

# PHYS 8803: High-Energy Astrophysics

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

**Instructor:** Prof. David Ballantyne

**Office:** 1-60 Boggs Building (MWF), C-201 Howey Building (TuTh)

**Telephone:** 404-385-3909 (MWF)

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

**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*, 3<sup>rd</sup> 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. Read the Academic Honor Code:  
<http://www.policylibrary.gatech.edu/student-affairs/academic-honor-code>
  5. Grades will be posted on Canvas. Students should check the accuracy of all grades.

**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 16<sup>th</sup>. 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

## **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>
  - 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>)
  - 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 2<sup>nd</sup> floor
  - You also may request assistance at [https://gatech-advocate.symplcity.com/care\\_report/index.php/pid383662?](https://gatech-advocate.symplcity.com/care_report/index.php/pid383662?)
- Counseling Center: <http://counseling.gatech.edu>; **404-894-2575**; Smithgall Student Services Building 2<sup>nd</sup> 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>; **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>
- Women's Resource Center: <http://www.womenscenter.gatech.edu>; **404-385-0230**
- LGBTQIA Resource Center: <http://lgbtqia.gatech.edu/>; **404-385-2679**
- Veteran's Resource Center: <http://veterans.gatech.edu/>; **404-385-2067**
- Georgia Tech Police: **404-894-2500**