

PX408: RELATIVISTIC QUANTUM MECHANICS

Michal Kreps (M.Kreps@warwick.ac.uk)

Objectives

At the end of this module you should:

- have an appreciation of the general nature of Relativistic Quantum Mechanics.
- have an understanding of the Dirac equation, its significance and its transformation properties
- be able to explain how some physical phenomena including spin, the gyromagnetic ratio of the electron and the fine structure of the hydrogen atom can be accounted for using relativistic quantum mechanics

Prerequisites

A thorough grounding in relativity, quantum mechanics, electromagnetism and electrodynamics is assumed. Formally, the module leads from the following modules:

- PX148 Classical Mechanics & Relativity (used to be PX109 Relativity)
- PX262 Quantum Mechanics and its Applications
- PX421 Relativity and Electrodynamics

Additional experience in quantum physics would be useful, for example from the following modules:

- PX101 Quantum Phenomena
- PX382 Quantum Physics of Atoms

Basic knowledge of particle physics, scattering and spectroscopy, as well as advanced mathematics (*eg.* from PX440 Mathematical Methods for Physicists III) will also be useful. Note also that the module leads *to*

- PX430 Gauge Theories of Particle Physics

Books

The classic text for this material is

- “Quantum Electrodynamics”, Feynman (1961, reissued 1998)

Note that the text uses a different notation to that which will be used in the lectures and handouts. Another classic text that could be of interest, but again with inherent challenges in the notation, is

- “The Principles of Quantum Mechanics”, 4th edition, Dirac (1981).

Brief introductions to relativistic quantum mechanics can be found in most of the basic particle physics text books, for example:

- “Introduction to High Energy Physics”, 4th edition, Perkins (2000).
- “Introduction to Elementary Particles”, 2nd edition, Griffiths (2008).
- “The Ideas of Particle Physics”, 3rd edition, Coughlan, Dodd & Gripaos (2006).
- “An Introduction to the Standard Model of Particle Physics”, 2nd edition, Cottingham and Greenwood (2007).

More advanced texts that also cover much of the material in PX430: Gauge Theories for Particle Physics would be suitable for those intending to also take that module.

- “Gauge Theories in Particle Physics”, 3rd edition (two volumes) Aitchison & Hey (2004)
- “Particle Physics: A Comprehensive Introduction”, Seiden (2005)
- “Quantum Field Theory”, revised edition, Mandl & Shaw (1993)
- “Quarks and Leptons”, Halzen & Martin (1984)

Several other relevant texts are available in the library. Note that while the theory covered in this module has not changed significantly for decades there have been many important experimental discoveries in that time. Hence, older texts appear dated in places, but can still be useful.

Notes

Thanks to previous lecturer, I have good quality notes, which cover basically full material of the module, although they contain just what will be said in this lecture. They should not substitute textbooks, but help you in following lectures. In sake of our environment I'm not going to print large number of copies, but they will be available in advance at module web page (http://www2.warwick.ac.uk/fac/sci/physics/teach/module_home/px408/) for those who want to have them before we cover material.