

# Special relativity, electromagnetism and general relativity

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# Preface

This is a live document, and is full of gaps, mistakes, typos etc.

# **Part I**

# **Spacetime**

# Chapter 1

## The Lorentz metric

### 1.1 The Lorentz metric

#### 1.1.1 The Lorentz metric

For lorentz:

$$(\delta v)^T M \delta v = \delta t^2 - \delta x^2 - \delta y^2 - \delta z^2$$

$$\text{Action} = \int \sqrt{\delta t^2 - \delta x^2 - \delta y^2 - \delta z^2}$$

$$\text{Action} = \int \sqrt{1 - \dot{x}^2 - \dot{y}^2 - \dot{z}^2} \delta t$$

$$\text{Action} = \int \sqrt{1 - v^2} \delta t$$

#### 1.1.2 The Lorentz metric with $c$

For lorentz with  $c$

$$(\delta v)^T M \delta v = \delta c^2 t^2 - \delta x^2 - \delta y^2 - \delta z^2 \text{ p Action} = \int \sqrt{\delta c^2 t^2 - \delta x^2 - \delta y^2 - \delta z^2}$$

$$\text{Action} = \int \sqrt{1 - \frac{\dot{x}^2}{c^2} - \frac{\dot{y}^2}{c^2} - \frac{\dot{z}^2}{c^2}} c \delta t$$

$$\text{Action} = \int \sqrt{1 - \frac{v^2}{c^2}} c \delta t$$

Because  $c$  is constant, we can simplify to:

$$\text{Action} = \int \sqrt{1 - \frac{\dot{x}^2}{c^2} - \frac{\dot{y}^2}{c^2} - \frac{\dot{z}^2}{c^2}} \delta t$$

$$\text{Action} = \int \sqrt{1 - \frac{v^2}{c^2}} \delta t$$

**1.1.3 Lorentz rotations****1.1.4 Lorentz boosts****1.1.5 The Lorentz group**

The Lorentz group consists of the Lorentz rotations and the Lorentz boosts.

**1.1.6 The Poincaré group****1.1.7 Group contraction from Lorentz to Euclid****1.1.8 Spacetime interval****1.1.9 Proper time**