SYLLABUS TO PHY 431,
INTRODUCTION TO NUCLEAR AND PARTICLE PHYSICS

PHY 431: Introduction to Nuclear and Particle Physics (3 credits)

Instructor: Prof.Edward Shuryak
Email edward.shuryak@stonybook.edu —
Office hours: TBD

Purpose:
This is an introductory course designed to provide an overview of modern Nuclear and Particle physics. There are several textbooks, but they mostly cover basic 20-th century material. Now we need to include more recent discoveries, such as quark-gluon plasma and merging neutron stars on nuclear side, and Higgs boson discovery at LHC. We also need to learn how to use online resources, such as tables of nuclear and particle states. Therefore we will not follow any book: written lecture notes would be provided weekly as we go, with information collected from multiple sources.

Approximate content:

(*) Discovery of nuclei: the Rutherford scattering experiments

(*) Quantum mechanical tunneling, α decays, very long-living isotopes

(*) The map of the nuclear world

(*) Light nuclei: Nuclear forces, Yukawa potential, deuteron and He^4

(*) Nuclear shell model

(*) Cosmological nucleosynthesis

(*) Nuclear fission, reactors, power production

(*) Nuclei produced in stars, fusion reactions in the Sun

(*) Current status of nuclear fusion program, reactors

(*) Neutron stars, their life and merger: production of heavy isotopes

(*) Accelerators, elements of relativistic kinematics

(*) Hadrons and leptons, particle detectors

(*) Quantum chromodynamics, gluons and quark types

(*) Heavy quarkonia as nonrelativistic hadrons:

(*) Mesons and baryons in quark models.

(*) Recent discoveries of 4,5,6-quark states

(*) QCD symmetries broken in the vacuum, the condensates and the pions

(*) Heavy ion collisions and quest for quark-gluon plasma

(*) Standard model of electroweak interactions

(*) Parity P and C, their breaking in weak interactions

(*) CP conservation and breaking, mass matrices for quarks and leptons

(*) W,Z gauge bosons, Higgs boson, electroweak symmetry breaking

(*) neutrino properties and main detectors

(*) elements of relativistic cosmology, microwave background, the QCD and electroweak phase transitions,

(*) cosmological baryon asymmetry puzzle

(*) other cosmological puzzles: dark matter and dark energy

What to Expect:
Significant part of this course (as others) is in solving homework problems. The problems are rather extensive: we will not have in-class quizzes.

There would be weekly assignments through Brightspace: by doing these problems you will reinforce understanding of the material presented at the lectures. This course will not involve mathematics, you will need to be able to make plots or tables for some problems. . Yet deuterons, shell model and quarkonia homeworks would include numerical solution of Schrodinger equation, so some level of mastering of Wolfram Mathematica (or equivalent solvers) will be needed.

Preparation for future HWs This course will not involve mathematics new to you. Yet you will need to be able to make plots. For deuterons, shell model and quarkonia homeworks would include numerical solution of Schrodinger equation, so some level of mastering of Wolfram Mathematica (or equivalent solvers) will be needed. Actually I will advocate its usage not only in few occasions when it will be necessary, but every week. Yes, it will require some learning curve but will save you a lot of time (e.g. by substituting numerical data with their units into formulae). Please upload free version from University web and learn elementary tasks like plotting a curve, or substituting "data" into an expression.

Course Grading and Attendance:
The grading for the course will be based on the completion of weekly homework assignments (50%) , midterm (20%) and the final exam (30%).

Student Accessibility Support Center (SASC) Statement:
If you have a physical, psychological, medical or learning disability that may impact your performance at exams, please contact the Student Accessibility Support Center (SASC) before those. They will determine with you what accommodations, if any, 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 the staff at the Student Accessibility Support Center (SASC). For procedures and information go to the following website: http://www.stonybrook.edu/ehs/fire/disabilities

Academic Integrity Statement:
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 are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology and Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at

`http://www.stonybrook.edu/commcms/academic_integrity/index.html`

Special note regarding plagiarism and dishonesty: All instances of suspected plagiarism or academic dishonesty will be brought before the Academic Judiciary Committee. All parties suspected (both the copier and the person who produced the original work) will be held accountable for any instance of plagiarism or dishonesty. You are responsible for protecting the security of your programming assignments by making sure that your directories are not world readable. If you are unsure how to secure your home directory see the instructor immediately.

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. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.