

**Carleton University Department of Physics**  
**PHYS 6602 – Advanced Topics in Particle Physics Phenomenology**  
**(Winter 2017)**  
**Course Outline**

**Instructors:**

Heather Logan (*coordinator*) (logan@physics.carleton.ca, 613-520-2600 x4319, 3324 HP)  
Kevin Graham (kevin\_graham@carleton.ca, x4373, 3322 HP)  
Thomas Grégoire (gregoire@physics.carleton.ca, x4371, 3348 HP)  
Razvan Gornea (rgornea@physics.carleton.ca, x4376, 2462 HP)

**Lecture times:** Wednesdays 4:00–5:30 p.m. and Fridays 3:30–5:00 p.m. For Prof. Grégoire’s lectures (weeks of Jan 30, Feb 6, and Feb 13), the lectures will be on Thursdays 2:00–3:30 p.m. and Fridays 3:30–5:00 p.m. All lectures will be in 3349 Herzberg (Sunray Lab). The first lecture will be on Wednesday January 11.

**Course Description:**

This course will consist of a variety of seminars and short lecture courses, and will cover topics of immediate interest to the research program of the department.

**Course Content:**

**K. Graham: Dark matter** [weeks of Jan 9, 16, and 23]

Dark matter comprises approximately 85% of the mass content of the universe and about 25% of the total energy. Although many possible solutions exist, no one, as yet, has discovered the nature of this elusive dark matter.

The first portion of this unit of the course will review the cosmological evidence for dark matter including discussion of galaxy rotation curves, galaxy cluster velocity dispersion, gravitational lensing, cosmic microwave background, big bang nucleosynthesis, and structure formation. This review will be followed by a discussion of possible candidates/solutions to the dark matter puzzle. Finally, a survey of the experimental techniques and results for selected dark matter search experiments will be provided.

**T. Grégoire: Supersymmetry** [weeks of Jan 30, Feb 6, and Feb 13]

Introduction to the supersymmetric algebra. Construction of supersymmetric Lagrangians. Introduction to the minimal supersymmetric Standard Model (MSSM).

**R. Gornea: Neutrinos** [weeks of Feb 27, Mar 6, and Mar 13]

We will cover the physics of massive neutrinos. We start with a review of weak interactions and neutrino properties. We will introduce the Dirac and Majorana neutrinos as well as a description of neutrino masses. Then we will discuss neutrino oscillations and the double beta decay. We conclude with an extensive review of the experimental techniques used to probe the physics of massive neutrinos.

**H. Logan: Extended Higgs sectors** [weeks of Mar 20, 27, and Apr 3]

An introduction to the motivations and phenomenology of models with more than one Higgs boson. I’ll cover the Standard Model plus a singlet, two Higgs doublet models, and models with triplets.

## Assignments and Grade Distribution

### Homework assignments (4 × 20%):

A set of homework problems will be assigned for each of the four course segments. The deadline for handing in assignments is two weeks after they have been given out.

### Final seminar (20%):

Each student will be expected to give a 20-minute seminar on a topic in particle physics. Please discuss your choice of topic with the course coordinator (H. Logan) before Reading Week. You should take this opportunity to learn about a particle physics topic that is not directly related to your thesis research. The talks will be scheduled during the April exam period in consultation with the class.

## Academic Policies

Please read and be familiar with the following Carleton University policies:

**Privacy and freedom of information:** <http://www6.carleton.ca/privacy/> .

**Academic integrity:** see item 18 of <http://calendar.carleton.ca/grad/gradregulations/> , in particular the sections on plagiarism and the unauthorized resubmission of work.

## Academic Accommodation Policies

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

**Academic accommodations for students with disabilities:** The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or [pmc@carleton.ca](mailto:pmc@carleton.ca) for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). Requests made within two weeks will be reviewed on a case-by-case basis. After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website ([www.carleton.ca/pmc](http://www.carleton.ca/pmc)) for the deadline to request accommodations for the formally-scheduled exam (if applicable).

**Religious obligation:** write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: <http://www2.carleton.ca/equity/> .

**Parental obligation:** write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: <http://www2.carleton.ca/equity/> .