Homework 6, due 11/4/04

12. Show that, for a matter-dominated universe (pressure negligible) the Euler (momentum) equation for the peculiar velocity (velocity minus Hubble expansion) and perturbative gravitational potential can be written in a comoving coordinate system as:

$$\dot{\mathbf{v}} + a^{-1}(\mathbf{v}\cdot\nabla)\mathbf{v} + H\mathbf{v} = -a^{-1}\nabla\phi \ .$$

Here $a(t)$ is the cosmological scale factor, $H(t)$ is the Hubble function, and the gradient is with respect to the comoving coordinate.

13. Show that the equation for the growth of linear perturbations in a matter-dominated universe:

$$\ddot{\delta} + 2H(t)\dot{\delta} - 4\pi G\rho_b(t)\delta = 0$$

has two solutions: a decaying solution $\delta \propto H(t)$, and a growing solution:

$$\delta \propto D(t) = H(t)\int_0^t \dot{a}(t')^{-2} dt'$$

14. Plot the logarithmic derivative $d\ln D/d\ln a$ as a function of Ω for a Friedman universe $\Lambda = 0$. (You will need to compute it numerically.) Show that it is well approximated by the expression $\Omega^{0.6}$.

NOTE: My paper *Gravitational Instability* in *Formation of Structure in the Universe* by Dekel and Ostriker is unfortunately not available online. You will need to consult the library copy. It is on reserve.