PHYSICS AND ASTRONOMY

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ABSTRACTS

A Feasibility Study for the Detection of Radon in Water by the Liquid Scintillation Method. Alice S. Bennett, Cheryl A. Bye, Hsin-I-Kao, David R. Ober and Michele M. Vakili, Ball State University, Muncie, Indiana 47306.—A Beekman LS 3801 liquid scintillation counting system was used to determine radon concentration levels in drinking water. Samples were prepared by introducing 10 ml of sample into the glass counting vial under 5 ml of scintillator flour. Calibration of the system was achieved by preparing Rn-222 standards from Ra-226 source solutions.

Radon concentration levels were determined for several wells and sources in east-central Indiana. One site was monitored daily for a period of two weeks in an attempt to establish baseline data for local fluctuations. In a separate study the activities for two samples were determined daily for sufficient periods of time to confirm that the characteristic 3.82-day half life associated with Rn-222 was being observed.

Real-time Holographic Interferometry of Vibrating Structures. Richard Booe and Uwe J. Hansen, Department of Physics, Indiana State University, Terre Haute, Indiana 47809.—The ability of critical replacement of the hologram in the exposure location to within a fraction of a wavelength of the recording light opens the possibility of observing interference between the reconstruction of the holographic image of the undeformed object with the light reflected from the displaced surface of the object. Generally the contrast between interference fringes for vibrating systems under such circumstances is insufficient for critical study. This study reports an attempt to increase that contrast by pulsing the laser illumination at the frequency of object excitation.

Optical Analysis of a Reflecting Strip Solar Concentrator. Clarence Brooks and Ronald Cosby, Department of Physics and Astronomy, Ball State University, Muncie, Indiana 47306.—Fresnel mirrors using flat reflective strips constitute one possible method for reducing the cost of reflective-type solar concentrators. In this project, the design and performance of a perfectly tracking, line-focusing concentrator is studied using an optical ray trace analysis. For constant width mirror strips mounted on a flat base, strip tilt angles and positions are determined for sunlight concentration on a flat finite-width absorber located at a selected focal position. Computation of the intensity distribution of concentrated sunlight in the absorber plane is described.

Solar Food Drying in the Republic of Guinea. Alseyni Diallo and Ronald Cosby, Department of Physics and Astronomy, Ball State University, Muncie, Indiana 47306.—Drying is an important method of food preservation in the tropical Republic of Guinea, especially for the dietary staple fish. Primary methods for fish drying range from the expensive use of charcoal and other fuels to open air solar drying. The use of solar food dryers to dry fish economically, rapidly and in a protected environment is proposed. Load considerations are reviewed and include the moisture diffusion processes and drying stages present. A solar dryer design is presented and progress on a dryer analysis is discussed.

Initial Studies of Radon Gas at Mammoth Cave National Park Using Activated Carbon Canisters. Vincent A. DiNoto, Jr., Jefferson Community College Southwest, Louisville, Kentucky 40272 and John Swez, Indiana State University, Terre Haute, Indiana 47809.—Radon gas (Rn-222) has been monitored at Mammoth Cave National Park since the middle 1970s. The monitoring has been done on a weekly basis using high volume air samplers and alpha particle detectors. The method used is the Kusnetz method. The levels measured within Mammoth Cave vary throughout the year and are dependent upon the temperature and pressure of the air outside the cave. These two meteorological parameters cause a change in the flow patterns of the air within the cave system. The levels which have been measured have been between 0.5 and 1.2 working levels.

During the spring and summer of 1987, we began a monitoring program of the cave system using activated carbon canisters. The canisters were counted on a multichannel analyzer with a NaI photomultiplier. Gamma rays of the Radon daughters were measured. The initial results of this data will be discussed.

Contributions of the Ford Foundation to Astronomy. Frank K. Edmondson, Department of Astronomy, Indiana University, Bloomington, Indiana 47405.—"Who have made the most important contributions to Astronomy?" Harlow Shapley answered this in the 1930s by naming Andrew Carnegie and John D. Rockefeller. The Carnegie Institution of Washington had built and supported the Mount Wilson Observatory, and the Rockefeller Foundation had funded the construction of the 200-inch Palomar telescope. The name of Henry Ford should be added to this list because the Ford Foundation provided funds in the 1960s for four important astronomical projects in the southern hemisphere: 1) The European Southern Observatory (ESO), $1,000,000, 1959 (paid 1964); 2) The Yale-Columbia Astrograph in Argentina, $750,000, 1960; 3) CSIRO for the Australian Solar Radio Telescope (Radioheliograph), ($550,000 plus a supplement of $80,000) = $630,000, 1962 & 1966; 4) Association of Universities for Research in Astronomy, Inc. (AURA) for half the cost of the Cerro Tololo (Chile) 150-inch telescope, $5,000,000, 1967.

These four grants will be discussed with special attention to the first and last, ESO and AURA.

An Effective Lagrangian for the Bosonic Sector of the Standard Model with a Heavy Fermion. Eduardo V. Flores, Department of Physics, Indiana State University, Terre Haute, Indiana 47809.—This paper is a study of the effects of a one-fermion family with a heavy particle in the low-energy boson sector of the Standard Model. In this approach, one of the fermion masses is light (m) and the other is heavy (M). At the one-loop level, heavy-fermion mass effects proportional to M^2 and ln(M/m) have been found. The form of the structures present in the effective Lagrangian has been

found by studying the symmetries of the path integral in the presence of a heavy fermion. For the sake of manageability, only the case of a heavy Higgs boson will be illustrated.

The Physics of Steel Drums. UWE J. HANSEN, Department of Physics, Indiana State University, Terre Haute, Indiana 47809; THOMAS D. ROSSING AND SCOTT HAMPTON, Department of Physics, Northern Illinois University, DeKalb, Illinois 60115.—The normal modes of vibration of a musical instrument contribute significantly to the radiated sound. The boundary conditions associated with individual sections of a steel drum, along with the inherent stiffness of the steel are conducive to considerable coupling between sections. The inherent normal modes of steel drum sections along with their relative coupling between sections has been studied using holographic interferometry and impulse excitation modal analysis. Results of the two techniques will be compared.

Pedagogical Advantages of SDI. R.H. HOWES, Department of Physics and Astronomy, Ball State University, Muncie, Indiana 47306.—Examples drawn from the technologies of SDI, popularly known as Star Wars, illustrate simple principles of physics such as the conservation laws. Although the physics and mathematics involved in these examples are very basic, they demonstrate some of the major technical issues involved in the debate over the feasibility of space based defenses against nuclear missiles. Real-world examples dealing with current issues show beginning physics students that even algebra-based physics can provide quantitative and relevant results on politically important problems. Students begin to dare to apply common sense estimates and back-of-the-envelope calculations using basic physics to problems drawn from the world around them. At the same time, better students become interested in learning the more advanced physics behind the sophisticated weapons described in these simple examples.

Air Resistance of the Ball-and-string Pendulum. M. MCINERNEY, Rose-Hulman Institute, Terre Haute, Indiana 47803.—The air resistance of a simple pendulum consisting of a golf ball supported by a nylon fishing line was studied experimentally by varying the length and width of the fishing line. With this technique we were able to distinguish between the air resistance due to the ball and that due to the line. Resistance terms linear and quadratic in speed were found and compared with theory. We found that the linear air resistance of the nylon line varied with width in contradiction to theory; and that the quadratic resistance of the golf ball was larger (at low speeds) than that of a smooth sphere in agreement with the observations of others. This work was supported in part by a grant from the Indiana Academy of Science.

An Orthogonal Least Squares Method for Data Correlation. BENJAMIN P. MILLER AND HOWARD E. DUNN, University of Southern Indiana, Evansville, Indiana 47712.—An orthogonal least squares method was developed for linear correlations of data sets in which both variables are subject to uncertainties in measurement. The method is based on expressing a standard linear regression solution in a rotated coordinate frame. The angle of rotation is determined for this line fit to satisfy the orthogonal least squares condition. The solution was found to be sensitive to the relative numerical scales of the two variables, but its application is considered appropriate to data sets rescaled to a particular dimensionless form which gives equal weight to both variables. A versatile computer program was developed for application of the method.

Determination of Indoor Radon Concentration Levels by Detecting Daughter Decay Products with a Geiger Counter. David R. Ober and Clifford M. Rotenberg, Department of Physics and Astronomy, Ball State University, Muncie, Indiana 47306.—Air samples were drawn through 0.8-micron Millipore filters (AAWP 047 00) at a rate of 20 liter/minute for 15 minutes. The air filter was placed between two facing GM tubes and count rates were obtained for 10-15 successive one-minute intervals. Count rates obtained by this method were compared to daughter concentration levels of radon and radon daughters measured by gamma-ray/high volume air sampler and canister methods, respectively. This simpler sampling and counting procedure was sensitive to radon levels at 0.5 pCi/liter; the procedure was found to be portable, quick, inexpensive, and quite suitable for detecting relative variations in concentration levels of radon daughters.

Physics of Concentrator Solar Cells. Momtaz Shaheen and Ronald Cosby, Department of Physics and Astronomy, Ball State University, Muncie, Indiana 47306.—Solar cells used with solar concentrators are exposed to varying and high levels of illumination. For dispersive concentrators, the concentrated sunlight intensity and its spectral content are non-uniform across the cell. Thus, P-N junction theory used as part of a concentrator solar cell model must consider high level injection and an appropriate absorption model. In this paper, a simple model of an N+-*P*-*P*+ concentrator solar cell is reviewed and extensions considered. Solutions of the continuity equations for excess carriers are presented and cell current-voltage relations are given.

Demonstration of the Charcoal, Cannister Method of Radon Detection. John Swez, Department of Physics, Indiana State University, Terre Haute, Indiana 47809.—The charcoal absorption technique is now very widely used to measure indoor radon concentrations. The technique requires exposing activated charcoal within a metal cannister for a period of two to seven days in an area of suspected radon concentration. After this passive period, the charcoal is counted for gamma rays emitting from radon daughters. A laboratory experiment demonstrating this procedure will be conducted. Different methods of evaluating radon daughter concentrations, the influence of changing exposure conditions such as relative humidity, radioactive daughter decay calculations and various techniques of calibration will also be briefly mentioned. Handouts will be provided so that the audience can easily understand the methodology involved.

Solution of Maxwell-Lorentz Equations in Co-moving Coordinate Systems. James B. Westgard, Department of Physics, Indiana State University, Terre Haute, Indiana 47809.—The general solution to the charged particle equations of motion is particularly elegant in a co-moving coordinate system. By defining a velocity field (representing a set of initial conditions) the equation becomes a particularly simple, partical differential equation. The calculations are performed in covariant form throughout, and the solution is seen to be related to conservation of canonical momentum. Examples of solutions for simple cases are given.

Measurement of Atmospheric Turbidity in Central Indiana. Bruce Wilcoxen and Walter Carnahan, Department of Physics, Indiana State University, Terre Haute, Indiana 47809.—We report the measurement of atmospheric turbidities in the area around Indianapolis. The turbidities have been measured by means of a sunphotometer calibrated on Mt. Evans. The turbidities have been measured at five wavelengths. Four of these wavelengths are coincident with the first four Thematic Mapper bands; the fifth is the World Meteorlogical Organization standards at 500 nm. The spectral information is analyzed to determine the particulate size distribution.