

# AST 520: High Energy Astrophysics

Spring 2023

Lectures: M & W 3:00-4:20pm, 140 Peyton Hall

Instructor: Anatoly Spitkovsky

We will study the vast and continually evolving subject of high energy astrophysics: the science of extreme environments and their observable manifestations. We will focus on the physics of the phenomena, with excursions into radiation, relativity and gas dynamics.

The recommended books for the course are: Rybicki and Lightman “Radiative Processes in Astrophysics,” Longair “High Energy Astrophysics,” (now all in one volume), Frank, King and Raine “Accretion Power in Astrophysics,” and Schutz “A First Course in General Relativity.” These books can be purchased from any online bookseller, although Rybicki & Lightman seems to be out of print and expensive. Maybe you can find it used. We will also use parts from lecture notes by Prof. Goodman from a previous iteration of this course. They are posted online at <http://www.astro.princeton.edu/~anatoly/AST520>, or on Canvas. There will be up to 5 homeworks and a final paper. The paper will involve an in-depth research-format write-up on a subject in high-energy astrophysics. The instructor will provide a sample list for project topics.

The course outline:

1. Jan 30	Intro, Eddington limit, OOM accretion
2. Feb 2	Relativity, superlum motion
3. Feb 6	Rad transfer, Doppler boosting
4. Feb 8	Bremsstrahlung I
5. Feb 13	Bremsstrahlung II; Synchrotron I
6. Feb 15	Synchrotron II, Self-absorption, Jets
7. Feb 20	Compton effect
8. Feb 22	Comptonization
9. Feb 27	Spherical accretion. Bondi Hoyle
10. Mar 1	Rad. efficiency
11. Mar 6	Accretion disks 1
12. Mar 8	Accretion disks 2
13. Mar 20	MRI/Binary evolution
14. Mar 22	Binary evolution
15. Mar 27	Binaries – LMXB/HMXB

16. Mar 29	Magnetic accretion; Structure of WD, NS
17. Apr 3	Astrophysical GR, BH orbits
18. Apr 5	Nuclear burning – X-ray bursts
19. Apr 10	Pulsars
20. Apr 12	Pulsars/ pulsar wind nebulae
21. Apr 17	Shock acceleration; cosmic rays
22. Apr 19	Cosmic rays and SNe
23. Apr 24	Gamma Ray Bursts
24. Apr 26	BZ effect, jet collimation