29::248 Quantum Gauge Theories Syllabus

Fall Semester 2015

Instructors: Yannick Meurice and Alexei Bazavov

Coordinates

Lectures: WF 2:00PM- 3:15PM, 618 Van Allen Building.

Yannick Meurice

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Course Content

Quantum field theories with local gauge symmetries have played an important role in recent developments for various fields of physics.
Quantum Electrodynamics (QED), the quantum theory of electrons and photons, is one of the major scientific accomplishments of the 20th century. Its nonabelian extensions used in particle physics (quantum chromodynamics and the standard electroweak theory) have provided a theoretical framework resulting in the predictions of the W, Z, and Higgs bosons which were confirmed experimentally.

The course is offered every other year and open to
graduate students who have taken Quantum Mechanics I and II and undergraduate students who have taken 29:140-29:141. Students who have not taken Quantum Field Theory before could read
chapters 2, 3 and 4 of Peskin and Schroeder's book ``Quantum Field Theory" or another textbook covering the Klein-Gordon and Dirac fields.
The course will make frequent use of Feynman diagrams and the Feynman rules can be used without a detailed knowledge of their mathematical derivation.
The grade will be based on homework assignments and an individual project resulting in a short paper and a presentation.

The course will have two parts. The first part will be Quantum Electrodynamics (QED) with emphasis on physics applications (scattering processes with electrons and photons, anomalous magnetic moments, atomic

spectroscopy, ...). The physical concepts involved in the description of these phenomena have wider applications, so graduate students interested in deepening their knowledge of modern theoretical physics would benefit from learning about these topics which have not been covered in our courses during the last two academic years.

The second part will depend on the research interests of the students and may include: quantum chromodynamics, weak decays of heavy quarks, conformal symmetry, field theory treatment of graphene and quark-gluon plasma. Students interested in having special topics included should contact the instructor early.

Textbooks

Main textbooks:

M. Peskin and D. Schroeder, Quantum Field Theory, Addison Wesley, 1995.

The Particle Data Group

See also:

C. Itzykson and J.B. Zuber, Quantum Field Theory, Dover, 1980.

C. Quigg, Gauge Theories of the Strong, Weak and Electromagnetic Interactions, Benjamin Cummings, 1983.

Xiao-Gang Wen, Quantum Field Theory of Many-Body Systems, Oxford, 2004.

T. DeGrand and C. DeTar, Lattice Methods for QCD, World Scientific, 2006.

A. Polyakov, Gauge Fields and Strings, Harwood, 1987.

S. Coleman, Aspects of Symmetry, Cambridge, 1985.

J. Smit, Introduction to Quantum Fields on the Lattice, Cambridge, 2000.

M. Creutz, Quarks, Gluons and Lattices, Cambridge, 1983

M. Le Bellac, Thermal Field Theory, Cambridge, 1996

H. Rothe, Lattice Gauge Theories, World Scientific, 1997

E. Fradkin, Field Theories of Condensed Matter Systems, Addison Wesley, 1991.

I. Montvay and G. Munster, Quantum Field on a Lattice, Cambridge, 1997.

N. Nagaosa, Quantum Field Theory in Condensed Matter Physics, Springer, 1999.

S. Weinberg, The Quantum Theory of Fields , Cambridge, 1994.

R. Feynman and A. Hibbs, Quantum Mechanics and Path Integrals, Mc Graw Hill, 1965

M. Srednicki, Quantum Field Theory, Cambridge, 2007.

Homeworks

A reading assignment and a problem set will be provided every two weeks during the class. Assignments will be handed in class.

Examinations and Final Grade

The grade will be based on homework assignments given typically every two weeks (50 percent) and an individual project resulting in a short paper and a presentation (50 percent).

Class Attendance

Attendance at lectures is highly recommended but not required. You are strongly encouraged to ask questions during the lectures. There are no ``stupid questions''.

DEPARTMENT OF PHYSICS & ASTRONOMY MAIN OFFICE

- 203 Van Allen Hall
- 319-335-1686
- Chair– Professor Fred Skiff at frederick-skiff@uiowa.edu

The College of Liberal Arts and Sciences

Policies and Procedures

Administrative Home
The College of Liberal Arts and Sciences is the administrative home of this course and governs matters such as the add/drop deadlines, the second-grade-only option, and other related issues. Different colleges may have different policies. Questions may be addressed to 120 Schaeffer Hall or see the CLAS Academic Handbook. [www.clas.uiowa.edu/students/academic_handbook/index.shtml]

Electronic Communication
University policy specifies that students are responsible for all official correspondences sent to their standard University of Iowa e-mail address (@uiowa.edu). Students should check their account frequently. (Operations Manual, III.II.15. 2. k.11.)

Academic Fraud
Plagiarism and any other activities when students present work that is not their own are academic fraud and are considered by the College to be a very serious matter. Academic fraud is reported by the instructor to the departmental DEO who enforces the departmental consequences. The Associate Dean for Undergraduate Programs and Curriculum is also informed. The Associate Dean enforces collegiate consequences which may included suspension or expulsion. See the CLAS Academic Handbook.

Making a Suggestion or a Complaint
Students with a suggestion or complaint should first visit the instructor, then the course supervisor and the

departmental Associate chair. Paul Kleiber. Complaints must be made within six months of the incident. See the CLAS Academic Handbook.

Accommodations for Disabilities
A student seeking academic accommodations should register with Student Disability Services and meet privately with the course instructor to make particular arrangements. For more information, visit this site. [www.uiowa.edu/~sds/]]

Understanding Sexual Harassment
Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. All members of the UI community have a responsibility to uphold this mission and to contribute to a safe environment that enhances learning. Incidents of sexual harassment should be reported immediately. See the UI Comprehensive Guide on Sexual Harassment at www.uiowa.edu/~eod/policies/sexual-harassment-guide/index.html for assistance, definitions, and the full University policy.

Reacting Safely to Severe Weather
In severe weather, the class members should seek shelter in the innermost part of the building, if possible at the lowest level, staying clear of windows and free-standing expanses. The class will continue if possible when the event is over. (Operations Manual, IV. **16.14.** Scroll down to sections e and i for severe weather information.)

*The CLAS policy statements have been summarized from the web pages of the College of Liberal Arts and Sciences.