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methods of classical relativistic eld theory. Scalar elds, spinor elds, gauge elds, and gravitational elds are treated. The material is based upon lecture notes for a course I teach from time to time at Utah State University on Classical Field Theory. This version, 1.2, is roughly the same as version 1.1. The update includes:

Classical electrodynamics and general relativity are perfectly consistent with one another. They are the most fundamental classical field theories and the main subject of this course. A third dimension in theory space was discovered by Planck who started quantum mechanics and introduced the fundamental action quantum h.

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classical electrodynamics. The concept of classical field emerged in the nineteenth century when the proper degrees of freedom have been identified for the electromagnetic interaction and the idea was generalized later. A half century later the careful study of the propagation of the electromagnetic waves led to special relativity.

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Notes for Classical Field Theory Section 1: Simple eld theory equations of motion in the form  $m \ddot{x} = k_1 a_2 h^{(i_1)} (\dot{x}^{i_1})$  we can apply the definition of the derivative  $\frac{d}{dt} x = \lim_{\Delta t \rightarrow 0} \frac{x(t+\Delta t) - x(t)}{\Delta t} = \dot{x}$  a twice to obtain the equations of motion in the limit  $\Delta t \rightarrow 0$ :  $\frac{d^2}{dt^2} x = \ddot{x}$  where  $m \ddot{x} = k_1 a_2 h^{(i_1)} (\dot{x}^{i_1})$  is the mass density which we keep fixed.

Maxwell's equations are a set of coupled partial differential equations that, together with the Lorentz force law, form the foundation of classical electromagnetism, classical optics, and electric circuits. The equations provide a mathematical model for electric, optical, and radio technologies, such as power generation, electric motors, wireless communication, lenses, radar etc.

Chapter 3 is devoted to Maxwell's theory as a classical field theory and to solutions of the wave equation. Chapter 4 deals with important applications of Maxwell's theory. It includes topical subjects such as metamaterials with negative refraction index and solutions of Helmholtz' equation in paraxial approximation relevant for the description of laser beams.

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A classical field theory is a physical theory that predicts how one or more physical fields interact with matter through field equations. The term 'classical field theory' is commonly reserved for describing those physical theories that describe electromagnetism and gravitation, two of the fundamental forces of nature. Theories that incorporate quantum mechanics are called quantum field theories. A physical field can be thought of as the assignment of a physical quantity at each point of space a

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waves led to special relativity.

#### Lecture Notes on Classical Field Theory

the classical theory before exploring the quantum theory, as the quantum theory is built on top of the entire relativistic electrodynamic conceptual framework already established. This set of lecture notes is designed to be used to teach graduate students (and possibly advanced and motivated undergraduates) classical electrody-namics.

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Classical eld theory is a very vast subject which traditionally includes the Maxwell theory of electromagnetism describing electromagnetic properties of matter and the Einstein theory of General Relativity.

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Classical electromagnetism or classical electrodynamics is a branch of theoretical physics that studies the interactions between electric charges and currents using an extension of the classical Newtonian model. The theory provides a description of electromagnetic phenomena whenever the relevant length scales and field strengths are large enough that quantum mechanical effects are negligible. For small distances and low field strengths, such interactions are better described by quantum electrody

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