PHYS4900/6900 (F21)
Introduction to Particle Physics and Structure of Our Universe

Instructor: K. Nakayama, Room 219

Class Hours: TR 11:10-12:25pm

Office Hours: TR 12:30-1:30pm or by appointment.

Course Materials: There is no particular textbook to be followed in this course. Instead, course materials, in the form of power point or pdf files and some reading texts, will be provided.

Class Attendance: Class attendance is mandatory. Each missed class will lower your grade in proportion to the total number of classes.

Assignments: Reports on selected topics to be turned in.

Grade: Grade = $\frac{1}{2}\times$(course attendance + participation) + $\frac{1}{2}\times$(report grade average)

Incompletes: Rules concerning withdrawals and incompletes: We will follow the rules of the UGA Bulletin concerning withdrawals and incompletes.

Grading Scheme: Use of the plus/minus system is a requirement – it is the only grading system approved for the University of Georgia.

$$\begin{array}{rrcll} & A & \equiv & [90,100] & A- \equiv [87,90) \\ B+ \equiv [80,87) & B & \equiv & [75,80) & B- \equiv [70,75) \\ C+ \equiv [65,70) & C & \equiv & [60,65) & C- \equiv [55,60) \\ D \equiv [50,55) & F & \equiv & [0,50) & \end{array}$$

Standard rounding will be used for the final numerical grade. For example, 89.499 will be 89 and $A-$, but 89.5 will be 90 and A. There are no exception to these letter grade assignments. All withdrawal will be processed in accordance with University policy as stated in the undergraduate bulletin. For withdrawals before the midpoint, a grade of "W" will be assigned for all cases.

Academic Honesty: All academic work must meet the standards contained in "A Culture of Honesty." Students are responsible for informing themselves about those standards before performing any academic work. More detailed information about academic honesty can be found at the website given above. As a UGA student, you are responsible for knowing and understanding this policy. If you have any questions about the propriety of actions relating to this course, you are obligated to ask me for clarification. See also the UGA website: `http://www.uga.edu/honesty/`.

Course Description: This course will introduce the students to Particle Physics starting from the discovery of atomic nuclei in 1911 by Ernest Rutherford and the subsequent discoveries of subatomic particles, such as the proton and neutron, all the way down to quarks and gluons, culminating in the current theory of particle physics known as the Standard Model. This theory is a theory of Electromagnetic, Weak and Strong interactions, three of the four fundamental forces in nature (the fourth interaction is the gravitational force). The basic physics ideas

along with the key experiments that have lead to the formulation of the Standard Model will be discussed, including the discovery of the Higgs Boson in 2012, a fundamental particle whose existence is required by underlying symmetries to complete the establishment of the Standard Model. Particular emphasis will be devoted to the current understanding of our universe from the Particle Physics point of view. Issues on dark matter and dark energy will be addressed. For this, there will also be a discussion on Cosmology, in particular, on the standard Big Bang Theory. Currently open issues in Particle Physics beyond the Standard Model will be discussed, especially, Supersymmetry and Grand Unification Theory.

All the discussions will be at a qualitative level so that, at the end of the course, the students will have a basic qualitative idea of the current understanding of Particle Physics and the structure of our universe from particle physics point of view.

Topics

Below is a tentative list of topics to be covered in this course. Note that it is subject to changes. These (and other) changes will be announced in class. Each student is *fully responsible* to keep track on such changes by attending class.

- **Scales:**
  From subatomic to cosmos: Energy, Length, Temperature & Time.
- **Fundamental Forces of Nature:**
  Gravity, Electromagnetic, Weak & Strong forces
- **Nuclear & Elementary Particles:**
  From the discover of atomic nuclei to quarks: an overview.
- **Standard Model:**
  Theory of Electromagnetic, Weak & Strong forces.
- **Quantum Electrodymanics:**
  Theory of Electromagnetic Force.
- **Quantum Chromodymanics:**
  Theory of Strong Force.
- **Electroweak Interaction:**
  Neutrino Physics.
- **Beyond Standard Model:**
  Super Symmetry (SUSY).
  Grand Unification Theory (GUT).
- **Gravity:**
  Dark Matter, Dark Energy & Gravitational Waves.
- **Cosmology:**
  Standard Big Bang Theory.

- **Unified Universe:**
  Cosmology & Particle Physics.
- **Structure of our Universe:**
  Patterns, Structures & Symmetries.

Coronavirus Information for Students for Summer 2021 Classes

Face Coverings and Social Distancing:
Following guidance from the Center for Disease Control and Prevention, as well as the University System of Georgia, face coverings are no longer required inside campus facilities, including classrooms. However unvaccinated individuals are strongly encouraged to continue wearing face coverings while inside campus facilities and socially distancing from others when possible. UGA will continue to follow social distancing this summer.

Monitoring Conditions:
Note that the guidance referenced in this syllabus is subject to change based on recommendations from the Georgia Department of Public Health, Centers for Disease Control, Governor's Office or University System of Georgia. For the latest on UGA policy, you can visit coronavirus.uga.edu.

How can I obtain the COVID-19 vaccine? University Health Center is scheduling appointments for students through the UHC Vaccine Portal. Learn more here https://www.uhs.uga.edu/healthtopics/covid-vaccine.

What do I do if I have symptoms?
Students showing symptoms should self-isolate and schedule an appointment with the Univesrity Health Center by calling 706-542-1162 (Monday-Friday, 8 a.m.-5p.m.). Please DO NOT walk-in. For emergencies and after-hours care, see, https://www.uhs.uga.edu/info/emergencies.

What do I do if I test positive for COVID-19?
If you test positive for COVID-19 at any time, you are required to report it through the DawgCheck Test Reporting Survey. We encourage you to stay at home if you become ill or until you have excluded COVID-19 as the cause of your symptoms. UGA adheres to current CDC quarantine and isolation guidance and requires that it be followed.

Guidelines for COVID-19 Quarantine Period (Revised on 6/7/21)
Effective Jan. 4, 2021, students who learn they have been directly exposed to COVID-19 but are not showing symptoms should self-quarantine for 10 days (consistent with updated Department of Public Health (DPH) and Centers for Disease Control and Prevention (CDC) guidelines). Those quarantining for 10 days must have been symptom-free throughout the monitoring period. Please correspond with your instructor via email, with a cc: to Student Care & Outreach at sco@uga.edu, to coordinate continuing your coursework while self-quarantined. We strongly encourage students to voluntarily take a COVID-19 test within 48 hours of the end of the 10-day quarantine period (test to be administered between days 8 and 10). Students may schedule a free test at the University Health Center by visiting https://clia.vetview.vet.uga.edu/.

If the test done on days 8-10 is negative, the individual may return to campus on day 10 , but MUST continue to closely monitor for any new COVID-19 symptoms through 14 days. Dawgcheck is the best method for monitoring these symptoms. If new symptoms occur, the individual must not come to campus and must seek further testing/evaluation.

If the test is positive at the end of the 10-day period, the individual must begin a 10-day isolation period from the date of the test.

Students, faculty and staff who have been in close contact with someone who has COVID-19 are no longer required to quarantine if they have been fully vaccinated against the disease and show no symptoms.

How can I obtain the COVID-19 vaccine?

University Health Center is scheduling appointments for students through the UHC Vaccine Portal. Learn more here - https://www.uhs.uga.edu/healthtopics/covid-vac