School of Mathematics

Module MA3432 — Classical electrodynamics 2010-11
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Lecturer: Dr. Nigel Buttimore

Requirements/prerequisites: prerequisite: MA3431

Duration: Hilary term, 11 weeks

Number of lectures per week: 3 lectures including tutorials per week

Assessment: Assignments wil not contribute formally to the final result except in bordeline cases.

ECTS credits: 5

End-of-year Examination: This module will be examined jointly with MA3431 in a 3-hour examination in Trinity term, except that those taking just one of the two modules will have a 2 hour examination. However there will be separate results for MA3432 and MA3431.

Description:

The purpose of Module MA3432 is to outline the properties of a Classical Eletrodynamics as an example of a massless vector field and to indicate important features in the theory of radiation, including the intensity and direction of emanations from accelerated particles with charge. Applications to determining the motion of charged particles in particular electric and magnetic fields are considered, emphasis being placed upon the rôle of radiation in finding the dynamics of the particles.

The module forms an element of the undergraduate programme in theoretical physics being built upon prerequisite first and second year courses in classical dynamics and mathematics and leading to courses in the fourth and final year including quantum field theory.

Content:

- Solving Maxwell's equations; Green functions for Laplacian, d'Alembertian
- Liénard-Wiechert potential; velocity, acceleration fields for moving charge
- Radiation theory; velocity and acceleration fields in three dimensions
- Non-relativistic Larmor formula and relativistic Liénard radiation formula
- Linear & circular accelerated motion; radiation in constant magnetic field
- Angular distribution of relativistic radiation; electric & magnetic elements
- Introduction to radiation damping; decay of the radius for a circular orbit
- Envoi: quantum chromodynamics and the unified electroweak interaction

Module website: `http://www.maths.tcd.ie/~nhb/sjsced.php`

Textbooks:

1. Classical Electrodynamics, J. David Jackson, John Wiley (3rd edition) 1998
2. Introduction to Electrodynamics, David J. Griffiths, Prentice-Hall, 1999
3. Electrodynamics courses at Stanford University: EM fields & EM radiation

Learning Outcomes: On sucessful completion of this module, students will be able to:

- describe how to find the Fourier transform of a Green function and hence evaluate it for the equation of d'Alembert
- use the retarded Green function to solve the Maxwell equations for electromagnetic fields in Heaviside-Lorentz units
- explain the concepts of electromagnetic potential and that of retarded time for charges undergoing acceleration
- show how the orthogonality and magnitude of electric and magnetic radiative fields may be established
- use expressions for the fields to evaluate the differential power radiated in a particular direction, and hence find the total power
- determine the motion of a radiating charged particle in the electric field of another charged particle or in a constant magnetic field

October 2, 2011