AST31100 - High-energy Astrophysics (2021)

Lectures Tu/Th 2:40-4:00pm (Chicago time, UTC-5)

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PLAN OF LESSONS

1) Jan 12: Introduction to High-Energy Astrophysics (slides)

2) Jan 14: Absorption and emission, black body (slides); Theory of radiation transfer (RL 1.1-1.4)

3) Jan 19: Theory of thermal emission (RL 1.5; G 2.1, 2.2)

4) Jan 21: Thomson and Compton scattering (RL 3.4; G 5.1-5.4)

5) Jan 26: Compton scattering: losses and spectrum (G 5.5-5.6)

6) Jan 28: Method of virtual quanta (note); Synchrotron emission (G 4.1-4.5)

7) Feb 2: Relativistic bremsstrahlung (notes); Nuclear processes of astrophysical interest: threshold (notes)

8) Feb 4: Intro to the standard model (slides); Nuclear processes: pion decay and HE photons and neutrinos (notes); Hillas criterion; Magnetic mirrors and Fermi acceleration (notes, first section only)

9) Feb 9: Shocks and Diffusive Shock Acceleration (see notes on Feb 4, also see slides);

10) Feb 11: Discovery of Cosmic Rays; Galactic CRs: spectrum, composition, transport (slides, zoom);

11) Feb 16: Extensive Air Showers; Ultra-high-energy CRs (slides, zoom);

12) Feb 18: Magnetic reconnection; Space weather (slides, zoom); Supernovae (L 13.1, pp 378-394);

13) Feb 23: Type Ia SNe; historical SNe; Explosive nucleosynthesis (slides, zoom);

White Dwarfs, Neutron Stars and Chandrasekhar Limit (L 13.2, pp 394-401) - DIBERT

14) Feb 25: White dwarfs, neutron stars, pulsars (slides, zoom)
The discovery of neutron stars (L 13.5 pp 406-419) - ZHANG

15) Mar 2: Black holes (L 13.11) (slides, zoom)

16) Mar 4: Pulsar magnetospheres and plerions (slides, zoom)

Neutron star and pulsar phenomenology (L 13.6, 13.7, 13.9, 13.10; pp 419-422, 424-429) - PAN


18) Mar 11: Introduction to Fast Radio Bursts; Sedov solution (zoom)

Gamma Ray Bursts (L 22.7, pp 704-713) - MALLABY-KAY

FINAL PRESENTATIONS (Mar 18, 1:30PM-3:30PM)

HOLST: Hobbs et al., 2010, The International Pulsar Timing Array project: using pulsars as a gravitational wave detector

ANBAJAGANE: Sazanov & Sunyaev 2015, Preheating of the Universe by cosmic rays from primordial supernovae at the beginning of cosmic reionization

CERNY: Merloni et al 2003, A Fundamental Plane of black hole activity

FITZPATRICK: Caprioli 2015, "Espresso" Acceleration of Ultra-high-energy Cosmic Rays

WANG: Shapiro et al. 1976: "A two-temperature accretion disk model for Cygnus X-1 - Structure and spectrum"

TEXTBOOKS

Longair, High Energy Astrophysics (Third Edition) --- L

Rybicki & Lightman, Radiative Processes in Astrophysics --- RL

G. Ghisellini, Radiative Processes in High-Energy Astrophysics --- G

Legend:

RL 1.1-1.4 means: Rybicki & Lightman, from Sec. 1.1 to 1.4;

G 1.1, 1.4 means: Ghisellini, Sec. 1.1 and 1.4;
Additional Manuals

Shapiro & Teukolsky, *Black Holes, White Dwarfs and Neutron Stars*

Krolik, *Active Galactic Nuclei*

Jackson, *Classical Electrodynamics*

Assignments and Collaboration

Except when stated otherwise, assignments are due on **Friday at 5pm UTC-5**.

Group work on the assignments is encouraged. **Collaboration** is sharing of ideas, as you teach one another.

Each person must use *their own words in each submission*, and give credit to those who collaborated on the work (i.e., add the names of collaborators to each submission). Phrases that appear on multiple students' work will result in no credit and proportional disciplinary action. If we are concerned that what you turned in does not represent your own understanding, but rather someone else’s, and thus represents plagiarism, then we may mark a zero for that lab report, a failing grade for the course, and file a student conduct complaint with the Dean of Students.

Exams and Grades

The final grade will be calculated as:

-- 50%: Assignments

-- 40%: Presentation (either on a manual section or on a paper)

-- 10%: Participation

The grade of **assignments turned in late will be decreased by 10% per day**.

Example: if the deadline is Friday 5pm, the grade is reduced by 10% between Friday 5:01pm and Saturday 5pm, 20% between Saturday 5:01pm and Sunday 5pm, and so on).

Feedback
We want to gather feedback from you about how the course is going for you, and how we might adapt it as we go. We welcome direct feedback to any of the contacts listed above. You can also submit anonymous feedback at the following link.

**Accessibility**

The University of Chicago is committed to ensuring equitable access to our academic programs and services. Students with disabilities who have been approved for the use of academic accommodations by Student Disability Services (SDS) and need a reasonable accommodation(s) to participate fully in this course should follow the procedures established by SDS for using accommodations. Timely notifications are required in order to ensure that your accommodations can be implemented. Please meet with me to discuss your access needs in this class after you have completed the SDS procedures for requesting accommodations. Phone: (773) 702-6000 Email: disabilities@uchicago.edu

**Recording and Deletion Policies**

The Recording and Deletion Policies for the current academic year can be found in the Student Manual under [Petitions, Audio & Video Recording on Campus](#).

- Do not record, share, or disseminate any course sessions, videos, transcripts, audio, or chats.
- Do not share links for the course to those not currently enrolled.
- Any Zoom cloud recordings will be automatically deleted 90 days after the completion of the recording.