PHYS-792
Nuclear Physics of Stars
Nuclear Astrophysics and the Origin of the Elements

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Office Hours: By appointment (send an e-mail) or just walk into my office.
Course: PHYS-792 “Nuclear Physics of Stars” (3 credits)
Lecture Hall: Classroom Building 109
Time: Spring Semester 2016, 01-13-2016 – 05-06-2016, Wednesdays & Fridays, 9:00 – 10:30 AM

The course will not follow a particular textbook, but "Nuclear Physics of Stars" by Iliadis is the recommended textbook. This book is an excellent complement to the lecture notes and it allows you to dig deeper into the details of a specific subjects as needed. It also is a good reference book for the field.

Reference books:

Course Web Address: D2L https://d2l.sdbor.edu/d2l/home/791083

Prerequisites: Nuclear and Elementary Particle Physics (PHYS-433), Quantum Mechanics I (PHYS-771) or permission of instructor.

Course Description: Nuclear Astrophysics is concerned with the study of nuclear processes that control quiescent as well as explosive stellar burning and the associated nucleosynthesis. It also is concerned with the role of nuclear physics at high density matter conditions as expected in White Dwarfs and Neutron Stars. The field, at the intersection of nuclear physics, astrophysics, and observational astronomy, explores the chemical evolution of our universe, determines the energetics of astrophysical objects, and identifies their observational signatures. Experimental nuclear astrophysics is characterized by four major directions: nucleosynthesis processes in stars studied with very low energy accelerator experiments; explosive nucleosynthesis processes requiring measurements far off of stability with radioactive beams; neutron-induced nucleosynthesis in late
stellar evolution pursued at reactor and neutron spallation facilities; and finally neutrino-induced nucleosynthesis, still mostly confined to theoretical prediction and observation.

**General Education Objectives:** This course fulfills Goal #6 of the South Dakota System General Education Requirements: Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world.

**Course Schedule:** (subject to change)
- Week-1: Introduction to Nuclear Physics and Nuclear Astrophysics
- Week-2, 3: Nuclear Reactions
- Week-4: Thermonuclear Reactions/Reactions at sub-coulomb energies
- Week-5: Big Bang and Big Bang Nucleosynthesis
- Week-6, 7: First Stars and Hydrogen Burning in Stars
- Week-8: Helium Burning and s-Process Nucleosynthesis
- Week-9: Carbon Burning and Advanced Burning Stages
- Week-10: Supernova Explosions
- Week-11: X-ray Bursts and r-Process Nucleosynthesis
- Week-12: Neutron-Star Mergers
- Week-13: r-Process Nucleosynthesis
- Week-14: General Aspects of Nuclear Astrophysics Experiments

**Instructional Methods:** This is primarily a lecture-based course. Lectures will be given at SDSMT. On average one homework assignment is expected for each chapter.

**Attendance:** In order to succeed in this course, students should attend the lectures, actively join group discussions, and do homework on time. The course assignments and exams are based on the material covered by the lectures and the textbook. In case missing a lecture is inevitable, be sure to borrow another student's class note and make sure that you understand what’s taught.

**Preparation:** Always be prepared to work. Please bring a pen and a notepad and to each class. Previewing the reading assignment will help understand the lecture more easily and so is strongly encouraged. More careful readings (not limited to the textbook) may be recommended after a lecture. Please do not hesitate to ask questions in class or by an in-person visit during instructor’s office hours.

**Class Etiquette:** Disruptive behavior in class will not be tolerated. Nothing is more distracting than incessant private chatting in class. If you would like to ask a question, raise your hand. If you have a cell phone, switch it off (or set it to silent mode) before class starts. Above all, please be considerate of the other students in the class.

**Make-Up Policy:** You are expected to take the exams on the scheduled dates. If you have a conflict with a particular exam date, please contact the instructor at least a week prior to the exam so that we can discuss accommodations.

**Homework:** Most weeks there will be homework assignments that have to be turned in by the announced deadline. Group work is welcome, but the work handed in must be original (not a word by word copy). Plagiarism will not be tolerated - please see me if you have questions about this. Often homework requires
numerical work. You are of course welcome to use various types of software to solve the problems. However, you must hand in detailed step by step information on how the problems have been solved, how equations have been derived etc. For example, you could print an excel spreadsheet and then list the equations you used for each calculations.

**Exams:** There will be two midterm exams, one in the middle of the course and one in the end (final exam). The exams will be closed book and will take place during the regular lecture time.

**Grading:** Grades will be calculated as follows:
- Class attendance: 10%
- Homework assignment: 40%
- Midterm Exam: 20%
- Final Exam: 30%

A = 85% and above  
B = 75 – 84 %  
C = 65 – < 74 %  
D = 50 – < 64 %  
F = below 50%

**Academic Integrity:** Public universities in South Dakota consider plagiarism, cheating, and other forms of academic dishonesty inimical to the objectives of higher education, therefore supports the imposition of penalties on those who engage in academic dishonesty. At the discretion of the instructor, a student caught engaging in any form of academic dishonesty may be: given a zero for that assignment, allowed to rewrite and resubmit the assignment for credit, assigned a reduced grade for the course, dropped from the course, or failed in the course.

**Freedom in Learning:** Students are responsible for learning the content of any course of study in which they are enrolled. Under the Board of Regents and South Dakota Public University policies, student academic performance shall be evaluated solely on an academic basis and students should be free to take reasoned exception to the data or views offered in any course of study. Students who believe that an academic evaluation is unrelated to academic standards but is related instead to judgment of their personal opinion or conduct should first contact the instructor of the course. If the student remains unsatisfied, the student may contact the department head and/or dean of the college that offers the class to initiate a review of the evaluation.

**Disability Accommodation:** Students who have the need of academic accommodations or access accommodations due to a documented disability should contact and register with the Disability Services Office at your home institution during the first week of class (or as soon as possible after the diagnosis of a disability during the semester). The Disability Services Office officially assists students through the process of disability verification and coordination of appropriate and reasonable accommodations. Students currently registered with Disability Services must obtain a new accommodation memo each semester.