THE VELOCITY DISTRIBUTION AND THE MASSES OF STARS FROM THE PROPER MOTIONS IN THE STELLAR CLUSTERS

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ABSTRACT. The velocity distribution for the stars of different masses in the typical open cluster was calculated, the velocity variations having been considered as a purely discontinuous random process. the comparison of calculated and observed mean square velocities for the different groups of stars in the Hyades cluster enables us to estimate the mean mass of the stars in the each group.

Some years ago we applied the approach of purely discontinuous random process to the problems of stellar dynamics (Petrovskaya, 1969a). The main pecularity of this process is the jumps of the characteristics under the influence of the field objects (Gnedenko, 1961). As it was shown by Henon (1960) such discontinuous velocity variations just take place in the stellar clusters. Specifically, the dissipation of the real grsvitating systems may be calculated only according to the purely discontinuous scheme.

We modified the Kolmogorov-Feller's equation describing such process having involved the absorbting screen. In reference to the changing of the star velocity under the influence of the stellar encounters this screen correspongs ti the escape velocity. When the velocity module of the star becomes larger or equal to the escape velocity, v_e, the star retires from the cluster.

Then we considered the evolution of the typical open cluster and found the stationary velocity distribution achieved by the stars of different masses when the irregular forces don't already alter the form of the velocity distribution function (Petrovskaya, 1969b, Kaliberda and Petrovskaya, 1970,1971,1972). These stationary distribution functions of velocity module are presented in Fig.1 for the stars of different masses m ($\bar{m}$ - the mean mass of stars in the cluster). The velocity module, v, is expressed in the

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units of $\sqrt{\bar{v}^2}$ - the mean square velocity,

$$x = v/\sqrt{\bar{v}^2}.$$

For the escape velocity we have the average value in the cluster, $v_e = 2\sqrt{\bar{v}^2}$ (Ambarcumian, 1938).

We can see that the less massive stars have the higher velocities on an average, as it follows of the tendency towards the energy equipartition. But the absorbting screen, v_e, prevents growing $\sqrt{\bar{v}^2}$ in invers ratio to the mass as it must be when $v_e = \infty$.

In principle, having the velocity distribution functions for the groups of stars belonging to different luminosity classes we can find the mean stellar mass in each group from the relative position of the distribution mode. But it seems more realistic to use the mean square velocity taking into account the possibility of observations. In Table I we present the values of mean square velocity for the stars of different masses in the quasistationary cluster.

TABLE I. The values of mean square velocity for the stars of different masses in the quasistationary cluster

$m/\bar{m}$	2	I	0.5	0
$\sqrt{\bar{v}^2}$	0.947	I.072	I.I0	I.4I

The interesting results on the estimation of the mean square velocity of the open cluster of Hyades were obtained by Pels et al. (1975). These authors used the proper motions of the star-member of the Hyades cluster with $3^m < V < 10^m$ (group I) and with $V > 9^m$ (group II). They found the convergent point of the proper motions and the distance to the cluster. Then the dynamical model was selected to describe the density distribution and the velocity dispersion of each stellar group. The dispersions of the velocity module were found to be 0.358 km/s and 0.403 km/s for I and II groups correspondingly. These values were obtained using the truncated maxwellian velocity distribution in the dynamical model, but the accuracy of that supposition is enough for our purpose. The mean velocity dispersion is equal to 0.386 km/s

Gunn et al. (1988) found the agreeable value 0.398 km/s from the radial velocities having calculated the mass of the cluster of the virial theorem.

After the comparison of the dispersion value with the data of Tabl.I we found the mass of typical star m_I=

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2.I $\bar{m}$ for group I, and m_{II}= I.I $\bar{m}$ for group II. Pels et al. took the masses m_I= I.36 $M_\odot$ and m_{II}= 0.68 $M_\odot$. If These values are correct then for the mean star mass in the cluster we can find $\bar{m}$ = 0.63 $M_\odot$.

The accurate prorer motions were found by Schwan (I990) for the 44 sright stars of the Hyades cluster with B-V< 0^m.5 (V < 7^m.5). In this study the velocity dispersion in one direction, 0.2I0 km/s, was obtained directly from the proper motion component μ_α (as more accurate), therefore the mean square velocity is equal to 0.36 km/s. Then, taking into account that the part of this quantity is due to the observational error, we find for these stars the mean mass m > 2.I $\bar{m}$. This value agrees with our previous estimations.

For the more detailed investigation we need in the accurate proper motions of the stars of different luminousity classes.

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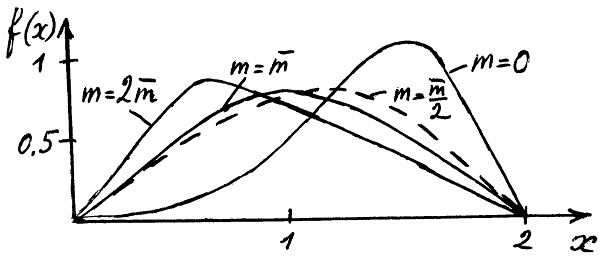

Figure I. The quasistationary distribution functions of the velocity module for the stars of different masses in the stellar cluster. The escape velocity is taken to be $v_e = 2\sqrt{\overline{v^2}}$, $\sqrt{\overline{v^2}}$ is the mean square velocity, $x = v/\sqrt{\overline{v^2}}$.