

Final Review Questions

May 6, 2014

If you have any question, you can come and see me on May 12 (until 4pm) and for last minute questions, May 13 in the morning.

Please review your homework carefully; there will be problems similar to those in the homework.

1 Format of the exam

0. Exam is at 1-3pm, Tuesday, May 13 in N305.
1. Concept questions (50%), including T/F, definition etc.
2. Quantitative question (50%), there will be two of them.
3. No equation will be provided, however, you will be fine if you could remember all the equations and definitions listed here. Calculator will be needed.

2 Friedmann Cosmology

1. Cosmological principles.
2. Robertson-Walter metric, what each term means:

$$ds^2 = dt^2 - \frac{R(t)^2}{c^2} \left[dr^2 + R_c^2 \sin^2(r/R_c) (d\theta^2 + \sin^2\theta d\phi^2) \right]$$

3. Friedmann equation, definition of each term:

$$\ddot{R} = -\frac{4\pi G}{3} R \left(\rho + \frac{3p}{c^2} \right) + \frac{1}{3} \Lambda R$$

$$\dot{R}^2 = \frac{8\pi G}{3} \rho R^2 - \kappa c^2 + \frac{1}{3} \Lambda R^2$$

$$\kappa = 1/(R_c^2)$$

4. A simple form of Friedmann equation in matter-dominated era:

$$H^2(z) = H_0^2 [\Omega_m (1+z)^3 + \Omega_k (1+z)^2 + \Omega_\Lambda].$$

5. scaling relations with redshift: $R \sim (1+z)^{-1}$, $\rho_m \sim (1+z)^3$, $\rho_r \sim (1+z)^4$, $T_r \sim (1+z)$.
6. Solution of Einstein-de Sitter model: $R = (t/t_0)^{2/3}$, $t_0 = (2/3)H_0^{-1}$, $t/t_0 = R^{3/2} = (1+z)^{-1.5}$.
7. Concepts of cosmological observations: redshift, luminosity distance, angular diameter distance, comoving distance, surface brightness dimming

3 Cosmological Parameters

You need to remember the (1) definition, (2) physical meaning, and (3) how to measure them, and, within 50%, the current value (i.e., Hubble constant is something like 60 - 80, CMB temperature is like 3K, I don't mind if you answer 3K or 2.7K or 2.731 K).

1. H_0 , Hubble constant; concepts of primary and secondary distance indicators
2. Ω_m , matter density parameter.
3. k : curvature
4. q_0 : deceleration parameter
5. Ω_Λ and Λ
6. Ω_b : baryon density parameter
7. T_0 , the current CMB temperature
8. t_0 , age of the universe
9. r_0 , correlation length

4 Cosmological History

You need to remember the physical meaning and approximately when each event happens, and the relative order of these events. (see slide 1 and 2 of the galaxy formation lecture notes on class website).

1. Planck time
2. baryon-antibaryon annihilation
3. electron-positron annihilation
4. epoch of nucleosynthesis
5. radiation dominated/matter dominated era
6. recombination
7. cosmic dark ages
8. formation of the first stars
9. reionization

5 Large Scale Structure and Galaxy Formation

You need to remember the following concepts:

1. galaxy redshift survey; great walls, voids, finger of god
2. $\xi(r)$, $P(k)$
3. main evidences of dark matter and non-baryonic dark matter
4. Hot Dark Matter, free-streaming and its impact on power spectrum
5. Cold Dark Matter
6. Reionization

6 Please look at homework problems, especially quantitative problems such as 4-3 and 5-3