419T Assignment - Week 10

Reading Assignment Abbreviations**:** **L**= Liddle; **H&H** = Hawley & Holcomb; **JL** = Jones & Lambourne

Topic: Summary: Current Status and Future

Reading:
L: 15**;** **H&H**: 17; **JL**: 7, 8.3, 8.5-end
Handouts: *Riess & Turner; Perlmutter;* ***Astronomy*** *reprint*

On the Course Links page:
Determination of Ω and Λ (slide numbers refer to those in upper right – NOT lower right, beginning with 7-): 33-end (skim through other slides as you like)

A. PROBLEM Answer the following questions and explain all your steps.
(*based on Carroll & Ostlie 28.11*)

An example of spontaneous symmetry breaking can be obtained by considering a small ball of mass m= 9.8 kg that is free to roll on a surface whose height (in m) is given by:

$$h(x) = kx^2 + \varepsilon x^4 ,$$

where $k = \pm 1$ m^{-1} and $\varepsilon = 0.5$ cm^{-3}. The gravitational potential energy of the ball is then $V(x) = mgh(x)$.

a) Make two graphs of $V(x)$ from x= -2m to x= 2m, one for each choice of sign for k.

b) The case of k = 1 m^{-1} corresponds to the symmetric false vacuum. Where is the point of equilibrium? Is this point stable or unstable? (In the case of stable equilibrium, if the ball is displaced slightly, it will return to the equilibrium point.)

c) The case of k = -1 m^{-1} corresponds to the broken symmetry of the true vacuum. Where are the three points of equilibrium? Which of these points are stable, and which unstable?

d) For the case of k = -1 m^{-1}, consider the ball at rest at the origin. What are the implications of the *uncertainty principle* ($\Delta x \Delta p \approx h/2\pi$) for the ball remaining at that position? In what ways is this situation analogous to that of the supercooled false vacuum just before inflation?

B. ESSAY – 4-5 pages
OK, here’s a real “tutorial paper subject:

Describe/define the *anthropic principle* and its variants. Attack or defend the anthropic principle according to your own beliefs.