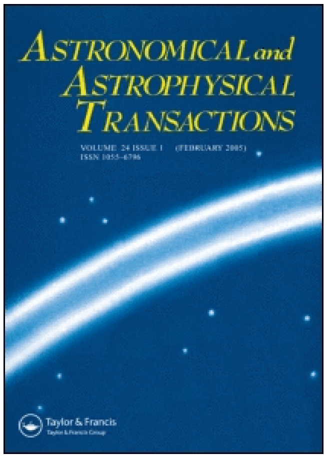

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A NUMERICAL EXPERIMENT SIMULATING AN OPEN CLUSTER†

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Some preliminary results of N-body simulations for open stellar clusters are presented.

KEY WORDS Numerical experiment, N-body problem, open cluster

Numerical N-body experiments have become a powerful tool in stellar dynamics in recent times, especially for the case of studying multiple stars and open clusters (Anosova, 1988). According to the existing criteria estimating the role of the irregular and regular forces in gravitationally bound stellar systems, such as Agekyan's one or that based on the ratio of the relaxation time to the characteristic one (e.g. Kulikovskij, 1985), in both of them the role of the irregular forces is not negligible. This fact justifies fully a direct N-body approach in the case of open clusters, which has become quite feasible due to the possibilities of the modern computers.

Our approach is a classical N-body one, i.e., the interaction among the stars follows Newton's law of universal gravitation. The details concerning the initial conditions, the mass distribution and the mathematical formalism are given elsewhere (Ninković and Ćatović, 1993). Agekyan's factor A and the ratio r of Agekyan's criterion (for details see Ninković, 1994) are also calculated. The former is found to be equal to 2.9 resulting in $r = 0.58$. Such a value of the latter clearly indicates that, in our test system, the role of the irregular forces is important.

Since the present procedure contains no algorithm which enable an automatic step control, we determine the size of the step empirically. The numerical stability is monitored by calculating the values of the first integrals (energy, angular momentum and that of mass center). Close encounters are thought to be the most probable sources of numerical instability. In such cases we diminish the step size.

We think that in this way we shall be able to carry out our experiment during a reasonable period in which we may reach the moment in the cluster evolution being about 10^8 yr after the initial one. A time interval of about 10^8 yr is sufficiently long for the evolution of a moderate open cluster (about 100 stars).

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We also examine the change of the so-called virial coefficient (the ratio of the total kinetic energy to the total potential energy modulus). Arbitrary chosen initial conditions yield the value of 0.07 as the initial virial coefficient. During the first million years – the interval for which we have as yet reliable results – its increase is apparent.

With regard that the initial radius of the cluster and the initial root-mean-square velocity suggest a characteristic time of about 6 Myr, there is time enough to expect further changes in the virial coefficient. For example, during the Myr treated by us it has changed the value from the initial one of 0.07 to 0.1.

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