Statistical analysis showed that the anthocyanin group was protected from gross developmental deficiencies over the binge alcohol group in regards to average body weight, crown-rump length, telencephalon size and liver size ($p<0.05$). While not delineating the mechanism, these preliminary results are the earliest support of the hypothesis that the antioxidant properties of blueberry anthocyanins mitigate the gross teratology effects of prenatal binge alcohol exposure. (Research supported in part by the Daniel B. Suter Endowment in Biology, Eastern Mennonite University.)

Posters

DEVELOPING TOOLS FOR TRAP CROPS: ELUCIDATING THE BIOSYNTHETIC PATHWAY OF THE AGGREGATION PHEROMONE MURGANTIOL IN THE HARLEQUIN BUG STINK BUG (*MURGANTIA HISTRIONICA*). Jason Lancaster[1], Dawn Gundersen-Rindal[2], Donald C. Weber[2] & Dorothea Tholl[1], [1]Biological Sciences, Virginia Tech, Blacksburg, VA 24061 & [2]USDA-ARS, Beltsville, MD. Harlequin bug (*Murgantia histrionica*) is a stink bug pest in the southeastern United States that feeds on crucifer crops and can cause considerable economic loss. Adult male harlequin bugs release the sesquiterpenoid aggregation pheromone murgantiol, which attracts other conspecifics to the host plant to feed and mate. Terpenoid aggregation or sex pheromones are produced by a variety of insect taxa, but their biosynthesis is largely unexplored. This project aims to identify the biosynthetic pathway as well as the tissue-specific site of biosynthesis of murgantiol in harlequin bug. We hypothesize that murgantiol is synthesized in a two-step pathway with a dual function prenyldiphosphate synthase/terpene synthase enzyme catalyzing its first step. RNAseq analysis identified a candidate gene, *MhFPPS1*, which is highly expressed in mature males but not in females, and may encode the proposed dual function synthase in murgantiol biosynthesis. We are in the process of functionally characterizing recombinant MhFPPS1. Moreover, we are currently using tissue dissection and transmission electron microscopy to examine the presence of murgantiol pheromone glands and *MhFPPS1* expression in these tissues.

**Astronomy, Mathematics, and Physics with Material Science**

TAPE-INFLUENCED INFRARED AND THERMAL POWER GENERATION. Graham P. Gearhart, Brian C. Utter, & Giovanna Scarel, Department of Physics & Astronomy, James Madison University, Harrisonburg VA 22807. Infrared (IR) radiation can be harvested and turned into an alternative source of energy through the use of a power generator (PG) device. A glowbar source generates IR radiation which is then directed onto the PG device for an extended period of time, and a voltage is generated. Our data suggests voltage and temperature are influenced by both the color and presence of tape in IR power generation, and that it does not behave as thermoelectric power generation.

DESIGN OF A NOBLE GAS CERENKOV FOR THE SUPER HIGH MOMENTUM SPECTROMETER FOR 12 GEV AT JEFFERSON LAB. Donal Day & Mikhail Yurov, Department of Physics, University of Virginia, Charlottesville, VA 22904. The 12 GeV upgrade of the accelerator and the associated experimental facilities at Jefferson Lab will provide innumerable new opportunities for nuclear science. In Hall C the new Super High Momentum Spectrometer (SHMS) will provide excellent angular and momentum resolution up to a maximum central momentum of 11 GeV/c and a diverse set of directed studies, from the spin structure of the neutron to multi-nucleon correlations in nuclei, are planned. These and other approved experiments demand robust particle identification. As part of the electron identification and pion rejection package, a 2 meter long, 4-mirror noble gas Cerenkov counter is being built. The design principles, expected performance and status of the project will be presented.

DETERMINING A MATHEMTICAL MODEL FOR A VOLTAGE INDUCED, EXCLUSIVELY TEMPORAL SOLITON. Aidan L. Gordon, Brian C. Utter, & Giovanna Scarel, Department of Physics & Astronomy, James Madison University, Harrisonburg VA 22807. Infrared radiation (IR) can be converted into a usable alternate source of energy. Here we study the voltage produced by a power generator device irradiated by IR radiation over a long period of time. We find features that suggest the existence of solitons and here we present some results of our study of their dynamics.

TWO-PHOTON EXCHANGE CONTRIBUTION TO ELASTIC ELECTRON-PROTON SCATTERING. Mikhail Yurov, Department of Physics, University of Virginia, Charlottesville, VA 22904. Two experimental techniques, Rosenbluth separation and recoil polarization transfer, used to extract proton's electromagnetic form factors ratio $G_E/G_M$ yield markedly different results. Modern theoretical calculations suggest that two-photon exchange might be responsible for the observed discrepancy and that it is epsilon dependent. Jefferson Lab Experiment E05-017 was designed to measure the two-photon exchange contribution over a wide range of $\varepsilon$ and $Q^2$. In contrast with the conventional Rosenbluth method, E05-017 detected the elastically scattered proton rather than the electron. This approach returns a much more precise extraction of the form factor ratios. After a brief description of the experimental goals and techniques, the current status of the analysis will be presented.

A PRECISION MEASUREMENT OF ISOSPIN DEPENDENCE IN THE 2N AND 3N SHORT RANGE CORRELATION REGION. Dien Nguyen & Donal Day, Department of Physics, University of Virginia, Charlottesville, VA 22904. Short Range Correlations (SRCs) have been recognized as responsible for the high momentum tail of the nucleon momentum distribution. Several experiments at Jefferson Lab have exploited inclusive scattering to study these SRCs. In an upcoming tritium experiment (E12-11-112) at Jefferson Lab, we will perform a precision test of the isospin dependence of two- nucleon short range correlations using mirror nuclei: $^3$He and $^3$H. The data taken at x>2 will also be used to study three-nucleon short-range

correlations. In this talk we will briefly present the motivation for this experiment as well as some of the experimental details and the expected results. In addition, we will discuss a method to check the absolute target thickness of both targets through elastic scattering.

OPEN EDUCATIONAL RESOURCES IN COLLEGE MATHEMATICS. Thomas C. Mosca III, Rappahannock Community College, Department of Mathematics, Warsaw, VA 22572. An open source teaching resource was examined and applicability to teaching undergraduate mathematics was discussed. The resource, MyOpenMath, is available free and without restrictions. The resource consists of PDF textbooks, and software having testing capability, self-grading homework, and tutorial videos, many of which are linked to particular homework problems. While not as well polished as textbooks and testing/ homework software available from established publishers, it was found to be adequate to the needs. Further refinements in grade keeping, homework and the ability to add and edit test problems are needed. Textbooks are lacking in scope, requiring the use of two texts by different authors to cover course material, leading to clumsiness in the transition from one to the other.

COMPUTATIONAL METHODS AND TOOLS FOR MODELING AND SIMULATING THE ELECTRONIC STRUCTURE AND TRANSPORT PROPERTIES OF MATERIALS USING THE PYTHON PROGRAMING LANGUAGE. Anthony A. Teate, Dept. of Integrated Science & Technology, James Madison University, 701 Carrier Drive, Harrisonburg, VA 22807. The Python Programming language has proven to be quite a robust tool for scientists and engineers. Several widely used packages, from computational physics to molecular modeling, have been developed primarily in the Python language or provide an interface to their API via Python. The extensibility of the language with open source add-on packages such as NumPy and SciPy as well as plotting packages such as Matplotlib can serve as the foundation for a complete exploratory research environment in numerical modeling and simulation. Here we use Kwant, another open source Python package, to perform numerical calculations on tight-binding models. We compute the electronic band structure and quantum transport properties of simple two-dimensional nanoscale (mesoscopic) systems. We show how sparse tight-binding Hamiltonians for graphene are easily solved by Kwant, and are used to calculate energy band structure as well as the quantum conductance even in the presence of localized defects in the system lattice. We also demonstrate how the combination of the tight-binding model approach and the Kwant package can be used in an undergraduate class on computational modeling and simulation of nanoscale materials using the Python programming language.

IONIC SELF-ASSEMBLED MONOLAYERS THIN FILMS FOR OPTICAL pH SENSORS. D. M. Topasna, M. Liu, & CH. Tseng, Department of Physics & Astronomy, Virginia Military Institute, Lexington, VA 24450. Ionic self-assembled monolayers thin films made from polymer and organic dye molecule were studied for optical pH sensing coatings. A number of films were fabricated in order to determine

the optimized parameters of the polymer and of the organic dye solutions. Optical pH responses of these films were also studied. The transparent films were immersed in solutions at various temperature and pH values. We found that the films are stable when immersed in solutions with pH values below 9.0 and temperatures below 90°C and they are still functional after longer immersion times. We will use the results of this project as a basis for future work with ionic self-assembled monolayers to build various sensors and exploit more sensing platforms.

ANALSIS OF THE POLARIZATION TECHNIQUES USED WITH THE VMI OPTICAL POLARIMETER. G. A. Topasna, Dept. of Physics & Astronomy, Virginia Military Institute, Lexington, VA 24450. An analysis of the precision of the aperture photometry technique used to determine the linear polarization of stellar radiation with the VMI optical polarimeter is presented. It is shown that variations in the ON aperture radius and OFF annulus radii contribute no greater than 0.01% to the uncertainty in the degree of polarization and that the polarization position angle has an uncertainty on the order of 0.1° for high S/N ratio measurements. Using these results we show that three polarization standards, HD 198478, HD 183143, and HD 187929 exhibit variation in polarization with a maximum difference of 0.2%, 0.3%, and 0.1% over the time period spanning 3 September 2013 to 21 November 2014.

HISTORICAL NOTES ON TWO COLD WAR SURVEILLANCE PROJECTS. James D. Lehman, Retired, Physics Department, James Madison University, Harrisonburg, VA 22807. Post WWII saw a concerted effort by the military and private agencies to collect information on the Soviet Union and Allies as to military capabilities. The National Security Agency was formed in 1948 from separate Intelligence Services of the Army, Air Force and Navy. A National Forest site in a mountain valley of Pendleton County, West Virginia was available for the first of two major projects. The Washington Naval Research Laboratory, NRL, advocated using the Moon as a passive reflector of Earth's electronic communication. After two preliminary testing projects, the 600 foot diameter Big Dish Radio Telescope was under construction in 1956 and was scheduled to be completed in five years. "Cover" of the highly secret installation was provided by staff astronomers and the close proximity of NRAO, Green Bank, WV. From the beginning there were cost over runs and little sequential movement from planning to design to actual construction. The Dept. of Defense killed the project in 1962. Site preparation began immediately for the second of the major projects. Double 900 ft. diameter Wullenweber antennas were constructed on site. An inland Naval Base accessed use of the receiving facilities, and served as "cover" for this highly secret interceptor project. The Wullenweber era served well in surveillance for three decades of the Cold War. Fifty or more of these sites worldwide were dismantled by the mid-1990's.

Posters

ARCTIC CLIMATE CHANGE: A SIMPLE MATHEMATICAL MODEL OF THE MELTING ARCTIC. Stephanie Norwood & Iordanka N. Panayotova, Dept. of Mathematics & Computer Science, Virginia Wesleyan College, Norfolk, VA 23502. Due to global warming there is an accelerated melting of the Arctic ice caps. Observations show that summer sea ice cover has been disappearing at approximately 70,000 $km^2$ per year. While the shrinking of the Arctic sea ice is a serious problem, an even bigger problem is the thinning of the ice. Measurements from submarines indicate that the ice has thinned by about 40% over the last two decades. When the area of the ice decreases, it replaces an area of white, which reflects about 90% of the solar radiation, by water surface, reflecting less than 10% of the solar radiation. This effect can additionally raise the global average rate of warming and the melting Arctic will contribute to a global sea level rise. In this work, we created simple mathematical models to study the changes in the sea ice area and thickness. We assumed that the ice melts at a rate proportional to the area present at time t, and used the fact that the sea ice is disappearing at approximately 70,000 $km^2$ per year. Fourier's law of heat conduction was used to create a differential equation for the rate of the melting ice. Despite the simplicity, the models capture some of the main features of ice melting/growing. The summer sea ice extent will decrease twice for less than 50 years. The ice thickness grows as the square root of time, meaning that with the increase of the ice thickness, the growth rate slows down, and inversely, with the decreasing of the ice thickness the melting process speeds up. Both models predict that the effect of climate change on Arctic caps will be devastating, resulting in their disappearing in our lifetime.

MATHEMATICAL MODEL OF EBOLA OUTBREAK. Nicole Johnson & Iordanka N. Panayotova, Dept. of Mathematics & Computer Science, Virginia Wesleyan College, Norfolk, VA 23502. The Ebola Virus originates in West Africa. The Ebola Virus Disease (EVD) has become a crisis in West Africa, centralized around Liberia, Sierra Leone, and Guinea, and is a potential threat to other areas of the world as United States and European Nations. Because the Ebola virus spreads only through direct contact with bodily fluids and not via airborne means like the influenza virus, its spread is easier to control than the influenza virus. But since there is no vaccination currently available for EVD, only physical methods can be used to limit contact by the susceptible population with the living virus. The objective of this project was to create a mathematical model of the spread of Ebola outbreak. The model used time as independent variable and the number of susceptible people, number of infected, number of death, and number of recovered as dependent variables. System of differential equations describing the variation between the dependent variables was created. The contact rate, the death rate and control measures parameters have been derived using real data from the latest outbreak in 2014. The model assessed the impact transmission control measures, such as providing medical facilities, protective garments, cleaning detergents, bags, and training to the population, would have on an outbreak.

Particularly, the model showed that applying transmission control measures is a viable way to mitigate negative impact of the outbreak by decreasing the ultimate number of people infected and who die. Conclusions of this model were supported by the findings from the observational studies during 2014 outbreak in Sierra Leone and Liberia.

PREDATOR OR PREY: MATHEMATICAL MODEL OF THREE SPECIES INTERACTIONS IN CHESAPEAKE BAY. McKenzie Dowd & Iordanka N. Panayotova, Dept. of Mathematics & Computer Science, Virginia Wesleyan College, Norfolk, VA 23502. Chesapeake Bay, the largest estuary in the United States, is an extremely complex ecosystem. The fisheries of the Chesapeake Bay play a very important role in the ecosystem, but have declined significantly as a result of overfishing, habitat loss and deterioration in water quality. Fisheries in the Bay are managed as single species entities, yet the multi-species nature of the ecosystem is very important. In this project, we created a three-species mathematical model that simulates the prey-predator interactions of three different species of the Bay ecosystem; menhaden, striped bass, and sharks. The model shows that the behavior of all three species is actually defined by the parameters affecting the bottom prey, the menhaden, and the top predator, sharks. When the product of the natural growth rate of menhaden and the propagation rate of the sharks is equal to the product of the declining rate of the menhaden in the presence of predator and the death rate of sharks in the absence of their prey, all three species have periodic behavior over time with a common period. If one of these parameters changes the whole system behavior changes, all three populations either increase without limit, or decrease over time and the top predator will become extinct first. The middle species, that play the role of prey and predator, act merely as a conduit between the bottom prey and the top predator. It is interesting to point out that both menhaden and shark populations are declining over the last 30 years by the same percentage of about 86%. The results of this model show that predator-prey interactions are very important for the whole ecosystem and have to be taken into consideration by the Fishery management who use multi-species models when taking decisions.

INVARIANT AMPLITUDES FOR DECAY OF HIGGS PARTICLE TO THREE Z BOSONS: NON-DYNAMICAL METHODS TO DISTINGUISH SCALAR AND PSEUDOSCALAR DECAYS. Deva A. O'Neil[1], Howard E. Haber[2] & Sang Y. Kim[1], [1]Physics Department, Bridgewater College, Bridgewater, VA 22812 & [2]Santa Cruz Institute for Particle Physics, Santa Cruz, CA 95064. In the CP-conserving Two-Higgs Doublet Model, the Higgs field $A^0$ is described as a pseudoscalar, due to exhibiting odd parity in coupling to fermions. However, in the absence of fermionic couplings, its parity is not well-determined. The decay of the $A^0$ to a ZZZ final state was found to be useful as a parity test for the $A^0$ in its bosonic interactions. Using non-dynamical methods, scalars and pseudoscalars were shown to produce distinct invariant amplitudes in parity-conserving decays to ZZZ. While this provides a method for experimental probing of the parity of $A^0$, the results apply to any decay of a (pseudo)scalar to three identical massive vector bosons.

A ROTATING METRIC THAT ACCOUNTS FOR THE ENERGY OF THE GRAVITATIONAL FIELD. Joseph D. Rudmin, College of Integrated Science and Engineering, James Madison University, Harrisonburg, VA 22807. The metric for a rotating field is found by equating the Einstein Tensor of a Lorentz transformed metric to a Lorentz transformed Einstein tensor of a stationary isotropic metric. In general relativity, the Einstein Equation describes how energy density and momentum density curve space and time. The Einstein Equation equates the Einstein Tensor, which is a curvature tensor, to the stress-energy tensor, which is the density of energy and momentum. The Einstein Tensor for an isotropic metric at rest has two terms, one which looks like a charge density, and the other which looks like an energy density of a field. The first term is the density of ordinary energy and momentum, and the second is the energy density of the gravitational field. The metric for a rotating field is not at rest. Since both the metric and the Einstein Tensor are tensors, they both must transform as tensors: The Lorentz transformation and the calculation of the Einstein Tensor must commute. This commutation takes the place of equating the Einstein Tensor to zero in conventional general relativity. The resulting differential equations exactly determine the metric. These equations are solved as Taylor Series, using the Parker-Sochacki method.

POLARIZATION MEASUREMENTS OF NGC 7380 IN BOTH BROAD AND NARROW BANDS. M. A. Tate & G. A. Topasna, Dept. of Physics & Astronomy, Virginia Military Institute, Lexington, VA 24450. The wavelength dependence of polarization is described by the Serkowski law $p(\lambda)/p_{max} = exp[-K\ln^2(\lambda_{max}/\lambda)]$ where $p_{max}$ is the maximum degree of polarization, $\lambda_{max}$ is the wavelength of maximum polarization and $K$ is typically taken to be a function of wavelength ($K \approx 1.86\lambda_{max}$). The Serkowski law is well-established for stellar observations using broadband filters. Previous observations of the isolated star HD 197770 using the VMI optical polarimeter have shown that it also accurately describes the wavelength dependence when using narrowband ($\Delta\lambda \sim 10$ nm) filters and that $p_{max}$, $\lambda_{max}$, and $K$ were, for both narrow and broad bands, nearly identical or within instrumental error. We made new polarization measurements for selected stars in the cluster NGC 7380 in front of the emission nebula Sh2-142. Both narrowband and broadband filters were used and the wavelength dependence of polarization was plotted. A nonlinear least squares fit to the Serkowski law was used to determine $p_{max}$, $\lambda_{max}$, and $K$. By comparing the two filter sets we find that the difference in the maximum degree of polarization is $\Delta p_{max} < 0.3$ % and the percent difference in $\lambda_{max}$ is less than 2%. However, fitted values of $K$ in the narrow band were significantly higher (>45%) than those in the broad band. Therefore, while the determination of $p_{max}$ and $\lambda_{max}$ is fairly unaffected by the choice of filters used to measure stellar polarization in the presence of the nebula emission, the values of $K$ appear to differ significantly.