Nuclear Physics I (PHY 551)

Lecturer

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Date: Monday and Wednesday; first lecture on January 27, 2025 (Monday)
Time: 2:00 - 3:20 pm
Room: Physics P130

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 the emerging interface with Quantum Information - 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, quantum information, 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
- Quantum simulations of strong interactions
- 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.

Homework: there will be regular biweekly homework assignments; you are expected to complete homework on time, and upload your homework to BrightSpace

Office hours

Monday, 3:30 - 5:00 pm, C142A

Wednesday, 3:30 - 5:00 pm, C142A

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 BrightSpace:

https://it.stonybrook.edu/services/brightspace

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

Covid-related regulations:

Face masks may be required in the classroom, depending on the University policy. All University covid-related regulations apply.

Critical Incident Management:

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Student Conduct and Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. For the latest COVID guidance, please refer to the following link .

Academic Integrity:

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website .