Advanced Cosmology

February 2015 – M2 NPAC

1 Course plan: 30h split in 10 lectures

1–2 Introduction to the structured universe, observables and statistical tools (1.5 lectures HD).
Introduction to the structured Universe. Why is the night sky dark ? Why galaxy formation is a(n interesting) problem ? Introduction to statistical tools: towards the power spectrum. Statistical tools: 3D and angular correlation functions, bias and dark matter, power spectra.

3- CMB and Planck (1.5 lectures HD).
CMB, CMB polarization. Overview of the latest Planck results.

4- Galaxy formation (1 lecture HD).
Bias, galaxies and clusters (link between dark and visible matter): theory of galaxy formation, and phenomenology of gastrophysics. Gas cooling.

5–7 Gravitational clustering with cold dark matter (3 lectures MJ).
Review of basics of Newtonian self-gravitating system (collisionless limit, violent relaxation, virialization etc); cold dark matter in an expanding universe, from the linear to the non-linear regime; hierarchical structure formation; N-body simulation (methods and results); the spherical collapse model and the Press-schecter formalism, halo models.

8- Reionization (1 lecture ML).
The Dark Ages of the Universe. Formation of the first luminous objects. Reionization processes: an introduction. Overview of some observational constraints: Gunn-Peterson test, Cosmic Microwave Background, redshifted 21cm line, etc. Future directions.

9- Magnetic fields in cosmology (1 lecture ML).
Why studying cosmological magnetic fields is essential. Introduction to the basics of magnetohydrodynamics in astrophysics. Origin of cosmological magnetic fields: models. Impact on the formation of large scale structures. Observational constraints: present and future.

10- Cosmic voids (1 lecture ML).
Much ado about cosmic emptiness: observational identification of voids, formation theories and modelling, cosmological impact(s).

2 Contacts

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3 Textbooks

• *Modern Cosmology*, S. Dodelson. Academic Press (Elsevier), 2003.

• *Galaxy Formation and Evolution*, H. Mo, F. van den Bosch, S. White, Cambridge, 2011.

• *Extragalactic Astrophysics and Cosmology: An Introduction*, P. Schneider, Springer, 2006.

• *Galaxy Formation*, M. S. Longair. Springer, 2008.

• *Cosmological Physics*, J. A. Peacock. Cambridge University Press, 1998.

• *Structure Formation in the Universe*, T. Padmanabhan, Cambridge University Press, 1993.

4 Practical Information

Lecture will take place at IAS, bat 209, from 9am to noon. It is located about 15 minutes from the RER station Orsay-Ville, so plan accordingly.
Please make sure the lecturers have your email address so that you receive information about the course during the semester.

5 Evaluation

The end of semester exam will consist in an oral exam, split in two parts:

- a discussion of a chosen article (a list of suggested articles will be distributed in the middle of the semester).
- general questions on the course

The date for the final exam is Friday, March 6th, 2015.

6 Other relevant textbooks

• *Principles of Physical Cosmology*, P. J. E. Peebles. Princeton University Press, 1993.

• *The Large Scale Structure of the Universe*, P. J. E. Peebles. Princeton University Press, 1980.

• *Observational Cosmology*, S. Serjeant, Cambridge, 2010.

• *Cosmological inflation and large scale structure*, A. R. Liddle & D. H. Lyth. Cambridge University Press, 2000.

• *Physical Foundations of Cosmology*, V. Mukhanov, Cambridge University Press, 2005.

• *Fundamentals of Cosmology*, J. Rich, Springer, 2002 (v.f. : *Principes de la cosmologie*, Editions de l'Ecole Polytechnique, 2002).

• *Cosmologie Primordiale*, P. Peter & J.P. Uzan, Belin, 2005.

• *Cosmology and Controversy*, H. Kragh, Princeton University Press, 1996. (History of cosmology 1915-1971)