

# **ASTR 610**

# **Theory of Galaxy Formation**

## **Lecture I**

**FRANK VAN DEN BOSCH**  
**YALE UNIVERSITY, FALL 2020**



# Important Information

**Instructor:** Prof. Frank van den Bosch (Office: 52HH#320)  
[frank.vandenbosch@yale.edu](mailto:frank.vandenbosch@yale.edu)

**Course Website:** <http://campuspress.yale.edu/astro610/>

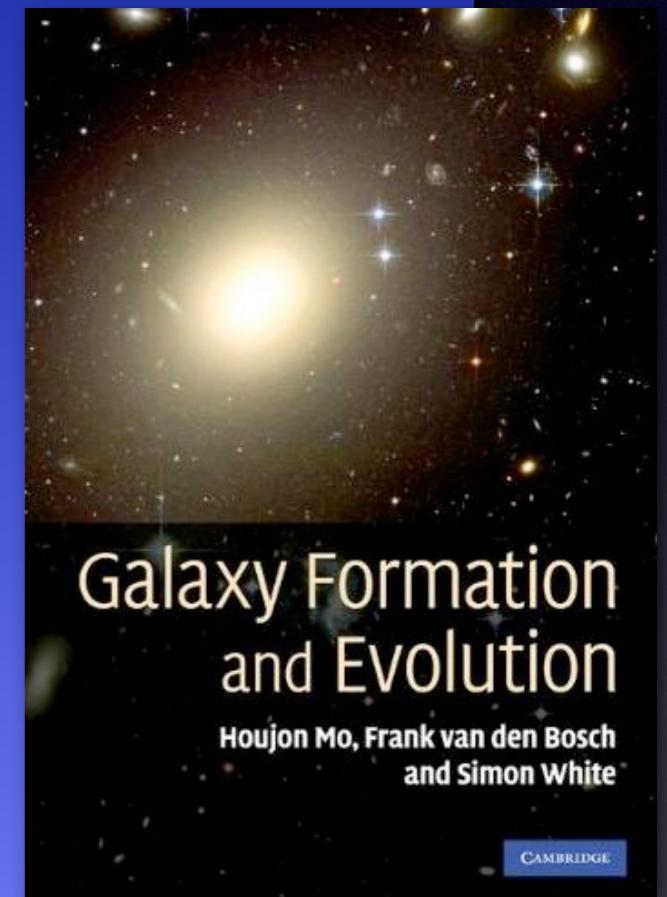
**Lecture Hours:** Tu-Th 9.00-10.15am [online via zoom]

**Textbook:** Galaxy Formation & Evolution  
Mo, van den Bosch & White (hereafter MBW)  
<http://www.astro.yale.edu/vdbosch/book.html>

**Syllabus:** available on course website & canvas

**Lecture Notes:** will be made available on course website

**Grading:** 40% Final Exam (oral)  
30% Term Paper & Presentation (topic picked in class)  
30% Problem Sets



# The Course

**Format:** 24 lectures (weeks 1-12; see lecture notes & MBW)  
2 classes with student presentations (week 14)

## Requirements:

graduate student in physics or astronomy  
familiarity with astronomy nomenclature (magn, Mpc,  $H_0$ )  
basic knowledge of extra-galactic astronomy  
(read chapter 2 of MBW)

## My goal for you:

to teach you the physics related to galaxy formation  
to teach you basic concepts & relevant nomenclature  
to prepare you for research in extra-galactic astrophysics

## What I expect from you:

read MBW in preparation of lectures (see syllabus)  
participate actively in class (ask questions)  
hand in problem sets on time  
term paper ( $\pm$ 8-10 pages on topic of current interest)  
presentation in class (=online) on term paper  
oral exam (1 hour, during exam period)

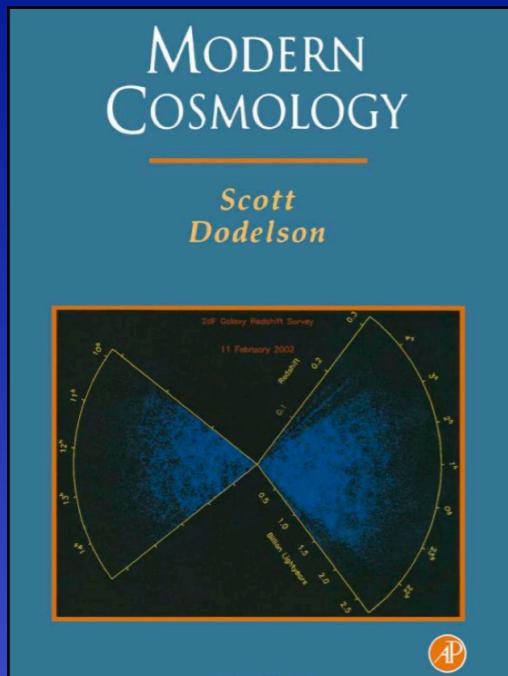
# Additional Recommended Textbooks



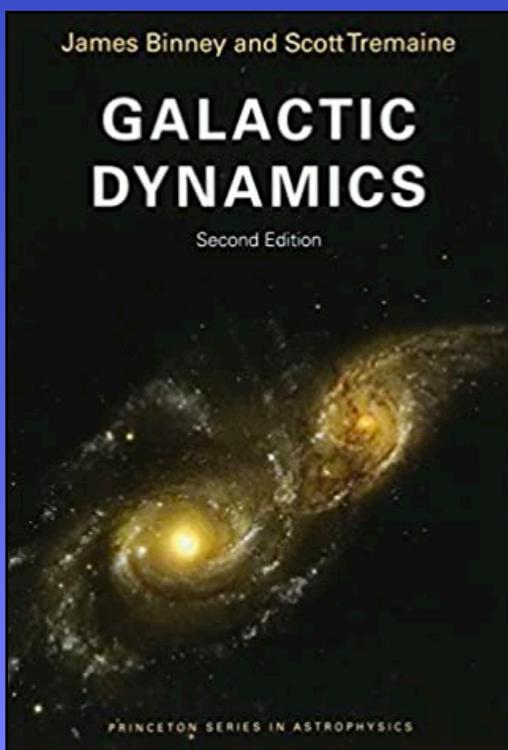
Good additional source of information.  
Somewhat less advanced than MBW.  
Does not cover the gastrophysical processes  
of galaxy formation (cooling, star formation  
feedback) in any detail.

One of the best graduate textbooks on cosmology.  
Excellent coverage of Newtonian perturbation  
theory. Does not cover galaxy formation in any  
detail, though...

# Additional Recommended Textbooks

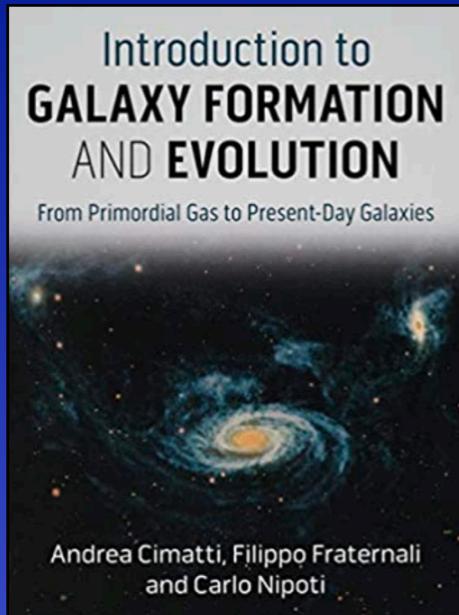


Detailed coverage of structure formation in the linear regime with superb treatment of relativistic perturbation theory.  
Nice chapter on likelihood analysis.  
Does not cover non-linear collapse, or galaxy formation.



A classic! Excellent textbook on dynamics.  
Has detailed information on equilibria, collisions and interactions of collisionless systems.

# Additional Recommended Textbooks



Brand new...an undergraduate companion to MBW.  
Excellent additional source of information,  
and very much up to date.



Good companion for MBW, with detailed treatment  
of reionization, first stars and 21cm cosmology.

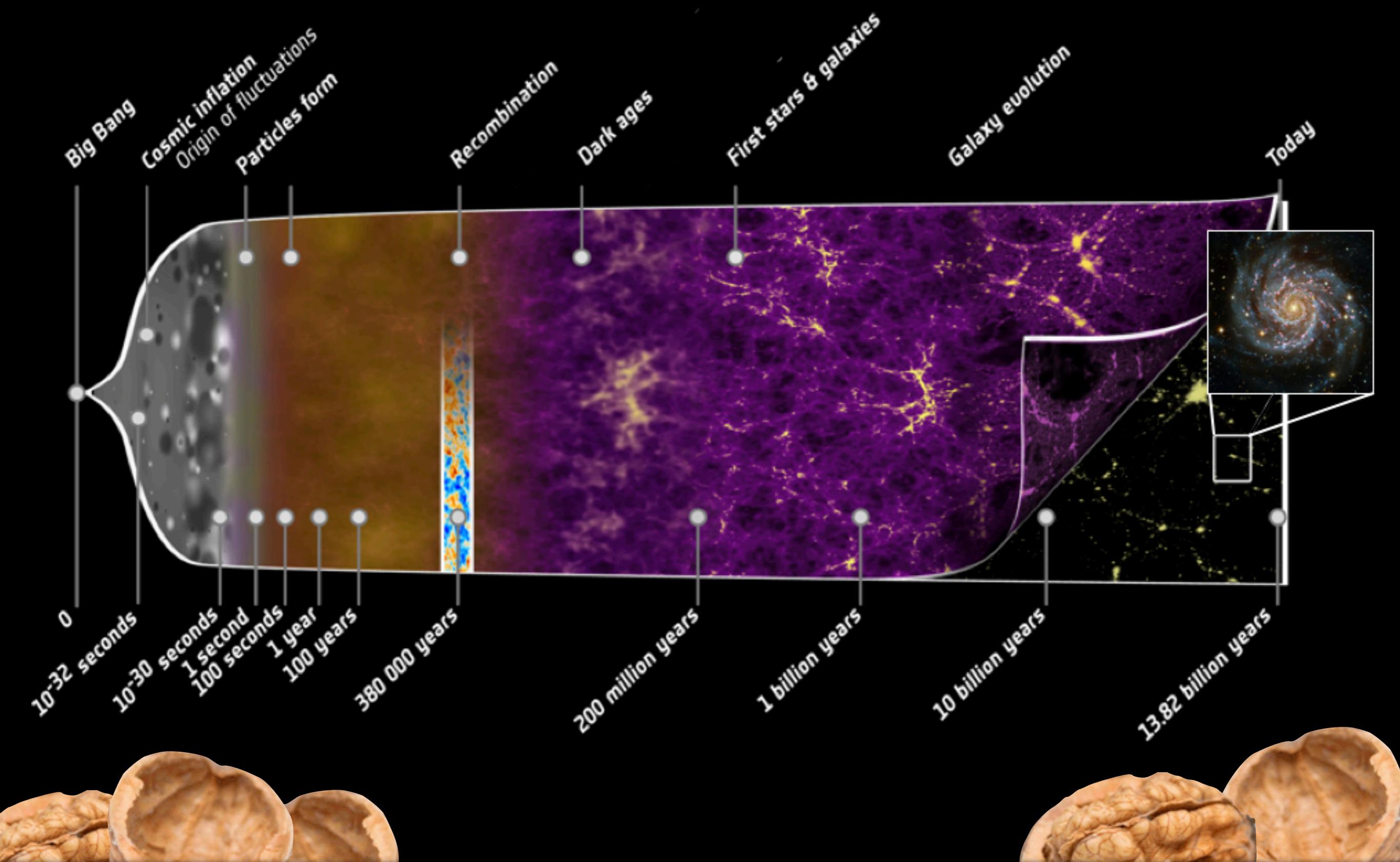
# Preliminary Schedule

week	Date	Topic	Textbook
1	Tue 09/01	Introduction; A Broad Brush Overview of Galaxy Formation	chapter 1
1	Thu 09/03	Cosmology (Riemannian geometry, FRW metric, cosmological distances)	§3.1
2	Tue 09/08	Relativistic Cosmology (GR, Friedmann eqs)	§3.2
2	Thu 09/10	Newtonian Perturbation Theory: linearized fluid equations	§4.1
3	Tue 09/15	Newtonian Perturbation Theory: baryonic perturbations	§4.1
3	Thu 09/17	Newtonian Perturbation Theory: dark matter	§4.1
4	Tue 09/22	Transfer Function and the Cosmic Microwave Background	§4.3 - §6.7
4	Thu 09/24	Non-linear collapse and Relaxation	chapter 5
5	Tue 09/29	Press-Schechter Theory, Excursion Set Formalism and Halo Mass Function	§7.2
5	Thu 10/01	Press-Schechter Theory, Excursion Set Formalism and Halo Mass Function	§7.2
6	Tue 10/06	Merger Trees and Halo Bias	§7.3 - §7.4
6	Thu 10/08	Structure of Dark Matter Halos	§7.5
7	Tue 10/13	Large Scale Structure	§6.1 - §6.2 - §6.5
7	Thu 10/15	Halo Model and Halo Occupation Statistics	§7.6 - §15.6

# Preliminary Schedule

8	Tue 10/20	Galaxy Interactions & Transformations	chapter 12
8	Thu 10/22	Cooling Processes & Photo-Ionization Heating	§8.1 - §8.3 - §8.4
9	Tue 10/27	Star Formation	§9.1 - §9.3 - §9.5
9	Thu 10/29	Supernova Feedback	§8.6 - §10.5
10	Tue 11/03	Structure and Formation of Disk Galaxies	chapter 11
10	Thu 11/05	Structure and Formation of Elliptical Galaxies	chapter 13
11	Tue 11/10	Numerical Simulations	App C
11	Thu 11/12	Active Galactic Nuclei	Chapter 14
12	Tue 11/17	The Inter-Galactic Medium	Chapter 16
12	Thu 11/19	Semi-Analytical Models of Galaxy Formation; putting it all together	
13	Tue 11/24	NO CLASS: Thanksgiving Break	
13	Thu 11/26	NO CLASS: Thanksgiving Break	
14	Tue 12/01	Student Presentations	
14	Thu 12/03	Student Presentations	

# Galaxy Formation in a Nutshell



# Galaxy Formation in a Nutshell

