ADVANCED ELECTRODYNAMICS

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Contents

Introduction

> "On the other hand, I think I can safely say that nobody understands quantum mechanics." – Richard Feynman, 1965

Four fundamental fources

- Gravitation
- Electromagnetism
- Strong nuclear force
- Weak nuclear force

In classical mechanics, we are dealing with point particles with mass and velocity; a wave has a wavelength and a frequency.

Maxwell's equations are the foundation of classical electromagnetism,

Definition .1 (Maxwell's equations)**.**

$$\begin{aligned} \nabla \cdot \mathbf{E} &= \frac{\rho}{\epsilon_0} \\ \nabla \cdot \mathbf{B} &= 0 \\ \nabla \times \mathbf{E} &= -\frac{\partial \mathbf{B}}{\partial t} \\ \nabla \times \mathbf{B} &= \mu_0 \mathbf{J} + \mu_0 \epsilon_0 \frac{\partial \mathbf{E}}{\partial t} \end{aligned} \tag{1}$$

Definition .2 (Maxwell's equations – integral form)**.**

$$\begin{aligned} \oint \mathbf{E} \cdot d\mathbf{A} &= \frac{Q_{\text{enc}}}{\epsilon_0} \\ \oint \mathbf{B} \cdot d\mathbf{A} &= 0 \\ \oint \mathbf{E} \cdot d\mathbf{l} &= -\frac{d\Phi_B}{dt} \\ \oint \mathbf{B} \cdot d\mathbf{l} &= \mu_0 I_{\text{enc}} + \mu_0 \epsilon_0 \frac{d\Phi_E}{dt} \end{aligned} \tag{2}$$

The conservation of charge is given by,

$$\frac{\partial \rho}{\partial t} + \nabla \cdot \mathbf{J} = 0, \tag{3}$$

and the Lorentz force law is

$$\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B}). \tag{4}$$

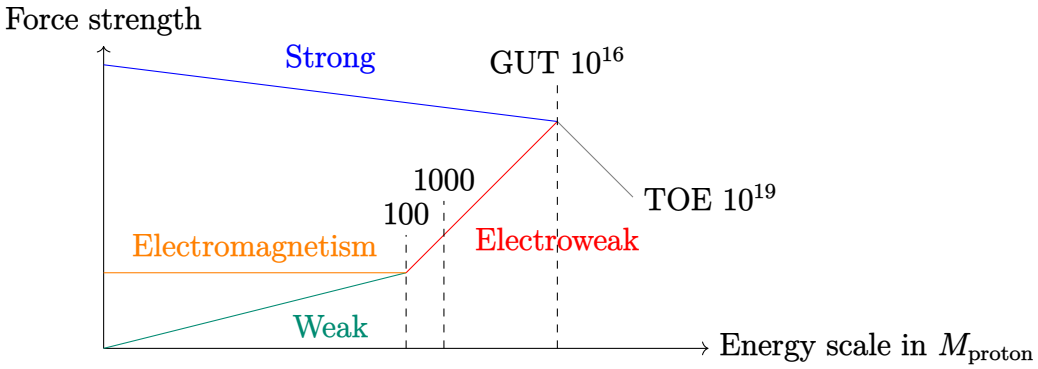
Maxwell unified electricity, magnetism and optics, showing that light is a wave.

Note (Speed of light).

$$c = \frac{1}{\sqrt{\epsilon_0 \mu_0}} = 299,792,458\,\mathrm{m/s} \tag{5}$$

Electromagnetism is the basis for all of chemistry and biology, and is the foundation of all of modern technology. Einsten postulated that light is quantized, speed of light is constant, and that the laws of physics are the same in all inertial frames.

At very high energies the weak nuclear force and the electromagnetic force are unified into the electroweak force. At even higher energies, the strong nuclear force is unified with the electroweak force into the grand unified force (GUT).



1 Relativity and Electrodynamics