Spring Term 1998 17 June 1999

**Ay207 Lecture Schedule**

**COSMOLOGY & EXTRAGALACTIC ASTRONOMY**

*Usually M-W 9:30-11:00, sometimes othertimes!*

Observatory Classroom

Jan 28 Wed — Introduction: Cosmological principle, Newtonian cosmology AL
Feb 2 Mon — Introduction: Structure formation: gravitational instability
the top hat model, a brief history of the Universe AL
Feb 4 Wed — Galaxies: history, morphology JH
Feb 9 Mon — Galaxies: morphology, stellar/gaseous content JH
Feb 11 Wed — Galaxies: stellar/gaseous content JH
Feb 16 Mon — ******** Presidents Day, no class ********
Feb 18 Wed — Galaxies: structure JH
Feb 23 Mon — The expanding Universe: Robertson-Walker Metric,
Geometry of the Universe AL
Feb 25 Wed — The expanding Universe: milestones in the
thermal history of the Universe. AL
Mar 2 Mon — Inflation, Neutrino decoupling, Nucleosynthesis AL
Mar 4 Wed — The Microwave Background: overview, ionization
history of the Universe, anisotropies AL
Mar 9 Mon — The Microwave Background: anisotropies
(theoretical overview) AL
Mar 11 Wed — Microwave Background: spectrum, dipole, anisotropies
(observational status) JH
Mar 16 Mon — Dark Matter: Observational evidence JH
Mar 18 Wed — Gravitational Instability: Linear theory AL
Mar 21 to 29 — ******* Spring Recess *********
Mar 30 Mon — Large Scale Structure: observations of the linear regime:
power spectrum of density fluctuations, large scale flows JH
Apr 1 Wed — Gravitational Instability: nonlinear theory: Press-Schechter
formalism, Zel'dovich approximation, biasing AL
Apr 6 Mon — Groups and clusters of galaxies JH
Apr 8 Wed — Galaxy formation: chemical evolution, luminosity function JH
Apr 13 Mon — Galaxy formation: high redshift galaxies, AGN JH
Apr 15 Wed — The intergalactic medium: the Lyman-alpha forest, Sunyaev-
Zel'dovich effect AL
Apr 20 Mon — Gravitational lensing AL
Apr 22 Wed — Measurements of cosmological parameters: $H_0$, $q_0$. JH
Apr 27 Mon — Empirical constraints on dark matter candidates AL
Apr 29 Wed — Summary of current status and forthcoming projects in
observational cosmology JH
May 4 Mon — Everything else you wanted to know about Cosmology
and did not dare to ask. JH,AL

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**Ay207**

**COSMOLOGY & EXTRAGALACTIC ASTRONOMY**

AL = Prof. Avi Loeb, P-237, 496-6808
JH = Prof. John Huchra, P-309, 495-7375

There will be 6 problem sets and a term paper on topics of our choice. The problem sets will count for 40% of the course grade. Assume class starting time is 9:30 sharp unless otherwise noted.

**Textbooks** —

Required:

*Structure Formation in the Universe*, 1993, by T. Padmanabhan, (Cambridge: Cambridge University Press).

*Galaxies and Cosmology*, 1995, by F. Combes, P. Boissé, A. Mazure and A. Blanchard, (Berlin: Springer).

Recommended:

*Physical Cosmology*, 1993, by P. J. E. Peebles, (Princeton: Princeton).

*The Early Universe*, 1990, by E. W. Kolb and M. S. Turner, (Redwood City: Addison-Wesley).

**AY207 Reference Resource List**

**General**

Galaxies: Structure and Evolution, R. J. Tayler.

The Realm of the Nebulae, 1936, E. Hubble.

Galaxies and the Universe, 1975, A. and M. Sandage, J. Kristian, eds. (Chicago: Chicago).

Galaxies, P. Hodge.

Galaxies, 1972, H. Shapley (Cambridge: Harvard).

Extragalactic Astronomy, J. Sérsic.

Extragalactic Astronomy, 1987, B. A. Vorontosov-Vel'yaminov (London: Harwood)

Galaxies, 6th Saas-Fee Advanced Course.

The World of Galaxies, H. Corwin and L. Binette, eds.

The Physical Universe, F. Shu, (University Science)

The Deep Universe, 23rd Saas-Fee Advanced Course, 1995 (Sandage, Kron and Longair) (Berlin: Springer)

Galaxies and Cosmology, 1995, F. Combes, P. Boissé, A. Mazure and A. Blanchard, (Berlin: Springer).

First Principles of Cosmology, 1997, E. Linder (Reading: Addison-Wesley).

Unsolved Problems in Astrophysics, 1997, J. Bahcall and J. Ostriker, eds. (Princeton: Princeton).

Introduction to Cosmology, 1997, Matts Roos (New York: Wiley)

Perspectives in Astrophysical Cosmology, 1995, M. Rees (Cambridge: Cambridge).

**Nearby Galaxies and Stellar Content**

The Milky Way As a Galaxy, G. Gilmore, I. King and P. van der Kruit.

Galactic Astronomy, D. Mihalas and J. Binney (San Francisco: Freeman).

The Andromeda Galaxy, 1992, P. Hodge (Dordrecht: Kluwer).

Nearly Normal Galaxies, S. Faber, ed. (Berlin: Springer)

Stellar Populations, C. Norman, A. Renzini and M. Tosi, eds.

Galactic Dynamics, J. Binney and S. Tremaine, (Princeton: Princeton).

Physics of the Galaxy and Interstellar Matter, 1982, H. Scheffler and H. Elsässer.

Star Formation in Stellar Systems, G. Tenorio Tagle, M. Prieto and F. Sànchez, eds.

Star Forming Dwarf Galaxies and Related Objects, D. Kunth, T. X. Thuan and J. Tran Thanh Van, eds.

The Galactic Interstellar Medium, 21st Saas-Fee Course, W. Burton, B. Elmegreen and R. Genzel.

The Evolution of Galaxies and Stellar Populations, B. Tinsley and R. Larson, eds.

The Globular Cluster Galaxy Connection, G. Smith and J. Brodie, eds., 1993, PASP Conference Series #48.

Massive Stars in Starbursts, C. Leitherer et al., eds., Cambridge University Press.

Dynamics of Disk Galaxies, B. Sundelius, ed.

Morphology and Dynamics of Galaxies, J. Binney, J. Kormendy and S. White.

Windows on Galaxies, G. Fabbiano, J. Gallagher and A. Renzini, eds., 1990, Kluwer.

Galaxy Evolution: The Milky Way Perspective, S. Majewski, ed.

Physics of Nearby Galaxies, 1993, Thuan, Balkowski and Tran Thanh Van, eds.

Stellar Populations, 1995, IAU Symp. 164, P. van der Kruit and G. Gilmore, eds. (Dordrecht: Kluwer)

Galaxies & Galactic Structure, 1998, D. M. Elmegreen (Upper Saddle River: Prentice Hall).

Spiral Structure in Galaxies, A Density Wave Theory, 1996, G. Bertin and C. C. Lin (Cambridge: MIT)

**The Distance Scale**

The Cosmological Distance Ladder, M. Rowan-Robinson.

The Extragalactic Distance Scale, S. Van den Bergh and C. Pritchet, eds.

Dècalages Vers le Rouge et Expansion de L'Universe, 1977, C. Balkowski and B. Westerlund, eds.

The Extragalactic Distance Scale, 1997, M. Livio, M. Donahue and N. Panagia, eds (Cambridge: Cambridge).

**Clusters and Large Scale Structure**

Large Scale Motions in the Universe, 1988, V. Rubin and G. Coyne, eds. (Orinceton: Princeton).

Clusters of Galaxies, W. Oergle, M. Fitchett, and L. Danly, eds.

The Minnesota Lectures on Clusters of Galaxies and Large Scale Structure, 1988, J. Dickey, ed. (Provo: ASP) ASP Conference Series #5.

The Large Scale Structure of the Universe, 1980, P. J. E. Peebles.

Large Scale Structures, 17th Saas-Fee Series, Martinet and Mayor, eds.

X-Ray Emission from Clusters of Galaxies, C. Sarazin, 1988, (Cambridge: Cambridge).

Gravitational Physics of Stellar and Galactic Systems, W. Saslaw.

Structure Formation in the Universe, T. Padmanabhan, Cambridge University Press.

Cosmology and Astrophysics Through Problems, 1996, T. Padmanabhan (Cambridge: Cambridge)

Morphological Cosmology, P. Flin and H. Duerbeck, eds.

Large Scale Structures and Peculiar Motions in the Universe, D. Latham and L. N. da Costa, eds.

Development of Large Scale Structure in the Universe, J. Ostriker.

Cosmological Aspects of X-Ray Clusters of Galaxies, NATO ASI, W. Seiter, ed., 1994, (Dordrecht: Kluwer).

Mapping, Measuring and Modelling the Universe, P. Coles, V. Martinez and M.-J. Pons-Borderia, eds., 1996, ASP Conference Series #94, (Provo: ASP).

Clustering in the Universe, 1995, S. Maurogordato, C. Balkowski, C. Tao and J. Tran Than Van, eds. (Gif-Sur-Yvette: Editions Frontieres).

**Active Galactic Nuclei and QSOs**

Quasars, G. and M. Burbidge.

Active Galactic Nuclei, C. Hazard and S. Mitton.

Quasar Astronomy, D. Weedman (Cambridge: Cambridge).

Active Galactic Nuclei, R. Blandford, H. Netzer and L. Woltjer.

Astrophysics of Active Galaxies and Quasistellar Objects, 1985, J. Miller, ed.

Gravitational Lenses, P. Schneider, J. Ehlers and E. Falco, (Berlin: Springer).

Physics of Active Galactic Nuclei, 1992, W. Duschl and S. Wagner, eds.

Active Galactic Nuclei, 1999, J. Krolik (Princeton: Princeton).

An Introduction to Active Galactic Nuclei, 1997, B. Peterson (Cambridge: Cambridge).

**Galaxy Evolution**

The Structure and Evolution of Normal Galaxies, 1981, S. Fall and D. Lynden-Bell, eds.

High redshift and Primeval Galaxies, J. Bergeron, et al. eds.

Towards Understanding Galaxies at High Redshifts, R. Kron and A. Renzini, eds.

Evolution of the Universe of Galaxies, R. Kron, ed.

Starbursts and Galaxy Evolution, T. X. Thuan, T. Montmerle and J. Tran Thanh Van, eds.

Massive Stars in Starbursts, C. Leitherer, et al., eds.

The Interplay Between Massive Star Formation, the ISM and Galaxy Evolution, 1996, D. Kunth, B/ Guiderdoni, M. Heydari-Malayeri and T. X. Thuan, eds. (Gif-Sur-Yvette: Editions Frontieres).

From Stars to Galaxies: The Impact of Stellar Physics on Galaxy Evolution, 1996 C. Leitherer, U. F.-von Alvensleben and J. Huchra, eds. (Provo: ASP) Volume #98 in the ASP Conference Series.

Galaxy Formation, M. Longair, 1998, (Berlin: Springer).

**Cosmology**

Relativity, Thermodynamics & Cosmology, R. C. Tolman, 1934, (New York: Dover).

Introduction to Mathematical Cosmology, J. N. Islam. (Cambridge: Cambridge).

Introduction to Cosmology, J. Narlikar.

Principles of Physical Cosmology, 1993, P. J. E. Peebles.

Gravitation and Cosmology, S. Weinberg.

Physical Cosmology, 1971, P. J. E. Peebles.

Modern Cosmology, D. Sciama.

Cosmology, The Science of the Universe, 1981, E. Harrison (Cambridge: Cambridge).

The Anthropic Cosmological Principle, J. Barrow and F. Tippler.

Particle Physics and Inflationary Cosmology, A. Linde,

Principles of Cosmology and Gravitation, M. Berry.

Inflation and Quantum Cosmology, A. Linde.

Observational Tests of Cosmic Inflation, T. Shanks, ed.

Observational Cosmology, 1978, 8th Saas-Fee Series, Maeder et al. eds.

Observational Cosmology, G. Chinarini, et al. eds., PASP Conf. Series #51 (Provo: ASP).

New Insights into The Universe, Martinez, et al. eds.

The Early Universe, E. Kolb and M. Turner, eds.

Cosmological Constants, J. Bernstein and G. Feinberg, eds. 1986, Columbia University Press.

Cosmology: The Origin and Evolution of Structure, P. Coles & F. Lucchin, 1996, (New York: Wiley).

Is the Universe Open or Closed?, P. Coles and G.F.R. Ellis, 1997, (Cambridge: Cambridge)

Critical Dialogues in Cosmology, 1997, N. Turok, ed. (Singapore: World Scientific).

An Introduction to Modern Cosmology, J. Bernstein, 1998, (New York: Prentice Hall).

Foundations of Modern Cosmology, J. Hawley & K. Holcomb, 1998, (Oxford: Oxford).

An Introduction to Modern Cosmology, A. Liddle, 1999, (New York: Wiley).

**Backgrounds**

Extragalactic Background Radiation, D. Calzetti, M. Livio and P. Madau, eds. 7th STScI Symp. (Cambridge: Cambridge).

3K: The Cosmic Microwave Background Radiation, R. B. Partridge, 1995, (Cambridge: Cambridge).

**Popular and Historical Books**

The Milky Way, B. and P. Bok

Stars and Clusters, C. Payne-Gaposhkin.

Morphological Astronomy, F. Zwicky.

The Discovery of Our Galaxy, C, Whitney.

Coming of Age in the Milky Way, T. Ferris.

Stars and Galaxies, Citizens of the Universe, D. Osterbrock, ed.

Particle Physics in the Cosmos, R. Carrigain and W. P. Trower, eds.

The First Three Minutes, S. Weinberg.

Cosmology + 1, O. Gingerich, ed.

The Universe of Galaxies, P. Hodge, ed.

Thursday's Universe, M. Bartusiak.

First Light, R. Preston.

Darkness at Night, E. Harrison.

The Dark Matter, W. and K. Tucker.

The Big Bang, J. Silk (San Francisco: Freeman) (note 1st edition better!)

Lonely Hearts of the Cosmos, 1991, D. Overbye (New York: Harper Collins.

The Fifth Essense, L. Krauss.

Through a Universe Darkly, M. Bartusiak.

The Shadows of Creation, M. Riordan and D. Schramm.

Bubbles, Voids and Bumps in Time, J. Cornell, ed.

Edwin Hubble, Mariner of the Nebulae, 1995, Gale Christianson, (New York: Farrar, Straus and Giroux)

The Farthest Things in the Universe, 1994, J. Pasachoff, H. Spinrad, P. Osmer and E. Cheng, Cambridge: Cambridge).

The Birth of the Universe, The Big Bang and After, T. X. Thuan, 1993, H. Abrams, Inc.

Edwin Hubble, the Discoverer of the Big Bang, A. Sharov and I. Novikov, 1993, (Cambridge: Cambridge).

The Man Who Sold the Milky Way: A Biography of Bart Bok, D. Levy, 1993, University of Arizona.

Cosmic Enigmas, 1994, J. Silk, (New York: AIP).

Before the Beginning, 1997, M. Rees (Reading: Addison-Wesley).

Cosmology and Controversy, H. Kragh, 1998, (Princeton: Princeton).

The Whole Shebang, T. Ferris, 1997, (New York: Touchstone).

Bright Galaxies, Dark Matters, V. Rubin, 1997, (New York: AIP).

**Catalogs and Atlases**

The Hubble Atlas, A. Sandage.

The Revised New General Catalogue, W. Tifft and J. Sulentic.

The Revised Shapley-Ames Catalog of Bright Galaxies, A. Sandage and G. Tammann.

Catalogue of Galaxies and of Clusters of Galaxies, F. Zwicky, et al.

Morphological Catalogue of Galaxies, B. Vorontosov-Vel'yaminov.

The Uppsala General Catalogue, P. Nilson.

The ESO Catalogue, Lauberts and West.

Nearby Galaxies Catalog, R. Tully.

Nearby galaxies Atlas, R. Tully.

HI Catalog, O.-G. Richter and W. Huchtmeier.

Reference Catalogue of Bright Galaxies, G. and A. De Vaucouleurs.

The Second RC of BG, G. and A. De Vaucouleurs and H. Corwin.

The Third RC, G. and A. De Vaucouleurs, et al.

The Atlas of Peculiar Galaxies, H. Arp.

Catalogue of Compact and Peculiar Galaxies, F. Zwicky.

NGC2000, Sky Publishing.

Guide Star CD-ROM Atlas, available on the net.

And innumerable articles from the *Annual Review of Astronomy and Astrophysics* as well as many other IAU Symposia and Colloquia.