Due: July 15, 2007

Physics Department Senior Design Project Proposal

Title: Ehrenfest's Paradox: length contraction in rotating systems

Project Type: [x] Team [x] Individual [x] Honors

Objective

Science: Determine if the effect of length contraction is present in rotating systems. Length contraction has never been measured in either rotational or linear motion yet it is a fundamental prediction of special relativity.
Engineering: Determine the effects of variables influencing a high precision measurement and design a system to overcome adverse effects of these variables.

Prior Background

One of my research interests is in precision measurements (laser frequency stabilization and measurement of wavelength). This project illustrates an application of precision measurement to relativity. Three students worked on this as a senior design project. Each designed a rotating wire apparatus, much of which is still available.

Student Expectations

Design either a rotating wire or disk apparatus then measure time delay at different radii and model variables influencing this delay. Determine these variables and if time permits then design a system to mitigate them (for example, design a vacuum system, implement feedback control on the brushless motor, use a commercial controller, or something else). Another approach for a different group of students is to set up an available spin stand for hard disk drives and measure time delay at different radii.

Supervision Plan

Frank Kowalski will supervise the students.

Resources

Time interval counter, scopes, detectors, modal analysis system, spin stand, laser, high speed avalanche photodiodes, and optical components are available. The students will construct an optical system to measure the time delay between points at different radii on the wire or disc.

Technical References

D.H. Weinstein, Nature 232, 548 (1971); M.L. Ruggiero, European Journal of Physics Vol. 24 pp.563-573 (2003); F. Selleri, Found. Phys. Lett. 10, 73 (1997)