Special Topics in Cosmology (Spring 2013)

Problem Set 2

1)Show, how we can extract the equation of the state of a Dark Energy model (quintessence) $\omega_{DE}(z) = P/\rho$ from luminosity distance observation of Type Ia SuperNovas. This process is named as reconstruction of dark energy model, discuss that what are the main problem of the reconstruction in practice.

Due to: 3 March 2013

2)Study the different Energy Conditions and discuss what conditions the cosmological observations impose to these conditions.

3) Discuss the different kinds of Equivalence Principle and the observational constraints on their accuracy. In the case of using the Modified Gravity(MG) theories, show what class of Equivalence Principle is not preserved.

Due to: 3 March 2013

4) Using SuperNova Type Ia data from the Union2 Sample,
from "$Amanullah et al. (The Supernova Cosmology Project), Ap.J., 2010." arxiv.org/abs/1004.1711$, using χ^2 analysis:
Find the best value of for ω_0 and ω_a of CPL-parametrization of Dark Energy model $\omega_{DE} = \omega_0 + (z/(1+z))\omega_a$

Due to: 3 March 2013

5)Using the least action principle for $f(R)$ Modified Gravity:

$$S = \frac{1}{16\pi G} \int d^4x \sqrt{-g} f(R),$$

show that the field equations are:

$$F(R)R_{\mu\nu} - \frac{1}{2}f(R)g_{\mu\nu} - \nabla_\mu \nabla_\nu F(R) + g_{\mu\nu}\Box F(R) = 8\pi G T_{\mu\nu},$$

where $F(R) \equiv \frac{\partial f(R)}{\partial R}$.

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