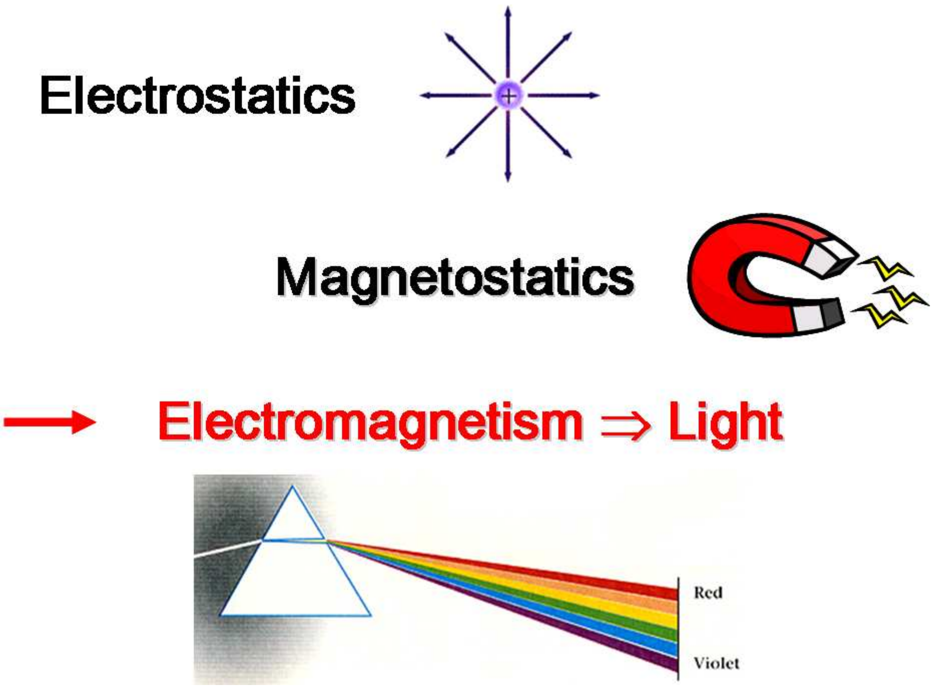
2005-v0

Electromagnetism and Light



Auke-Pieter Colijn and Marcel Vreeswijk
University of Amsterdam

Foreword

This introductory course in electromagnetism was first a lecture developed by prof.dr. Frank Linde who is director of the Dutch Institute for Particle Physics (NIKHEF) now. The guide line of these lectures is provided by the book "Introduction to Electrodynamics, David J. Griffiths, Prentice Hall, 3rd ed.". Our experience is that this book is just beyond reach for first year university students. Certainly, parts of this book can be used already in the first year, but only parts. Therefore we have written the report you are reading now to provide a bridge between high-school and university books on this topic. This is also the primary reason that we write in English. Nevertheless, we strongly recommend to get the book of Griffiths, which is needed in the third year anyway.

An on-line version of the lectures and other documentation can be found on the web page http://www.nikhef.nl/user/h73/knem.html

Amsterdam, March 2005.

Introduction

What are the forces that control the world around you? Your answer may be the united states army or some fundamentalist group. In fact, the $fundamental$ forces that control our world are the

- Gravitational force, known by everybody. This force is fairly weak, but it seems to rule our everyday life;
- Weak force, which is responsible for radioactive decay. This force is stronger than gravitation but much weaker than the other forces below;
- Electromagnetic force, which keeps atoms and molecules together and is responsible for almost everything in our everyday life: from mobile phones to processes in your body;
- Strong force, which keeps protons and nuclei together.

In this report we concentrate on the electromagnetic force, or more general, on classical electromagnetic theory. The classic theory provides a macroscopic description of electromagnetic phenomena. Quantum effects are ignored as well as relativistic effects. This implies that this description will fail at very small distances or high speeds.

We start with electrostatic and magneto-static theory and proceed with time dependent effects, like induction. On our way through the theory we will deduce (and apply) the full set of Maxwell equations. Finally we use these equations to derive that electromagnetic waves, light, exists. The set of Maxwell equations represent the complete classical electromagnetic theory and, by accident or not, are relativistic invariant.

At the end of each section, you find a subsection named 'Knowledge and Skills'. In these subsections the key- definitions and formulas discussed in the corresponding section are listed. An overview of the skills you should have acquired is also given. The exercises (in Dutch) that we make during the lectures are added as an appendix. Last, but certainly not least, a description of the experiments (practicum) that are embedded in this course are added in a second appendix.