CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)
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Project Number
S1509

Project Title
The Doppler Effect and the Fiber Gyroscope

Abstract

Objectives/Goals
My project relates to the Doppler Effect and how it is used to measure rotation in a fiber gyroscope. This Doppler effect introduces a frequency shift on a beam that can be measured by using a Sangnac interferometer. I used a turntable as my rotating platform. My rotation speed (measured by number of turns/ second) is my independent variable and the number of fringes shifted is my dependent variable.

Methods/Materials
I used a HeNe laser to assemble a Sagnac interferometer where two beams propagate in opposite direction on a rotating platform. The interferometer used a long fiber as the beam carrier for the two counter propagating beams to enhance the Doppler effect. A turntable served as the rotating platform. I used a beamsplitter to produce the two beams that were injected into the fiber, and observed the fringe pattern created by the return beams on a screen. We then observed the change in fringe patterns as the spool of fiber rotated on the turntable. We observed the fringe motion at three different rotation speeds corresponding to 17, 33 and 45 rpm.

Results
My hypothesis was correct; we were able to build a basic Fiber Optic Gyroscope and measure the Doppler shift introduced by a rotating platform. We measured the Doppler shift for three rotational speeds of a turntable and the number of fringes observed by the Sagnac interferometer were within 5% of that predicted by theory.

Conclusions/Discussion
The simple fiber optic gyrsoscope that we assembled was able to measure roataion with surprising accuracy (5%). There were two possible sources of error; the poor contrast ratio of the fringes and the ability to only count the fringe shift with limited accuracy (half a fringe). Reasons for the poor contrast included the use of a non-polarization maintaining fiber and difficulty in balancing the intensities of the two beams. These issues were overcome by doing multiple trials (at least 10) for each rotational speed. This enabled us to reduce the standard deviation to approximately 10% of the average value at the higher speed (45 rpm) and less than 25% of the average value at the lowest speed (17 rpm).

Summary Statement
Measuring rotational speeds using the Doppler Shift in a fiber optic gyroscope.

Help Received
Father helped identify project and collect data.