Nuclear Physics I (PHY 551)

Lecturer

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Date: Monday and Wednesday; first lecture on February 1, 2021 (Monday)
Time: 11:45 am - 1:05 pm
Room: **online instruction via Zoom** (access from BlackBoard) initially, then (depending on the epidemiological situation) Engineering 145

Course Description

PHY 551 is a course on the foundations of modern nuclear physics. With the discovery of the "perfect liquid" behavior of quark-gluon plasma at nearby Relativistic Heavy Ion Collider (RHIC) at BNL and the Large Hadron Collider (LHC) at CERN, recent advances in the understanding of Quantum Chromo-Dynamics, and with new theoretical approaches to strongly correlated systems - this is a rapidly evolving field with a broad cross-disciplinary impact.

The goal throughout this course is to develop a deep understanding of the foundations of nuclear physics, to master computations of basic observables (cross sections, decay rates, etc), and to learn about new theoretical ideas and the key role of experimental measurements. For the students interested in nuclear and particle physics, the course will provide the knowledge base necessary to begin their research. The students with interests in other fields (condensed matter physics, AMO, astrophysics) will get acquainted with new methods for strongly correlated systems that emerge in nuclear physics.

Outline of the course

- The Standard Model and its constituents
- Quark model of hadron structure
- The structure of the nucleon; Bjorken scaling and the parton model
- Quantum Chromo-Dynamics
- Confinement and chiral symmetry breaking
- Chiral perturbation theory
- Nuclear force
- Nuclear structure
- Electroweak interactions in nuclei
- Nuclear matter under extreme conditions: quark-gluon plasma
- Nuclear astrophysics
- Nuclear energy

Pre-requisites

Students are expected to have a knowledge of quantum mechanics and relativity, but no previous acquaintance with quantum field theory is presumed.

Recommended texts and sources

1. F. Halzen and A. Martin, “Quarks and Leptons: An Introductory Course in Modern Particle Physics”
2. M. Peskin and D. Schroeder, “An introduction to quantum field theory”
3. J.D. Walecka, “Theoretical Nuclear and Subnuclear Physics”

Several of the topics covered in the course cannot yet be found in any textbook; the references to the original papers will be given.

Requirements

Regular attendance: you are expected to attend **all classes online**. The students will be asked to answer questions online during the lectures, all answers will be recorded.

You should attend the class by **Zoom**; the link is provided in BlackBoard.

The Zoom account is provided by SBU and can be accessed and configured at https://stonybrook.zoom.us/

Homework: there will be regular biweekly homework assignments; you are expected to complete homework on time, and submit homework via BlackBoard (as an “assignment”).

Office hours

Monday, 3:00 - 4:30 pm, by **Zoom** (please schedule by email)

Wednesday, 2:30 - 4:00 pm, by **Zoom** (please schedule by email)

Grading

Homework - **50%**

Mid-term - **25%**

Final exam - **25%**

Students will be able to access the current status of their grades.

Class attendance (both online and in-person) will also be considered in the final evaluation.

Web page

Homework, lecture notes, etc will appear at Blackboard Suite:

https://blackboard.stonybrook.edu

Special Notes

Any excuses (medical or otherwise) are to be documented, and discussed with the instructor in a timely manner. If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact Disability Support Services at (631) 632-6748 or http://studentaffairs.stonybrook.edu/dss/. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the following website: http://www.sunysb.edu/ehs/fire/disabilities.shtml