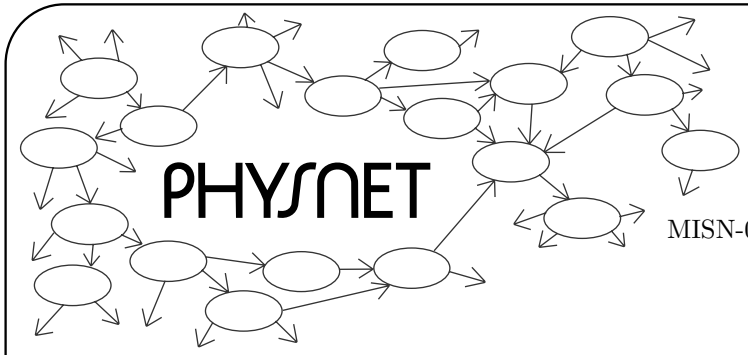

MISN-0-465

HISTORICAL INTRODUCTION TO SPECIAL RELATIVITY

Relativity

Project PHYSNET Physics Bldg. Michigan State University East Lansing, MI

HISTORICAL INTRODUCTION TO SPECIAL RELATIVITY

by

C. P. Frahm

Title: **Historical Introduction to Special Relativity**

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Version: 2/1/2000 Evaluation: Stage B0

Length: 2 hr; 9 pages

Input Skills:

1. Vocabulary: Maxwell's equations, wave equation, light waves, speed of light, interference, index of refraction.

Output Skills (Knowledge):

K1. Give a synopsis of the historical development of special relativity from Newton to Einstein.

K2. Describe each of the following and state its significance for the theory of relativity: (a) Michelson-Morley experiment, (b) Stellar aberration, (c) Fizeau drag effect.

K3. Compare the Newtonian and Einsteinian conceptions of (a) the character of space and time, (b) the relativity principle.

K4. State the postulates of special relativity.

External Resources (Required):

1. W. Rindler, *Essential Relativity* (Van Nostrand, 1977).
2. R. Resnick, *Basic Concepts in Relativity and Early Quantum Theory*, Wiley (1972).

External Resources (Optional):

1. A. Einstein, "On the Electrodynamics of Moving Bodies" (Intro.), in Einstein et. al., *The Principle of Relativity*, (Dover).

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New authors, reviewers and field testers are welcome.

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1. Introduction

The main thrust of this course will be to develop a working knowledge of special relativity and an introductory knowledge of general relativity. As a consequence, the historical aspects of both topics will play a rather limited role. In fact, they could be dispensed with entirely. However, there are a number of reasons for devoting some time to the historical background of relativity. First of all, it is a marvelous example of the way in which man's understanding of the universe progresses: the formulation of ideas, tests of the ideas, formulation of new ideas, etc.. Second, it is a story of two men - Newton and Einstein - who almost single-handedly formulated mammoth and elegant pillars of knowledge concerning the physical universe. Every physics student should be familiar with this story.

2. Procedures

1. Read Rindler, sections 1.1 - 1.13 for an overview. Note that there are five important steps in the chronology:

   (1) Newton's formulation of mechanics including his conception of absolute space and time, his famous three laws, inertial frames and Newtonian (or Galilean) relativity.

   Note: Within the context of Newtonian physics there is no *mechanical* means of singling out that one inertial frame which is absolute space.

   (2) Maxwell's formulation of electrodynamics including the implication of a wave motion propagating with a unique speed c, the identification of electromagnetic waves with light and the (erroneous) identification of the medium for these waves, the "luminiferous ether," with absolute space.

   (3) The experimental and observational search for the luminiferous ether (absolute space) by optical and other means.

   (4) The attempts by Lorentz, Fitzgerald and others to modify classical physical concepts in order to preserve the concept of absolute space and yet account for the negative results of the attempts to find absolute space.

   (5) Einstein's formulation of the special theory of relativity.

   Read Resnick, sections 1.4 - 1.10. Do not attempt to fill in analytical details on this first reading. Your concern is with the chronological development. Note how the reading material fits into the above five historical steps.

   Read the introduction to "On the Electrodynamics of Moving Bodies" by A. Einstein. Available in the paperback book *The Principle of Relativity*, by Einstein, et al.. Note that Einstein was motivated by two concerns:

   (a) the fact that Maxwell's electrodynamics is not covariant under Galilean transformations, i.e. Maxwell's equations have different forms in different inertial frames when transformed with the Galilean transformation. He refers to this behavior as an asymmetry.

   (b) the unsuccessful attempts to discover any motion of the earth relative to the luminiferous ether.

   Perhaps you can tell from the tone of this introduction that Einstein was more concerned about the "asymmetries" than the negative results of ether searches. This, of course, is contrary to the present day textbook emphasis on the Michelson- Morley experiment.

   The following two quotes from Einstein, although having nothing to do with relativity, provide much food for thought for serious-minded physics students.

   "The most incomprehensible thing about the world is that it is comprehensible."

   "What really interests me is whether God had any choice in the creation of the world."

2. Reread Resnick, sections 1.5 - 1.7. Fill in all details of the analyses.

   ▷ Work exercises 10, 12, 13 and 14 on pages 36-37 of Resnick.

3-4. Review reading material for Output Skill K1.

Acknowledgments

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