Quantum Physics & Relativity
PHYS10121

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1. INTRODUCTION

Relativity Theory (Einstein 1905)
and
Quantum Theory (Planck, Einstein, Bohr, Schrödinger, Heisenberg, Dirac 1900-1928)

Constitute the two pillars of modern physics. The synthesis of the two (called Quantum Field Theory) provides the basis for our current understanding of the fundamental laws which underpin all known natural phenomena.

They are both essentially counter intuitive. Examples:

- Absolute time and space are meaningless concepts.
- Mass and energy are one and the same thing.
- At small enough distances, matter behaves as if it were made of both waves and particles.

It is ok for Nature to defy our common sense. Attempting to understand quantum physics and relativity using common sense is doomed to fail and invariably leads to confusion. We must put our trust in experiment and mathematics.

Apart from providing the intellectual foundation of modern physics there are numerous practical examples of quantum theory and relativity in action, here is just a randomly chosen bunch:

- Nuclear energy (burning of the sun, age of the earth)
- Global Positioning Satellites (GPS)
- Chemistry
- Integrated circuits (PC's, mobile phones)
- X-rays, CAT scans, MRI and radiotherapy

At the end of this course I hope you will have a good grasp of Einstein's Special Theory of Relativity (more advanced ideas are treated in the Advanced Dynamics option next semester, and his General Theory of Relativity, which deals with the warping of space and time, can be studied in the 4^{th} year).

Quantum Physics is a big subject and this is the first of several courses which you can take during your degree – my goal is to introduce you to the basic concepts in preparation for a more mathematical treatment in the 2^{nd} year.

Recommended textbooks:

- "University Physics with Modern Physics", 11th Edition
  Young & Freedman (Addison Wesley)

- "Special Relativity"
  French (W.W. Norton & Co)

Supplementary reading:

- "The Feynman Lectures on Physics", Volumes I and III
  Feynman, Leighton & Sands (Addison Wesley)