Astronomy 431: Physics of Stars, Neutron Stars & Black Holes

MW 245-400, SSB 622

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available for appointments via Zoom

About 5/8 of the course will be devoted to the nature and evolution of normal stars. Stellar evolution leads naturally to compact objects: white dwarfs (not in the title!), neutron stars and black holes. We will spend the remaining 3/8 or so of the course on these. In all cases we will use observed properties to focus our attention on physical principles needed to understand basic questions such as "Why do stars shine?" and "How do we detect a black hole?"

Topics to be covered include:

- Observational overview for ordinary stars; the fundamental question of stellar astronomy
- Hydrostatic balance; simple solutions
- Energy transport in stars: radiative diffusion; convection
- Energy production in stars: H-burning and the main sequence; He burning
- Probes of interiors of stars
- Outcomes of stellar evolution: which stars become white dwarfs, neutron stars or black holes?
- White dwarfs: properties, structure, mass and radius scale
- The white-dwarf/brown dwarf/planet connection
- Neutron stars: properties, structure, mass and radius scale. The nature of dense matter.
- Detection: accretion, radio pulsars, X ray pulsars, cooling
- Black holes: Physics in extremely strong gravitational fields, discovery via accretion, detection via gravitational radiation
- Probes: Electromagnetic and gravitational radiation

Problems will be posted for more or less every lecture. You do not have to hand them in and they will not be graded, but you should do them as indicated before the associated lecture.

In addition, there will be two prelims plus a take-home final.

Lecture notes for this course will be posted at Canvas. Generally, these are broken up into individual topics covered in individual lectures.

Useful texts are also available online via the Library (unlimited users). Kippenhahn & Weigert is a somewhat more advanced than this course. Hansen, Kawaler & Trimble is mainly at the level of this course, but more

Kippenhahn & Weigert, Stellar Structure and Evolution

Hansen, Kawaler & Trimble, Stellar Interiors: Physical Principles, Structure, and Evolution
(FYI, Steven Kawaler is a Cornell grad who took this course).

Reserve (Math Library): Prialnik, An Introduction to the Theory of Stellar Structure and Evolution This is a nice introductory text but somewhat less detailed than this course.