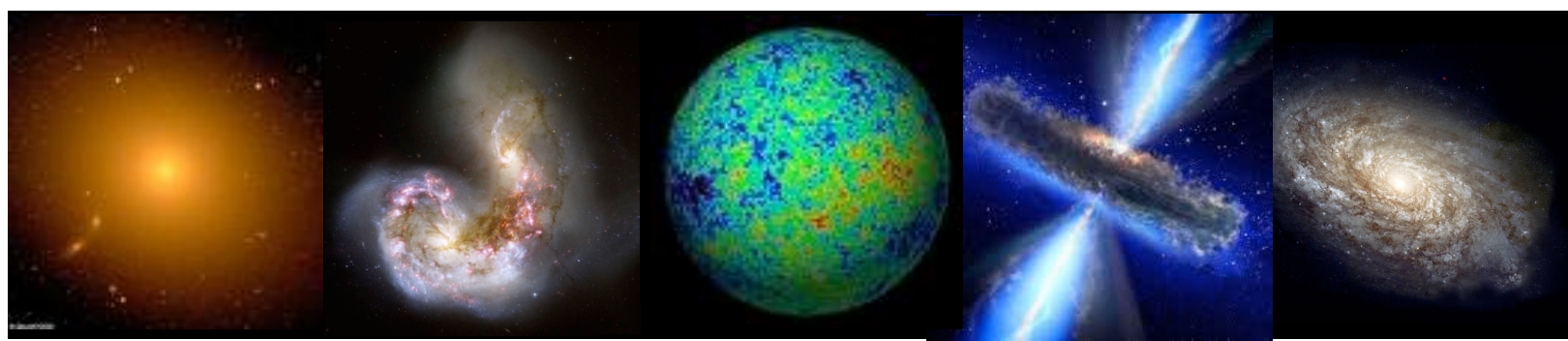


# ASTRO 610; Spring Semester 2024

## THEORY OF GALAXY FORMATION



### Course Description

This course prepares the student for state-of-the-art research in galaxy formation and evolution. The course focusses on the physical processes underlying the formation and evolution of galaxies in a  $\Lambda$ CDM cosmology. Topics include a brief introduction to cosmology, Newtonian perturbation theory, the spherical collapse model, formation and structure of dark matter haloes (including Press-Schechter theory), large scale structure, cooling processes, theory of star formation, feedback processes, the structure and formation of disk galaxies and ellipticals, AGN, and supermassive black holes, and N-body simulations. The course also includes a detailed treatment of statistical tools used to describe the large scale distribution of galaxies and introduces the student to the concepts of galaxy bias and halo occupation modeling. During the final lectures we will discuss a number of outstanding issues in galaxy formation, and the students will present and discuss their term paper on a current topic in the field of galaxy formation & evolution.

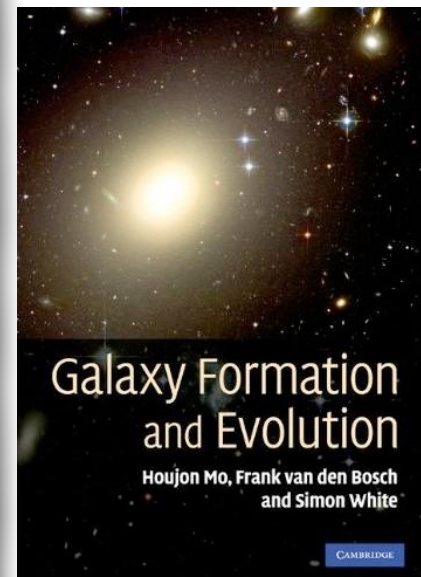
**Instructor:** Prof. Frank van den Bosch (Office: KT# 649)  
[frank.vandenbosch@yale.edu](mailto:frank.vandenbosch@yale.edu)

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

**Lecture Hours:** Monday & Wednesday 9.00 - 10.15am  
location TBD

**Textbook:** Galaxy Formation & Evolution  
(Mo, van den Bosch & White)

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



# Preliminary Schedule

week	Date	Topic	MBW
1	Wed 01/17	Introduction; A Broad Brush Overview of Galaxy Formation	chapter 1
1	Fri 01/19	Cosmology (Riemannian geometry, FRW metric, cosmological distances)	§3.1
2	Mon 01/22	Relativistic Cosmology (GR, Friedmann eqs)	§3.2
2	Wed 01/24	Newtonian Perturbation Theory: linearized fluid equations	§4.1
3	Mon 01/29	Newtonian Perturbation Theory: baryonic perturbations	§4.1
3	Wed 01/31	Newtonian Perturbation Theory: dark matter	§4.1
4	Mon 02/05	Transfer Function and the Cosmic Microwave Background	§4.3 - §6.7
4	Wed 02/07	Non-linear collapse and Relaxation	chapter 5
5	Mon 02/12	Press-Schechter Theory, Excursion Set Formalism and Halo Mass Function	§7.2
5	Wed 02/14	Merger Trees and Halo Bias	§6.1 - §6.2 - §6.5
6	Mon 02/19	Structure of Dark Matter Halos	§7.3 - §7.4
6	Wed 02/21	Large Scale Structure	§6.1 - §6.2 - §6.5
7	Mon 02/26	Halo Model and Halo Occupation Statistics	§7.6 - §15.6
7	Wed 02/28	Galaxy Interactions & Transformations	chapter 12
8	Mon 03/04	Cooling Processes & Photo-Ionization Heating	§8.1 - §8.3 - §8.4
8	Wed 03/06	Review of material covered so far [in class discussion]	
9	Mon 03/11	NO CLASS: Spring Break	
9	Wed 03/13	NO CLASS: Spring Break	
10	Mon 03/18	NO CLASS: Spring Break	
10	Wed 03/20	NO CLASS: Spring Break	
11	Mon 03/25	Star Formation	§9.1 - §9.3 - §9.5
11	Wed 03/27	Supernova Feedback	§8.6 - §10.5
12	Mon 04/01	Structure and Formation of Disk Galaxies	chapter 11
12	Wed 04/03	Structure and Formation of Elliptical Galaxies	chapter 13
13	Mon 04/08	AGN and supermassive black holes	chapter 14
13	Wed 04/10	Numerical Simulations	App C
14	Mon 04/15	Outstanding Issues in Galaxy Formation I	
14	Wed 04/17	Outstanding Issues in Galaxy Formation II	
15	Mon 04/22	Student Presentations	
15	Wed 04/24	Student Presentations	