1 Weekly main assignment for week 5 AST3220

Prepare for class (to be discussed in plenary)

Consider a perfect fluid obeying the equation of state $p = w\rho$ (where w is a constant and we've set $c = 1$). a) Use the equation for adiabatic expansion to find $\rho(a)$ for general values of w.

b) Use this and the first Friedmann equation for a flat universe containing just one fluid of the kind discussed above to find $a(t)$ and $\rho(t)$ for general values of w.

c)

- Dust has equation of state $p_m = 0$.
- Radiation has equation of state $p_\gamma = \frac{1}{3}\rho_\gamma$.
- A cosmological constant has equation of state $p_\Lambda = -\rho_\Lambda$.

Use your results from a) and b) to obtain $\rho(a)$, $\rho(t)$ and $a(t)$ for universes containing each of these three fluids seperately. Comment on your results.

d)Write the Friedmann equations for a general curved universe with all three fluid components mentioned in c). If you considered curvature to be a fluid of this kind too, what would its equation of state be?

c) Write down the second Friedmann equation for a single fluid universe with equation of state $p = w\rho$ for a general w. What would w have to be in order to get an accelerated expansion or contraction of the universe (i.e. $\ddot{a} > 0$).

Prepare or at least look at before class

Exercises 1.6, 1.11, 1.12 and 1.13 in the lecture notes.