8.286 Lecture 19
November 19, 2013

THE COSMOLOGICAL CONSTANT

Summary of Lecture 19

A Preliminary Measurement of the Cosmic Microwave Background Spectrum by the Cosmic Background Explorer (COBE) Satellite

J. C. Mather, E. S. Cheng, et al.

Data from Berkeley-Nagoya Rocket Flight, 1987

Original COBE Measurement of the CMB Spectrum, Jan 1990. Energy density is in units of electron volts per cubic meter per gigahertz.

Defining $\rho = \rho_n + \rho_{\text{vac}}$ and $p = p_n + p_{\text{vac}}$:

$$\frac{d^2 a}{dt^2} = -\frac{4\pi}{3} G \left( \rho_n + \frac{3p_n}{c^2} - 2\rho_{\text{vac}} \right) a.$$  

$$\left( \frac{\dot{a}}{a} \right)^2 = \frac{8\pi}{3} G (\rho_n + \rho_{\text{vac}}) - \frac{kc^2}{a^2}.$$  

Dominance of vacuum energy at late time implies

$$H \to H_{\text{vac}} = \sqrt{\frac{8\pi}{3} G \rho_{\text{vac}}},$$  

$$a(t) \propto e^{H_{\text{vac}} t}.$$  

The age of an open ($\Omega < 1$), closed ($\Omega > 1$), or flat ($\Omega = 1$) universe containing only nonrelativistic matter.

The smooth curve is the best fit blackbody spectrum, at $2.735^\circ$ K.
The age of a flat universe containing nonrelativistic matter and vacuum energy.
8.286 The Early Universe
Fall 2013

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