AS 757 - High Energy Astrophysics – Spring 2013

Brief Overview: This course will provide an overview of selected topics in high-energy (or relativistic) astrophysics - sometimes called particle-astrophysics and/or astro-particle physics. The course will examine fundamental physical processes, as well as their applications to interesting high-energy astrophysical systems and situations. We begin with particle acceleration, then radiative processes, and move on to applications to supernovae, neutron stars and pulsars. We will then examine high-energy aspects of the physics of accreting systems, both stellar and galactic. If time permits we will also explore particle-astrophysics aspects of dark matter and dark energy, and other exotic topics (e.g., ultra-high energy cosmic rays, gamma ray bursts, etc.). We will also delve into some experimental topics in high-energy astrophysics where appropriate.

Meeting Times: Tuesdays and Thursdays, 2:00 – 3:30 PM

Instructor: Professor Kenneth Brecher, CAS Room 518, x 3423

Office Hours: TBA

Text: There is no required text since no single book covers all of the topics we will be considering. However, the following books are highly recommended. Copies of them will be on reserve in the Astronomy Department Library. Handouts will also be distributed.

M.S. Longair, High Energy Astrophysics: Third Edition, (Cambridge U. Press, 2011).

F. Melia, High Energy Astrophysics (Princeton U. Press, 2009)

G. B. Rybicki & A. P. Lightman, Radiative Processes in Astrophysics (J. Wiley & Sons, 1979).

S. L. Shapiro & S. A. Teukolsky, Black Holes, White Dwarfs & Neutron Stars: The Physics of Compact Objects (J. Wiley & Sons, 1983).

Grading: The grade will be based on problem sets (50%) and on a research paper (50%).

Lecture Outline: The specific selection of topics is subject to change.

I. Basic physical processes (~ 6 weeks)
- A. Particle acceleration and diffusion; origin of cosmic rays
- B. Charged particle radiation processes (Synchrotron, Compton, Bremsstrahlung)
- C. Magnetic field generation, MHD and plasma processes
- D. High energy particle interactions (including neutrinos)

II. Physics of Compact Objects and Supernovae (~ 5 weeks)
- A. Supernovae (radiation processes, formation of compact objects); gamma-ray bursts
- B. Neutron star physics
- C. Pulsar physics (single magnetized neutron star radiation processes; also binary pulsars)
- D. Accretion processes involving compact stars
- E. Ultrahigh energy cosmic ray and related astro-particle physics processes

III. Extragalactic Objects (~ 2 weeks)
- A. Quasars, Blazars, Active Galactic Nuclei - accretion processes and jets
- B. Particle astrophysics of dark matter, dark energy and other exotic topics

Version 1: January 17, 2013 **- Kenneth Brecher**