Report No.2 for 銀河天文学特論 III(Ginga tenmongaku tokuron III)

Answer the following questions either in Japanese or in English. Submit your report to the administration office of Department of Astronomy.

Due date: Feb.5 (Monday), 2018

Q1. How to measure the Hubble constant H_0

Pick up (at least) one method to measure H_0, and explain the method with your own words within three pages. Give the best value of H_0 based on a paper, and write down why you think it is the best.

Q2. How to measure cosmological density parameters Ωs

Pick up two methods to constrain **Ωs**, and explain the methods with your own words within three pages for each. Give the best value of Ω based on a paper, and write down why you think it is the best.

(If you could not attend classes several times, choose more than two methods.)

Q3. Age of the universe

(1) Derive the age of the universe *t_age*

$$t\_age = \frac{1}{H_0}\int_0^{\infty} \frac{dz}{(1+z)\left[\Omega_{M0}(1+z)^3 + \Omega_{R0}(1+z)^4 + \Omega_{\Lambda 0} - \kappa_0(1+z)^2\right]^{\frac{1}{2}}}$$

from the Einstein equation

$$\left(\frac{\dot{a}}{a}\right)^2 + \frac{kc^2}{a^2} - \frac{\Lambda c^2}{3} = \frac{8\pi G}{3}\rho$$

(2) Simplify the equation for the following cases.

A. flat and matter dominated ($\Omega_{R0} = 0, \quad \Omega_{\Lambda 0} = 0, \quad \kappa_0 = 0$)

B. negative curvature and matter dominated ($\Omega_{R0} = 0, \quad \Omega_{\Lambda 0} = 0, \quad \kappa_0 < 0$)

(3) Calculate *t_age* for both cases A and B for Ω_{M0}=0.28, H_0=70km/s/Mpc

(4) Calculate *t_age* for the cosmological parameters you chose in Q1 and Q2.