

Course Outline

Unit

1. Introduction
2. Fundamental Observations
 - 2.1 The Night Sky is Dark
 - 2.2 On Large Scales, the Universe is Isotropic and Homogeneous
 - 2.3 Galaxies Show a Redshift Proportional to Their Distance
 - 2.4 The Universe Contains Different Types of Particles
 - 2.5 The Universe is Filled with a Cosmic Microwave Background
3. Newton Versus Einstein
 - 3.1 Newton's Way
 - 3.2 Einstein's Way: Special Relativity
 - 3.3 Einstein's Way: General Relativity and the Equivalence Principle
 - 3.4 Describing Curvature
 - 3.5 The Robertson-Walker Metric
 - 3.6 Proper Distance
4. Cosmic Dynamics
 - 4.1 Einstein's Field Equation
 - 4.2 The Friedmann Equation
 - 4.3 The Fluid and Acceleration Equations
 - 4.4 Equations of State
 - 4.5 Learning to Love Lambda
5. Model Universes
 - 5.1 Evolution of Energy Density
 - 5.2 Empty Universe
 - 5.3 Single-Component Universes
 - 5.3.1. Matter Only
 - 5.3.2. Radiation Only
 - 5.3.3. Lambda Only
 - 5.4 Multiple-Component Universes
 - 5.4.1. Matter + Curvature
 - 5.4.2. Matter + Lambda
 - 5.4.3. Matter + Curvature + Lambda
 - 5.4.4. Radiation + Matter
 - 5.5 Benchmark Model
6. Measuring Cosmological Parameters
 - 6.1 "A Search for Two Numbers"

- 6.2 Luminosity Distance
- 6.3 Angular-Diameter Distance
- 6.4 Standard Candles and the Hubble Constant
- 6.5 Standard Candles and the Accelerating Universe

- 7. Dark Matter
 - 7.1 Visible Matter
 - 7.2 Dark Matter in Galaxies
 - 7.3 Dark Matter in Clusters
 - 7.4 Gravitational Lensing
 - 7.5 What's the Matter?

- 8. The Cosmic Microwave Background
 - 8.1 Observing the CMB
 - 8.2 Recombination and Decoupling
 - 8.3 The Physics of Recombination
 - 8.4 Temperature Fluctuations
 - 8.5 What Causes the Fluctuations?

- 9. Nucleosynthesis and the Early Universe
 - 9.1 Nuclear Physics and Cosmology
 - 9.2 Neutrons and Protons
 - 9.3 Deuterium Synthesis
 - 9.4 Beyond Deuterium
 - 9.5 Baryon-Antibaryon Asymmetry

- 10. Inflation and the Very Early Universe
 - 10.1 The Flatness Problem
 - 10.2 The Horizon Problem
 - 10.3 The Monopole Problem
 - 10.4 The Inflation Solution
 - 10.5 The Physics of Inflation

- 11. Structure Formation: Gravitational Instability
 - 11.1 The Matthew Effect
 - 11.2 The Jeans Length
 - 11.3 Instability in an Expanding Universe
 - 11.4 The Power Spectrum
 - 11.5 Hot versus Cold
 - 11.6 Baryon Acoustic Oscillations

- 12. Structure Formation: Baryons and Photons
 - 12.1 Baryonic Matter Today
 - 12.2 Reionization of Hydrogen
 - 12.3 The First Stars and Quasars
 - 12.4 Making Galaxies
 - 12.5 Making Stars