Astronomy 202b: Cosmology (Tue./Thu., 9:30-11:00AM, Spring 2010)

Syllabus

Course Instructors

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Course Requirements

Problem sets (due every second week): 30% of grade

1 presentation (last two weeks of the Spring semester): 20%

Final Exam: 50%

Course Texts

Required :

⋆ Loeb, A. 2010, When Did the First Stars and Galaxies form? (Princeton: Princeton U Press); http://www.cfa.harvard.edu/∼loeb/loeb.pdf

⋆ Padmanabhan, T. 1993, Structure Formation in the Universe (Cambridge: Cambridge Univ. Press)

Recommended :

⋆ Schneider, P. 2006, Extragalactic Astronomy and Cosmology (Berlin: Springer)

⋆ Mukhanov, V. 2005, Physical Foundations of Cosmology (Cambridge: Cambridge Univ. Press)

Course Outline

I. Introduction **1/26, 1/28**

The big picture

Composition of the current universe

Scales in Astrophysics

Standard observables

II. The Big Bang: Birth of our Universe **2/2,2/4,2/9**

The cosmological principle: isotropy and homogeneity

The Hubble expansion: the redshift-distance relation

Relics from the Big-Bang: the microwave background, synthesis of light elements

Geometry of the Universe: the expansion factor, lookback time

Cosmological parameters: the Hubble constant, the mean mass density

III. Thermal History of the Universe **2/11, 2/16, 2/18**

Early times: Planck era, inflation, Baryogenesis, Electroweak and QCD phase transitions, neutrino decoupling

Nucleosynthesis

Ionization history of the universe: cosmological recombination, reionization, the Lyman-α forest

The Microwave background: spectrum and anisotropy data from the COBE satellite and ground-based observations

IV. Origin of Structure In the Universe **2/23, 2/25, 3/2**

Dark matter in the universe: evidence, searches: laboratory experiments, gravitational microlensing, Cold Dark Matter (CDM)

Primordial seeds of density fluctuations: linear theory, power-spectrum,

Spherical Collapse Model

Dark Matter Halos: mass distribution and virial properties

V. Formation of Galaxies and Their Feedback **3/9; 3/11, 3/23, 4/1**

Young galaxies at high redshifts and the epoch of reionization

Probing the Intergalactic Medium through the Lyman-α Line

21-cm Cosmology

Quasars and Gamma-Ray Bursts

Galaxy types: *Spirals*: Tully-Fisher relation; *Ellipticals*: fundamental plane

VI. The Interstellar Medium and the Formation of Stars **3/25, 3/30**

Physical conditions in the interstellar medium: densities, temperatures, dust

Star formation: virial equilibrium, the Jeans instability, effects of rotation and magnetic fields

Effects of stars on their environment: Strömgren spheres, supernova blast waves

VII. Stellar Structure **4/6, 4/8**

Hydrostatics: balance of momentum and energy, boundary conditions

Nuclear energy production: Coulomb barrier, the proton-proton chain, the CNO cycle, the triple-alpha reaction

Radiative transfer: opacity, conduction, convection

The Sun: properties, helioseismology, the solar neutrino puzzle

Polytropes: the Lane-Emden equation

The color-magnitude (H-R) diagram: main sequence, giants, supergiants, evolutionary tracks

VIII. White Dwarfs, Neutron Stars and Black Holes **4/13, 4/15**

White Dwarfs: degenerate electron gas, the Chandrasekhar mass

Neutron stars: degenerate neutron gas, pulsars

Stellar collapse and Supernovae

Black holes: properties, evidence for their existence: stellar binaries, galactic nuclei

Massive black holes in distant quasars and nearby galaxies

Accretion flows near neutron stars and black holes: spherical accretion, the α-model

Presentations and Summary **4/20, 4/22, 4/27, 4/29**