

Exercises IV Joint ICTP School on Cosmology

lecture 01

January 18, Valerie Domcke

1 - Continuity equation (2pt). Starting from the two Friedmann equations

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{1}{3}\rho - \frac{k}{a^2}, \quad \frac{\ddot{a}}{a} = -\frac{1}{6}(\rho + 3p), \quad (1)$$

derive the the continuity equation,

$$\frac{d\rho}{dt} = -3H(\rho + p). \quad (2)$$

2 - Friedmann equations in conformal time (4pt).

- (a) Re-express the Friedmann equations in conformal time τ , with $d\tau = dt/a(t)$ (2 pt)
- (b) Consider an FRW model with $k = 0$, dominated by a single component with $p = \omega\rho$ and ω is constant. How do the scale factor $a(\tau)$ and the comoving Hubble horizon $(aH)^{-1}$ scale with τ in the three cases of matter domination, radiation domination and vacuum energy ($\omega = -1$) domination? (2 pt)