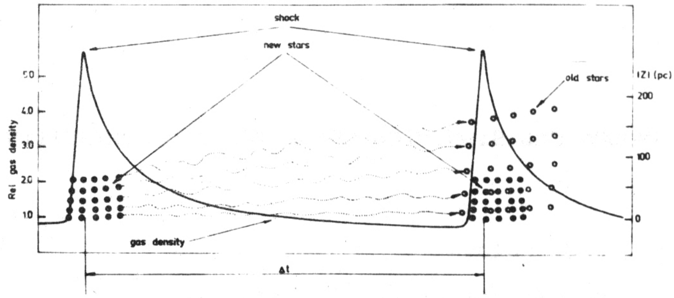

Figure 1.The superposition of stars having lifetimes and stars newly born due to the shock front. $\Delta t=2.5\times10^{8}$ years near the sun. The run of the gas density is taken from Roberts (1969).

tion but with a ratio of the velocity dispersions of 1:2. (Woolley, 1965). (Fig.2.)

$$\nu(z) = \nu_1(0)\exp(-\Phi(z)/2\sigma_{1z}^2)+\nu_2(0)\exp(-\Phi(z)/2\sigma_{2z}^2)$$
$$\sigma_{1z}:\sigma_{2z} = 1:2$$

where ν, Φ, and σ_z are the space density of the corresponding stars, the gravitational potential, the velocity dispersion perpendicular to the Galactic plane, respectively. The indices 1 and 2 refer to the subsystems mentioned.The logarithmic ratio $\log(\nu_2(0)/\nu(0))$ of the density of the less compact com-

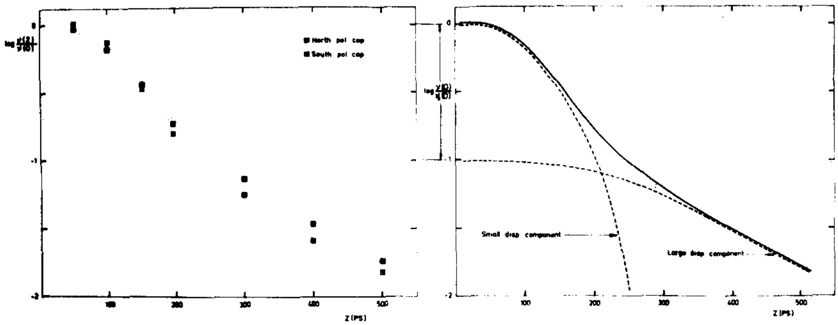

Figure 2. The space density curve of the AO stars perpendicular to the Galactic plane (according to van Rhijn) and its schematic representation by means of superposition of two kinematically distinct subsystems.

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ponent to the total density at z=O depends on spectral type and shows a break at AO in the values of the ratios. We can see this effect on Fig.3. using the data of different investigators:

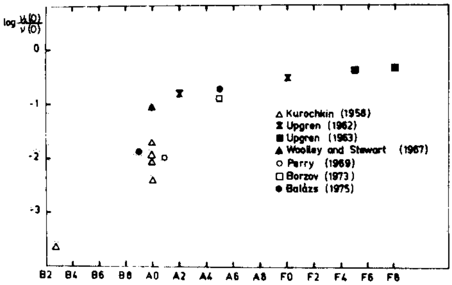

Figure 3. The dependence of the logarithmic ratio on the spectral type using the data of different investigators.

DISCUSSION

The existence of two kinematically different subsystems is a direct consequence of the picture outlined above but it would be difficult to explain supposing continuous star formation. The small dispersion component relates to the young stars while the larger velocity dispersion belongs to the stars have been formed in previous passages of the density wave. The coexistence of both subsystems appears at stars having lifetimes greater than the time difference of two passages of the density wave. If this assumption is correct the lifetime of the stars at which the break occurs coincides necessarily with the time between two consecutive passages. The τ lifetimes of the AO stars, at which the break appears, are about $\tau=3\times10^8$ years (Iben, 1967). The uncertainties of the spectral classification of the late type B and early type A stars on spectrograms of small scale determine a confidence interval around AO in Fig.3. The corresponding interval lies between spectral types B8 and A2 or between 1.5×10^8 and 5.5×10^8 years, respectively. So we get the following inequality: $1.5\times10^8<\tau<5.5\times10^8$ years and estimated value of $\tau=3\times10^8$ years. This time is close to the theoretically required 2.5×10^8 years within the uncertainties of the estimation.

Our recent discussion, however, does not rule out other mechanisms of star formation having the same characteristic time. Observations in directions in which the distances to the shock front along the stream lines different, and consequently different the time passed, may show changes of the velocity dispersions and of the spatial densities perpendicular to the Galactic plane.

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