

Astronomy, Mathematics and Physics

QUANTITATIVE ANALYSIS OF BACKGROUND RADIATION PARTICLE TRACKS IN A LARGE DIFFUSION CLOUD CHAMBER USING “IMAGEJ” DIGITAL IMAGING TECHNIQUES. Robert Brik¹ & David B. Hagan², ¹Massachusetts Institute of Technology 02139 and ²Science Museum of VA, 2500 W. Broad St., Richmond VA 23220. Cloud chambers are used to view radiation trails from solar, cosmic, and terrestrial sources. Image processing software was utilized to identify and quantify the differences between various particles. Alpha, Beta, Proton, and Muon particle images were analyzed to determine every particle's general geometry. Images were collected from the manufacturer, from photography, and from video. Each image was thresholded and then a statistical analysis was run. The particles' were found to have certain characteristics that made them distinct and easily identifiable by imaging software. Some of the more distinguishing traits were shown to be the ratio of area to perimeter, Feret's diameter, intensity skew, kurtosis, and circularity. Additionally, it was shown that a particle may produce various streaks, such as an almost circular point and a long straight line. These variations initially look like different particles; therefore, these similarities and variations have been catalogued as different types of the same particle. Using image analysis to isolate and count the particles allows for more efficient experimentation and a decrease in experimentation error.

SOLVING MATH WORD PROBLEMS WITH ENGLISH GRAMMAR. Richard A. Garrett & Richard S. Groover, Dept. of Math & Science, J. Sargeant Reynolds C.C., Richmond, VA 23228. A short term study in overall student effectiveness solving mathematical word problems took place during Spring 2009 academic semester. Developmental math students, who are prone to higher levels of math anxiety, were essentially learning new problem solving methods despite the fact that their course work was largely review. Students included were studying Algebra and were given a method for solving word problems in their classroom. The method involves breaking sentences down and analyzing their component pieces which are marked by grammar symbols. By properly analyzing these key points in every English sentence within the original problem, students were able to use their own knowledge of the language in order to create a reference map in order to translate English into Mathematics. A complete math problem is then constructed and solved by combining each piece. Encouragement in practicing this method resulted in overwhelmingly positive success rates regarding final answers and pattern recognition. Additionally, students who practiced this method showed higher confidence levels in Mathematics and became more self-motivated in solving problems.

INFRARED EMISSION PROPERTIES OF Nd: KPb₂Br₅ FOR SOLID STATE LASERS. C. Hanley¹, E. Brown¹, U. Hömmerich¹ & S. Trivedi², ¹ Department of Physics, Hampton University, Hampton VA 23668 and ²Brimrose Corporation of America, Baltimore MD 21236. We report on the crystal growth and optical properties of Nd:KPb₂Br₅ crystals for potential applications in mid-infrared (MIR) solid-state lasers. Following optical pumping at 800 nm, Nd:KPb₂Br₅ exhibited a broad MIR

emission centered at $\sim 5.25 \mu\text{m}$ with a bandwidth of $\sim 730 \text{ nm}$ at full width half maximum. For a moderate Nd^{3+} concentration of $\sim 5.5 \times 10^{19} \text{ cm}^{-3}$, the mid-IR was predominantly due to transition ${}^4\text{I}_{11/2} \rightarrow {}^4\text{I}_{9/2}$. The peak emission cross-section obtained using the Fuchtbauer-Ladenburg method was $\sim 0.6 \times 10^{-20} \text{ cm}^2$. The MIR emission lifetime was measured to be $\sim 50 \text{ ms}$ at room temperature. The radiative lifetime obtained from a Judd-Ofelt analysis was $\sim 47 \text{ ms}$, which indicates a MIR emission quantum efficiency near unity. The obtained spectroscopic results suggest the possibility of a MIR laser operating at $\sim 5.5 \mu\text{m}$ based on Nd: KPb_2Br_5 . However, further improvements in the purification and crystal growth of Nd: KPb_2Br_5 are necessary to obtain laser quality samples. This study was funded in part by the National Science Foundation and Army Research Office.

MASSIVE AND MASSLESS BOSONS WITHOUT A HIGGS POTENTIAL. Joseph D. Rudmin, Integrated Science and Technology Dept., James Madison University, 800 S. Main St., Harrisonburg, VA 22807. In 1967, Steven Weinberg, Sheldon L. Glashow, and Abdus Salam published their "WGS Theory" which describes many observed fermions and bosons, and the symmetries of their interactions, and explains why the weak force which transforms those symmetries has short range while the electromagnetic force has long range. This theory offers a unified description of the weak force and electromagnetism. It received the 1979 Nobel Prize in Physics, partly due to its remarkable success in explaining the masses of many particles, and how they interact. However, the Higgs potential mechanism of WGS Theory predicts the Higgs boson, which has not yet been observed. This paper presents an alternative mechanism based on the effects of fermion polarization, for achieving the same result, and some further paradoxes and problems with both mechanisms.

MICROPROCESSOR ARITHMETIC--EFFICIENT LONG DIVISION AND MULTIPLICATION IN ANY NUMBER BASE WITHOUT A MULTIPLICATION TABLE. Joseph W. Rudmin, Dept. of Physics and Astron., James Madison Univ. 22807. Digital accuracy of standard numeric formats is limited by computer processors and by software. Such limitations in 2009 are presented. Methods of avoiding these limits and alternative arithmetic algorithms are presented, including the Russian Peasant Method, and two methods of long division, one of which is suitable for almost arbitrarily large numbers, and the other a new algorithm for long division which does not use trial divisors, and uses only the mathematical operations of shift, add, and subtract.

YORK RIVER, VA WATER TEMPERATURES AS SURROGATES FOR HISTORICAL WATER TEMPERATURES ELSEWHERE IN CHESAPEAKE BAY, VIRGINIA. Thomas C. Mosca III¹ & W.C. Coles², ¹Dept of Mathematics, Rappahannock Community College and ²Division of Fish and Wildlife – Department of Planning and Natural Resources. Temperature is one of the fundamental physical parameters of a body of water, and the rate and magnitude of marine chemical, physical and biological events are highly dependant upon water temperature. However, there are few long-term water temperature data sets in the Chesapeake Bay to establish

temporal trends. The water data maintained by the Virginia Institute of Marine Science (VIMS) at Gloucester Point, VA on the York River are the only continuous long-term water temperature data available for the Virginia portion of the Chesapeake Bay. The purpose of this paper is to present regression equations to predict water temperatures in eight regions of the Chesapeake Bay (upper and lower Virginia portions of the Bay, upper and lower portions of the James, Rappahannock and York rivers), from the VIMS temperature data. These regressions may be used to correlate temperatures with other documented data, and to fill holes in other data sets. We compared the monthly mean temperatures at VIMS to temperatures gathered on a monthly schedule in eight strata of Chesapeake Bay and the three major tributaries. The relationship between the VIMS pier temperatures and temperatures measured in other parts of Chesapeake Bay is very strong ($R^2 \geq 95\%$), and therefore is a useful surrogate for temperature in ecological studies of other parts of the lower Chesapeake Bay.

CONCENTRATION DEPENDENT STUDIES OF THE LASER-INDUCED INFRARED EMISSION FROM KCl-NaCl TABLETS. O. Oyebola¹, U. Hömmerich¹, E. Brown¹, Clayton S. C. Yang², S. B. Trivedi³, A.C. Samuels⁴ & A.P. Snyder⁴, ¹Department of Physics, Hampton University, VA 23668, ²Battelle Eastern Science and Technology Center, Aberdeen, MD 21001, ³Brimrose Corporation of America, Baltimore, MD 21236, and ⁴Edgewood Chemical Biological Center, Aberdeen Proving Ground, MD 21010. Laser Induced Breakdown Spectroscopy (LIBS) has emerged as a widely used analytical technique to determine the elemental composition of chemical substances. Most previous LIBS studies were performed in the ultraviolet to near-infrared (~200-980 nm) spectral region. In this work, results are reported on the extension of conventional LIBS to the mid-infrared (mid-IR) spectral region from 2-5 μm . Pumping with a pulsed Nd: YAG laser (1064 nm), mid-IR LIBS signatures were observed from solid KCl tablets at 2.72 μm , 3.15 μm , 3.77 μm , and 4.05 μm . In agreement with the NIST spectral database, the observed mid-IR emission lines were assigned to atomic transitions between higher lying energy states of neutral potassium (K) atoms. Further IR LIBS studies on KCl focused on the 2.72 μm emission line due to its relatively high intensity. A series of KCl-NaCl tablets with different amounts of potassium were prepared to determine the mid-IR LIBS detection limit of potassium. The preliminary results indicated a LIBS detection limit of 0.5wt% of potassium in the prepared KCl-NaCl samples. This study was funded in part by the Army Research Office.

STOCHASTICITY AND SPONTANEOUS SYMMETRY BREAKING IN THERMALLY INDUCED BENDING VIBRATIONS OF STRUCTURES. Anthony A. Teate, Department of Integrated Science and Technology, James Madison University, 800 S. Main St., Harrisonburg, VA 22807. A model is developed for thermally induced bending vibrations of uniformly heated beams in still air that assumes a non-linear dependence of the ratio of the unsteady to the steady-state component of the heat transfer coefficient on the velocity of the bending vibrations. This model also includes a *stochastic driving term* to account for the effects of thermal fluctuations in the ambient air and the concomitant random impacts on the beam and yields a non-linear, stochastic description of the heated vibrating beam for the

dimensionless displacement $S(t)$ of the form:

$$\frac{d S(t)}{dt} = \alpha_1 S - \alpha_2 S^3 + \tilde{F}(t) \quad \text{where } \tilde{F}(t) \text{ is purely random,}$$

stationary, Gaussian, process with zero mean, and represents the effects of the amplitude fluctuations due to the random impacts of the ambient air on the beam and

where the α_i are constants dependent upon the thermal and modal bending moments, damping ratio and the phase difference between the velocity fluctuation and thermal bending moments. We solve the stochastic differential equation by constructing a symmetry breaking, bi-stable *Thermal Potential Energy Function*, a Lyapunov global stability function which permits a general investigation and analysis of the system's stability and the effects of pressure on thermally induced bending vibrations.

ASTRONOMICAL POLARIMETRY AT VIRGINIA MILITARY INSTITUTE.

Gregory A. Topasna, Daniela M. Topasna & Gerald B. Popko, Department of Physics and Astronomy, Virginia Military Institute, Lexington, VA 24450. We present current work on the design, construction, and testing of a two-beam optical polarimeter to be used with the 20-inch telescope at the Virginia Military Institute observatory. The basic operation of the device will be discussed as well as results which demonstrate the two-beam method in the laboratory. Issues regarding automation and data handling as well as planned observations will be presented.

Biology

DELAYED TREATMENT WITH SILDENAFIL ATTENUATES ISCHEMIC CARDIOMYOPATHY. V.Q. Chau, F.N. Salloum & R.C. Kukreja. Div. of Cardiology, Virginia Commonwealth Univ., Richmond, VA 23298. We previously showed that chronic inhibition of phosphodiesterase-5 (PDE-5) with sildenafil immediately after permanent occlusion of the left anterior descending coronary artery (LAD) limits myocardial infarction (MI)-induced heart failure (HF) in mice. To mimic more clinical scenarios, we hypothesized that chronic treatment with sildenafil beginning at 3 days post MI would also preserve LV function and reduce HF progression. Adult male ICR mice underwent MI by permanent ligation of the LAD after baseline echocardiography was performed. Three days post MI, a repeat echocardiography was conducted. Mice with LV fractional shortening (FS) less than 25% received sildenafil (21 mg/kg; ip; BID, Group I) or volume-matched saline (Group II) for 25 days. At the completion of 28 days following MI, the mice underwent a repeat echocardiography prior to sacrifice. Group I expressed less LV dilatation than group II, and group I showed better contractility as compared with group II. LV end-diastolic diameter (LVEDD), increased from a baseline value of 3.4 ± 0.1 mm to 4.2 ± 0.1 at 72 hr post MI. At 28 days post MI, LVEDD was increased to 5.2 ± 0.1 mm for group II, as compared 4.6 ± 0.1 mm in group I ($P < 0.05$ vs. Group II). Fractional shortening decreased from a baseline value of $47 \pm 1\%$ to $19 \pm 1\%$ at 72 hr following MI. At 28 days post MI, FS was $21 \pm 1\%$ for group I and $13 \pm 1\%$ for group II, ($P < 0.05$ vs.