Outline

- Go over homework (8.1)
- Newtonian equivalents of Friedmann equations
- Solutions

Friedmann Equations

- First Friedmann equation: $\left(\frac{\dot{R}}{R}\right)^2 = \frac{8\pi}{3} G\rho - \frac{k c^2}{R^2}$

- Acceleration equation: $\frac{\ddot{R}}{R} = -\frac{4\pi G}{3c^2}\left(\rho c^2 + 3P\right)$

- Energy conservation: $\dot{\rho} c^2 = -3\frac{\dot{R}}{R}\left(\rho c^2 + P\right)$

- Want to find $R(t)$
  - First need to know dependence of ρ and P on R.
  - The equation of state of the universe.

Newtonian Model of the Universe

- Model universe as a sphere of radius R, mass M, density ρ.
- Consider motion of a galaxy of mass m at edge of sphere.
  - Kinetic + potential = total energy = E
  - Behavior for $E = 0$, $E < 0$, $E > 0$?
  - Do on board, compare to Friedmann equations.

- Find acceleration equation on board, compare to Friedmann

- How do we deal with pressure?
  - Derive third Freidmann equation.

Homework

- For next class:
  - Problem 8.2