

229C Final (due Dec 15, 5pm)

Essay Take any of your favorite experiment or observation discussed in the class. Discuss the followings. (1) Physics motivation. (2) Technique chosen. (3) Result. (4) Limitation. (5) Possible future improvements.

The rest are for those willing to solve problems.

1. The halo mass density is often modeled by the following simple functional form:

$$\rho_h(r) = \frac{v_\infty^2}{4\pi G} \frac{1}{r_c^2 + r^2}, \quad (1)$$

where r_c is the “core radius,” and v_∞ is the rotational velocity at $r \gg r_c$. Calculate the rotation curve, and the total mass up to the “halo radius” $r_h \gg r_c$.

2. Numerically solve the coupled equation for the Universe and the inflaton with a purely parabolic potential

$$\left(\frac{\dot{R}}{R}\right)^2 = \frac{8\pi G}{3} \frac{1}{2}(\dot{\phi}^2 + m^2\phi^2) \quad (2)$$

$$\ddot{\phi} + 3\frac{\dot{R}}{R}\dot{\phi} + m^2\phi = 0, \quad (3)$$

with your choice of m and the initial value $\phi(0)$. Assume $\dot{\phi}(0) = 0$. Compare the solution to both the slow-roll approximation and the coherent oscillation approximation.