PHYS 180 **Fall 2024** **Prof. R. Brandenberger**

SPACE, TIME AND MATTER

Tentative Course Outline:

1. Overview
2. Newtonian View of Space, Time and Matter
3. Special Relativity Revolution
4. General Relativity Revolution
5. Black Holes
6. Pre 1980 Cosmology
7. Waves and Particles
8. Quantum Mechanics
9. Forces of Nature
10. Modern Cosmology
11. Superstrings and the Grand Challenges for 21st Century Physics

Note: Tentative midterm date: Friday, Nov. 22 (tutorial on Nov. 20).

Texts

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The following books will be used in this class. The first five are classic texts but with various different styles. The last one is a recent book written for a class with similar goals as PHYS 180.

1. E. R. Harrison, *Cosmology*, second edition (Cambridge Univ. Press, Cambridge, 2000).

   This text was written for a course on space, time and cosmology at the level accessible to all university students. It covers all aspects of space and time which will be covered in PHYS200, includes more information on astronomy and cosmology, but does not discuss the quantum nature of matter. This book is in the traditional textbook style.

2. P. C. W. Davies, *Space and Time in the Modern Universe*, Cambridge Univ. Press, Cambridge, 1977.

   This is a classic text which gives a concise description of our modern view of space and time. It is written by one of the grand masters of the field, a winner of the prestigious Templeton Prize.

3. R. Stannard, *The New World of Mr. Tompkins* (Cambridge Univ. Press, Cambridge, 1999).

   This is an extensively revised and "modernized" version of the classic text by G. Gamov, one of the fathers of the field of cosmology. In this book, Mr. Tokpkins is exposed to lectures on modern physics by *the professor*, and travels to lands where the "non-intuitive" features of modern physics are present in exaggerated form. The book is not a traditional textbook. Several chapters of this book will be assigned reading.

4. Brian Greene, *The Elegant Universe* (W.H. Norton, New York, 1999).

   This is a superbly written popular science book on the subject material of the class written by a leading expert in superstring theory who is Professor

of Mathematics and Physics at Columbia University. He is known for his unique talent of explaining modern physics without the use of mathematics, he produced a "NOVA" television show of the subject material of this book. Sections of this book will be assigned reading, in particular in later parts of the class.

5. R. Feynman, *Six Easy Pieces* (Basic Books, 2005)

   These six pieces are six key chapters from Richard Feyman's introductory three volume "Lectures on Physics". I will make use of the lectures related to the quantum theory of matter.

6. D. Perlov and A. Vilenkin, *Cosmology for the Curious* (Springer, 2017).

   A text written for a class at a similar level as PHYS 180, but with different emphasis.

Format

The lectures will provide an overview of the important concepts. There will be bi-weekly homework sets whose aim is to make sure that the students understand and can work with the concepts presented in class. Students will be encouraged to form study groups in which they can discuss the materials among themselves, and then present their questions to the lecturer and TAs in the office hour sessions (which will be held via zoom). At the end of the course, students are asked to team up in groups of two and produce a poster on a topic which complements what was covered in class.

Meeting Times: Wed, Fri. 8:35 - 9:55, Rutherford 112)

Office Hours:

Robert Brandenberger: TBA, Rutherford 332.

Daniel Amouyal: TBA

Rebecca Hamel: TBA

Naman Jain: TBA

Course information: Course information will be available on McGill MyCourses, and also on my home page http://www.physics.mcgill.ca/ rhb/

Proposed Grading Scheme

* 40% Homework
* 15% Midterm
* 30% Final exam
* 15% Poster

Lecture availability

Lectures will be a combination of board presentation and slides. The slides will be posted on McGill MyCourses. However, the slides alone do not provide a complete and self-contained description of what was presented in class. However, readings for each week will be posted on MyCourses.

Academic Integrity Statement

The following information must be included on course descriptions due to University rules:

McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see www.mcgill.ca/students/srr/honest/ [www.mcgill.ca] for more information).

Language of Submission

In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English and French any written work that is to be graded.

Contact

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Note: In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.