

Introduction to Cosmology

Talk by Alexander Dueck at PhD seminar, 9-11 March 2011, MPIK

Contents

1. INTRODUCTION
 - 1.1. The Metric
 - 1.2. General Relativity and the Einstein Field Equation
 - 1.3. Cosmological scales / distances (stars, galaxies, gal.-clusters, superclusters)
2. FRIEDMANN-ROBERTSON-WALKER SPACETIMES
 - 2.1. The Friedmann Equation
 - a) Different names for equations
 - b) Define and explain redshift, some small calculation!
 - c) Critical density (for flat curvature), cosmological density parameter Ω , different contributions to Ω
 - 2.2. Solving the Friedmann Equation
 - a) (proportionality of energy density and scaling factor in radiation-/matter-/lambda-dominated flat universes) – important point: energy density of vacuum does not stay at all \rightarrow creating energy out of nothing!
 - b) For either matter- or radiation-domination, the universe is singular as $t=0$: the universe has finite age!
 - c) Densities of three types of matter today are: ...
 - 2.3. The Hot Big Bang and the Cosmic Microwave Background
 - a) Rough history of the universe (how to transform time \leftrightarrow temperature \leftrightarrow z ??? and for temperature: $eV \leftrightarrow K$ from $k_B=0,86 \cdot 10^{-5} eV/K$)
 - b) Saha eqn. For equilibrium ionization of hydrogen, baryon asymmetry, recombination temperature and redshift \rightarrow CMB temperature
 - c) Anisotropies in the CMB
3. THE FLATNESS AND HORIZON PROBLEMS
 - 3.1. Non-flat universes with general contents
 - 3.2. How inflation can solve the flatness and horizon problems

References

For “quick start” / introduction / if you do not want to get lost in details:

1. TASI Lectures on Inflation - William H. Kinney – arXiv:0902.1529v2
This was the basis of the talk. Nice and very brief review. If you do not want to follow detailed calculations, but just want to get an idea and an overall picture very quickly.
2. Astrophysical Cosmology, Lecture notes by Alan Heavens, Edinburgh University
<http://www2.ph.ed.ac.uk/teaching/course-notes/documents/118/1446-AstrophysicalCosmology.pdf> (or google “Alan Heavens Astrophysical Cosmology”)
Explains very nice. Historical start.
3. Nice web tutorial: <http://www.astro.ucla.edu/~wright/cosmolog.htm>
4. Roos, Introduction to Cosmology (quite short introductory text, brief on observations)
5. Bothun, Modern Cosmological Observations and Problems
6. Liddle, An Introduction to Modern Cosmology

For much more detailed discussions:

1. Kolb & Turner, The early Universe
2. John A. Peacock, Cosmological Physics
3. Weinberg, Gravitation & Cosmology
4. Peebles, Principles of Physical Cosmology