

PHYSICS AND ASTRONOMY

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ABSTRACTS

A Liberating Course in Physics. JOSEPH J. BELLINA, JR., Saint Mary's College, Dept. of Chemistry and Physics, Notre Dame, IN 46556.—A course in physics for non-science students will be described. The course content is limited to a few concepts which are studied in depth to encourage students to rethink their notion of scientific explanations. The rethinking begins early in the course when the stereotypical factual nature of science is symbolically denied by literally denying the motion of the earth, a "fact" which seems beyond denial! What develops is a course in the evolution of ideas about motion in the heavens and on the earth, from pre-Socratic Greeks through the Renaissance to Einstein. The perspective throughout the course is that of paradigm development and change as described by Thomas Kuhn. Weekly laboratory experiments allow the students to investigate the issues discussed in lecture, without the usual cookbook format. The structure of the course and the laboratory exercises will be described.

Measurements of Radon in Muncie City Water. ALICE S. BENNETT, DAVID GOVAER, JOHN HAMMER, NATALIE LONGFELLOW, and DAVID R. OBER, Ball State University, Muncie, IN 47306.—A Beekman LS 3801 liquid scintillation spectrometer was used to determine radon concentration levels in city drinking water samples taken from several sites in Muncie. Samples were prepared by immediately placing 10 ml of water into a vial containing 10 ml of Mineral Oil Scintillator (85% mineral oil and 15% fluor from NEN Research Products). After three to four hours, water samples and background measurements were conducted in 50-minute intervals. Radon concentrations for several city sites were monitored over a period of weeks. These results will be compared to radon levels obtained for samples taken at the city water plant (before treatment) which were from the White River and city well, the city's sources of drinking water.

Preliminary Network Model of a Silicon Concentrator Solar Cell. CLARENCE BROOKS and RONALD COSBY, Department of Physics and Astronomy, Ball State University, Muncie, IN 47306.—A model for a silicon solar cell under illumination from a line-focusing concentrator has been developed for the simplified case of two or more longitudinal busbars on the surface of the cell. The model consists of a network of one-dimensional $n^+ - p - p^+$ photodiodes and takes into account bulk and sheet resistances of the cell. A previously developed Fortran program simulates the current-voltage performance of these individual photodiodes under varying levels of illumination. Gauss-Jordan reduction of an augmented matrix (representing Kirchhoff equations) is used to solve for the sheet currents in terms

of the photodiode currents. An Ada program has been written to simulate overall current-voltage performance of the cell for any desired number nodes. The cell model characteristics and preliminary simulation results are discussed.

Double Crystal X-Ray Spectrometer for High Sensitivity Lattice Parameter Measurements. ROBERT C. BUSCHERT, MARK A. GUENGERICH, and CARL S. HELRICH, Department of Physics, Goshen College, Goshen, IN 46526.—Single crystal diffraction is not precise enough to measure very small changes in lattice parameter because of wide diffraction peaks (e.g., 0.2°). Double crystal diffractometers with narrow peaks (0.07 to 10 sec. of arc) are necessary for high sensitivity. To solve the problem of indexing or resetting in normal double crystal diffractometers the authors have developed a diffractometer in which the 2nd crystal can be rotated on an axis perpendicular to the planes of diffraction. This facilitates easy alignment and changing of samples and, along with the use of a movable x-ray source, allows the use of only 1 precision axis. The diffractometer can measure change in lattice parameter of ≥ 1 part in 10^7 . Results will be presented on some single-crystal semiconductors such as ZnSe and GaAs, including some with thin, single-crystal films.

Assembly and Evaluation of a Radon Calibration Chamber: First Attempt. SHANKAR GURU and JOHN SWEZ, Department of Physics, Indiana State University, Terre Haute, IN 47809.—Attempts to commercially calibrate charcoal cannisters used in radon testing have proven to be very expensive. This paper reports on our progress towards the construction of a radon calibration chamber. Theoretical calculations have been performed utilizing an electronic spreadsheet on the production of radon from the decay of radium (Ra^{226}). Calculations can be extended to sum the total of alpha producing daughters and predict the activity with which a lucas cell would measure in the atmosphere within the chamber. Aqueous solutions traceable to the National Bureau of Standards will be used as the radon generator. The chamber will be attached to a modified lucas cell for continuous alpha monitoring. It is anticipated that the chamber will be utilized during the fall of 1988 in conjunction with a Radon Workshop funded by the Higher Education Commission, State of Indiana. In this workshop, cannisters from facilities who have traceable calibration records will be compared with cannisters calibrated with the ISU generator. One of the beneficial advantages of radon calibrator is the ability to control environmental factors such as temperature, humidity, and air particulate quality.

Low Temperature Physics in the High School Classroom: High Temperature Superconductivity. UWE J. HANSEN, Department of Physics, Indiana State University, Terre Haute, IN 47809.—Title II funds have been obtained from the Indiana State Commission of Higher Education to conduct a series of workshops on high temperature superconductivity with the objective of training high school teachers, as well as providing minimal equipment to introduce this topic into the secondary classroom. In this presentation, we will explore a number of phenomena at liquid Nitrogen temperatures culminating in the demonstration of the floating magnet "Meissner Effect."

Modal Studies of Hand Bells. UWE J. HANSEN, Department of Physics, Indiana State University, Terre Haute, IN 47809 and THOMAS D. ROSSING, Department of Physics, Northern Illinois University, DeKalb, IL 60115.—Hand Bells are traditionally tuned such that the fundamental resonance coincides with the pitch of

the bell with the next lowest resonance an octave and a fifth above the fundamental. The air motion inside the mouth gives rise to an additional frequency component at double the fundamental frequency. Higher overtones contribute to the characteristic bell sound. Studying bell modes using near field sound pressure level monitoring, holographic interferometry, and impulse excited modal analysis has permitted an ordering of modes in a pattern not unlike a periodic table. The anomaly in that pattern occurring for a series of low order modes, resulting from the nature of the boundary condition will be discussed.

Air Resistance and Energy Efficient Transportation. MELINDA HARMAN and RUTH HOWES, Department of Physics and Astronomy, Ball State University, Muncie, IN 47306.—Increasing speed reduces the number of miles traveled by an automobile while burning a gallon of gasoline. A major reason for this reduction in efficiency at high speeds is that the force of air resistance on the vehicle increases as the square of velocity. A simple mechanical model for the effect of air resistance on the power consumption of a vehicle has been constructed based on the size and shape of the car. The predictions of the model for several popular automobiles are compared to published data on fuel efficiency. On the basis of this simple model, a lower speed limit on the highway is clearly desirable from the standpoint of energy conservation.

The Effects of Spin-Spin Interaction on the Magnetic Susceptibility of Dilute Magnetic Semiconductors (DMS). CARL S. HELRICH, Goshen College, Department of Physics, Goshen, IN 46526.—In spite of great interest in DMS and their potential technological importance, no general theory exists for the variation of susceptibility with temperature for these materials. Particularly deviations from the Curie-Weiss Law at low temperatures have not been accounted for in a picture based on interactions. Such a theory based on cluster expansions in which exchange effects are added hierarchically is presented. The results, carried to interactions among four spin states, provide good agreement with experiment. The emerging picture also provides an understanding of low temperature deviations from the Curie-Weiss Law in terms of exchange interactions.

Testing Drift Chambers as a Component of Preparation for the Fixed Target Run for Experiment #683 at FNAL. JEFFREY R. JOHANNING, Fermi National Laboratory, Batavia, IL 60510 and GERALD P. THOMAS, Department of Physics and Astronomy, Ball State University, Muncie, IN 47306.—Drift chambers are a major component of tracking devices as used in the large scale electronic detection and measurement systems so often found in high energy physics experiments at major accelerator laboratories such as Fermi National Laboratory. Their optional operation is a highly desirable feature for a successful run of data taking. Such chambers are being tested at FNAL in conjunction with the upcoming run of experiment #683 at FNAL. Details of the design, layout, and procedures used in testing of such DC's will be given. Problems, such as high voltage arcing, will be described and preliminary testing results will be discussed.

X-ray Diffraction Studies of Thin Titanium Nitride Films. DAVID RENNEKE, Department of Physics, Augustana College, Rock Island, IL 61201, JEREMY KROPPF, ROBERT BUSCHERT, and CARL HELRICH, Department of Physics, Goshen College, Goshen, IN 46526.—At graze angles (90° - angle of incidence) of ≤ 10 milliradians (mrad) x-ray incident on TiN surfaces are totally reflected from the surface. As the graze angle is increased, penetration can be controlled providing measurement

of lattice parameter as a function of depth. Employing a highly collimated $F_K\alpha$ beam (beam width $< 450\ \mu\text{m}$ and graze angle control to within $\pm 0.1\ \text{mrad}$), we studied total reflection and penetration of x-rays in TiN films sputtered on glass and on Si. We present total reflectivity and penetration curves as well as studies of lattice parameter variation. Under the conditions employed stress/strain relations may be studied in various crystal directions. We present preliminary measurements of the corresponding Young's Moduli.

An Assessment of the Effect of Various Developers on the Sensitivity of Hypersensitized Kodak Technical Pan Film. ROGER L. SCOTT, Department of Physics and Astronomy, Ball State University, Muncie, IN 47306.—The effect of seven common developers was tested on samples of Kodak Technical Pan Film, which were hypersensitized by baking in forming gas, a non-explosive mixture of nitrogen and hydrogen. Before development, the film was exposed on a tube sensitometer, allowing the generation of standard characteristic curves, and thus a determination of relative light sensitivity or "speed."

Implementation and Application of a Single Chip, Off the Shelf, 8-Bit Microcomputer in the Context of Monitoring and Control of a Physical System. GERALD P. THOMAS, Physics Department, Ball State University, Muncie, IN 47306 and ROBERT D. COX, Physics Department, Ball State University, Muncie, IN 47306.—With the advent of single chip microcomputers, the microcomputer control portion of certain physical hardware systems can be less costly as well as occupy less space. Many of these control and monitoring applications require only the limited RAM/ROM featured on such chips. The Motorola MC68705P3 version of an MCU features a bootstrap for loading a user defined monitor yet needs only a few temporary external chips. The monitor then permits desired real-time interaction with peripherals, both with I/O peripherals, for easier RAM access during control/monitor ROM program development, and with the peripherals to be controlled/monitored themselves. The performance of the chip in the context of a typical application will be discussed.

Design and Implimentation of a Microcomputer-Based Alarm System. SUSAN L. THOMPSON, Physics Department, University of Cincinnati, Cincinnati, Ohio 45221 and GERALD P. THOMAS, Physics Department, Ball State University, Muncie, IN 47306.—A large number of alarm applications for microcomptuers exists, such as detection of burglar movements, and water level movement, etc. Voice message alarms can form an interesting and useful subset of these alarm modes. An alarm system will be presented which consists of a sensing section, a voltage reducer, a debouncer, a KIM system board microcomputer, and a VOTRAX model 200 Personal Speech Synthesis System. The sensing section consists of a light beam and photodetector which outputs a signal that is subsequently reduced and debounced for IRQ vector interrupt service routine that then handshakes voice phoneme data to the VOTRAX via the KIM's data and control ports.. The various components of hardware will be discussed as well as the 6502 assembler program that controls the processing of the alarm interrupt and nature of the voice alert mode. The overall performance of the system will also be discussed.

Analysis of Tracking Error Effects for the Fresnel Mirror Solar Concentrator. YONG ZHAN and RONALD COSBY, Ball State University, Muncie, IN 47306.—A line-focusing Fresnel mirror solar concentrator consists of long mirror segments placed on a base such that incident sunlight is redirected to a desired focal line.

Since sun-tracking is required and economic considerations force the use of simple tracking equipment, proper design requires information on the effects of tracking errors. In this project, optical ray tracing and energy analysis has been used to model this type of concentration under imperfect sun-tracking conditions. Specifically, the model includes mathematical expressions for finding the intensity profiles of concentrated sunlight in planes above the mirror. An Ada computer program has been written to generate intensity profile data for selected ranges of tracking errors and concentrator parameters. Data analysis includes graphical display of profiles, computation of geometrical concentration ratios, and comparisons of the results with the perfect tracking case.

