THE VELOCITY DISPERSION IN THE COLD COLLAPSE

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Abstract. We investigate the growth of the velocity dispersion in the initial stage of the cold dissipationless collapse of spherical collisionless systems by a perturbation theory. We show that the tangential velocity dispersion grows faster than the radial one for the system with centrally condensed initial density profile.

For the formation of the galactic halos cold collapses is often discussed, which is the collapse of the collisionless system whose initial virial ratio is much smaller than unity. It is known from N-body simulations that the cold collapse of the system results in a *prolate* final shape of the system (e.g. Min & Choi 1989, Aguilar & Merritt 1990), independent of its initial shape and initial density profile. These studies, however, are interested in the relationship between the initial condition and the final state of the system, so what made the system prolate still remains as a question. To make this point clear, the understanding of the internal dynamics in the collapsing collisionless system is important. As a first step we analyzed the behavior of the velocity dispersion as effective pressure by perturbation theory, in the outer region of spherical collisionless systems, for the initial free fall stage (Kan-ya *et al.* 1994). Apart from fluids we have no analog of the

L. Blitz and P. Teuben (eds.), Unsolved Problems of the Milky Way, 423–424.

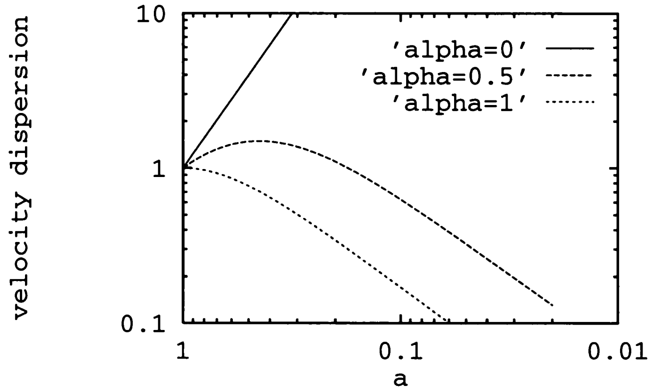

Figure 1. The radial velocity dispersions normalized by the initial values. The curves show for the initial density profile proportional to $r^{-\alpha}$ with indicated values of α. The tangential velocity dispersion is equal to the radial one with $\alpha = 0$, irrespective of the value of α.

equation of state for collisionless system. So we must solve the behavior of the velocity dispersion from the collisionless Boltzmann equation.

We assumed that initially the third moment of the distribution function is negligible with no cross correlation between the velocity of different directions. Then we solved the time evolution of the velocity dispersion from the moment equations of the collisionless Boltzmann equation, truncated until the second moment. This truncation is valid in this case. As a result we showed that the growth of the velocity dispersion is determined by the local compression of a mass shell. In Figure 1 we show the behavior of the solution in the system whose initial density profile is proportional to r^{α}. Our solution is depends on a, the scale factor of the collapse of a mass shell with $a(t = 0) = 1$, and the initial density profile of the system. From this figure we see the tangential dispersion grows faster than the radial one for centrally condensed initial density profile. This result implies that the radial-orbit instability is suppressed in the outer region for this stage of collapse (cf. Aguilar & Merritt 1990).

References

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