Winter 2010 GWPI Physics Graduate Courses

Note: All classes are in the Main Link Room (EIT2053 at UW or MACN 101 at UofG) unless otherwise stated. Also note the class start dates.

705 (UW) 7050 (UofG) Statistical Physics II
Instructor: Anton Burkov Time: MW 11:00-12:30 (classes start January 4th)
Phases and phase transitions, mean field theory. Critical phenomena, scaling, universality. Renormalization group, Wilson-Fisher fixed point near 4 dimensions, calculation of critical exponents. Topological transitions: Kosterlitz-Thouless transition in the XY model, vortices, duality. Nonlinear sigma model. Quantum phase transitions.
Recommended texts:
1. *Lectures on Phase Transitions and the Renormalization Group* by Nigel Goldenfeld. ISBN #9780201554090, Perseus Distribution
2. *Scaling and Renormalization in Statistical Physics* by John Cardy. ISBN#9780521499590 Cambridge University Press
3. *Quantum Phase Transitions* by Subir Sachdev. ISBN#9780521004541 Cambridge University Press
Prerequisite: 704 or consent of the instructor

706 (UW) 7060 (UofG) Electromagnetic Theory
Instructor: Frank Wilhelm-Mauch Time: MW 9:30-11:00
(classes start January 4th)
Electromagnetism is arguably the most relevant of the fundamental interactions, given that it covers almost all of optics, chemistry, and condensed matter. This course covers the classical theory of electromagnetism in an advanced form. It also introduces the main mathematical techniques that can be used in other topics in physics, in particular variational calculus for fields, Green's functions, use of symmetries etc. The goal of the course to provide thorough understanding of this fundamental theory and prepare you for the next step e.g. in quantum optics, relativity, quantum field theory, or continuum mechanics.
Required Text: There is no required text, but a required download of Eric Poisson's lecture notes (http://www.physics.uoguelph.ca/~poisson/research/em.pdf). They will be used in chapters 2, 3, and 4 of the course but not necessarily in linear order. There is also a complete set of typed lecture notes provided through UW-ACE. These will be debugged and adapted during the course. Main inspirations for the approach the course is taking are:
L.D. Landau, E.M. Lifshitz, Classical Theory of Fields (Course of theoretical Physics, Volume 2), Butterworth-Heinemann, N.Y., 1980
L.D. Landau, E.M. Lifshitz, L.P. Pitaevskii, Electrodynamics of Continuous Media (Course of theoretical Physics, Volume 8), Butterworth-Heinemann, N.Y., 1984 A.O. Barut, Electrodynamics and Classical Theory of Fields and Particles, Dover, N.Y., 1981
J. Schwinger et al., Classical Electrodynamics, Perseus, N.Y., 1998
Note: you are not required to have these books.

731 (UW) 7310 (UofG) Solid State Physics
Instructor: Russell Thompson Time: TTh 2:30-4:00
(classes start January 12th)
Phonons, electron states, electron-electron interaction, electron-ion interaction, static properties of solids.

Required Text: *Solid State Physics* by Ashcroft & Mermin, ISBN#0-03-083993-9, Nelson Education

752 (UW) 7520 (UofG) Molecular Biophysics
Instructor: Vladimir Ladizhansky Time: TTh 11:30-1:00
(classes start January 12th)
Protein structure. Nucleic acids structure. Factors determining protein and nucleic acid structures. Protein Stability. Biomembranes. Membrane proteins and their functions. Membrane transport. Evolution and protein folding. Human perspective: conformational diseases. High resolution methods for protein structure determination. Nuclear magnetic resonance. Application of NMR to structure and dynamics determination in soluble and membrane proteins.
Recommended Textbook Information: *Biophysical chemistry part I: The conformation of biological molecules* Charles R. Cantor and Paul R. Schimmel, ISBN#9780716711889, published by W. H. Freeman and Company

771-1 (UW) 7710-01 (UofG) Special Lecture and Reading Course
Topic: Models of Nuclear Structure
Instructor: Paul Garrett (UofG) Time: TTh 10:00-11:30
(classes start January 12th)

UofG students will need to complete a 'Course Add/Drop & Change' (found at: http://www.uoguelph.ca/registrar/graduatestudies/files/addform.pdf) form in order to enroll in this course.

This course will be an intensive examination of the models used for nuclear structure. Beginning with the nucleon-nucleon potential, the development of mean fields, the nuclear shell model, pairing, the collective Bohr-Mottelson model, and the Interacting Boson Model.
A series of lectures will be given on the following topics:
Part I: Overview of the Nuclear Landscape
Part II: The Nuclear Mean Field
Part III: The Mean-field Shell Model
Part IV: Pairing Correlations
Part V: Deformed Mean Fields
Part VI: Collective Hamiltonians – the Bohr-Mottelson Model
Part VII: Algebraic Methods in Structure
Recommended Textbook Information:
"Nuclear Models" by Walter Greiner and Joachim A. Maruhn, Publisher: Springer, ISBN-13: 978-3540780465
"From Nucleons to Nucleus: Concepts of Microscopic Nuclear Theory" by Jouni Suhonen, Publisher: Springer, ISBN-13: 978-3540488590
"The Nuclear Many-Body Problem" by Peter Ring and Peter Schuck, Publisher: Springer, ISBN-13: 978-3540212065

771-2 (UW) Special Lecture and Reading Course
Topic: Implementation of Quantum Information Processing Location: RAC 2009 (classes start January 5th)
Instructor: Frank Wilhelm-Mauch (UW) et al Time: TTh 10:00-11:30

Midterm Exam: February 22, 2010, 2:00-4:30 p.m., RAC 2009

FINAL EXAM: **April 12, 2010, 2:00-4:00 p.m., RAC 2009**

UW students will require a permission number to enroll in this course. Contact gwp@sciborg.uwaterloo.ca in order to obtain this number.

Photonic quantum computing (interference and superposition principle of light, polarization; polarization qubit; photoelectric effect; photon hypothesis; dual rail qubits; beamsplitters and phase rotators; the KLM proposal), Superconducting qubits (a single wavefunction for a macroscopic number of particles / London theory of superconductors; the Josephson effect; quantizing electric circuits; different types of superconducting qubits; decoherence sources), NMR (single spin in a magnetic field; states at high temperatures; Rabi oscillations, interactions between spins; frequency-addressing), Ion Trap quantum computing (trapping ions, selective adressing, shelving readout, motional gates), Atomic quantum computing (light-induced forces, optical lattices)
Prerequisite(s): CO681/CS667/PHYS767 "Quantum Information Processing" or an introductory quantum mechanics course. Contact the instructor directly (fwilhelm@iqc.ca) if you have any questions regarding the background required.
Text: Courseware will be provided

785 (UW) 7850 (UofG) Quantum Field Theory for Cosmology
(cross listed with AMath 872
Rooms: MC 1061 and Alice Room 301 at Perimeter Institute
Instructor: Achim Kempf Time: Tues 4:00-5:30 and Thurs 5:00-6:30
(classes start January 14th)
Introduction to scalar field theory, from scratch. The Casimir and Unruh effects. Advanced quantum field theoretic techniques for quantum fields on curved space times. Quantum fluctuations of scalar fields and of the metric on curved space-times. Application to inflationary cosmology and the study of the cosmic microwave background. The difficulties with quantizing gravity.
Text: Free lecture notes will be made available.
Recommended text: *Introduction to Quantum Effects in Gravity*, by V. Mukhanov and S. Winitzki, published by Cambridge University Press, 2007

Last revision: January 4, 2010