Prof. Shapiro AST 376

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 Equivalence Principle
   - 3.2 Describing Curvature
   - 3.3 The Robertson-Walker Metric
   - 3.4 Proper Distance

4. Cosmic Dynamics
   - 4.1 The Friedmann Equation
   - 4.2 The Fluid and Acceleration Equations
   - 4.3 Equations of State
   - 4.4 Learning to Love Lambda

5. Single-Component Universes
   - 5.1 Evolution of Energy Density
   - 5.2 Curvature Only
   - 5.3 Spatially Flat Universes
   - 5.4 Matter Only
   - 5.5 Radiation Only
   - 5.6 Lambda Only

6. Multiple-Component Universes
   - 6.1 Matter + Curvature
   - 6.2 Matter + Lambda
   - 6.3 Matter + Curvature + Lambda
   - 6.4 Radiation + Matter
   - 6.5 Benchmark Model

7. Measuring Cosmological Parameters
   - 7.1 "A Search for Two Numbers"
   - 7.2 Luminosity Distance
   - 7.3 Angular-Diameter Distance
   - 7.4 Standard Candles and the Hubble Constant
   - 7.5 Standard Candles and the Accelerating Universe

8. Dark Matter
   - 8.1 Visible Matter
   - 8.2 Dark Matter in Galaxies
   - 8.3 Dark Matter in Clusters
   - 8.4 Gravitational Lensing
   - 8.5 What's the Matter?

9. The Cosmic Microwave Background
   - 9.1 Observing the CMB
   - 9.2 Recombination and Decoupling
   - 9.3 They Physics of Recombination
   - 9.4 Temperature Fluctuations
   - 9.5 What Causes the Fluctuations?

10. Nucleosynthesis and the Early Universe
    - 10.1 Nuclear Physics and Cosmology
    - 10.2 Neutrons and Protons
    - 10.3 Deuterium Synthesis
    - 10.4 Beyond Deuterium
    - 10.5 Baryon-Antibaryon Asymmetry

11. Inflation and the Very Early Universe
    - 11.1 The Flatness Problem
    - 11.2 The Horizon Problem
    - 11.3 The Monopole Problem
    - 11.4 The Inflation Solution
    - 11.5 The Physics of Inflation

12. The Formation of Structure
    - 12.1 Gravitational Instability
    - 12.2 The Jeans Length
    - 12.3 Instability in an Expanding Universe
    - 12.4 The Power Spectrum
    - 12.5 Hot versus Cold