Cosmology 1

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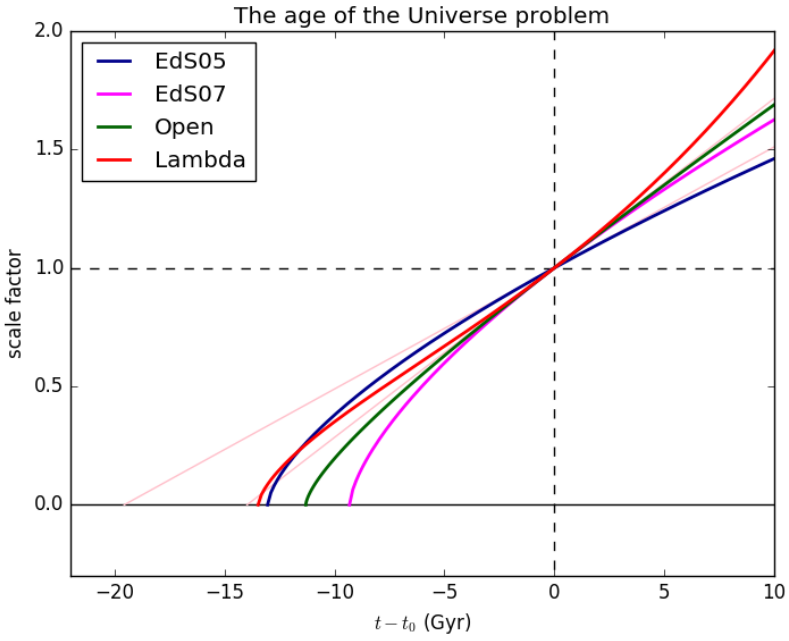
Solution of proposed problem, lecture 12
Topic: models with cosmological constant.

(a) The requested plot will be similar to this one:



This plot reports also, for sake of clarity, the scale factors of two Milne (empty) universes with $h = 0.5$ and $h = 0.7$. The universe ages result $t_0 = 13.04$ Gyr (EdS05), $t_0 = 9.31$ Gyr (EdS07), $t_0 = 11.30$ Gyr (Open) and $t_0 = 13.47$ Gyr (Lambda).

(b) The four universe ages are different from the globular cluster one as follows: 1.29σ (EdS1), 3.25σ (EdS2), 2.2σ (Open), 1.06σ (Lambda). These are underestimates of the discrepancy, because globular clusters do not form an instant after the Big Bang. The EdS07 model would have been clearly ruled out in the '90s, while Open would be disfavoured.

(c) For the Open model, the transition from matter to curvature domination is easily obtained by requiring that the two contributions to the second Friedmann equation, $\Omega_m a^{-3}$ and $\Omega_k a^{-2}$, are equal, obtaining $a^\star = \Omega_m/\Omega_k = 0.42$, that is at $z = 1.38$. The equivalence of matter and dark energy densities (equality of $\Omega_m a^{-3}$ and Ω_Λ) takes place at $a = (\Omega_m/\Omega_\Lambda)^{1/3}$, from which $a = 0.75$ or $z = 0.33$, while the start of the accelerated expansion phase is at $a = (\Omega_m/2\Omega_\Lambda)^{1/3} = 0.60$, $z = 0.67$.