1

**Individual Instruction: A Comparison Of Long-Term Trends In Four Science Departments**

Craig Rosebrock and Robert T. Dillon, Jr. Department of Biology, College of Charleston

Through the recent history of science education at the College of Charleston, students have not uniformly availed themselves of opportunities to enroll in independent research, seminars, tutorials and bachelor's essays. We performed an analysis of variance on the total enrollment in such "courses of individual instruction" over the Biology, Chemistry, Geology, and Physics Departments for the calender years 1986 to 1994. The independent variables were department, year, and F/M ratio, the ratio of faculty (tenured and tenured track) to students majoring in each department.

Only the effect of department was significant; the larger departments, Biology and Chemistry, enrolling more than Geology and Physics. Separate analysis by department showed, for both Biology and Chemistry, significant positive relationships between year and enrollment and significant negative relationships between F/M ratio and enrollment. Unexpectedly, our data suggest that enrollment in courses of independent instruction has tended to increase over the years in Biology and Chemistry, in spite of increasing faculty workload. Faculty in these two departments are especially deserving of hefty raises.

2

**The Development Of A Visualization Interface For The Groundwater Resource Database Of The Trident Area Of South Carolina**

Jacob L. Dimond and Christopher Abate, Department of Geology, College of Charleston

With increasing use of groundwater resources, detailed data on the characteristics of water wells is being collected by many regulatory agencies. In South Carolina, the Department of Natural Resources has compiled a database consisting of 1400 wells constructed in Berkeley, Dorchester, and Charleston counties, with each record possessing up to forty-one attributes. To facilitate interpretation and analysis of this database, a Geographical Information Software (GIS) interface was constructed. This interface consists of an integration of the water well data with other geographic data layers for the three county area. This
allows rapid construction of interpretive maps at any scale of interest, summary charts, and statistical graphs to visualize the spatial characteristics of the data set. Some examples of interpretive maps include: the distribution of municipal water supply wells greater than 1500 feet deep color coded by maximum yield, the distribution of domestic wells color coded by depth, and wells for which pump test data are available color-coded by transmissivity and labeled with depth. All visual elements are stored as links to the data set, not as subsets of the data itself. Thus, as the database is periodically expanded, all visual elements are automatically updated as well. Finally, it is possible to develop this interface into an end user application, giving regulatory officials, the public, teachers, and students access to relevant information involving water wells and the groundwater resource, while restricting their access to the original database.

3

Multivariate Comparisons Of Dental and Cranial Morphology Between Two Isolated Cercopithecus Mona Populations

Ronald R. Paciorek(1, 2), Dana A. Cope(1), Robert T. Dillon Jr.(2), and Mary E. Glenn(3)

(1)Department of Sociology and Anthropology, (2)Department of Biology, College of Charleston, Charleston, SC 29424-0001; (3)Department of Anthropology, Northwestern University, Evanston, IL 60628

This study was conducted to determine whether a population of the African forest guenon (Cercopithecus mona) introduced on the West Indies Island of Grenada demonstrates significant cranial and dental morphologic differentiation from a sample taken in Western Cameroon. Males and females were analyzed separately. Forty dental and cranial measurements were analyzed on 13 females from Grenada and 20 African females. Eight significant principal components were extracted from the correlation matrix over the 33 cases. Twenty-six dental measurements were taken on 16 males from Grenada and 23 African males. Eighteen significant principal components were extracted from the covariance matrix calculated over these 39 cases. The first principal component of each matrix was excluded, to eliminate size variance. Discriminant function analyses distinguished females from the two populations with 94% accuracy, and males with 97% accuracy. This high level of differentiation may be attributable to genetic drift and/or natural selection, which may have occurred over 300 years of reproductive isolation.

4

Hydrothermal Mineral Mapping Using AVIRIS Data Near Goldfield, Nevada

Nicole Albright and Robert Nusbaum, Department of Geology, College of Charleston, Charleston, SC 29424

The Goldfield district has produced more than 130 metric tons of gold, 45 metric tons of silver, and 3420 metric tons of copper. The epithermal (<1 km depth) mineralization was accompanied by intense acid-sulfate hydrothermal alteration. Classic alterations zones have been mapped by researchers including: advanced argillic, phylllic-argillic, argillic, and propylitic. The ore bodies are associated with advanced argillic zones which include alunite and jarosite. The scarcity of vegetation, dry climate, and abundance of hydrous silicates in the alterations zones, make the Goldfield district well suited for study using NASA's AVIRIS (Airborne Visible and Infrared Imaging Spectrometer) system. We used AVIRIS data to map the distribution of alunite, jarosite, montmorillonite, pyrophyllite and calcite clarify alteration zoning patterns.
and possible environmental problems associated with the epithermal mineralization. This research is supported by NASA JOVE and the South Carolina Space Grant Consortium.

---

**AVIRIS Remote Sensing Applied To The Southern Mono Lake Basin, California**

Megan Weiner and Robert Nusbaum, Department of Geology, College of Charleston, Charleston, SC 29424

Mono Basin is a closed tectonic depression located at the base of the Sierran escarpment. Prominent geologic features within the study area are: 1) the Mono Craters which form a conspicuous, swelling 12 km arc along a faulted zone north of the Long Valley Caldera; and 2) sediments marking the lowering of Mono Lake. We will present results of an AVIRIS (Airborne Visible and Infrared Imaging Spectrometer) study of volcanic, geothermal, lake shoreline, grass burned, and other features of the Mono Lake area. Maps were produced delineating lithologic units from burn areas and vegetated areas. The extent of vegetation was used to distinguish relative ages of volcanic units ranging from about 500 years to less than 10,000 years. This research is supported by NASA JOVE and the South Carolina Space Grant Consortium.

---

**Children in Homes Without Television**

William H. Moody, Faye B. Steuer, and Merillat A. Staat, Psychology Department

Four families living without television were identified through a newspaper ad. One family was eliminated from the study due to its acquisition of a television. Questionnaires were disseminated to each family and returned prior to the interview. Interviews were scheduled in the subjects' homes at their convenience. Standardized test scores were requested from the parents to determine their children's academic standing. The researchers' observations indicated that all family members engaged in normal healthy interactions and had normal social contacts outside the home. The children were generally successful in school. Participation in numerous hobbies and outside organizations were reported by each family.

---

**A Look At Pyroclastic Deposits On The Northwest Limb Of The Moon**

Cassandra R. Coombs
Department of Geology
College of Charleston

Explosive volcanic, or pyroclastic, materials are unique phases in the lunar soils. They provide important clues to the composition, distribution, and modes of emplacement of explosive volcanic materials on the Moon. Among the most primitive of lunar rocks, pyroclastic glasses directly sample depths as great as 400 km. Earth-based telescopic studies have provided most of our information concerning lunar pyroclastic deposits. Combined with the returned lunar sample studies, recent telescopic data, and analyses of lunar
photography, we continue to gather new information on the nature and origin of these materials. Based on their unique spectral signatures, two major classes and five subclasses of the lunar pyroclastic deposits have been identified. Regional deposits are more numerous, extensive, thicker, and widely distributed than previously thought, leading us to suggest that they may exhibit distinct compositional variations and that they would provide ideal resource materials for a lunar base. Returned sample studies and the recently collected Galileo and Clementine data also corroborate these findings. In addition, it has been suggested that pyroclastic deposits might prove to be an important source of lunar resources as well as an excellent site for a lunar base. Seven pyroclastic deposits were examined in this study: 3 in the Lavoisier region, one SE of Gerard, Briggs A, Cardanus, and Lichtenberg.

A Statistical Definition of the Compositional Differences Among Aquifers in Charleston County

Candice Dickhaut
Masters in Environmental Studies Program

The classification of ground water plays an important role in an understanding of the geochemical properties of an aquifer. The aquifers underlying Charleston County are: the surficial aquifer, the Santee Limestone aquifer, the Black Mingo aquifer, the Black Creek aquifer, and the Middendorf aquifer.

Water quality depends greatly on the rock formation encompassing the ground water and, in itself, is another form of classification. Statistical analyses such as the Analysis of Variance (ANOVA) test and Multiple Comparison Procedure provide an additional method of classifying aquifers based on their properties and dissolved constituents. Properties such as pH, temperature, and alkalinity, and concentrations of dissolved constituents such as calcium, sodium, magnesium, potassium, iron, silica, chloride, and fluoride are important characteristics of ground water in each aquifer. This study uses the statistical tests aforementioned to identify differences that exist between the mean values of the dissolved constituent concentrations in each aquifer of Charleston County. The results suggest statistical differences in the properties of pH, temperature, and alkalinity and in the dissolved constituents chloride, fluoride, sodium, calcium, and potassium. No significant differences were found in magnesium, total iron, or silica concentrations.

What Geochemical Reactions Affect The Composition Of Leachate From A Municipal Landfill?

Susana L. Comte-Walters, Environmental Studies Program

Leachates from municipal landfills have the potential to contaminate ground water. The composition of a leachate as well as the geological characteristics of the area will determine the geochemical reactions that take place downgradient from the landfill. These geochemical reactions may affect the concentration of dissolved species in the ground water. In addition, biological processes may also affect ground water composition.
Water analysis data from typical upgradient (at the landfill), as well as downgradient wells for two municipal landfills, were obtained from the literature. The Shelby County landfill (SCL) is located near Memphis, TN (1), while the Borden landfill (BL) is located in Ontario, Canada (2). Both landfills are placed on sandy aquifers. However, while the BL is located on a carbonate rich base, the SCL is not. The concentrations were used as input for the U.S. Geological Survey model code "NETPATH" to determine equilibrium solubility of mineral phases and speciation for both landfills. Geochemical reactions for both landfills are postulated based on the results from the model, and other observations from the data.

For both landfills, precipitation of iron species (mainly as FeCO$_3$ (siderite), Fe$_2$O$_3$ (hematite), FeO(OH) (goethite), and FeS$_2$ (pyrite) appear to be the predominant reactions. These precipitations could decrease dissolved iron concentrations in the groundwater. Attenuation of dissolved manganese concentration could occur by precipitation of MnCO$_3$ (rhodochrosite). Dissolution of CaCO$_3$ (calcite) due to high partial pressures of carbon dioxide (CO$_2$) could occur at the BL. However, the results of the model are questionable. Dissolution of calcite is expected at the SCL. Precipitation of CaSO$_4$ (gypsum) is predicted from the results of the model for the BL. Ionic exchange could be the reason for the sharp decrease in the concentration of dissolved potassium ion at this landfill. This mechanism, however, does not appear to be of importance at the SCL.

Crystallographic analysis along the ground water path downgradient from the landfill should be used to confirm the results of the modeling.

REFERENCES

A Hydrologic Study Of Two Thermally Impacted Watersheds At The Savannah River Site

Megan E. Keevican and Christopher Abate, Department of Geology, College of Charleston, Charleston, SC 29424

Pen Branch and Four Mile Creek are tributary watersheds to the Savannah River which drain the DOE's Savannah River Site. After the recent termination of years of thermal discharge from nuclear reactors, the ecology, topography, and hydrology of both watersheds are in a state of transition. To support U.S. Forest Service efforts to reestablish native vegetation a study of the subsurface hydrology was undertaken. Drive point piezometers were installed in transects perpendicular to the stream channels and in nests of differing depths to determine shallow vertical and horizontal hydraulic gradients. Both streams appear to be gaining significant flow from a deeper groundwater system. Horizontal gradients are highly variable both spatially and temporally, and are perhaps related to whether the transect is generally wet or dry, the stratigraphy of the transect, and weather conditions present. Slug tests have also been conducted to constrain the range of hydraulic conductivity and compute rates of deep groundwater recharge to the complex shallow alluvial sediments. An integrated analysis of the stratigraphic and hydrologic conditions present provides an improved understanding of the controls on watershed behavior.
Determining The Role Of CA3-30, A Gene Found To Be Upregulated In Pancreatic Cancer

Jeannie M. Chapman, College of Charleston, Michael W. Graber, Takis S. Papas, Clifford W. Schweinfest*, Dennis K. Watson*, College of Charleston, Center for Molecular and Structural Biology, Hollings Cancer Center, MUSC.

Pancreatic cancer is one of the most deadly types of cancer. It is the ninth most common in incidence and the fourth most common in fatalities. There is a great need for genetic markers for this cancer because it presents itself late in the course, and the median length of survival is only eleven months. In an attempt to find these genetic markers and perhaps some form of treatment, we performed subtractive hybridization between normal pancreatic and a pancreatic adenocarcinoma cell line. From this, the gene CA3-30 was found to be upregulated in the cancer cells. No sequences in the databases consulted matched that of CA3-30. Because of the upregulation of this gene, we performed a transfection of the anti-sense CA3-30 message into parentals of a pancreatic cancer cell line, PANC-1, in order to knock down the expression of the CA3-30 gene. We expected this knock-down to provide information on the role of CA3-30 in pancreatic cancer. We suspected that it either played a role in maintaining the transformed state of the cells or was a consequence of the transformed state. Fifty-one CA3-30 clones were picked from the transfection. Northern blots were performed to screen RNA prepared from each clone. We found four clones showing a successful knock-down of the endogenous RNA transcription. These clones were used in growth curve assays in comparison to PANC-1 parentals to measure their growth rates as well as contact inhibition. And, since nontransformed cells do not grow well in soft agar, we also performed soft agar assays to measure the clones' ability to grow in soft agar. No deviation from the parental behavior was observed in the growth curve assay. However, a marked difference in the formation of colonies in the soft agar was seen between the parentals and the transfectants.

Climatology of Charleston: The Heat Island Effect

Chris Petrusak and B. Lee Lindner, Department of Physics and Astronomy, College of Charleston

The goal of my research is the determination of heat island in downtown Charleston. Heat Island is detected by comparing daily minimum temperatures of a rural and an urban site. Temperature data was taken using three weather stations placed at certain locations in the Charleston area. One located in downtown Charleston, another in the Francis Marion Forest and a third located on Edisto Island. The data was then analyzed to detect heat island.

The Environmental Management Of The Koppers Superfund Site: Are Our Regulations Adequate To Prevent A Recurrence?
A 102 acre contaminated site located on the banks of the Ashley River in Charleston, South Carolina, known as the Koppers site, has been designated a superfund site due to high levels of industrial wastes discovered in the soils and subsurface waters. Several enterprises have conducted activities on the property throughout this century resulting in the contamination of the site, namely Koppers Inc., a wood preserving operation. But, other processes seem to have contributed to the degradation of the property, including the manufacturing of fertilizers, the land filling of solid wastes, the storing of liquid wastes, and the repairing of vessels. Furthermore, a release of the contamination was facilitated by a subsequent dredging endeavor on the property. Regulations governing these types of operations have become a great deal more extensive and sophisticated in the last thirty years. By analyzing the implementation of the environmental regulations pertaining to coastal zone management, surface water pollution control, and solid and hazardous waste management and groundwater protection, throughout the history of the site, a conclusion can be drawn as to whether this type of contamination is likely to recur at a facility like the Koppers site.

14

The Preparation Of Substituted 1(2h)-Isoquinolinones From Polylithiated 2-(2-Methylphenyl)Hydrazinecarboxylic Esters and 2-Methylbenzamides--Related Results

Sharon E. Davis, A. Cameron Church, Charles F. Beam, Department of Chemistry and Biochemistry
College of Charleston

2-(2-Methylphenyl)hydrazinecarboxylic acid esters and 2-methylbenzamides were prepared by the condensation of 2-methylbenzoyl chloride (o-toluoyl chloride) and hydrazinecarboxylic acid esters (alkyl carbazates including methyl, ethyl, and tert-butyl) or amines (e.g., benzylamine, anilines), and they were lithiated with excess lithium diisopropylamide (LDA). The former polylithiated intermediates are presumed trianion-type intermediates, and they were condensed with aromatic esters followed by acid cyclization to the 3-substituted-1(2H)-isoquinolinones (isocarbostyrils), whose yields ranged from 36-90%. Acid hydrolysis of the N-carbo-tert-butoxy group did not occur (5 examples) [in press]. The latter 2-methylbenzamides (o-toluic acid amides) have also undergone dilithiation/condensation/cyclization to additional isocarbostyrils, usually in 50-70% yields [in progress].

15

Relationship Between Environmental Attitudes, Knowledge, And Perceptions Of Threat

Dawn Hughes, Brenda Bizzell, and David N. Sattler, Department of Psychology, College of Charleston

This study examined the relationship between environmental attitudes, environmental knowledge, and perceptions of threat to the environment. The participants were 114 (34 men, 80 women) undergraduate students at the College of Charleston. The participants completed a 4-part questionnaire. Environmental attitudes were measured by the New Environmental Paradigm scale (Dunlap & Van Liere, 1978) and the Belief and Behavioral- Intention scale (Stern, 1993). We designed a survey to measure perceptions of
environmental threat and a questionnaire to assess environmental knowledge. Perceptions of environmental threat were moderately positively related to both the Behavioral-Intention scale and the New Environmental Paradigm scale. Environmental knowledge was weakly positively related with the Belief and Behavioral-Intention scale, but not with New Environmental Paradigm scale.

16

The Preparation Of Pyrazole-Carboxylic Acids and Pyrazole-Carboxylic Acid Tert-Butyl Esters--Related Results

A. Cameron Church, Sharon E. Davis, and Charles F. Beam, Department of Chemistry and Biochemistry College of Charleston

C(alpha),N-Carboalkoxyhydrazones were prepared by condensation of C(alpha)-ketones with hydrazinecarboxylic acid esters (alkyl carbazates including methyl, ethyl, and tert-butyl), dilithiated with excess lithium disopropylamide (LDA), condensed with succinic or glutaric acid anhydride, and cyclized to pyrazole-carboxylic acids [in press]. Other C(alpha),N-hydrazones (e.g., phenylhydrazones from condensation of phenylhydrazone and ketones) were also dilithiated with excess LDA, condensed with phthalic anhydride, and cyclized to other pyrazole-carboxylic acids [in progress]. C(alpha),N-Carbo-tert-butoxyhydrazones were dilithiated with excess LDA, condensed with select esters, and cyclized to N-carbo-t-butoxy pyrazoles. The N-carbo-t-butoxy did not undergo hydrolysis under the acid cyclodehydration conditions of this step [submitted for review]. Studies involving the preparation of N-p-toluenesulfonyl pyrazoles and other pyrazoles are also in progress.

17

Chronology Of Metals Deposition, Shipyard Creek Marsh Charleston, South Carolina

Blaine McCleskey and June Mirecki, Environmental Studies Program and Department of Geology, University of Charleston, Charleston, SC 29424

A 340-cm long core from the salt marsh adjacent to Shipyard Creek (SYC) has been analyzed to determine the chronology of anthropogenic metals input. SYC is located on the Charleston peninsula and drains into the Cooper River. The Charleston Naval Base, shipyards, and industries surround this salt marsh and tidal creek.

The chronology of sediment deposition was established using Pb$^{210}$ and Cs$^{137}$ isotope analysis in the upper meter of the core. The average sedimentation rate determined from the unsupported Pb$^{210}$ (which is the total activity minus the supported activity; the latter was taken as an average at the base profile) was calculated to be 0.60 cm/yr. The Cs$^{137}$ maximum activity occurred at a depth of approximately 25 cm for the 1962 peak and at 32 cm for the 1954 peak which gave a sedimentation rate comparable to that of Pb$^{210}$. Using 0.60 cm/yr as an average constant sedimentation rate, the SYC core probably represents deposition during the last 550 years.

Sediment composition was characterized using grain size analysis and determination of percent total organic
The percent of sand, silt, and clay were determined using a Microscan particle size analyzer. This core shows fairly homogeneous grain size distribution, consisting primarily of 40 to 60 percent silt. The TOC content of the SYC core was determined by wet chromium oxidation titration (Walkey-Black (1947) titration method). TOC content ranged from 1.0 to 4.0 percent in the core. The core showed very little change in its lithology.

Metals were extracted with 25% v/v hydrochloric acid (EPA method 200.1) and the concentrations of Cd, Co, Ni, Cr, Pb, Cu, and Zn were determined using inductively coupled plasma - atomic emission spectroscopy (ICP-AES) methods. Increased concentrations of Cr, Pb, and Zn were discovered in the top 10 cm of the core, which represents the last 30 years. At 100 cm (approximately 150 years ago), increased concentrations of Zn, Cd, Pb, Cu, and Cr were found. And at 350 cm (approximately 475 years ago), an increase in Cd concentration was detected. Very little bioturbation occurred in the upper meter of the core, which was concluded by the sharpness of the 100 cm Zn peak. There was also no correlation between percent clay content and metals concentrations. Therefore, the Shipyard Creek core does represent an archive of sediment-bound metals input events.

18

Oral Alcohol Consumption By C57bl/6j Male And Female Mice In A Limited Access Paradigm: An Examination Of Alcohol's Reinforcing Efficacy

Angie Bandy, Brian M. Kelley, and Lawrence D. Middaugh
Department of Psychology, College of Charleston
Department of Psychiatry and Behavioral Sciences, MUSC

Alcoholism is one of the leading health problems in the United States. Approximately 15% of Americans will develop alcoholism (about 15 million American's are presently affected). Males tend to have higher rates of alcoholism compared to females (about 2.5 to 1). The cost of alcohol abuse in the U.S. is estimated to be $100 billion per year. Furthermore, only a small portion of alcoholics actually make it to treatment, and 75% of those individuals relapse within one year. Studies using animals have shown that genetic makeup and environmental factors contribute to the initiation and continuation of alcohol consumption. If a suitable animal model for alcoholism could be developed, novel experimental treatments could be examined. The goal of the present study is to delineate the mechanisms that contribute to increased alcohol intake and alcohol preference in adult (about 10 weeks old) male (n=10) and female (n=11) C57BL/6J mice. Mice were initially maintained at 80% of their natural ad libitum body weights (it has been found that animals consume more of any drug of abuse during mild food deprivation). During the training phase (6 weeks) of this experiment, mice were fed their daily food allotment prior to the 30 minute test session during which time no water was present. In addition, the concentration of ethanol was increased from 0% to 15% (one week intervals). After this training sequence, a number of experimental conditions were implemented in order to understand the degree to which alcohol came to serve as a positive reinforcer in these subjects. Some conditions included mild food and water deprivation, just food deprivation, and no deprivation. Also, a two-bottle choice paradigm was examined during different test conditions to better understand which factors are most important in determining the reinforcing efficacy of alcohol. The results demonstrate that male and female mice consume significant amounts of alcohol (significant pharmacological effects are produced at these volumes). Furthermore, under most conditions both male and female mice display a preference for ethanol over water when given a choice of the two and this effect is concentration dependent (the higher the concentration, the greater the preference). Finally, differences in alcohol intake were observed between male and female mice with female mice generally consuming more alcohol than males (g/kg). Based on the success of this animal model, potential pharmacotherapies for alcoholism can be evaluated, and perhaps lead
DAD1- AND DAD2-Like Agonist Effects On Motor Activity Of C57 Mice

J.P. Halberda and L.D. Middaugh, Department of Psychology, College of Charleston

As noted in previous studies on rats, the results of the present experiments indicate that the DAD1-like agonists SKF 38393 and, with some exception, SKF 82958 can either elevate or reduce the locomotion of C57 mice, the particular effect depending upon dose and testing condition. However, in contrast to the several reports indicating that DAD2-like agonists produce a biphasic action on motor activity of rats, quinpirole, a DAD2-like agonist, produced only a monotonic reduction in the locomotion of C57 mice in the present study. This reduction in activity occurred whether the mice were male or female, were young or mid-aged adults, were naive or well habituated to the test environment, or were injected with very low or very high doses administered either IP or SC. We conclude that the receptor systems mediating the effects of DAD1-like agonists on motor activity of C57 mice, and probably other strains, are similar to those of rats; however, that the systems mediating the effects of the DAD2-like agonist quinpirole are dissimilar for the two species. Possible reasons for differences in the effects of quinpirole on C57 mice vs rats include species differences in DA subreceptor numbers, anatomical distribution, affinity states, or interactions.

The "Missing Link" between Short-Period Mass-Transfer Binaries and Bipolar Planetary Nebulae: M2-9

Heather Preston, Department of Physics and Astronomy, College of Charleston

Where are all the binary systems? In field stars, between 40 and 60% are determined to be binaries, while among the central stars of planetary nebulae (PNe), the figure is much lower. Quite probably, there are more binary nuclei than are detected, due to the difficulties of obtaining good, narrow spectral lines to determine velocity shifts in the central stars. Much work is being done to link bipolar planetary nebula (BPN) morphologies to the existence of binary nuclei (Palmer et al., 1996; McCarthy et al., 1996; Cuesta, Phillips, Mampaso, 1995; etc.) Another effect which has not been widely considered is that in general in a sufficiently close binary system, the observable "object" that arises from the transition of one member from late asymptotic giant branch (AGB) star to planetary nebula nucleus (PNN) is not a PN at all, but a mass-transfer binary system such as a recurrent nova or cataclysmic variable (CV). Numerical models have shown that a fast stellar wind expanding into a surrounding gaseous medium which has an extreme density gradient will form a BPN (Dwarkadas, Chevalier, and Blondin, 1996, and refs therein). Other studies have shown that outer Lagrange point losses can occur in mass-transfer binary systems, such as those that lead to CVs, which will tend to concentrate the gas ejected from the system in the orbital plane of the binary. When the slow, high-mass-loss wind from a post-AGB star starts to become the fast, low-mass-loss wind of an exposed PNN, the increasingly hot gas is no longer concentrated in the plane of the binary, and instead "blows a bubble" in the surrounding, denser medium. This bubble will be a BPN; the greater the density contrast, the more extreme the bipolarity. If the binary is close enough to continue mass-transfer, but not close enough to capture (essentially) all of the mass lost by the evolving PNN (as a CV below the "period
gap" would), an intermediate object, with central star spectral characteristics of a short-period mass-transfer binary, but a surrounding extreme BPN, is created. The author presents observations (from several sources: see figures) and interpretation of just such an object, the young planetary nebula M2-9.

Computer Controlled Hydroponic Food Production Freshman Engineering Design Project

Michael L. Emmel and Jake H. Halford, Department of Physics & Astronomy

The Physics Department at the College of Charleston operates a two-year, common curriculum, engineering transfer program with cooperating engineering institutions in the southeast. The engineering students enroll in a series of five engineering courses during the first four semesters. A Freshman Design Project was introduced into the INTRODUCTION TO ENGINEERING course last year. The goal of the Freshman Design Project was to design and build a computer controlled hydroponic (soil-less) garden in the greenhouse. The design project was organized similar to a large engineering project. Eight separate work groups were formed with 4-5 students each. Each group chose a leader and began work on their part of the project. Group leaders met each week to discuss progress and to coordinate work. A project director was elected to coordinate to work in one of the following eight groups; Plant Care, Hydroponic Methods, Growing Media, Lighting, Structural Supports, Hydroponic Feeding, Electrical Power and Computer Programming and Interfacing. This freshman design project was very successful in giving freshman engineering students a hands-on learning experience in areas in which they had no experience. The hydroponic project involved biology, chemistry, physics, structures, mechanics, fluids, programming, electrical power, computer interfacing, electronic controls, lighting and greenhouse use. Engineering students also gained valuable experience working in groups and group leaders gained experience in group and project management.

Distribution Of The Flammulated Owl In The Non-Breeding Season

Barry Nickel and Arch McCallum, Department of Biology, College of Charleston

The Flammulated Owl (Otus flammeolus) is an environmentally sensitive, insectivorous species that occupies commercially valuable ponderosa pine (Pinus ponderosa) forests in the western United States. The U. S. Forest Service, which administers much of the habitat in which these birds breed, is anxious to keep the species off the endangered species list. One of the problems for any management plan is that the winter range of this presumably migratory species is largely unknown. Some authorities believe that it winters near the breeding grounds rather than migrating to Mexico, as is usually assumed. To test the migration hypothesis indirectly, we collated 135 specimen or photographic records and 382 published records (not substantiated by specimens) from the U.S. and Canada. We predicted a positive correlation between latitude and the Julian dates at which Flammulated Owls were first encountered in the spring and a negative correlation between latitude and the Julian dates of last encounter in the autumn.

Despite an increase in late-Autumn records in the past 20 years, the Flammulated Owl remains virtually undetected in the U. S. in January and February. Although our prediction of a correlation between latitude
and date appears supported for the spring, fall records are rather uniformly distributed with respect to date and latitude. Interpretation of such data is fraught with uncertainty; but, we cautiously interpret the asymmetry of the pattern as suggesting that some individuals indeed attempt to overwinter in the north, but that few survive.

23

The Synthesis And Photophysics Of 2-(2'-Hydroxyphenyl)-Benzoazoles

Stefan Schilling and Shannon Martinez, Department of Chemistry & Biochemistry, College of Charleston, Charleston, SC 29424

Various derivatives of 2-(2'-hydroxyphenyl)benzoxazole with electron donating substituents in a resonance position were synthesized by reacting o-aminophenol and the appropriately substituted benaldehyde or benzoic acid. The compounds were then studied to investigate the competition between the processes of proton transfer and charge transfer in different solvent systems. Specifically, the derivatives include 2-(2',4'-dihydroxyphenyl)benzoxazole, m.p.:196-198 C, yield:4.0%; 2-(2'-hydroxy-4'-methoxyphenyl)benzoxazole, m.p.:115-116 C, yield:42.0%; 2-(2'-hydroxy-4'-diethylaminophenyl)benzoxazole, m.p.: 130-132 C, yield:3.4%. In non-polar solvents, proton transfer should be the dominant process; whereas, in more polar solvents, charge transfer should be the principal phenomenon observed.

24

The Effect Of Plant Density, Predator Aggression, And Prey Density On Survival Rate Of The Prey Fish

Justin Leveton and Arch McCallum, Department of Biology, College of Charleston

Natural selection favors behaviors that reduce the likelihood of being preyed upon, and a number of predation-avoidance adaptations have been proposed by behavioral ecologists. Fish are excellent organisms for controlled experimental tests of these mechanisms. We used African cichlids (Melanoshromis acei) as predators, and guppies (Poecilia reticulata) as prey, to test concurrently three such hypotheses: (1) Larger numbers of prey satiate predators and reduce the likelihood of being preyed upon, (2) More underwater vegetation provides more cover and reduces the likelihood of being preyed upon, and (3) Larger numbers of predators compete more for space, and in the process, have less time for feeding, reducing the likelihood of being preyed upon for the prey.

We randomly assigned cichlids (predators) to 1 of 4 tanks containing 0, 1, 2, or 3 cichlids. Each tank was then randomly assigned 5 or 10 naive guppies (prey) and high or low plant cover. Each treatment was replicated 5 nights, with new randomly selected guppies introduced each night, and with water changed every 5 nights. Survival of guppies was assessed after 1 hr, and again the next morning.

Predators killed most guppies over the course of the night, but in the first hour prey survival was consistent with all 3 predictions (p < .01 for all 3 factors of a 3-way Kruskal-Wallis test). These results not only corroborate the hypotheses when tested jointly, they show the importance of time-based assessment of survival in experimental studies.
An Examination Of Beachfill Performance Related To The Folly Beach Renourishment Project, Folly Island, South Carolina

Michael E. Moeller and Michael P. Katuna, Department of Geology, The College of Charleston, Charleston

Folly Island, S.C., is a barrier island that has experienced significant erosion over the last several decades. The erosion can be primarily attributed to the blockage of the natural longshore sediment supply by the jetties which delineate the entrance to Charleston Harbor. In an attempt to mitigate the problem, a federally-funded renourishment project was initiated. From January to May of 1993, approximately 2.5 million cubic yards of sand was emplaced along Folly Beach. Monitoring efforts were initiated to record the performance of the beachfill material. Surveys were conducted from 1992 to the present, in order to calculate the change in the total sediment budget for the island. Results show a significant loss of beachfill material, far exceeding the project design fill volume requirements. Future renourishment, if conducted, will have to be done at a much earlier date than was initially projected. These monitoring efforts are on-going, and will aid in future beach management and policy decisions regarding the use of soft-stabilization techniques, such as renourishment, along the South Carolina coast.

Creation and Study of a Laboratory Generated Tornado

Ronald K. Harris and Laney Mills, Department of Physics, College of Charleston

The object of this study is to create a laboratory-sized tornado and to measure some of its properties. The tornado generator consists of a box 16in x 16in x 32 in. Heated water in the center of the box floor creates the updraft needed for the formation of a tornado. Air flowing in from the corners of the box gives the necessary vorticity. I will report on the measurements of wind speed and the pressure of the tornado. The wind speed is determined by analyzing frame-rate CCD digital images showing sequential positions of features of the tornado. The pressure is determined by analyzing the rise in water at the base of the tornado. Since the buldge has the approximate shape of a spherical mirror, the height of the buldge (and hence the pressure drop) can be determined by studying the reflection of a grid from the bulge itself.

Satellite Imagery And Aerial Photography To Monitor Wetlands Environments: A Preliminary Study

Michael E. Moeller, Cynthia R. Hall, Robin Humphreys, and Cass Coombs
Department of Geology - Satellite Mapping Environmental Remote Sensing Facility (SMERF)
College of Charleston

The Charleston area is bordered to the northeast and southwest by barrier island complexes which include back-barrier estuarine systems. In the last 20 years these systems have come under increased pressures from
a rapidly expanding population base with related increases in commercial, residential, and infrastructure
development. This estuarine environment supports wildlife and fish habitats, provides an erosional barrier
for the mainland during floods and storms, and helps improve the overall water quality. This study is a
preliminary attempt to identify gross morphological changes within the back-barrier estuarine system
located along the Intracoastal Waterway between Sullivan's Island, S.C. and the Isle of Palms, S.C. using
satellite imagery and aerial photography. Work included identifying and delineating a study site, obtaining
various images of study site, and performing preliminary classifications using Earth Resources Data
Analysis System (ERDAS) Imagine image processing software. Results of this study will help lay the
foundation for a much more extensive study scheduled to begin in the fall of 1996 that will allow for a more
detailed examination and mapping of any changes to the wetlands environment from development.

28

The Feasibility Of Phytoremediation To Remediate Contaminants At A North
Charleston Superfund Site

Trey Smith
Master of Environmental Studies Program
The Medical University of South Carolina & The University of Charleston

The feasibility of using phytoremediation to clean up a U.S. EPA Superfund site (Koppers Co., Inc.) in
North Charleston, South Carolina was examined. Principal contaminants at this site include creosote,
arsonic, and lead. Phytoremediation refers to the use of green plants and plant-associated microorganisms to
remediate contaminated soils and sludges. Contaminants can be extracted, contained, or rendered harmless
by plants that sequester the pollutant in the contaminated environment, or remove and/or degrade the
pollutant in the soil. Phytoremediation may offer a less expensive alternative or supplement to expensive,
capital-intensive technologies for hazardous waste clean-up. The use of freshwater and estuarine wetland
environments to phytoremediate contaminants has been previously demonstrated.

29

Marine Science Based Education Using A Hypercard Tutorial

Nicole J. Spoerer and Leslie R. Sautter
Departments of Biology and Geology
College of Charleston

The purpose of this project is to test the use of a Hypercard marine science based tutorial, the COASTTeam
Tutor, developed by Dr. James Reynolds (Colgate University) and Dr. Leslie Sautter (College of
Charleston). Elementary, junior and high school students can use this tutorial in the classroom to learn and
reinforce lessons previously taught in areas of marine science (including geology, biology, physics and
chemistry).

I began by building marine science questions and answers using scanned images within several areas,
including fishes, the ocean planet, Plate Tectonics and marine ecology. Questions are specifically directed
towards the learning capabilities of fourth and fifth grade students. (In the future versions of this tutorial
will be expanded to include marine questions designed for first grade through college level students.)
The COASTTeam Tutor was introduced to teachers and students in three elementary schools within the Charleston County School District. An evaluation was obtained from the computer technicians, the teachers, and selected forth or fifth grade students.

30

Influence Of The Imported Red Fire Ant On An Old Field Arthropod Community

Tracee Lund and Brian Scholtens
Biology Department
College of Charleston

The imported red fire ant (Solenopsis invicta) is a pest species that has great impact on agriculture, wildlife, humans, and the environment. A clear understanding of fire ant effects on natural arthropod communities will be helpful in controlling their population. We studied the ecological impacts of the red imported fire ant on surface-active arthropods at the Dill Plantation in Charleston, SC. Species diversity and distribution in the infested field was assessed using pitfall traps. Positive correlations were found between the number of fire ants captured per trap and the date of capture, the numbers of isopods, beetles and spiders, and the total catch per trap. No significant correlations were found with the numbers of herbivores, or other less abundant groups in the traps. Our findings agree with other studies that have found significant effects of the red imported fire ant on the diversity and distribution of native arthropod communities.

31

Lightning Lure: The Effects of Radius of Curvature on Charge Storage Capacity

David A. Pelkey
Department of Physics and Astronomy
College of Charleston

The research presented on this poster concerns the effects of radius of curvature of conductors on their ability to store a charge. The research was motivated by the concept of using a large radial surface to attract lightning to a desired location for scientific purposes. To test the feasibility of the field experiment I proposed a laboratory experiment made up of two successive parts. The first stage, which involved directly measuring the charge storage capacity as a function of radius of curvature, has been completed and the results are shown here. Based on the success of this stage, the second stage, which is an idealized model of the field experiment, is ready to proceed. In addition to the need to consider the feasibility aspect was the need to design a lightning strike detector/counter to monitor the field experiment. Results of the design efforts are also shown.

32

Construction Of A Preparative HPLC System: From Design To Operating System
The recent increase in the everyday use of high pressure liquid chromatography in undergraduate research laboratories has created a need for a better understanding of the technique by the undergraduate as well as a cost effective means of obtaining the instrument. These needs can be met simply by allowing the undergraduates to construct the preparative HPLC system. The preparative system with the exception of the detector can be assembled in about one month. The system consisting linearly of a solvent reservoir, industrial grade solvent pump, pulse dampener, pressure gauge, injection port, column, detector and collection reservoir is simple to assemble. The design element is best supervised by someone experienced in the use of preparative HPLC; however, the majority of the decision making should fall on the undergraduate. The two manufactured components used are the industrial grade pump and the detector. These manufactured components represent the primary cost of the system but cannot be avoided. The most important system component the column is the only source of variable cost in the system. This cost is substantially lower if the column is packed by the undergraduate; however column packing is a science in itself and is better performed by experienced manufacturers. All of the other components listed as well as the stainless steel tubing and pressure tight fitting must be carefully chosen by the undergraduate to insure safety and cost effectiveness.

33

Determination Of Gasoline Additives By FTIR

Amy McCay and James P. Deavor
Department of Chemistry & Biochemistry
College of Charleston

Fourier Transform Infrared (FTIR) Spectroscopy will be used to quantitate oxygenated additives (ethanol and various ethers) in gasoline using an attenuated total reflection (ATR) technique. Both lab-prepared and commercial mixtures will be analyzed. Calibration plots will be drawn. The method of standard additions will also be employed. Oxygenates are used to both increase octane number and to decrease air pollution.

34

Integrated Assessment, STUGE, and Mathematica

Michael P. McLaughlin, Laney Mills
Department of Physics
College of Charleston

"Integrated Assessment" is an environmental science exercise in which one combines simplified versions of several supercomputer size environmental models to obtain results outside the scope of any of these models taken separately. A very prototypical example is PC computer program "Sea Level and Temperature Change Under the Greenhouse Effect" (STUGE), by T.M.L. Wigley, T. Holt, and S.C.B. Raper. The user inputs values for the annual rates of net emissions into the atmosphere of the greenhouse gases carbon dioxide, nitrous oxide, methane, and several halocarbons. The program computes the corresponding annual increases
in atmospheric concentrations, then the corresponding increases in global temperature, and finally the resulting rise in sea level. Since a study of all these various models constitutes virtually a complete course in environmental science, the College of Charleston Physics Department has been developing these individual models separately using the familiar Mathematica symbolic programming language. These individual models and their respective interactions are the subject of this presentation.

35

Modeling of Separation on Porous Membranes I. An Investigation of the Pore Size Distribution of a Membrane

J. Anthony Brown, Michael P. McLaughlin, and Mikhail M. Agrest
Department of Physics
College of Charleston

To solve a problem involving the filtration of a given type of solution using membrane technology, one has to have information about the behavior of different kinds of solution in terms of the molecular weight distribution (MWD) with respect to a given pore size distribution (PSD) in the employed membrane. The entire problem to design a method of separation consists of two general stages: analysis of the pore structure of the membrane and modeling of the filtration process through membranes. The use of an electron microscope is essential in determining the membrane's PSD. Images of the Gelman Sciences "Supor" membranes were analyzed by computer imaging programs to generate a complete picture of the PSD. The PSD were interpolated by exponential functions using "Mathematica." Although data shows that the PSD is uniform across a particular surface, the PSD appears to vary at different depths. This lends credibility to the idea that the pores should be treated as cones rather than straight cylinders. Additional investigations spanning the entire depth of the membrane are required for a more thorough analysis.

36

Selection Of Remediation Alternatives At The Koppers Site: A Description Of The Superfund Process, And Evaluation Of Possible Outcomes

Susana L. Comte-Walters
Environmental Studies Program
University Of Charleston

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), also known as the "Superfund legislation", mandates the U. S. Environmental Protection Agency (USEPA) to provide for the immediate and long term cleanup of sites contaminated with hazardous chemicals listed in the National Priorities List. The Koppers site in North Charleston, SC, formerly a wood treatment facility, is one of those sites.

In selecting a long term remediation alternative, the USEPA must compare other available alternatives using the nine criteria specified in the National Contingency Plan. While these criteria provide a framework for evaluation, they introduce ambiguity and controversy into the process. As a result, cost-efficiency and long term cleanup goals are very seldom achieved. A discussion of the criteria as well as some of their shortcomings are included in this paper.
Data from the literature as well as communications with USEPA and SC Department of Health and Environmental Control (SCDHEC) officials were used to discuss the possible outcomes for the Koppers site. Based on these, a proven, permanent, on-site soil remediation technology is to be expected in the proposed plan for soil remediation. However, the use of an innovative technology may be allowed for groundwater. While in the final selection of a target cleanup level, involvement of the potential responsible parties (PRPs) may affect the outcome of the selection as well as the choice of a cleanup level, public participation appear to be minimal, contradicting the spirit of the legislation.

Finally, some recommendations for redefining how a remediation alternative is selected are made.

### 37

**Bioremediation Of Hydrocarbon Contaminated Soil At The Kopper's Creosote Facility**

Will Lowry  
Environmental Studies Program  
Medical University of South Carolina and the University of Charleston

The Kopper's Wood Treating Facility is a designated superfund site and has extensive hydrocarbon contamination of soils and groundwater due to years of treating wood with creosote. It is possible to remediate the subsurface soil at the site, defined here as a depth of between two and five feet, with natural hydrocarbon degrading organisms.

There are several methods that can be used to remediate hydrocarbon contaminated subsoil and this paper will evaluate three methods: (1) biological enhancement, the adding of nutrients and non-indigenous organisms to the soil, (2) biosparging, the pumping of air into the soil to provide oxygen, and (3) vertical circulation wells, the adding of nutrients to the soil through injection wells. The use of chemical and biological surfactants to increase the availability of the contaminants will also be examined.

Costs for the different bioremediation methods will also be evaluated and compared with the costs of more traditional methods such as excavation in order to determine the best method of treatment.

### 38

**APT Observations of the Multimode Cepheid, BQ Serpens**

Joshua Spruill and Robert J. Dukes, Jr.  
Physics & Astronomy Department  
The College of Charleston  
Charleston, SC 29424

In this paper I will discuss photometric observations of the Cepheid variable star BQ Serpens which have been obtained over the last five years with the College of Charleston's Automatic Photometric Telescope located on Mt. Hopkins in southern Arizona.
Cepheid variables are stars which are F - G spectral type giant and supergiant stars and which lie in the region of the HR diagram known as the instability strip. These stars are characterized by especially stable pulsations in either the fundamental or first overtone mode. BQ Serpens has been reported to be one of a very small number of multimode Cepheids. These are Cepheids which are pulsating in both the fundamental and first overtone modes. I have been able to verify this claim with our data and will present the details of my analysis. I will also report on an attempt to verify an earlier indication of the presence of a third pulsational frequency.

This work has been supported, in part, by N.S.F. Grants #AST8616362, #AST9115114, and #USE-9156184 to the College of Charleston.

39

What's In Your Backyard? A Case Study Of The Charleston Koppers Superfund Site And The Neighboring Communities

Catherine McCrary
Environmental Studies Masters Program
University of Charleston and The Medical University of South Carolina

The Koppers Superfund site is located in Charleston, SC in what many call the "neck" area. In addition to the Koppers site, the Charleston "neck" area is comprised of many industries and hazardous waste sites. Situated amidst these industrial and hazardous waste areas are small residential communities. The residential communities are predominately low income districts within the City of Charleston. This project focuses on the Rosemont community which is just North of the Koppers site, however the Silver Hill neighborhood on the South of the Koppers site will also be discussed.

Interviews were conducted with 10 community leaders to determine if there is a significant difference between community leaders in the Charleston "neck" area and leaders in the "greater" Charleston area in: 1) the priority needs of the Rosemont community, 2) the knowledge of the contamination at the Koppers site, 3) the knowledge of the health effects from the Koppers site on the Rosemont community, and 4) how concerned they are about the Rosemont community residents.

40

Lead Mobility at the Koppers Superfund Site

Todd Shearer
Environmental Studies Program, MUSC/University of Charleston

The Koppers Superfund Site is located in a highly industrialized area adjacent to the Ashley River in Charleston, South Carolina. The site is also surrounded by estuarine tidal marsh with a series of canals leading to the Ashley River. High concentrations of heavy metals and organic pollutants are known to exist within and around the site. Several sediment and water samples from the site have been found to contain elevated lead (Pb) concentrations (Sediment range<1 to 3940 mg/kg; Surface water range<1 to 720μg/L). Pb is known to be toxic to humans and many other organisms especially at high concentrations. Lead generally forms highly insoluble complexes such as PbCO3(s) and Pb sulfides under most surface water
conditions concentrating in the sediments. Tidal marshes such as those found at the Koppers site can present highly variable water conditions with respect to salinity, dissolved oxygen, and pH. Although the highest Pb concentrations at the Koppers site were measured in sediment samples, some of the corresponding surface water samples contained high Pb values as well.

Pb concentrations in surface water and sediment samples from the Koppers site (RI/FS Work Plan; ENSR, Inc., 1995) were evaluated to determine the distribution lead between mobile dissolved species and insoluble complexes. Water quality parameters (including dissolved oxygen, specific conductance, temperature, and pH) were also measured for all samples presented in this study. Distributions coefficients (KD; where KD = [Pb]SED/[Pb]SW) were calculated for twenty-four paired sediment-water samples at the Koppers site to estimate the Pb mobility in shallow ground water and surface water.

Dissolved oxygen, specific conductance, and pH were used to determine if a correlation existed between KD values and varying surface water conditions. Statistical analysis did not show a significant correlation among KD values and measured water quality parameters. Several factors may have affected the ability of this study to find a correlation including limited sample size (n=24) and because of changing physicochemical water conditions throughout the tidal cycle.

Scientific Results From APT's

Frances C. Halter, Jennifer L. Jordan, and Robert J. Dukes, Jr.
Physics & Astronomy Department
The College of Charleston
Charleston, SC 29424

Automatic Photometric Telescopes have been regularly making variable star observations for over ten years. There are seven of these of similar designs at the Fairborne Observatory site at the Whipple Station of the Smithsonian Astrophysical Observatory on Mt. Hopkins in southern Arizona. In this paper we report on a survey of results from these telescopes which have been published in astronomical literature. We conducted this survey using the Astrophysics Data System, Astronomy and Astrophysics Abstracts, and Science Citation Index. We searched using the term "Automatic Photometric Telescope" as well as the names of known users of APT's. For each reference we located we attempted to find the original publication. Finally, we compare the results for APT's with similar surveys conducted for other classes of telescopes.

Aerophotography Of Barrier Islands Of South Carolina On CD-ROM: Easy Access To Hard-To-Find Images

Robin R. Humphreys, David A. Sansbury, Cynthia R. Hall, and Mitch Colgan
Department of Geology
College of Charleston

Aerial photography of the South Carolina coastal regions provide coastal managers and researchers with a valuable tool for shoreline change analysis. South Carolina's shorelines are extremely dynamic and require
constant monitoring and careful management. Aerophotographic imagery of the shoreline supplies researchers, administrators and the general public with information that can enable effective land use planning and decision-making. Aerophotographs of the barrier islands of South Carolina from Cape Romain to Hilton Head taken in 1993 at a scale of 1:500 on populated islands and 1:1000 on unpopulated islands were provided by South Carolina's Office of Ocean and Coastal Resource Management. These images were scanned on a flat-bed scanner and were integrated into a user-friendly Hypercard database program on a Macintosh computer. The photographs were combined with a graphical index of the flight line information of the coastal regions and aerophotographs that may be displayed and printed at a resolution of 400 DPI (dots per inch) on both Macintosh and PC computers. Plans for future coastal CD-ROMs with aerial photography from previous years are being considered.

43

Attempts to Identify mRNA's Expressed Exclusively During Pine Pollen Tube Growth

Tanya Santiago and Bob Frankis,
Biology Department, College of Charleston

Previous work indicates that pine pollen, unlike the pollen of commonly studied species of angiosperms, shows temporal changes in gene expression during the course of germination and pollen tube growth. In an attempt to better understand the molecular events which underlie the process of pine pollen germination, a cDNA library was generated using mRNA extracted from pollen in the process of germination. In the work described here, the techniques of northern blotting was used to identify recombinant cDNA plasmids representing mRNA's expressed only during the latter stages of pollen tube growth.

44

Galaxy Redshifts with a $1 Spectrograph?

Harold Nations, Derek Buzasi, and Hannes Greim
Dept. of Physics and Astronomy
College of Charleston

We report on the use of both blazed and unblazed transmission gratings for doing digital spectroscopy in introductory and advanced physics and astronomy labs. The use of objective prisms to do low resolution spectroscopy in astronomy has a long and glorious history. This history includes the discovery of thousands of quasars and the spectral classification of hundreds of thousands of stars. Most of this work has been accomplished using full-aperture prisms on large Schmidt telescopes using relatively long exposure times with photographic plates as the detector. We describe the use of transmission gratings in a novel "non-objective" mode with modern, affordable Charge-Coupled-Device (CCD) detectors. When used with amateur-sized telescopes or commercial camera lenses this enables one to do meaningful, quantitative spectroscopy in even the introductory lab environment. Examples of laboratory and astronomical spectra will be shown and discussed.
**Trends In Spatial And Temporal Distributions Of Water Wells In The Trident Area Of South Carolina**

C. Scott Elliott and Christopher Abate  
Department of Geology  
College of Charleston

Extensive information on water wells is collected by the South Carolina Department of Natural Resources and logged into a tabular database. This database consists of over 1400 well records, each with up to 41 attributes, for water wells in the tricounty area near Charleston. To facilitate interpretation and analysis of this database, a Geographic Information System interface was developed, allowing rapid sorting, analysis, and map generation.

Using this analysis tool, trends in the spatial and temporal distributions are revealed which characterize the nature of exploitation of groundwater resources in the region. For example, by sorting water wells by date drilled and water use we find that while the total number of wells drilled each year has increased, the relative proportions of wells for particular uses has not remained constant. These changes appear to reflect regional patterns of domestic housing growth, industrial growth, and the evolving environmental regulatory concerns. Another example is the relation between water usage and well depth. As expected, shallow wells are used primarily for low yield domestic supplies, whereas, deep wells are more suited for industrial or municipal purposes which require high yield.

Documentation of this analysis consists of full color maps along with related statistical charts which quantify and help convey these important trends. It is hoped that the results of this analysis will help regional planners in cautious and responsible future exploitation of groundwater resources.

---

**Vacuum-Vaporizer Well (UVB)/Biological Remediation**

Shirley D. Conner  
Environmental Science Program  
MUSC/C of C

The UVB system is one of several treatment options suggested for remediation of the Koppers, Charleston, South Carolina plant site. The system is able to effectively decrease levels of low-molecular weight polycyclic aromatic hydrocarbons in contaminated groundwater. Treatment occurs in situ, eliminating the need for groundwater removal and disposal. In addition, groundwater is circulated through a stripping reactor where volatile organic chemicals are removed before reintroduction into the aquifer.

Depending on site conditions, a UVB well is able to produce a groundwater circulation cell of 80 to 150 feet in diameter. Groundwater is circulated through the treatment well which can be inoculated with microorganisms and/or nutrients to facilitate the degredation process. If needed, multiple wells may be installed within a contamination zone.

Although this process would not be applicable as the only means of treatment for the site in question, it
Endothelin Enhancement Of Isoproterenol Stimulated Camp Formation In Cultured Vascular Smooth Muscle Cells

Kashana Akins
College of Charleston

The effect of endothelin on isoproterenol-stimulated cAMP accumulation was investigated in vascular smooth muscle cells cultured from rat thoracic aorta. Incubation of vascular smooth muscle cells for 60 seconds with .1uM endothelin produced a 2-fold decrease in 1uM isoproterenol-induced cAMP formation. Endothelin also had a little to no effect on basal levels of cAMP. This effect of endothelin to decrease isoproterenol-induced cAMP formation was inhibited by the phosphodiesterase inhibitor, isobutylmethylxanthine (IBMX). Pre treatment of vascular smooth muscle cells with IBMX, inhibited the effect of endothelin to decrease isoproterenol-induced cAMP formation by 50%. These results indicate that the effect of endothelin to decrease isoproterenol-induced cAMP formation is mediated by the phosphodiesterase enzyme, IBMX.

Orbital Period Determination of Five Binary CSPN Candidates

Allan Espano, Derek Buzasi, Heather Preston, and Robert J. Dukes, Jr.
Department of Physics and Astronomy
College of Charleston

Many field stars are known to be physical binaries or multiple star systems. It is believed that a similar proportion of CSPN (Central Stars of Planetary of Nebulae) are also binaries or multiple stars, although these are rarely found. Not all planetary nebulae are spherically symmetrical in shape. Often the morphologies of planetary nebulae suggest some type of axial orientation and can vary in shape from mildly elliptical to distinctly bipolar. It is this deviation from a spherical morphology which leads one to suspect that such CSPN are good candidates for being non-single stars. However, due to the difficulty of obtaining useful stellar spectra for radial velocity measurements, there is little concrete evidence to confirm these suspicions. By analyzing the variability in radial velocities from data taken over a two-year period with a redesigned Cassegrain spectrograph at the Palomar 1.5-m telescope, this project intends to determine the orbital periods five binary CSPN candidates and to obtain important information about the ranges of possible physical parameters, such as orbital radii, of the systems.

Computer Simulation of a Phase Change in a Van der Waals Solid

Marcia C. Smoak and Jeffrey Wragg
We present an approach to creating a computer simulation of the phase change of a Van der Waals solid to a liquid. The simulation visually and numerically models a solid of spherically symmetric atoms through the melting transition. Mathematica is used to simulate two-dimensional and three-dimensional models of solid and liquid argon. The force between neighboring atoms is derived from the Lennard-Jones potential. A working simulation models the evolution of position and velocity of atoms in this system, indicating the transition from solid to liquid. Applications of a functional simulation will be presented.

Effect Of "Roasting" On Total Heterotrophic Bacteria Plate Counts In Crassostrea Virginica (Gulf Coast Oysters)

Charlotte Newman and Susan J. Morrison
Department of Biology, College of Charleston

Molluscan shellfish are filter feeders which are easily contaminated with bacteria in polluted waters and with naturally occurring pathogens in estuarine environments. This has led to cases of severe illness and death in humans who consume contaminated shellfish. The purpose of this project was to examine the effects of one popular method of cooking on bacteria counts in oysters. Bacteria levels in Crassostrea virginica (Gulf Coast oysters), determined before and after oyster roasts in this region, showed little reduction; however, the experiments were complicated by low initial counts and the roasting conditions. In a simulated oyster roast done in the laboratory, the total heterotrophic bacteria plate counts from oysters roasted for times ranging from zero to ten minutes remained around 1100 colony forming units/gram, again showing little reduction. Bacteria isolated from oysters before and after cooking included predominately Gram- positive, spore-forming rods as well as some Gram-negative rods.

Faculty Job Satisfaction at the College of Charleston

Christopher C. Liberatos and Peter J. Rowe
Department of Psychology, College of Charleston
Luis F. Parra
Bowling Green State University

The present study examined job satisfaction of College of Charleston faculty. 365 full-time faculty were mailed the Job Descriptive Index (JDI), along with a number of demographic questions, with 189 returns. Means of the six scales of the JDI (Work on Present Job, Supervision, Opportunities for Promotion, Present Pay, Co-workers, and the new Job in General scale) by each of the five schools (Arts, Business/Economics, Education, Humanities/Social Sciences, and Sciences/Math) were examined. The relationship between seniority and job satisfaction was also examined, as well as intention to quit, which is currently being considered as a possible addition to the instrument. Levels of satisfaction were found to be moderate with some variability on individual facets (scales), and relatively high for the global Job in General scale. Seniority was found to have no relationship with general satisfaction. Intention to quit had a significant
negative correlation with the Supervision, Work, Co-workers, and Job in General scales.

The Latitudinal Distribution of Magnetic Activity on the Lower Main Sequence: Implications for Angular Momentum Evolution

Derek L. Buzasi
Department of Physics and Astronomy
College of Charleston

On the Sun, magnetic activity (spots and plage) is essentially restricted to latitudes within 45 degrees of the solar equator. However, active stars such as RS CVn systems and T Tauri stars generally show polar activity. I model the evolution of a toroidal magnetic flux tube as it rises from the base of the convection zone in various lower main sequence stars, and show that, on the main sequence, polar activity is more likely for rapidly rotating stars with thick convective envelopes, as it is due to the Coriolis effect. A similar effect is expected for RS CVn and T Tauri systems.

An important consequence of polar activity is the inhibition of angular momentum loss from these systems. On the lower main sequence, angular momentum is lost via the interaction of the stellar magnetic field with the outflowing stellar wind. However, if regions of strong magnetic field are confined to the poles, stellar spindown rates can be dramatically reduced, by up to an order of magnitude for the M stars.

Low Level Exposure To Nicotine During Early Development Increases Ethanol Sensitivity In Male But Not Female Mice

Jacki Thompson, Brian M. Kelley, and Lawrence D. Middaugh
Department of Psychology, College of Charleston
Department of Psychiatry and Behavioral Sciences, MUSC

Cigarettes and other forms of tobacco are highly addictive because of nicotine. Among adults in the United States, 91.3% tried their first cigarette and 77.0% became regular smokers before they were 20 years old. Cigarette smoking is on the rise among young Americans; the increase is greatest among eighth graders, who are only 13- to 14- years old. Their current rate of smoking rose by 30 percent between 1991 and 1994, from 14.3 ‰ to 18.6 ‰. More than 3,000 US teens become regular smokers each day, with girls smoking at a higher rate than boys. Cigarettes will kill far more of today's children than all other drugs combined, including alcohol. This study examined the influence of chronic low level nicotine exposure during adolescence on future ethanol sensitivity in C57 BL/6J. Mice were approximately three weeks old at the start of this study. For five weeks, mice (26 males and 26 females) were injected (subcutaneously) twice daily Monday through Friday with nicotine (1.0 mg/kg) or distilled water. During the third week, the mice were injected with nicotine (1.0 mg/kg, SC) or distilled water and motor activity was monitored. There were no differences in activity between the two treatment conditions. In addition, there were no differences in growth between treatment groups across the five weeks of nicotine or water injections or after the injections ceased. Furthermore, the doses of ethanol used in this study did not influence weight gain. After the five weeks of nicotine treatment, mice were given four daily motor tests (15 minutes). This established an
activity baseline and allowed the mice to acclimate to the activity monitoring system. Mice were then given two ethanol injections (.625 mg/kg or .875 g/kg, IP) and motor activity was assessed. The injections were counterbalanced between the two days. Neither of these low doses produced any change in activity. Activity testing resumed two days later, and the mice received two injections of 1.5 and two injections of 2.0 g/kg ethanol. Mice were then injected for five days with a rather high dose of ethanol (3.0 g/kg—a dose known to suppress motor activity) in order to assess differences in sensitivity to ethanol's motor suppressing effects. The 1.5 and 2.0 g/kg injections produced increases in motor activity for all groups. The nicotine-exposed male mice showed a greater increase in motor activity compared to their control group across all test conditions. In contrast, no differences in activity were found between the female groups. Results from the five daily ethanol injections with the 3.0 g/kg concentration showed that the nicotine-exposed male mice were again more sensitive to ethanol-induced motor effects, because greater reductions in activity were noted, and behavioral tolerance appeared to develop more quickly. Results from this study demonstrate that low level nicotine exposure can alter ethanol's stimulatory effects in male but not female mice.

---

54

A Simple Equilibrium Experiment With Some Added Surprises (Enrichments)

Tiffany Hays, Natalie Weltz and Laney Mills
Physics & Astronomy Department
College of Charleston

In this torque-equilibrium experiment, invented by David Smith of the University of the Virgin Islands and brought to the College of Charleston by Don Drost, students are asked to study a sample piece of a weak mono-filament fishing line to pre-compute how many strands and what unstretched length would be needed to support a 1 m long "2 x 4" board at a 45° angle with a 3 kg mass attached to the top end. The string is to run from the midpoint of the board to a point about a half meter from the pivot.

This experiment has been found to be rich in challenges. Since the tension needed to support the system increases rapidly as the length corresponding to the targeted 45 degrees is reached, it can occur, for a Hooke's Law string (stretch is proportional to applied force), that there are two equilibrium string lengths. Not only does one of these correspond to a very much larger angle than the desired 45 degrees, but also, the system will always select this undesirable angle!

Even worse, extensive testing has revealed that strings are not Hooke's Law systems, but instead exhibit very nearly parabolic dependence of force on stretch. Thus, the shape of the force supplied by a multi-strand bundle of such strings closely parallels the shape of the "tension-needed" curve. Even the tiniest error in the starting length can result in errors seeming entirely inappropriate to the experiment.

Surprisingly, the matter is resolved with resulting new insight for the students. The actual experiment will be demonstrated.

---

55

A Rotational Inertial Experiment Presents An Interesting Error Analysis Challenge

Thomas Baskerville, and Jennifer Hoguet, and Laney Mills
When an object rolling down a laboratory hill is timed over a measured distance, the conservation of energy allows the moment of inertia to be computed in terms of the mass and radius of the object, the descent height, and the final center of mass velocity. The resulting expression for the moment of inertia contains a difference term with the result that the computation of the propagation of an error in the velocity into the moment of inertia result is more complicated than the usual Maclaurin expansion of the expression in terms of velocity. When one computes the expected error from first principles, one finds that this expression is surprisingly sensitive to errors in the velocity. In the case of a sphere, the % error in moment of inertia is seven times the % error in velocity. A working version of the experiment will be demonstrated.

A Hydrologic Budget Study Of A Forested Watershed On The Lower Coastal Plain Of South Carolina

Karen Waters, Laura Murray, and Christopher Abate
Department of Geology
College of Charleston

The College of Charleston, Department of Geology in collaboration with the United States Forest Service Center for Forested Wetlands Research devised a hydrologic budget study for a representative forested watershed on the Lower Coastal Plain. The site selected was a 371 acre watershed at the Santee Experimental Forest near Huger, SC. This study was intended to provide a better understanding of watershed behavior over the annual climate cycle and serve as a basis for estimating water residence time and cumulative outflows.

To construct this hydrologic budget, field data were collected by the USFS on: daily onsite precipitation and temperatures, daily streamflow discharge at a concrete weir at the basin outlet, and weekly watertable elevations. Though watertable data were not available, for Water Year 1991 a monthly hydrologic balance of the watersheds net recharge and discharge was developed using a spreadsheet. This spreadsheet allowed for various data manipulations such as unit conversions and inventory period summations.

Graphs of daily measurements show clear relationships between precipitation and runoff events. Monthly hydrologic balances reveal increases and decreases in watershed storage (as groundwater) in response to seasonal change. The annual balance provides confidence in the approximations of individual terms and allows for estimation of cumulative volumetric throughflow. This budget, combined with field measurements of the soil and sediment hydrologic properties is intended to be the basis for a digital model of the ground water - surface water flow system.

Spread Of Calcium Transients In The Tubular Myocardium

Robert P. Thompson, Joshua B. Spruill, Qin Pan and Thomas C. Trusk
Calcium-sensitive fluorescent dye and live video or confocal scanning microscopy were used to image the spread of calcium transients, probably associated with cardiac depolarization, across the surface of the tubular chick heart. Dissected hearts were incubated for 15-45 minutes with methoxyacetylated Calcium Green I and imaged for 1-2hr in HEPES buffered Tyrode's solution under coverslips at room temperature. Confocal line-scanning at 50-500 Hz allowed estimation of wave propagation rates in defined directions along or about the heart from Stages 9-18, until encroaching epicardium obscured the outer layer of myocardium. These optical images of cardiac contraction revealed left-sided sino-atrial pacemaker foci prior to HH Stage 12, with clearly right-sided dominance established by stage 16-17. Propagation velocities were typically greater around the circumference of the heart tube than along its length. Such anisotropic conduction became especially clear (2-3 fold) within the AV canal during Stages 16-18, coinciding with emergence of distinct conduction delay from atrial to ventricular tissue. Experimental lacerations of atrial tissues at left and right margins demonstrated rapid redistribution of depolarization in either direction around the AV junction, with subsequently normal depolarization along the looped primitive ventricle. Similar inward or outward radial compensation of the otherwise peristaltoid contraction of the curved ventricle was seen near lacerations across the inner or outer margins of the ventricle. Coordinated contraction along the entire heart tube could be interrupted by cooling. Individual myocytes in quiescent hearts often displayed spontaneous calcium oscillations, interrupted, and then abolished, by restitution of coordinated contractions by gradual warming. Under such manipulation, rhythmic fluorescence of isolated atrial foci often preceeded circular atrial rhythms, in either direction, in the absence of ventricular depolarization. AV conduction and depolarization throughout the primitive ventricle resumed with warming to 21-22C, but depolarization along the outflow tract was not completely restored until about 24C. Further warming (25-30C) led to arrhythmias, including skipped ventricular beats, and propagation velocities beyond our measurable limit (20mm/sec). These observations suggest that 1) rapid circumferential propagation of contraction may subserve a sphincter-like function in the early AV canal, with similar rapid radial compensation active in ventricular contraction, and 2) electrotonic coupling in atrium, ventricle and outflow tract may be independently regulated.

Nonlinear Optics in Liquid Thin Films

Steven J. Lindauer II and Jeffrey L. Wragg
Department of Physics and Astronomy
College of Charleston

The nonlinear interactions of pulsed coherent light (Nd:YAG laser, 8 ns pulses, at 1064, 532 and 266 nm) are studied for thin (<50 um) liquid layers confined by dielectric or metallic boundaries. The emitted light is collected and analyzed by a double spectrograph equipped with a CCD detector. The propagation of radiation in confined spaces is strongly influenced by the nature and geometry of the confinement. The emissions from thin film regions show effects due to the mode structure of the cavity. The radiation pattern of allowed modes is dictated by the liquid film thickness, the optical properties of the liquid, and the confining cell. Difficulties have been encountered in maintaining uniform cell thickness. This has made it impossible to obtain good raman and fluorescent spectra to date. Strategies for better cell techniques and, possibly, some data will be presented.

This project is supported by grants from the Research Corporation and the NASA Space Grant Consortium.
The Limnology Of The Angara River, Lake Baikal To Bratsk, Siberia, Russia: A Preliminary Study

Heather Tiszai(1), Jennifer McAvoy (1), Mitchell Colgan (1), and Douglas Williams(2)
(1) College of Charleston and the (2) University of South Carolina

The Angara River, the only river to drain Lake Baikal in Siberia, Russia, flows north after it joins the Yenisei River and ultimately empties into the Arctic Ocean. The Angara-Yenisei river system is one of the world's longest river systems, but little information about this river has been reported in the literature. In the Summer of 1995, the authors and their Russian colleagues conducted a preliminary study of the water quality of the first segment (460 km) of the Angara River from Lake Baikal to Bratsk Reservoir. From the pristine environment of Lake Baikal, the Angara flows through areas altered by industry, agriculture, and logging. After taking baseline limnological data on Lake Baikal, we used a CTD and a spectrophotometer to measure water quality at thirty-seven river stations. The ranges of observed values were; Dissolved Oxygen (10.5 to 14.3 mg/l), Phosphates (0.0 to 0.18 mg/l), Nitrates (0.9 to 3.3 mg/l), Nitrites (0.002 to 0.028 mg/l), Sulfate (0.0 to 22.0 mg/l), pH (6.9 to 8.4), and Temperature (0.72 C to 7.69 C). Because of the industrialization and logging on the banks of the river, it was assumed that we would find a great contrast in the water chemistry between the pristine waters of Lake Baikal and the Angara River. This drastic change was not revealed by this study. The changes recorded were primarily the result of natural physical changes to the river as it made its way north. This preliminary study provides the first baseline data for the Angara River, and this study of the Angara River will continue this summer.

We thank Bill Murray for funding the expedition.

Earthquake Hazards Associated With The Charleston Area

Allison Epps, Beth Findley, and the Honors Geology Class
College of Charleston

An earthquake with a magnitude of 6.9, with the epicenter in Charleston, occurred along the Ridgeville fault in 1886, and it devastated the Charleston area. As students of the Honors Environmental Geology class, we decided to map the city with regard to the earthquake hazard areas to predict how the city would fare in the event of another earthquake. The area we mapped covered the peninsula beneath Calhoun Street. The class chose two leaders who would be responsible for the final map and the report. The 21 member class was then divided into 8 teams. Each team was assigned an area of Charleston to survey. The teams used the following criteria to rate their area: reclaimed land, previous earthquake damage, condition, age, number of stories, building type, and presence of high ground. The teams were also asked to rank their area with regards to this information. The Charleston area beneath Calhoun Street should be ranked overall as an area which would suffer major destruction. If an earthquake of similar magnitude as 1886 earthquake the were to strike, our prediction is that at least 75% of the buildings would be damaged. Most of the buildings are old, and both new and old buildings are not built to withstand vibrations from an earthquake. The areas of Charleston on high ground, with newer buildings and little previous earthquake damage, would fare the best.
and would suffer little damage.

The Role of Territoriality and Aggression in Betta Splendens as Measured by Aggressive Attacks

Melissa B. Valentine and Emily Redfearn
Department of Biology
College of Charleston

In terms of territorial defense, an animal may aggress towards any rivals that trespass into its territory in order to protect itself and the resources found there. When preserving their territory, animals behave in a way related to their relative status when encountered by another animal of their species. Five male Betta Splendens, paired into dyads with one another to produce a total of ten separate measured interactions occurring in a neutral territory, established relationships of dominance and subordinance with one another. Measurements of these same dyads three days and then six days later exhibited a significant decrease in latency of attack time. We concluded that once Betta Splendens assume social roles upon initial interaction with a rival, these roles serve as templates for future encounters where the Betta may once again need to defend his territory. As hypothesized, body size appeared to be a determinant for which fish assumed the dominant role. On a second trial, the subordinate Bettas were allowed to establish their own territory where interactions occurred after seven days of adjustment time. We did not observe role reversal as we expected, where the subordinate fish became dominant in order to protect his territory, nor did we observe a decrease in latency time to attack over three consecutive trials. We concluded that the Bettas did not display the enhancement of resource holding power that we expected in this second trial.

Collaborating Research Program In Astronomy Between The University Of The Virgin Islands And The College Of Charleston

Donald M. Drost and Harold L. Nations, Department of Physics and Astronomy, College of Charleston, and David J. Smith, Division of Science and Mathematics, University of the Virgin Islands

Collaborative work begun in 1994 was continued in May-June, 1995, at Etelman Observatory of the University of the Virgin Islands on Crown Mountain on St. Thomas in the United States Virgin Islands. The principle objective of the work continues to be the collection of rotation periods for several young and pre-main sequence stars. These rotation periods are to be determined from precision Charge Coupled Device images. Following evaluation of the telescope in November, 1994, several objectives were necessary pursuant to upgrading the telescope for the intended observations. During May-June, 1995, first, mechanical deficiencies detected in the Etelman telescope were corrected by over-hauling the German equatorial mount and fitting the mount with electronic digital encoders. Second, small polar axis alignment problems were studied and worked on. Third, UVI faculty and students were trained to perform extinction measurements necessary for long term evaluation of the site as a potential location for an automatic telescope. Finally, images were taken using CCD imaging technology. Results of all work including images produced on the upgraded Etelman telescope will be presented. All work supported by a South Carolina Space Grant.
The Influence Of Roads And Firebreaks On Amphibian Populations

George W. Eason, Jr. and John E. Fauth
Department of Biology, College of Charleston

We examined patterns of amphibian diversity using twenty-one temporary freshwater ponds in the Francis Marion National Forest near Charleston, South Carolina. New data was collected in response to a previous herpetology class project, which showed that amphibian species richness increases as distance to the nearest road decreases. The class data showed that ponds distant from roads contained many invertebrate predators and few or no amphibians. However, those closer to the road had more diverse populations of amphibians and vertebrate predators.

We predicted that increases in amphibian diversity (primarily tadpoles of ranid frogs) were the result of the introduction of fish through roadside ditches and firebreaks. Our new data confirmed that both amphibian and fish diversity was correlated with nearest road type. Ponds close to major roads (which generally have drainage ditches on both sides) had more species of amphibians and fish. Firebreaks around the perimeter of ponds also may alter their faunas. For example, we rediscovered adults of the endangered flatwoods salamander (Ambystoma cingulatum) in a pond without a firebreak. This species prefers temporary ponds with little leaf litter; allowing burns to consume dried pond basins would provide appropriate habitat for this salamander.

Contributions Toward Developing Methods for the Determination of Metal Speciation in Environmental Samples

Karen A. Moody and W. Frank Kinard
Department of Chemistry and Biochemistry
College of Charleston

Understanding the fate of chemical contaminants in the environment requires a knowledge of the chemical forms may exist for an element, not just simply its concentration. The mobility of trace metals in the environment are a function of the speciation or state of chemical complexation of these metals. This work represents an approach to quantitatively measuring the strength of complexes formed by lanthanide elements by UV-Vis spectroscopy.

The effect of the concentration of a homologous series of organic ligands upon the visible spectra of neodymium is reported in this study. Neodymium is a model for the lanthanide fission products that are a constituent of the high level radioactive waste currently stored at the Savannah River Site. Results of this work will help define the operating parameters for ultra-sensitive laser photoacoustic spectroscopy measurements on similar systems that will be made at the Savannah River Ecology Laboratory this summer.
Ab Initio Molecular Orbital Study Of The Reaction Of Trimethylgallium With An H Radical

Alema Galijatovic and Kristin D. Krantzman, Department of Chemistry, College of Charleston, Charleston, South Carolina 29424

Thermal decomposition of trimethylgallium (TMG) in the presence of NH$_3$ can be used for GaN film production. This type of process is known to leave carbon behind, which can be deleterious to the GaN film. Experimentally, it has been demonstrated that the use of hydrogen atoms from the gas phase can be effective in removing carbon from trimethylgallium adsorbed on SiO$_2$. Theoretical studies of these reactions in the gas-phase have been undertaken in order to understand the energetics and the mechanisms by which these reactions can occur. The reaction of trimethylgallium with an H radical has been investigated using ab initio molecular orbital calculations. It has been demonstrated that the reaction energy for Ga(CH$_3$)$_3$ + H $\rightarrow$ GaH(CH$_3$)$_2$ + CH$_3$ and the reaction energy for Ga(CH$_3$)$_3$ + H $\rightarrow$ Ga(CH$_3$)$_2$ + CH$_4$ are much smaller than the dissociation energy for decomposition, Ga(CH$_3$)$_3$ $\rightarrow$ Ga(CH$_3$)$_2$ + CH$_3$. Therefore, the H radical facilitates scission of the Ga-C bond.

Animations Of The Construction Of Hybrid Orbitals

Mark Ray and Kristin D. Krantzman, Department of Chemistry and Biochemistry, College of Charleston and Jeffrey Wragg, Department of Physics, College of Charleston

In general chemistry, organic chemistry and physical chemistry, valence bond theory is used to describe chemical bonding. Hybridized atomic orbitals are constructed as linear combinations of the s and p atomic orbitals. This mathematical concept is hard for students to visualize, and is probably one of the most difficult topics to teach in the general chemistry course. Mathematica notebooks have been developed to illustrate the construction of hybrid orbitals. The notebooks develop the concept of electron probability density. An animation is produced which shows the gradual transformation from s and p orbitals to the hybrid orbitals. The purpose of the notebook is to aid students in their ability to visualize the construction of hybrid orbitals. In addition, the notebook can be used by students in physical chemistry as an exercise to understand the mathematics used in the linear combination of atomic orbitals.

Molecular Dynamics Simulations of F(g) + SiF$_3$(a) $\rightarrow$ Gas-Phase Products

Tim Kenny, Ronnie Barth and Kristin D. Krantzman
Department of Chemistry
College of Charleston

Silicon fluorine etching is an important process that is used in the production of semiconductor devices. Experiments have shown that steady-state etching arises from direct reactions between incoming fluorine
gas atoms and a reactive fluorosilyl layer. The fluorosilyl layer is hypothesized to contain SiF, SiF₂ and SiF₃ groups arranged in a tree-like structure. Our research focuses on one of the elementary reactions in the process of silicon-fluorine etching: F(g) + SiF₃(a). Molecular dynamic simulations of the reactions between gaseous fluorine atoms and an SiF₃ adsorbate on the Si{100}-(2x1) surface are performed using the SW potential. 500 trajectories are performed with normal incident fluorine radicals at 2.0 eV, 3.0 eV, 5.0 eV and 7.0 eV.

The objective of the simulations is to determine the reaction probability, mechanisms of formation and the energy distribution of the gas-phase products as a function of incident kinetic energy of the incoming fluorine radical. SiF₄ is the major product. At 5.0 eV and 7.0 eV, SiF₃ is a minor product An SN2-like mechanism is responsible for the formation of SiF₄. In addition, at 5.0 eV and 7.0 eV, the simulations have discovered a previously unknown mechanism for the formation of SiF₄, which involves an insertion between a silicon-silicon bond.

---

**Molecular Dynamics Simulations Of F(g) + SiF₃(a) and F(g) + SiF₂-SiF₃ (a) → Gas Phase Products**

Adam Darcy and Kristin Krantzman  
Department of Chemistry  
College of Charleston

Fluorine etching of silicon is widely used in the manufacture of microelectronic devices. The reaction of the incoming gaseous fluorine atom with either an SiF₃ or an SiF₂-SiF₃ adsorbate on the silicon surface was examined in detail using molecular dynamics simulations at 5 eV, 7 eV, and 9 eV. Two potential energy functions were used in these simulations. The original was developed by Stillinger-Weber and the second is a reparameterization of the Stillinger-Weber potential by Weakliem, Carter and Wu. This study was performed in order to obtain a better understanding of the mechanisms of fluorine etching as well as to determine the sensitivity of the results of the simulations to the parameters in the potential energy function.

---

**A Study of the Advance and Retreat of the Polar Caps on Mars**

Mitch Freeman and B. Lee Lindner  
Department of Physics and Astronomy  
College of Charleston

We have simulated the Martian polar caps using a computer model. Of particular interest to us are certain peculiarities observed from earth based telescopes in the advance and retreat of polar cap ice. The observations have been collected over the past twenty years by our colleagues at the HIDA and KWASAN observatories. By using basic physical formulae, we have written a computer program which mimics these observations successfully. Our innovations include an accurate treatment of surface roughness and topography, which we find to be very important in the observed peculiarities in the advance and retreat of
the polar ice caps on Mars. Hence, we believe it is possible to learn about the surface properties of Mars through analysis of observations of the Martian polar caps. We acknowledge the support from the National Science Foundation, International Programs Division.

70

Patterns of Differential Digestion of Sedimentary Bacteria by the Deposit Feeder, Arenicola marina

April Goldfinch and Grain Plante
Department of Biology
University of Charleston

Sedimentary bacteria are consumed and digested by deposit-feeding macrofauna. This predator-prey relationship may markedly influence biogeochemical cycling and food web dynamics. Bacterial community compositions, for instance, may be altered by selective digestion of diverse strains, thus influencing rates of geochemical reactions.

We used a turbidimetric assay to compare the lytic susceptibilities of bacteria when exposed to the digestive fluids collected from the deposit-feeding polychaete, Arenicola marina. Two dozen environmental isolates were tested under identical conditions. Significantly different bacteriolytic rates were observed (P<0.0001); 80% of strains were completely resistant to lysis, while the remaining strains exhibited varied rates of digestion.

Potentially important differences among these strains, such as cell wall type (gram-positive v. gram-negative), and production of exopolymeric capsules, were examined in an effort to identify mechanisms for differential digestion.

All of the gram-positive bacteria were resistant to lysis, while 29% of the gram-negative bacteria were susceptible. Using the G-test of independence (with Williams' correction) we could not reject the null hypothesis that cell wall type and susceptibility were independent (0.05<P<0.10).

Approximately 36% of the strains tested produced capsules. All of the encapsulated bacteria were resistant to digestion as compared to 67% of the non-encapsulated bacteria. This influence of encapsulation on resistance was significant (P<0.025; G-test of independence).