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Exercise; IV. LORENTZ TRANSFORMATIONS OF FRAMES ; Lorentz Transformations; The Lorentz Matrix; Pattern of the Lorentz Matrix; The Lorentz Sum of Speeds; Addition of Speeds via Matrices; Addition of Speeds via Areas; Exercises; The Hyperbola of Time-Stamped Origins; Invariance of Minkowski Length
The Time-Stamped Origins TheoremInterpreting the Time-Stamped Origins Theorem; Tangent Lines of Simultaneity; Exercises; V. GRAPHIC RESOLUTION OF THE PARADOXES ; The Accommodating Universe Paradox; Preview; Setup for the Minkowski Diagram; Resolving the Accommodating Universe; Exercises; The Length-Time Comparison Paradoxes; An Overview of the Paradoxes; Resolving the Mutual Length-Time Paradoxes; Summary; Exercises; The Twin Paradox; An Overview of the Paradox ; A Simplifying Assumption; Setup for the Minkowski Diagram; Resolving the Twin Paradox; General Relativity Confirmation; Exercises
The Train-Tunnel ParadoxAn Overview of the Paradox ; A Distance Lemma; The Train-Tunnel Minkowski Diagram; Explaining Mutual Contraction; Resolving the Train-Tunnel Paradox; Exercises; The Pea-Shooter Paradox; An Overview of the Paradox; The Fizeau Experiment: Adding Speeds; Exercises; The Bug-Rivet Paradox; The Minkowski Diagram; Coordinates in the Minkowski Diagram; The Slinky Connection; Exercises; VI. ENERGY AND MASS ; E = mc2; How We Came to This Place; Speed-Dependent Mass: an Intuitive View; Equivalence of Mass and Energy; A Numerical Example; Exercises
VII. THE MATHEMATICS OF WAVES AND LIGHT

Sommario/riassunto

Illustrated Special Relativity shows that linear algebra is a natural language for special relativity. It illustrates and resolves several apparent paradoxes of special relativity including the twin paradox and train-and-tunnel paradox. Assuming a minimum of technical prerequisites the authors introduce inertial frames and use them to explain a variety of phenomena: the nature of simultaneity, the proper way to add velocities, and why faster-than-light travel is impossible. Most of these explanations are contained in the resolution of apparent paradoxes, including some lesser-known ones: the pea-shooter paradox, the bug-and-rivet paradox, and the accommodating universe paradox. The explanation of time and length contraction is especially clear and illuminating. At the outset of his seminal paper on special relativity, Einstein acknowledges the work of James Clerk Maxwell whose four equations unified the theories of electricity, optics, and magnetism. For this reason, the authors develop Maxwell's equations which lead to a simple calculation for the frame-independent speed of electromagnetic waves in a vacuum. (Maxwell did not realize that light was a special case of electromagnetic waves.) Several chapters are devoted to experiments of Roemer, Fizeau, and de Sitter to measure the speed of light and the Michelson-Morley experiment abolishing the aether. Throughout the exposition is thorough, but not overly technical, and often illustrated by cartoons. The volume might be suitable for a one-semester general-education introduction to special relativity. It is especially well-suited to self-study by interested laypersons or use as a supplement to a more traditional text.