CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
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Project Number
J1729

Project Title
The Groovy Gratings Experiment: Using Diffraction Patterns to Measure Data Track Spacing on CDs and DVDs

Abstract

Objectives/Goals
The objective of this project was to accurately choose and derive the correct diffraction grating equation (there are many forms) and to analyze the laser diffraction patterns from CDs and DVDs to prove that DVDs have smaller data track spacing than CDs.

Methods/Materials
The materials used in this project were a laser, CD, DVD, laboratory clamp, measuring tape, pencil, copper pipe, machinists vice, and a wall. I inserted the pipe inside the vice, and fastened the laboratory clamp onto the pipe. I placed the laser inside the clamp, placed each disc up against the wall, and turned the laser on. I used the machinist vice to position the laser aperture so that all beams grazed the wall for easier viewing and measurement. I measured the rise and run of all beams and calculated their angles. To create multiple trials, I varied the incident beam angle to see if the grating equation would hold true.

Results
Before performing the experiment, I derived the correct diffraction grating equation to prove that it worked for CD and DVD diffraction. I proved my hypothesis true because DVDs had an average data track spacing of 737nm, compared to a 1548nm average for the CD. It was impossible to find the track spacing of a blu-ray disc as only beam reflection occurred.

Conclusions/Discussion
My work showed that DVDs have about half the data track spacing of CDs. This shows that as the gaps between the individual data tracks became smaller, the angle of the diffracted beam became bigger, as the increased differences in the sines of the incident and diffracted beams served as the denominator, but the numerator remained constant. I also found that the DVDs had less diffracted beams than the CDs because the increased number of data track spaces in the DVD created more wave propagation, leading less constructive interference. This is consistent with the grating equation, showing lower diffracted wave orders (m) as spacing (d) decreases. The blu-ray disc showed only specular reflection. My research shows that blu-ray discs have a track spacing of 320nm, which may be why light waves from my 650nm laser were not diffracted. Most blu-ray players use 405nm violet lasers to obtain diffraction.

Summary Statement
I derived the best diffraction equation, shined a laser at the surface of a CD and DVD, measured the angles of the diffracted beams from each disc, and used my equation to prove that DVDs have smaller data track spacing than CDs.

Help Received
My father helped me to understand the concepts of a mathematical proof and trigonometry; friend and scientist Mr. Bob Stiffler provided research materials.