Name(s)	Project Number
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Project Title

Relativity on the Desktop: Illustrative Models of Einsteinian Physics

Abstract

Objectives/Goals

One of the fundamental principles of modern science is that the speed of light is constant in every inertial frame of reference. In this science project we consider why this principle is true. We approach this question by constructing a scale model universe which we call Solitonland. In this model universe, there exists solitonlight with speed c*. All other physical processes are controlled by the Sine-Gordon equation, a single nonlinear partial differential equation. Using only two special kinds of solution, we show how one can construct kink measuring rods and breather clocks from the material of this universe. We then show explicitly and precisely that the speed of solitonlight, as measured with these soliton rods and clocks, is independent of the inertial system. Thus in Solitonland, that the speed of solitonlight is a universal constant follows from the structure of Solitonland itself rather than as a postulate as it does for the speed of real light in our own physical universe.

Methods/Materials

Experimentally, we construct a physical model of Solitonland in which the speed of solitonlight is drastically slower than the speed of real light enabling us to do relativistic experiments on the desktop.

Results

In these experiments we are able to visualize Lorentz contractions and hear time dilations. Thus we show that a scale model universe can be constructed, both literally out of ordinary material and mathematically in our minds, and studied in a way that sheds light on the relativistic effects seen in our own physical universe. The actual observers themselves need not literally exist in the models; we can imagine what they would measure if they were actually there, the important point being that they make their measurements completely from within the confines of their own universe.

Conclusions/Discussion

We consider the implications of our scale model universe to our own universe. We show that in any universe, either real or imagined, that has certain minimal characteristics which include the existence of light signals and measuring devices that can be used to measure the speed of these signals, the speed of light in that universe will be constant in every inertial frame. Thus, to the extent that this result is a general principle for all universes that satisfy these minimal conditions, the mystery of why the speed of light is a universal constant in our own physical universe should be dispelled.

Summary Statement

This project is concerned with understanding why one of the fundamental principles of modern science is true; thus we consider both theoretically and experimentally why the speed of light is constant in every inertial reference frame.

Help Received