STATISTICS OF A-TYPE STARS AS POSSIBLE INDICATOR OF STAR FORMATION

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ABSTRACT

Space distribution and kinematics of stars are determined by the initial distribution, i.e. the distribution of spatial positions and kinematical data just after the birth, and dynamical effects the stars experienced during their life. Evidence is presented that the space distribution of A type stars perpendicular to the galactic plane might be a result of periodic star formation having a characteristic time of $10^8 < \tau < 6 \times 10^8$ years.

INTRODUCTION

The space distribution of stars as derived from observations is a result of two main physical processes. The first important process is the star formation which produces an initial distribution of stars, characterized by their spatial, kinematical and physical data. The second main process is the dynamical evolution by means of regular and irregular forces which act on the stars and give them their present distribution. The distribution observed is a superposition of subsystems of different ages having probably different dynamical histories and initial conditions.

In the case of OB stars the dynamical evolution is unimportant since their lifetime is too short in comparison to evolutionary time scales. In the case of A type stars, however, the life times can be some 10^9 years and the dynamical evolution can change the initial distribution drastically.

SPACE DISTRIBUTION OF A TYPE STARS

Space distribution of A type stars differs significantly from space distribution of OB stars. Unlike OB stars they do

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not display spiral arms, they distribute more smoothly but some concentrations can be observed (McCuskey, 1965). There is also a strong difference in the distributions perpendicular to the galactic plane. The OB type stars concentrate strongly in the galactic plane. Removing the members of the Gould belt the scale height of these stars is less than 100 pc (Stothers and Frogel, 1974). The space distribution of B type stars can be well represented by the following simple formula in the direction perpendicular to the galactic plane:

$$D(z) = D(o)\exp(-\Phi(z)/\sigma_W^2) \quad (1)$$

Where $D(z)$, $\Phi(z)$ and σ_W^2 are the number density, the gravitational potential and the velocity dispersion in the z direction, respectively. This expression does not fit the respective space distribution of A type stars. A satisfactory fit can be achieved in the $(z)<600$pc domain, however, if one fits the actual distributions superposing two components each having the form of the right side of equation (1) but the velocity dispersions have a ratio of about $\sigma_{1W}:\sigma_{2W}=1:2$ (Wolley and Stewart, 1967)

$$D(z) = D_1(o)\exp(-\Phi(z)/\sigma_{1W}^2) + D_2(o)\exp(-\Phi(z)/\sigma_{2W}^2) \quad (2)$$

The ratio $D_2(o)/D(o)$ measures the percentage of the component of higher velocity dispersion compared to the total density in the galactic plane. This quantity is independent of the possible distance scale errors, therefore it is very appropriate for comparing the results of different authors.

Using the $D(z)$ distributions of stars of different spectral types obtained by different authors I found a dependency on spectral type in the ratio defined above (Balázs, 1975). At spectral types earlier than AO $\log(D_2(o)/D(o))<-2$, i.e. $D_2(z)$ makes little contribution to the total density in the galactic plane. Passing towards later spectral types, however, the logarithmic ratio jumps up to about -1 at AO and gradually increases afterwards to about -0.5 at F8. The jump means that $D_2(z)$ suddenly becomes more prominent in the total density distribution at AO spectral type.

The jump at AO on the $\log(D_2(o)/D(o))$ v.s. spectral type plot can be easily accounted for the discontinuous star formation. Namely, velocity dispersions, i.e. σ_W^2, are increasing with increasing stellar ages (Wielen, 1974). This increase can be adequately described by assuming a diffusion proces which causes an increase of the variances of z co-ordinates as well (Wielen, 1977). The observed $D(z)$ of a given spectral type is composed of two subsystems having different velocity dispersions. Combining the increasing σ_W^2 with uniform distribution of stellar ages the presence of two characteristic velocity dispersion would be difficult to explain. Supposing discontinuous age distribution, however, the pres-

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ence of two subsystem is a natural consequence. If the characteristic life time of stars of a given spectral type is smaller than the time required for increasing the velocity dispersion up to σ_{2W}, only the small dispersion component, i.e. σ_{1W}, is significant. As a consequence of discontinuous star formation the larger dispersion component appears if the lifetime of a star is greater than the characteristic time between two consecutive star formation activity. The sudden increase of the prominence of $D_2(z)$ results in a jump in the $\log(D_2(o)/D(o))$ v.s spectral type diagram. In our case this jump appeared near AO. The lifetime of these stars and the accuracy of classification on small scale spectra gives an estimate for the period of star formation of

$$10^8 \text{yrs} < \tau < 6\times10^8 \text{yrs}$$

AGE DISTRIBUTIONS

The interpretation of the space distribution of A type stars in terms of discontinuous star formation and diffusion processes is based on many speculative elements. Age distributions of these stars revealing the characteristic period expected above would give important support for proving the scenario outlined in the preceding paragraph. Any method which is capable of determining the positions of stars on the HR diagram can give the age of the stars if one uses appropriate theoretical isochrones. Studying the age distribution of A type stars brighter than 6.5 mag Balâzs and Tôth (1981) found a probable periodicity of 4.5×10^8 years.

The study of age distributions requires accurate location of stars on HR diagram and can be done on limited samples only. Determining space distributions, however, is possible on much more extended samples and Schmidt telescopes are well suited to this purpose. The combination of results obtained from these big samples with work yielding age distributions can give insight into the star formation processes going on in our Galaxy.

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