
PHYSICS 541 / ASTRONOMY 541

THE PHYSICS OF COMPACT OBJECTS

SPRING Semester 2015

Call Numbers: PHYS 40321/ ASTR 40338

Credit: 1 Unit (4 Hours)

Time: Tu-Th, 12:30 PM – 1:50 PM

Room: 144 Loomis Lab

Professor Stuart L. Shapiro

A rigorous survey of the physical properties of black holes, white dwarfs and neutron stars. The formation of compact objects. Equilibrium configurations, equations of state, stability criteria and mass limits: the influence of rotation and magnetic fields. Pulsar phenomena. Black hole spacetimes. Hawking radiation. Mass flow in binary systems; spherical and disk accretion; high-temperature radiation processes; pulsar spin-up. Compact X-ray sources, X-ray and γ -ray bursts. Supermassive black holes in star clusters and dense galactic nuclei: dark matter spikes. Gravitational and neutrino radiation from supernova collapse and binary coalescence; aLIGO and eLISA; multimessenger astronomy.

Emphasis will be on the application of fundamental physical principles to compact objects. Interactions involving all four of the fundamental forces of nature will be explored. The discussion will draw on many different branches of physics including nuclear physics, solid state physics, relativity, hydrodynamics, astrophysics and high energy physics.

Target: The course will be aimed at beginning graduate students and upper level undergraduates. It will be a broad survey designed to provide all students with a thorough introduction, as well as a firm foundation for those who wish to pursue research in the field. The course will be repeated on alternate years.

Note: The basis for the 1974, 1983, 1993 and 2002 Nobel Prizes in Physics will be thoroughly explored.

Prerequisites: A good background in physics at the undergraduate level (electromagnetism, statistical mechanics and thermodynamics, classical and quantum mechanics and special relativity). No astronomy or general relativity is assumed (the necessary concepts and mathematical tools will be developed as required).

Text: *Black Holes, White Dwarfs and Neutron Stars: The Physics of Compact Objects*, by S. L. Shapiro and S. A. Teukolsky (New York, Wiley).

