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2.D Summer Research Program for High School Students

Ten students participated in the 8-week, summer of 1991 high school student research program at the Laboratory for Laser Energetics (LLE). The participants spent most of their time working on individual research projects, the results of which were presented at a symposium for their parents, teachers, and members of the LLE staff. Written reports of their work will be a permanent record of this summer's program. The students also participated in a series of seminars designed to teach them some of the concepts underlying the work performed at LLE, and they toured the Nuclear Structures Research Laboratory and the Strasenburg Planetarium. The components of the program are described in more detail in the following sections.

This is the third year LLE has had a summer program for high school students and the first that the program has been partially supported by the National Science Foundation (NSF). The goals of the program are to expose students to state-of-the-art research in science and technology, and to incite them to pursue a career in these fields. We also hope that the enthusiasm generated by the program will be be transferred to the students' peers.

The students, all of whom had completed their junior year, were selected from 60 outstanding applicants from 23 local high schools. Each student sent a letter of application, an NSF applicant form, and a copy of their transcript. In addition, each student was required to have a letter of recommendation from a science or math teacher. The applications were read and 20 of the applicants were invited for 25-minute interviews at LLE. The final ten were chosen after these intensive interviews.

Projects

Each student, working under the direct supervision of one of the staff members of the laboratory, was assigned a research project. The students, their high schools, and their projects are listed in Table 48.III.

Table 48.III: High school students and their projects.

Student	High School	Project Title
Roger Clark	Penfield	UV Alignment Table
Ana Cotto	Benjamin Franklin	Neutron-yield Measurements with a Photomultiplier Tube
Robert Dick	Greece Arcadia	Scattering in Isotropic and Anisotropic Media
Jeffrey Dvorin	Brighton	A Better Approximation of the Diffusion Equation
Mark D. Forbes	Pittsford/Mendon	Design of a Photo-emissive, Electrostatically Focused Electron Gun
Elizabeth Randall	East	Spatial Resolution as a Function of Film Exposure
Franklin S. Turner	Rush-Henrietta	Analysis of Refractive Image Distortion
Helen Vayntrub	Brighton	Laser-Drilling Pinholes for X-ray Pinhole Cameras
Jeanne Yax	Nazareth	Does Perturbation Theory Accurately Describe Multiphoton Ionization?
Nora Yip	Webster	Wavefront Analysis Using Shearing Interferometry

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Roger Clark–UV Alignment Table

The ultraviolet (UV) alignment table is a major component of the OMEGA laser system. The system incorporates a high-quality UV laser for alignment and beam-transport measurements. Roger's project involved a redesign, and subsequent installation, of the optical layout. He simplified the layout and significantly improved the UV-laser-beam quality.

Ana Cotto–Neutron-yield Measurements with a Photomultiplier Tube

A photomultiplier tube (PMT) coupled to a scintillator can be used to measure the neutron yield from fusion experiments. A neutron strikes the scintillator, producing a light pulse detected by the PMT. Ana's project was to calibrate the response of the PMT's as a function of their bias voltage and of the incident light flux. In this case a flashlamp light source was used as a reproducible source of x-rays to simulate the neutron source. Figure 48.24 shows a calibration of one of the PMT's at a bias voltage of −1600 V. The experimentally observed PMT charge produced as a function of the amount of incident light is plotted, along with calculated values.

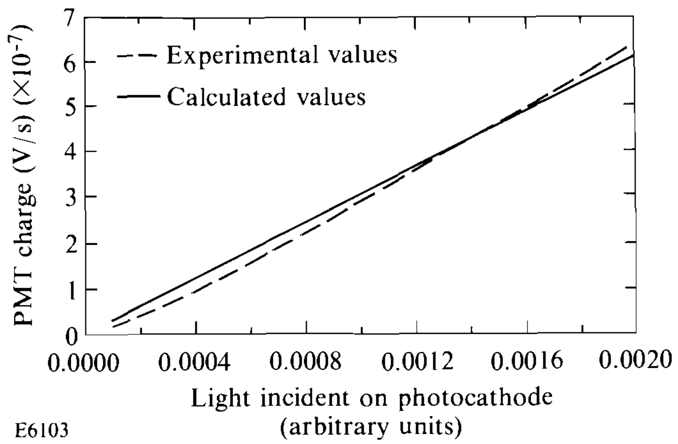

Fig. 48.24
A comparison of the measured (dashed) and calculated (solid) PMT charge as a function of the amount of incident light.

Robert Dick–Scattering in Isotropic and Anisotropic Media

The goal of this project was to measure the scattering of laser light in isotropic and anisotropic media: in particular, to study the scattering of light off dentine (dental tissue). A HeNe laser was incident on the material and the angular distribution of the absorption and scattering of the light was measured with a photodiode. Robert found that dentine has negligible absorption and exhibits strong forward scattering. The distribution of the scattered light strongly suggested that dentine has a crystalline structure. This is shown in Fig. 48.25, where the scattered light from dentine is compared to opal glass, an isotropic scatterer.

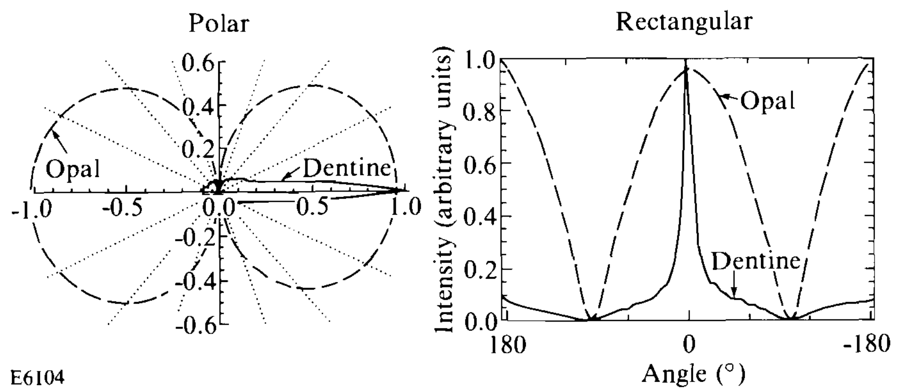

Fig. 48.25
Angular intensity distributions for light passing through opal glass and dentine.

Jeffrey Dvorin–A Better Approximation of the Diffusion Equation

In many of the computations performed at LLE to model the fusion experiments, the diffusion equation must be solved numerically. The solution depends on a tradeoff between accuracy and the length of time required for computation. Jeffrey's project involved testing new averaging schemes to be used in the solution of the diffusion equation. It was found that, in some cases, significant increases in computational speed could be achieved without sacrificing accuracy.

Mark D. Forbes–Design of a Photo-emissive, Electrostatically Focused Electron Gun

Electron optics are an important part of a number of experiments at LLE. A sophisticated electrostatic modeling code was used to design an electron gun with a photo-emissive electron source for use in an investigation of crystal structure and melting. Mark's goal was to produce the smallest possible beam diameter that would also have a small divergence over a 30–60-cm focusing distance.

Elizabeth Randall–Spatial Resolution as a Function of Film Exposure

An important question for many of the diagnostics used at LLE is how the photographic film used as the recording medium responds to different light fluences. In this project, the effect of the exposure on the spatial resolution of the film was measured. Two types of film were used: Kodak high-speed infrared 4143, and Kodak T-Max 400. Elizabeth found that as the fluence (from a 1-ns duration IR laser pulse), and hence the exposure, was increased, the spatial resolution of both films decreased.

Franklin S. Turner–Analysis of Refractive Image Distortion

In an experiment performed by C. Darrow[1] from Lawrence Livermore National Laboratory the image of a grid was projected through a plasma and the distortion of the image was measured at various distances, allowing a measure of the spatial profile of the plasma density. Franklin analyzed this data, showing that the refracted rays followed apparent straight-line trajectories, as expected. He also prepared the data for direct comparison with numerical simulations. A comparison of the measured and calculated contours of the refraction angle is shown in Fig. 48.26. Figures 48.26(a) and 48.26(b) show the experimental scattering angles in the horizontal and vertical plane, while Figs. 48.26(c) and 48.26(d) show the results of the numerical simulations.

Helen Vayntrub–Laser-drilling Pinholes for X-ray Pinhole Cameras

X-ray pinhole cameras are one of the important diagnostics used at LLE. They are used to observe the size of the compressed pellets. For high spatial resolution, pinholes of 2–10-μm diam are required. The pinholes are produced by tightly focusing a laser beam onto a thin metal foil, and then drilling a hole. A high-quality laser beam is required to make the best pinholes. Helen studied the size of the hole produced as a function of the peak laser intensity.

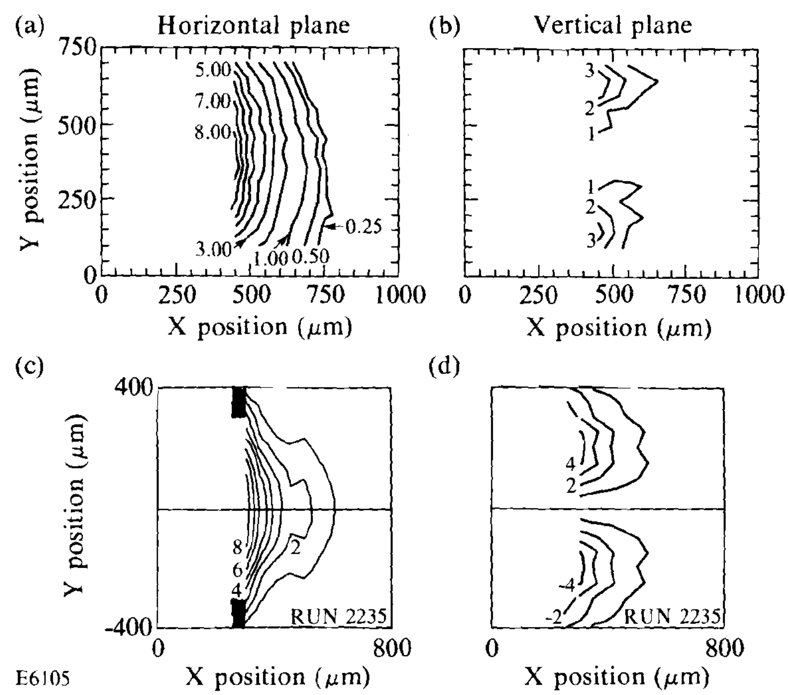

Fig. 48.26
Contours of the refraction angles in degrees. (a) Contour plot of the horizontal refraction angle θ_x. (b) Contour plot of the vertical refraction angle θ_y. The contours on the bottom of the graph are negative, and the ones on top are positive. Predicted refraction-angle contours for the plasma, as calculated by *SAGE*, are shown in Figs. 48.26(c) and 48.26(d). (c) Horizontal refraction angle θ_x. (d) Vertical refraction angle θ_y.

Jeanne Yax–Does Perturbation Theory Accurately Describe Multiphoton Ionization?

The multiphoton ionization experiments performed by many different experimental groups were compared. Jeanne searched the published literature, the data presented was digitized, and the slope of the number of ions detected versus peak laser intensity was measured. In perturbation theory, this slope should be equal to the minimum number of photons required for ionization. This was found to be true for the lowest charge states, except in the experiments that used the fewest optical cycles in their ionizing laser pulse.

Nora Yip–Wavefront Analysis Using Shearing Interferometry

The quality of optical components can be tested using interferometry. The collimation of a laser beam can also be measured. In this project, Nora compared shearing interferometry with two-beam interferometry. The advantages of a shearing interferometer are: it does not require a separate reference beam, and quick tests of phase information can be obtained with moderate resolution. In many cases it was found that a measurement of phase information from a shearing interferometer agreed with the higher-resolution phase information obtained from a two-beam interferometer.

Symposium

The summer ended with a research symposium given by the students. It was attended by parents, teachers, and members of the LLE staff. The students wrote and presented an overall introduction to the presentations, describing the work performed at LLE this summer and the relationships among their projects. Each student made a 10–15-min presentation about their research work, and answered questions. Finally, a group conclusion summarizing the projects was presented. The students also prepared a 10–20-page written summary of their work. These papers will be compiled into a report that will be available to any interested parties.

Conclusions

In the third year of LLE's summer high school research program, ten students from local high schools spent eight weeks at LLE working on research projects. These projects are part of the ongoing research at the laboratory, so the students were immersed in a real research environment, with all of its attendant frustration and satisfaction.

ACKNOWLEDGMENT

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