**PHYS 8803: High-Energy Astrophysics**

Spring 2018, MWF 11:15am-12:05pm, Howey Bldg S204

**Instructor:** Prof. David Ballantyne

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**Office hours:** 10:00am-11:00am MWF or by appointment

**Class website:** <http://ballantyne.gatech.edu/phys8803/index.html>

**Suggested Textbooks:** *High-Energy Astrophysics*, by F. Melia, Princeton Univ. Press

*High Energy Astrophysics*, 3rd Edition, by M. Longair,

Cambridge Univ. Press

*Introduction to High-Energy Astrophysics*, by S. Rosswog & M. Brüggen, Cambridge Univ. Press

**Outline:** *I. Radiation Processes*

1. Quick Review of Classical E&M Radiation Theory
2. Bremsstrahlung
3. Synchrotron
4. Thomson Scattering
5. Compton Scattering/Inverse Compton Scattering/Comptonization

*II. Accretion Physics*

* + - 1. Bondi-Hoyle Accretion
      2. Standard Thin Accretion Disk Theory
      3. Timescales and Stability
      4. Introduction to MRI/Modern Accretion Theory

*III. Astrophysical Sources*

* + - 1. AGNs/Galactic Black Holes
      2. Pulsars/Accreting Neutron Stars
      3. Clusters
      4. GRBs
      5. White Dwarfs (if time)

**Evaluation:** Two problems sets (Due: February 28th, April 18th) 25% each

Review article and presentation (see below) 25% each

(Scale: A=90-100; B=80-89; C=70-79; D=60-69; F <= 59)

**Notes:** 1. Late assignments *not* accepted unless previous arrangements have been made.

2. Students encouraged to work and discuss problems together, but written work *must* be your own.

3. Lecture notes will be put on the course website, as will assignments and solutions.

4. Grades will be posted on Canvas. Students should check the accuracy of all grades.

5. 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.

**Learning Outcomes:** At the end of the course students should be able to describe the observed characteristics of the three main radiation processes presented in class. Students should be able to describe the basic physical processes that give rise to the different spectral forms for each radiation mechanism. Students will also be expected to understand and perform calculations with both Bondi-Hoyle and thin accretion flows. Finally, students should be able to describe how these physical processes lead to the observed properties of accreting black holes, neutron stars, and clusters of galaxies.

**Review Article:** 5-10 pages (not including references) on topic in high-energy astrophysics. Include figures/tables/equations as necessary. Topic must be approved by instructor by February 16th. Presentation (minimum 20 minutes) during class at the end of the semester. Review article due April 23rd.

**Further References:** *I. Radiation Processes*

* *Radiative Processes in Astrophysics*, by G. Rybicki & A. Lightman, Wiley
* *The X-ray Spectral Properties of Photoionized Plasmas and Transient Plasmas,* 1999, in X-ray Spectroscopy in Astrophysics, eds van Paradijs, J. & Bleeker, J.A.M., volume 520 of *Lecture Notes in Physics*. Berlin: Springer-Verlag, pp. 189-268
* *The Physics of Astrophysics, Volume I: Radiation* by F.H. Shu, University Science Books

*II. Accretion Physics*

* *Accretion Power in Astrophysics*, by J. Frank, A. King & D. Raine, Cambridge University Press
* *Advection-Dominated Accretion around Black Holes* by R. Narayan, R. Mahadevan & E. Quataert (arXiv:astro-ph/9803141)
* *Radiatively Inefficient Accretion Disks* by H. Spruit (arXiv:astro-ph/0003143)
* *Physics Fundamentals of Luminous Accretion Disks Around Black Holes* by O. Blaes (arXiv:astro-ph/0211368)
* *Instability, turbulence and enhanced transport in accretion disks*, by S. Balbus & J. Hawley, 1998, Rev. Mod. Phys., 70, 1
* *Enhanced Angular Momentum Transport in Accretion Disks*, by S. Balbus, 2003, ARA&A, 41, 555

*III. Astrophysical Sources*

* *Active Galactic Nuclei*, by J. Krolik, Princeton University Press
* *Compact Stellar X-ray Sources*, edited by W. Lewin & M. Van der Klis, Cambridge University Press
* *Black Holes, White Dwarfs and Neutron Stars,* by P. Shapiro & S. Teukowsky, Wiley
* *Gamma-Ray Bursts and the Fireball Model*, by T. Piran, 1999, Physics Reports, 314, 575
* *Theories of Gamma-Ray Bursts*, by P. Meszaros, 1998, ARA&A, 40, 137
* *High Energy Radiation from Black Holes*, by C. Dermer & G. Menon, Princeton University Press

**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 <http://www.catalog.gatech.edu/policies/honor-code/> or <http://www.catalog.gatech.edu/rules/18/>. Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

**Accommodations for Students 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 <http://disabilityservices.gatech.edu/>, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail the instructor as soon as possible in order to set up a time to discuss your learning needs.

**Student-Faculty Expectations Agreement:** At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See <http://www.catalog.gatech.edu/rules/22/> for an articulation of some basic expectation 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.

**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.

**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**