DO BARYON STRUCTURES SURVIVE AFTER THE DECAY OF UNSTABLE PARTICLES ?

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A possibility of a universe dominated by unstable particles has been suggested recently as an interesting solution to various cosmological problems. In this scenario, however, nonlinear structures may be disrupted or even smoothed out during the decay of unstable particles. In order to obtain the survival condition of baryon structures, we studied evolution of systems composed of baryon and unstable particles by the numerical integration of the Vlasov equation.

The initial behavior of the system depends on the ratio of the lifetime of the unstable particles τ_X to the initial free-fall time scale $t_{ff,i}$ of the system; if $\alpha \equiv \tau_X/t_{ff,i} \lesssim 1$, then the system has been smoothed out without reaching the equilibrium state (see Fig.1; the numbers in the figure denote the time in units of $t_{ff,i}$). On the contrary, the system with $\alpha \gg 1$ once reaches the nearly equilibrium configuration and afterwards evolves adiabatically (Fig.2). In the latter case, it is easy to show that the characteristic radius $R_c(t)$ and velocity dispersion $\sigma_c(t)$ of the system change as $M_{tot}^{-1}(t)$ and $M_{tot}(t)$, respectively. The survival condition of structures is found as $\alpha > 1/(3\beta^2)$, where β is the ratio of the energy densities of baryons and unstable particles before decay.

For cosmologically plausible ranges of τ_X and β, galaxies satisfy this condition and their evolution is understood very well by an adiabatic behaviour. On the other hand, clusters of galaxies have a possibility of disruption in future due to the decay of unstable particles.

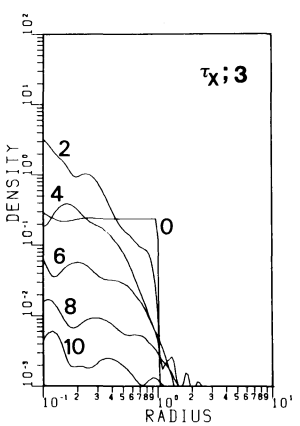

Fig.1

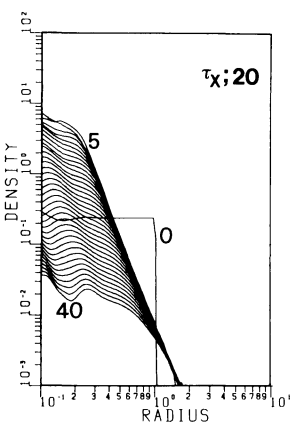

Fig.2

References

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