Syllabus

AST/PHYS 5022, Cosmology, Fall 2008

http://www.astro.umn.edu/∼llrw/a5022_f08.html

Instructor: Liliya L.R. Williams

Relativity: Special; Lorentz transformations, time dilation and length contraction, causality, simultaneity, four-vectors, stress-energy tensor. General; basic ideas, equivalence principle, geometry of curved spaces; outline of the derivation of Einstein field equations; Friedmann equation from the field equations.

Global Geometry: cosmological principle, Friedmann-Robertson-Walker metric, the scale factor, dynamics: Friedmann equation, particular cases with radiation, dust, cosmological constant. Applications of Friedmann eqns: relations between proper time, redshift, angular diameter distance, luminosity distance, volume element; horizons. Cosmological tests of global geometry: standard candles, standard rulers, age tests, volume tests, and other miscellaneous ones; ways to measure the Hubble parameter.

Inflation: difficulties with the Standard Big Bang model, mechanism of inflation, reheating/preheating, spectrum of density perturbations from inflation, limits on the observed spectrum, Harrison-Zeldovich spectrum, fine-tuning of the potential and other features of inflation.

Early Universe: phase transitions and topological defects; thermal history; main events in chronological order: baryogenesis, primordial nucleosynthesis of D, He3, He4, Li7; photon-to-baryon ratio and expansion rate of the Universe; observational determinations of the light element abundances.

Cosmic Microwave Background: overall observed properties of the CMB, temperature fluctuations: dipole and higher multipoles. Primary temperature anisotropies: super-horizon scales and the Sachs-Wolfe effect, sub-horizon scales and the acoustic peaks, damping scale. Secondary anisotropies. Polarization of the CMB; cosmological parameters from the CMB; detecting CMB. Dark matter: evidence; baryonic vs. non-baryonic DM; cold DM and hot DM.

Structure formation: evolution of structure in the early Universe: growth of super- and sub-horizon sized perturbations, transfer function. Evolution of density perturbations before and after matter-radiation equality. Linear theory of gravitational instability; Jeans analysis; evolution of mass clustering; Press-Schechter formalism and statistics of discrete objects. Measuring mass inhomogeneities: correlation functions, counts in cells, power spectrum, mass and luminosity functions, biasing. Measuring mass inhomogeneities via dynamical means: bulk flows on large scales, dipole from galaxies vs. CMB, galaxy redshift surveys, pair-wise velocities, velocity dispersions in galaxies and clusters.

Grading

Homework (problem sets about every other week)	25%
Mid-term (Thu Sep 25th, and Tue Nov 4th)	20%
Presentations (∼30 mins each; last 2 weeks of classes)	20%
In-class participation	10%
Final exam (Wed Dec 17th, 10:30am-12:30pm)	25%

Suggested texts:

J.A. Peacock, *Cosmological Physics*, CUP

P.J.E. Peebles, *Principles of Physical Cosmology*, PUP

E.W. Kolb & M.S. Turner, *The Early Universe*, Addison-Wesley

V. Mukhanov, *Physical Foundations of Cosmology*, CUP

M.S. Longair, *Galaxy Formation*, Springer

W. Rindler, *Relativity: Special, General, and Cosmological*, Second edition, OUP

Talks, seminars, etc:

Monday Lunch Seminars, 12:15, rm 435

Third Annual Misel Family Lecture
Finding the Big Bang, P. James E. Peebles, Princeton U - September 23, 2008

Neutrino Frontiers Workshop - October 23-26, 2008 (Radisson)