**PHYS 8803: Cosmology & Galaxies**

Fall 2017, MWF 11:15am-12:05pm, Howey Bldg S107

**Instructor:** Prof. John Wise

**Office:** 1-61 Boggs Building

**Email:** [jwise@physics.gatech.edu](mailto:jwise@physics.gatech.edu)

**Office hours:** 2:00pm-4:00pm Tuesdays or by appointment

**Class website:** <https://sites.google.com/view/phys8803w/syllabus>

**Textbook: Galaxy Formation and Evolution**, Authors: Mo, van den Bosch, & White. ISBN: 0521857937 ([author's website](http://www.google.com/url?q=http%3A%2F%2Fwww.astro.yale.edu%2Fvdbosch%2Fbook.html&sa=D&sntz=1&usg=AFQjCNHzHsSrVuIvMjIQzoJgQdooIgJKyA), [Amazon](https://www.google.com/url?q=https%3A%2F%2Fwww.amazon.com%2FGalaxy-Formation-Evolution-Houjun-Mo%2Fdp%2F0521857937&sa=D&sntz=1&usg=AFQjCNFW9BPSBk16lEBe-EWc1chIYgnc-A))

**Course Objectives:** In this class, we will learn about the relevant physics that govern that cosmological processes and galaxy formation and evolution. We will focus on cosmology for the first third of the semester, and galaxy formation and evolution for the remainder of the term. We will apply physics ideas from the four major disciplines (classical mechanics, quantum mechanics, statistical mechanics, and electromagnetism) to describe observed behavior in galaxies and their cosmological setting.

This course will be mainly taught by conventional lecture methods with in-class projects and discussions. The lectures will not necessarily cover all of the material that will be used in the homework or projects. Lecture notes will be posted online in the format of Jupyter notebooks and/or PDFs, which the students should check their accuracy.

**Overview of topics covered:**

1. Cosmology – Inflation, Big Bang Nucleosynthesis, Primordial Perturbations
2. Structure Formation – Gravitational Collapse, Large-scale clustering, Gas dynamics and radiative cooling
3. Galaxy Formation – Disk galaxies, Galaxy mergers, Elliptical galaxies, Active galaxies

**Course grades:** The course grade will be entirely determined from your scores on the homework sets, projects, final paper, and class presentations. There will be no tests or final exams as this class is project-based.

**Final letter grades:** A = >89.5%, B = 79.5-89.4%, C = 69.5-79.4%, D = 59.5-69.4%, F = <59.4%. All decimal places smaller than tenths of a percentage point are truncated.

* Three projects: 20% each
* Seminal paper presentation: 15%
* Term paper: 15%
* Term paper presentation: 5%
* Peer evaluation of term presentations: 5%

**Seminal Papers:** I will pick several seminal papers on various relevant topics that will be presented by students during most Friday classes. Please email me or tell me in class about your choice. First come, first serve. These sessions will be like a journal club, where I encourage discussion throughout the period. Your presentation should cover all of the important background, motivation, results, and subsequent impact on the field. I will do the first presentation, so you get some ideas on what's expected from the content and style of the talk.

**Projects:** There will be three projects, each worth 20% of the final grade, during the semester. One will concern cosmology; one will concern large scale structure, and the other will be about galaxies. Projects are due in electronic form (upload them on T-square) at 6pm on the specified due date. Late assignments are not accepted unless previous arrangements have been made. Students are encouraged to work and discuss projects together, but the written work must be your own.

The three projects, composed of an analytical portion, a computational portion, and your interpretation of the results, will be due

* **Cosmology Project (due Wednesday, October 11)**
* **Large Scale Structure Project (due Friday, November 3)**
* **Galaxies Project (due Wednesday, November 29)**

Project descriptions will be posted on T-square approximately one month before the due date.

**Term Paper: Due date: Friday, December 8th, 6pm (upload to T-square Dropbox)**

Confirm topic with me by **Friday, October 20th**

**Presentation Schedule**

* Monday, November 27th:
* Wednesday, November 29th:
* Friday, December 1st:

**List of Potential Topics**

(as people choose their topics, I will remove them from website)

* Dark matter particle candidates
* Gravitational waves from inflation
* Primordial black holes
* Streaming velocities between baryons and dark matter at recombination
* Dark matter annihilation
* Warm dark matter
* Constraining dark energy with baryon acoustic oscillations
* The first stars
* The impact of reionization on galaxy formation
* Quenching of satellite galaxies
* Observational constraints on the shapes of dark matter halos
* The nature of damped Lyman alpha systems
* Origin of the cosmic star formation history
* The missing baryon problem
* Origin of the mass-metallicity relation of galaxies
* The impact of AGN feedback on galaxy formation
* Origin of the relation between a galaxy and its central black hole
* What can globular clusters teach us about galaxy formation?
* The angular momentum distribution of gas in dark matter halos
* Supernova feedback in numerical simulations
* Supernova feedback in semi-analytical models
* Constraining models of galaxy formation with gravitational waves from SMBH mergers
* Formation and dynamics of cosmological bubbles
* or define your own and confirm with me!

**Instructions & Guidelines**

* Pick one of the topics in the list or define your own
* One topic per student – first come first serve!
* Search the literature for relevant papers ([arXiv](http://www.google.com/url?q=http%3A%2F%2Farxiv.org%2Farchive%2Fastro-ph&sa=D&sntz=1&usg=AFQjCNF1VXlAJJCMMsO52F3Fod0JfBNaAg), [ADS](http://www.google.com/url?q=http%3A%2F%2Fadsabs.harvard.edu%2Fabstract_service.html&sa=D&sntz=1&usg=AFQjCNEgzjJs9k_pAkuRIWEIrvUchsP9EA) are very useful!). References in the textbook are also handy.
* Pick 2-4 papers that will form the basis of your paper
* As a guideline, pick papers with at least 10 citations per year since publication (see "citation history" in ADS entries)
* Read your chosen papers and work through them until you understand the theoretical basis for their findings.
* Write a review paper (8-10 pages) that summarizes your findings. This page count does not include references. Include any relevant figures, equations, and tables in your paper.
* Prepare a ~20 minute presentation based on your paper that you will give at the end of the term.

**Statement of Intent for Inclusivity**

As a member of the Georgia Tech community, I am committed to creating a learning environment in which all of my students feel safe and included. Because we are individuals with varying needs, I am reliant on your feedback to achieve this goal. To that end, I invite you to enter into dialogue with me about the things I can stop, start, and continue doing to make my classroom an environment in which every student feels valued and can engage actively in our learning community.

**Attendance:** Each student should be aware of the regulations that are listed in the student handbook. The class attendance policy, which the Georgia Tech regulations say shall be at the discretion of the instructor, will be as follows: There will be no prescribed maximum number of unexcused absences for this class. However, if it is apparent that lack of attendance at class may be impairing a student's performance in the course, the instructor may require that the student not miss more classes, under the penalty of failing the course. Please consult <http://catalog.gatech.edu/rules/4/> for details on what constitutes an excused absence and other aspects of the Georgia Tech Attendance Policy.

**Academic Integrity:** Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit either of these links ([one](http://www.google.com/url?q=http%3A%2F%2Fwww.catalog.gatech.edu%2Fpolicies%2Fhonor-code%2F&sa=D&sntz=1&usg=AFQjCNGSnI7XUtRb62Pt5F8MFpZn-L-pDg), [two](http://www.google.com/url?q=http%3A%2F%2Fwww.catalog.gatech.edu%2Frules%2F18%2F&sa=D&sntz=1&usg=AFQjCNFks6LlbOi1HrzuLsGncccLPIzVDA)). Any student suspected of cheating or plagiarizing on an assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

**Accommodations for Individuals with Disabilities:** If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404) 894-2563 or [this link](http://www.google.com/url?q=http%3A%2F%2Fdisabilityservices.gatech.edu%2F&sa=D&sntz=1&usg=AFQjCNFRnBbHdUUMo9Kp24mJRGrjE9YZTw), as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

**Student-Faculty Expectations:** At Georgia Tech we believe that it is important to continually strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See [this link](http://www.google.com/url?q=http%3A%2F%2Fwww.catalog.gatech.edu%2Frules%2F22%2F&sa=D&sntz=1&usg=AFQjCNGmR4gHww27Af_yPg0W0ER7RkVqyQ) for an articulation of some basic expectations – that you can have of me, and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech, while in this class.

**Unexpected Problems:** If a snow and/or ice storm (or any other cause for the Institute to close) occurs on a day scheduled for a problem set due date, it will be due on the first day the Institute opens again. Submit your assignment to the previously specified venue (for example, T-square or email) if class is not held that day. Check the GT web pages and class announcements on T-square for information.

**Support Services and Resources**

In your time at Georgia Tech, you may find yourself in need of support. Below you will find some resources to support you both as a student and as a person.

***Academic support***

* Center for Academic Success [http://success.gatech.edu](http://success.gatech.edu/)
  + 1-to-1 tutoring <http://success.gatech.edu/1-1-tutoring>
  + Peer-Led Undergraduate Study (PLUS) <http://success.gatech.edu/tutoring/plus>
  + Academic coaching http://success.gatech.edu/coaching
* Residence Life's Learning Assistance Program <https://housing.gatech.edu/learning-assistance-program>
  + Drop-in tutoring for many 1000 level courses
* OMED: Educational Services (<http://omed.gatech.edu/programs/academic-support>)
  + Group study sessions and tutoring programs
* Communication Center ([http://www.communicationcenter.gatech.edu](http://www.communicationcenter.gatech.edu/))
  + Individualized help with writing and multimedia projects

***Personal Support***

Georgia Tech Resources

* The Office of the Dean of Students: <http://studentlife.gatech.edu/content/services>; **404-894-6367**; Smithgall Student Services Building 2nd floor
  + You also may request assistance at <https://gatech-advocate.symplicity.com/care_report/index.php/pid383662?>
* Counseling Center: [http://counseling.gatech.edu](http://counseling.gatech.edu/); **404-894-2575**; Smithgall Student Services Building 2nd floor
  + Services include short-term individual counseling, group counseling, couples counseling, testing and assessment, referral services, and crisis intervention. Their website also includes links to state and national resources.
  + *Students in crisis may walk in during business hours (8am-5pm, Monday through Friday) or contact the counselor on call after hours at* ***404-894-2204****.*
* Students’ Temporary Assistance and Resources (STAR): <http://studentlife.gatech.edu/content/need-help>
  + Can assist with interview clothing, food, and housing needs.
* Stamps Health Services: [https://health.gatech.edu](https://health.gatech.edu/); **404-894-1420**
  + Primary care, pharmacy, women’s health, psychiatry, immunization and allergy, health promotion, and nutrition
* OMED: Educational Services: [http://www.omed.gatech.edu](http://www.omed.gatech.edu/)
* **Women’s Resource Center:** [**http://www.womenscenter.gatech.edu**](http://www.womenscenter.gatech.edu/)**; 404-385-0230**
* **LGBTQIA Resource Center:** [**http://lgbtqia.gatech.edu/**](http://lgbtqia.gatech.edu/)**; 404-385-2679**
* **Veteran’s Resource Center:** [**http://veterans.gatech.edu/**](http://veterans.gatech.edu/)**; 404-385-2067**
* **Georgia Tech Police: 404-894-2500**