PHYSICS

Chairman: Torsten Alväger, Department of Physics,
Indiana State University, Terre Haute, Indiana 47907

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Ball State University, Muncie, Indiana 47306
was elected Chairman for 1973

ABSTRACTS

Comparison of the Newit-Dombrowski-Knelman Equation and the Modified Howe's Equation for the Determination of the Rising Velocity of Gas Bubble in a Static Fluid. Robert H. L. Howe, Eli Lilly and Company, Tippecanoe Laboratories, Lafayette, Indiana 47902, and Hakki Dingil, Istanbul Technical University, Istanbul, Turkey.——A modified equation by Howe for the determination of the rising velocity of a gas bubble in a static liquid column was presented. Its comparison with the Newit-Dombrowski-Knelman equation was discussed.

A Study of the Angular Distribution of Scattered Muons in Muon-Nucleon Interactions at 15.8 GeV/c. Ali M. Guima and Gerald P. Thomas, Department of Physics, Ball State University, Muncie, Indiana 47306.——Inelastic muon-nucleon interactions were studied using the nuclear emulsion technique. The momentum of the primary muon beam was 15.8 GeV/c. Muons and other leptons of high energy make excellent probes to study nucleon structure. Muon beams of small contamination, using accelerators, became available in 1965, but data are limited.

In this experiment, we scanned several nuclear emulsion pellicles for muon-nucleon inelastic scatters and measured the angular distribution of the scattered muon at 15.8 GeV/c. The results were compared with previous data and also with the theoretical form factor predictions at this momentum.

Lithium Precipitation in Elemental Semiconductors Containing Disordered Regions. George C. Huang and Ronald M. Cosby, Department of Physics, Ball State University, Muncie, Indiana 47306.——A simple model describing the precipitation of lithium on defects in fast-neutron-irradiated elemental semiconductors was developed for the case where lithium is a minor n-type dopant. The theory of disordered regions in irradiated semiconductors is reviewed and the expected sink-like behavior of these defects for the fast-diffusing lithium ion was described. A solution of the continuity equation with appropriate boundary conditions indicated an exponential decay of lithium concentration in the volume surrounding a disordered region. The decay time constant was related to the size of the space charge region, the concentration of disordered regions, and the diffisivity of lithium. The magnitude and variation of this time constant with temperature and defect concentration was calculated for fast-neutron-irradiated n-type germanium containing lithium.

Electronic Conduction in Amorphous Silicon Dioxide. CARL C. SARTAIN, Department of Physics, Indiana State University, Terre Haute, Indiana 47809.——Electron energy bands in solids are due to the merging and spreading of the electronic energy levels in the atoms of which the solid is formed. Thus, energy bands are due to the proximity of atoms, not to the ordering of atoms into single crystals. The optical absorption properties of fused quartz implies that a conduction band exists at 6.5 ±0.1 electron volts above a filled band. The conductivity of fused quartz at low electronic fields (about 1 volt per centimeter) and at high temperature (up to 1800° Kelvin) fits the equation

$$\sigma/\sigma_\infty = \exp\ (E/2kT)$$

where σ is the electrical conductivity, E is the energy gap, k is Boltzmann's constant and T is the absolute temperature. The energy gap was 6.6 ± .1 ev in agreement with the optical value. The results of this experiment are consistent with the existence of energy bands in amorphous SiO_2 and with electronic conduction, not ionic.

The Use of Electrostatic Quadrupoles in Scanning Electron Microscopy. PHILLIP C. NORISEZ, Department of Physics, Indiana State University, Terre Haute, Indiana 47809.——A feasibility study of the use of electrostatic quadrupole lenses in scanning electron microscopy was reported. It relied heavily on computer analysis of the equations of motion of an electron in the electric field set up by such a lens.

A Novel Video Sweep Circuit for a Scanning Electron Microscope. JOHN A. SWEZ and JAMES B. WESTGARD, Department of Physics, Indiana State University, Terre Haute, Indiana 47809.——Conventional Scanning electron microscopes employ beam intensities of 10 A/cm^2 and can rely on conventional video sweeps because of the low electron intensities used. Unorthodox designs such as microscopes with field emission electron sources can increase beam intensities over a factor of 1000. These recent designs necessitate changes in video sweep which minimizes electron damage. The video sweep described employs a triangular waveform which acts as the horizontal sweep but triggers a clock pulse at each high and low output of the waveform. The resulting pulse is fed into a synchronous binary counter which sums the individual horizontal sweeps. The output of the binary counter serves as the input to a vertical sweep voltage. An interlacing sweep can be easily provided by forcing the binary counter to count two pulses *in lieu* of a single clock pulse and by providing the necessary digital logic to change the maximum binary count to an odd number (decimal equivalent). The described video sweep can function well at television sweep frequencies with a minimum amount of radiation damage.

A Design for a Plastic Scintillator—Ge(Li) Spectrometer for Obtaining Suppressed Spectra. J. P. COLLINS, R. L. PLACE and D. R. OBER, Department of Physics, Ball State University, Muncie, Indiana 47306.——A design for a plastic scintillator—Ge(Li) spectrometer consisting of a 10-inch diameter, 12-inch long plastic cylinder having provisions for inserting a Ge(Li) detector perpendicular to the cylinder axis was described. In the design, light is funneled by reflection to either end where detection is accomplished using two 5-inch photomultiplier tubes. Two truncated cone light guides are used to couple the scintillator ends with the photomultiplier tubes. Compton suppression is accomplished by operating the Ge(L) - plastic scintillator in anticoincidence.

Photographing the 10 July 1972 Total Solar Eclipse in Nova Scotia. DANIEL A. MITCHELL[1], DUANE W. WARN, GARY E. TOMLINSON and MALCOM E. HULTS, Department of Physics, Ball State University, Muncie, Indiana 47306.——In addition to our primary objective of shadow band detection, many different types of procedures were used to photograph the partial and total phases of the eclipse. Using high quality telescopes and cameras, Mitchell obtained superb photographs of the totality. Warn used a Mamiya/Sekor 1000 TL camera with a Spiratone 400-millimeter f/6.3 telephoto lens mounted on a Criterion equatorial clock-driven mount designed for a 6-inch telescope. All photographs of the total phase were taken at f/8 and at speeds of 1/2 to 1/250 second using high speed Ektachrome film (ASA 160). The photographs of the partial phases were taken with the same system with a dark red aerial camera lens filter hand held over the telephoto lens. The settings were f/8, 1/250 second with high speed Ektachrome film.

A similar system, used by Tomlinson, was set up about 40 miles approximately west of Antigonish near Mt. Thom. This system also used a Spiratone 400-millimeter f/6.3 telephoto lens on a Practica camera mounted on a tripod (no clock drive). Again, high speed Ektachrome film was used.

Selected photographs of both the partial and total phases of the eclipse, showing most of the interesting features that occur, were shown.

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Photoelectric Detection of Shadow Bands at the 10 July 1972 Solar Eclipse. DUANE W. WARN, DANIEL A. MITCHELL[1] and MALCOM E. HULTS, Department of Physics, Ball State University, Muncie, Indiana 47306.——Continuing our studies of shadow bands (first in Brazil, 1966, second in North Carolina, 1970) a team of 14 persons set up visual, photographic and photoelectric equipment at Malignant Cove, Nova Scotia. Shadow bands were detected on all six channels of a photoelectric system using three narrow band and three wide band filters to detect the variation of shadow band phenomena with optical wavelength. A second system consisted of one photocell connected to a set of electronic filters, each tuned to a separate frequency of light intensity fluctuation. The output of each filter was read on a meter and the set of meters was photographed continuously. A third system consisted of two photocells each connected to a channel of a two channel strip chart recorder, a fourth system monitored rf noise at 3.85 mHz, and a fifth system was an electronic thermometer connected to a strip chart recorder.

Shadow bands were strongest in blue, weaker in red and weakest in green light. The light intensity frequency composition was quite complicated consisting of a continuous 6 Hz frequency with an approximate 22 Hz frequency appearing from approximately 50 seconds to 10 seconds before totality. The rf noise began to increase approximately 22 minutes before totality and increased by at least a factor of five peaking at approximately third contact, *i.e.*, the end of totality. The electronic thermometer showed a 23° Fahrenheit drop in temperature the minimum being at third contact.

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The I.S.U. Expedition to the Solar Eclipse of July 10, 1972. A. BARBEE[1], C. BIBO, P. DILAVORE[1], D. EMMONS, C. R. HANGER, J. KELLY, M. MCCANDLESS, D. PITTS, M. POKORNY and D. ROBINSON, Department of Physics, Indiana State University, Terre Haute, Indiana 47809.——In the summer of 1972, the Physics Department sent a group of students to Prince Edward Island, Canada, to perform experiments involving the total solar eclipse. The projects attempted included conventional photography of all phases of the eclipse through Questar telescopes, photography of the elusive shadow bands, electronic detection and computer analysis of the shadow band structure, 16 millimeter time-lapse photography of the eclipse, and Fourier-transform spectroscopy of the corona.

The appearance of a cloud which obscured the sun during totality negated the shadow band experiments, since there were no shadow bands at our location, and the Fourier-transform spectroscopy. However, the sun was still somewhat visible through the cloud, and interesting photographs were obtained.

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NOTE

Cosmic Rays and Faster-than-Light Particles. TORSTEN ALVÄGER and WILLIAM FROST, Department of Physics, Indiana State University, Terre Haute, Indiana 47809.——The possible existence of particles traveling with a speed always exceeding that of light in a vacuum (faster-than-light particles) has been discussed extensively during the past decade. A recent review was given by Bilaniuk and Sudarshan (2). Experimentally, several investigations to search for the particles have been performed, all with negative results so far (1). We discuss here a new experiment, now in progress, to search for neutral faster-than-light particles in cosmic ray events.

Energetic primary cosmic ray particles entering the earth's atmosphere give rise to various nuclear reactions, of which the products develop into a shower-like phenomenon which travel toward the surface of the earth at almost the speed of light. If faster-than-light particles exist and react with ordinary matter, they may be produced in connection with cosmic ray showers. A time-of-flight experiment could in principle single out possible faster-than-light particles. This technique has been used in this investigation.

The detector arrangement that was used consisted of two plastic scintillation detectors, each of dimensions 1 foot x 3 feet x 1/2 inch, connected in coincidence. The output from Detector 1 was fed to the start input of a time-to-amplitude converter (TAC-unit), while the output from the coincidence unit was used as a stop pulse for the TAC-unit. A multi-channel pulse height analyzer registered signals from the TAC-unit.

The occurrence of a shower was defined as the appearance of a signal from the coincidence unit. An event consisting of a particle exciting Detector 1 prior to the shower will be registered by the pulse height analyzer. However, a particle detected in Detector 1 at a time

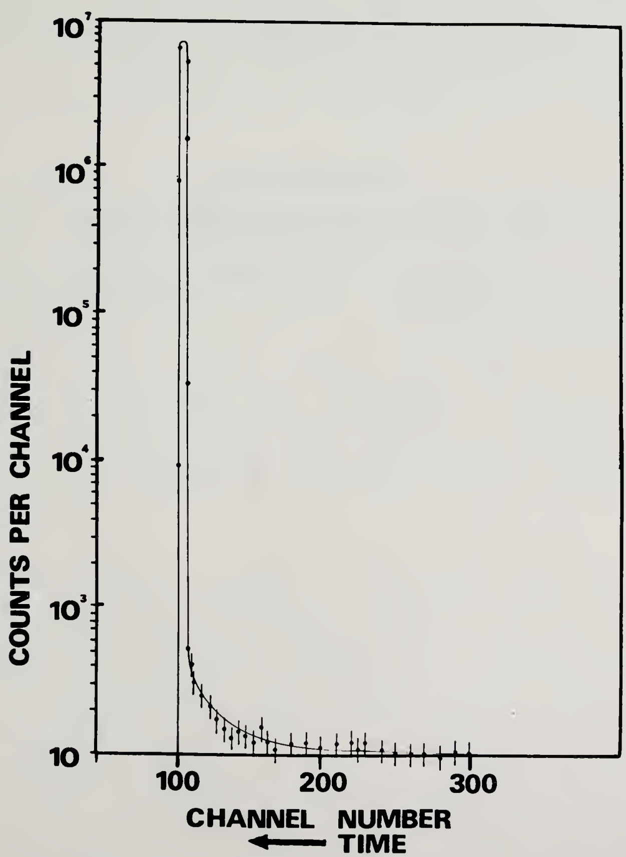

FIGURE 1. *Time-of-flight spectrum registered by the multichannel pulse height analyzer. Total measuring time 240 hours. The peak corresponds to shower particles not accompanied by particles arriving prior to the shower. Possible faster-than-light particles should appear to the right of the peak. Calibration: 1 channel = 1.4 nanoseconds.*

delayed relative to a shower will be disregarded by the detector arrangement. Therefore, besides general background particles, only faster-than-light particles could be registered.

Figure 1 gives an example of a time-of-flight spectrum registered by the multichannel analyzer. The total measuring time was 240 hours and the sensitive time range of the TAC-unit was about 1 μs. The peak corresponds to showers not accompanied by a single particle detected in Detector 1. Possible faster-than-light particles should appear to the right of the peak in the figure. From the data it can be deduced that the ratio of shower intensity to possible faster-than-light particle intensity was larger than 1.3 x 10^4. This ratio was not too useful, however. What was of interest was to find an upper limit on the production cross-section of faster-than-light particles. This can be obtained by assuming a particular model for the production and propagation of the particles. Such an evaluation is presently in progress as well as an extension of the experiment itself. The authors appreciate valuable help by Mr. K. Wright and Mr. J. Cunningham. This work was supported in part by an Indiana State University Research Grant.

Literature Cited

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