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ABSTRACTS OF PAPERS PRESENTED AT THE ANNUAL MEETING

GENERAL SESSION

FRIDAY, NOVEMBER 19, 10:00 A.M.

UNIVERSITY CENTER THEATER

RICHARD J. RARIDON, *Chairman*

The Consortium Approach to the Development of New Facilities and Programs in Tennessee. Robert E. Martin, Tech Aqua Di-

rector. Financial limitations in Tennessee educational institutions often preclude the development of specialized facilities and impose restrictions on innovative programs. A trend seems to be developing in various granting agencies to support the consortium approach to the solution of these problems. The consortium approach also provides an avenue of cooperation between public and private institutions with the support of governmental agencies.

for first-row transition-metal atoms and ions have been extended to additional electronic configurations. The results suggested several improvements in the 4s wavefunction parameters. Formulas are reported for extending the "double-5 3d wavefunctions over the range of atomic orbitals d^1 through d^9 ". The results are intended for use in calculations of chemical bonding.

A Computer Method for Treating Multiple Electron Donor-Acceptor Interactions. Y. E. Ho and C. C. Thompson, Memphis State University. Recently, there has been increasing experimental evidence that many electron donor-acceptor systems originally thought to involve only a simple 1:1 interaction do, in fact, contain higher order complexes. The evaluation of association constants and other thermo-dynamic properties from spectroscopic measurements on systems in which multiple equilibria occur is a formidable task. We have developed a computer program that uses a search technique over a four-dimensional array to determine simultaneously the association constants and molar absorptivities for both 1:1 and 2:1 donor-acceptor interactions. The method has been applied successfully to complexes of tetracyanoethylene with aromatic hydrocarbon donors in nonpolar and slightly polar solvents.

Metal Carbonyl Derivatives of Bis(diphenylstibino) methane. T. W. Beall and L. W. Houk, Memphis State University. Syntheses of the first metal carbonyl derivatives of a bidentate antimony ligand are reported. When the Group VIB metal hexacarbonyls are allowed to react with $[(C_6H_5)_2Sb]_2$, CH_3 , pentacarbonyl monodentate complexes are formed initially. Extended reactions promote chelation and the formation of tetracarbonyls. The latter react with halogens to yield nonsaline, seven-coordinate tricarbonyl derivatives of the type $M(CO)_3(dsb)_2X_n$. Proposed structures and bonding characteristics are discussed based on spectral data.

A Magnesium Treatment for Inhibiting the Dezincification of Brass in Water. C. R. Schmitt, Union Carbide Corporation, Nuclear Division, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee. The rate of dezincification of a brass valve exposed to demineralized water at 160° F was found to be linear with exposure time up to 162 hours. When approximately 10-20 ppb magnesium was dissolved in the water prior to exposure with brass, the rate of dezincification of the brass at 160° F was greatly reduced. In a study of the mechanism of corrosion inhibition of the magnesium-passivated brass by spark source mass spectrometry and electron microprobe analyses, it was confirmed that magnesium was present as an integral part of the protective film or coating on the brass surface. The corrosion resistance of an untreated and a magnesium-treated valve was also evaluated in an accelerated corrosion test using a synthetic sea water at 25° C, and after a six-month immersion period, the magnesium-passivated brass had shown considerably less corrosion.

The Determination of Activity Coefficients of HCl in 2-pyrrolidone Over the Temperature Range 25 to 50° C. William H. Zuber, Jr. and J. H. Jackson, Memphis State University. The standard reduction potential of the silver-silver chloride electrode was calculated from EMF data. The cell used can be represented by:



For the temperature range 30 to 60° C E° can be represented by

$$E^\circ = 2.5077229 - 1.13943 \times 10^{-4}T + 1.60000 \times 10^{-6}T^2$$

From these data the activity coefficients for HCl in 2-pyrrolidone over a range of concentrations from 0.0005 to 0.0250 molal were calculated and compared to those calculated using a simple Debye-Hückel "limiting law".

Technique for Processing Small Samples of Electromagnetically Separated Mercury Isotopes. E. W. McDaniel, L. O. Love, A. M. Veach and F. B. Thomas (Retired), Oak Ridge, National Laboratory. Isotopically enriched samples of mercury in milligram quantities are collected in continuously renewed films of Octoil-S. Energetic ions, produced in calutron, carbonize the oil film, thus forming a solid mass which retains the mercury even in the presence of 10^{-4} Torr. The steps involved in the recovery and purification of as little as one milligram of mercury from this carbonized mass include degreasing, removal of solids from the backing plate, vacuum distillation of the mercury from the heater carbon, removal of residual organic materials, and subsequent electrodeposition of mercury onto gold foil. Nearly all our output capacity for Hg-196 is channeled into medical use; other isotopes have limited medical applications and are sought in determinations of nuclear properties.

A Review of Tennessee's High School Chemistry Teacher Certification Requirements. DeWitt B. Stone, The University of Tennessee at Martin. In Tennessee, a person may complete as few as eight semester hours of college chemistry and be certified to teach high school chemistry. The stronger, and be certification in chemistry requires sixteen semester hours of college chemistry. These requirements fall short of the 1960 recommendations of 18 and 28 semester hours by the AAAS Cooperative Committee on the Teaching of Science and Mathematics. A survey of eight states (Colorado, Illinois, Kentucky, Ohio, North Carolina, Florida, Alabama, and Texas) which geographically encircle Tennessee, shows their average requirements to be 14.0 and 23.4 semester hours of college chemistry for "general" and "specific" certification for high school chemistry. Some upgrading of Tennessee's requirements seems in order.

ENGINEERING SECTION

GEORGE DAVIS, SCIENCE, 130

JAMES B. DELANO, Chairman

Technology in a Real-Life World: a Panel Discussion. Introduction. James Delano, Tullahoma. Large segments of our population cannot understand why our country whose sciences and technologies have made prodigious advances is slow and even reluctant - to respond to the solution of problems concerning the "basic needs" of society. Some of the problems concerning the society's basic needs are not new ones: large segments of the world population need food, shelter and potable water; the land, atmosphere and waters are becoming even more polluted; natural resources are dwindling because of wasteful practices; our cities are decaying and people are living among mazes which are not easily disposed; and in addition, methods for administering health care are needed.

The purpose of this panel discussion is to explore some of the problems concerning the interactions of technology and society:

How should we communicate with each other for each to respond to the other's needs?

What direction should education take in our colleges and universities?

What can be done with our vast technological, educational and governmental disciplines to meet the needs of the real-life world?

Some Cybernetic Aspects of Community-Technology Interactions. T. Charles Helvey, University of Tennessee Space Institute. A few minutes will be devoted to introduce Cybernetics and explain some of the controversial definitions of this new science. There is no question about it that in our democratic society the subset of the community and the subset of technology are in close interrelation and interdependencies. Although this fact is well known to almost everybody who is involved in any phases of the structuring or promoting of these two subsets. However, not enough people are familiar with the value of the approaching of all the problems from the overall systems point of view. The major part of the presentation is devoted to the demonstration how direct, as well as second and third order interactions play a major part in the establishment of the homeostatic parameters of both systems. Besides some theoretical explanations, practical examples will be quoted in which the Cybernetic approach to problem solving in such areas as socio-dynamics and technological achievements are working together for the benefit of the community.

Physical Scientists, Engineers, and Social Problems. David H. Grubbs, Middle Tennessee State University. Many social problems confronting all levels of government both here and abroad have certain aspects about them that lend themselves to treatment by the methods, techniques, and mental attitudes toward problem solving that have been developed by the physical scientists and engineers. Interest has already been shown by some scientists and engineers in attacking certain problems of society, and great strides forward already have results in some cases and high expectations exist for break-throughs in other certain key areas.

For example, the process of communication has been immeasurably improved through the combination of rocketry and sophisticated satellites. Transportation breakthroughs such as the

Bay Area Rapid Transit program are heavily dependent on relatively recent development in systems analysis and computer technology. Certain development in riot control and criminal detection, though controversial to some extent, show that physician scientists can make strong inputs into attempts to deal with social problems.

It is the thesis of this paper that though there are encouraging signs of interdisciplinary work between social scientists and political scientists and engineers, this process has not proceeded far enough, fast enough, or deep enough. A call is made for an analysis of social and governmental problems by interdisciplinary teams so that full utilization can be made of the special competencies available in the various fields.

Educating Engineers for the Last of the 20th Century. Edward M. Dougherty, President, Aronetic Inc. Tullahoma, Tennessee. The rules of the economic game are being changed rapidly. It is no longer sufficient that one have the capital and know-how to produce and market a product that satisfies the customer. Now one must also do it in a manner satisfactory to the employee, the Government, and the bystander who may be standing or living nearby. All this, of course, must still be done competitively.

Universities in the past have not been noted for their responsiveness to the needs of the real world. The desires and talents of the Educators, as would be expected, have frequently taken precedence over outside demands with the possible exception of some professional schools.

Engineering Colleges, while subject to the same internal influences as the rest of the University, have made an attempt to meet a real need. Now the demands are growing so broad and the problems that require solution are so complex, sophisticated and inter-related, industries of the future will have great difficulty spelling out their needs even should the Colleges pledge themselves to meet them.

The result, I believe, will be an Engineering College System of greater diversity than we know today. One College curriculum and instructional technique will resemble others only in outward form sufficient to get accredited while the students would hardly recognize they had worked for the same degree. Such diversity may be our salvation.

GEOLOGY AND GEOGRAPHY SECTION

OLD MAIN, CBJ

F. T. FISCHER, Chairman

An Empirical Approach to Limestone Classification Via a Computer Model. David N. Lunsden, Memphis State University. Limestone classification schemes have evolved through observation and testing to the point where a satisfactory framework, adaptable to almost any study, now exists. In the hopes of gaining insight into underlying cause and effect interactions between five constituents of a limestone, micrite, spar, fossils, coated grains, and oolites, a computer program was evolved in which these constituents interact to form mathematical "rocks." Each constituent was assigned a continuous distribution function (normal, lognormal or exponential) which were constrained to vary from zero to unity along the x axis. The means, standard deviations and expected values were varied. At points calculated and the "rock" then assigned a position in one of selected along the x axis the proportion of each constituent was several classification schemes tested. Results so far obtained have not revealed a scheme in which the "rocks" were classified into natural and unique categories. Definitions of classification boundaries play an important role in results obtained.

The Sandstone Sinkholes of the Cumberland. Phillip J. Losenz, The University of the South, Ward Rouse, North Carolina School of the Arts. Twelve large sandstone sinkholes on the Cumberland Plateau in or near Grundy County, Tennessee, were investigated. All sinks were excavated in the Crab Orchard Formation (Sewanee Conglomerate) and were found to be located within a few hundred feet from the escarpment along an axial plane running southwest to northeast. The average sinkhole studied was about ninety feet deep and 450 feet in diameter. However, the range is from small shallow depressions to large structures that were difficult to distinguish from hollows or caves. (Water-filled sinkholes in sandstone will be reported

later.) The survey was concluded with a detailed study of the large sinkhole atop the western escarpment of Burrow Cove.

"The Barrens" A Study in Geographic Terminology. William W. Chester, The University of Tennessee at Martin. The term barren is, in many instances, an incorrect use of terminology to identify certain geographic phenomena. For example, many writers incorrectly identify glades as barrens and others use these terms interchangeably. The purpose of this paper is to advance two origins of glade formations and show their functional use in select areas of so-called "barrens" in Kentucky and Tennessee. Numerous writings concerned with the barrens in Kentucky and Tennessee were reviewed for background data. In addition, the so-called "barrens" of West Tennessee were investigated during various field excursions. After working in the area, it is the opinion of the writer that serious consideration should be given toward elimination of the term barren and embrace the term glade to identify the geographic features discussed in this paper.

Several Geological Applications of Radar Imagery. G. K. Moore, U. S. Geological Survey, Water Resources Division. The geological features that are visible on radar imagery of Tennessee include bedding, faults and other lineations, large sinkholes and quarries, strip mines, anticlines and synclines, and a dome, hitherto unmapped. Everything visible on radar imagery also is visible on aerial photography, but subtle topographic features are enhanced by shadowing on radar. Thus, some geological features also are enhanced. Other unique advantages of radar are an all-hour and all-weather capability, target illumination from any azimuth and from almost any vertical angle and both like and cross polarized returns.

Future of the New Earth Science Program in Tennessee Secondary Schools. R. Jerry Rice, State Department of Education, and James X. Corgan, Austin Peay State University. Earth science was officially added to the secondary school curriculum in Tennessee during the 1969-1970 school year. Nine school systems offered earth science to their eighth and ninth grade students. In 1970-71, fifty-seven school systems adopted an earth science textbook as a basal text, and twenty-seven additional systems adopted an earth science textbook as a supplementary text for eighth or ninth grade programs. In 1971-72, 95% of Tennessee school systems offer earth science or an earth science-oriented general science course. Rapid growth of the earth science program poses many problems. If the program is to succeed, Tennessee colleges and universities must provide trained teachers; the schools must view earth science as a significant professional specialization; educators must continue to encourage a variety of innovative approaches to earth science instruction; and Tennessee's practicing earth scientists must regard the secondary school teacher as a fellow professional.

Multi-well Limestone Aquifer Test. J. M. Wilson, J. M. Kennedie, Tenn. Division Water Resources, and F. G. Stearns, Vanderbilt University. In October 1971 a nine-well limestone aquifer (pumping) test was conducted in Wilson County near Mt. Juliet, Tennessee. Preliminary figures indicate a porosity of .003 percent for the Carters Limestone. Water levels were measured prior to the test to establish the static water level, and gamma-ray logs were run to establish geologic contacts. Unusual features of this test are the large number of observation wells and the amount of data available for analysis. Malfunctions of the generator on the first day of the test caused on and off operation of the pump. This resulted in additional aquifer development. Static water level in the pumping well and the four wells to the north rose 2 feet. To the southwest a decline of almost 2 feet resulted. Originally, the gradient of the water table was 47.3 feet per mile. After the water level adjustment the gradient was 36.8 feet per mile. This change (apparently permanent) existed for several subsequent weeks even though rain recharged the aquifer. Some of the thoughts about what caused the decrease in gradient are: (1) Dewatering of part of the aquifer, and (2) Aquifer development (increased horizontal and/or permeability).

Clay Mineralogy of Tennessee K-Bentonites. R. W. Loumbury, Memphis State University, and W. M. Mathura, Purdue University. Altered volcanic ashfalls of Ordovician age occur in surprising thicknesses in central Tennessee and in the Chattanooga area. Exposures 1.5 to 5 feet thick were observed in the field. The volcanic origin of these interesting deposits is clearly indicated by the textures, mineral composition, and field relations. Samples collected chiefly in the Nashville and Chattanooga

nooga areas have been compared with others collected over an area of nearly one million square miles from New York to Alabama and Missouri and from units of Devonian age. The clays in these horizons have been variously described in the past as potassium bentonite or K-bentonite and metabentonite. X-ray, thermal and optical analyses indicate that these deposits are chiefly mixed-layer clays. Illinite greatly exceeds monmorillonite in the interstratified clay. These clays are much less expansive than the montmorillonite of smectite bentonites of the West.

Tidal Glat Deposits in Upper Ordovician Rocks Exposed along Interstate 75 between Chattanooga and Cleveland, Tennessee. Richard E. Bergenback, University of Tennessee, Chattanooga. A sedimentary rock sequence composed from the base up of a calcally interbedded carbonate and gray shale, poorly bedded calciniferous limestone and gray shale, poorly bedded calciniferous limestone, red- and green-mottled mudstone, calcirudite, and calcisiltite, red- and green-mottled mudstone, calcirudite, and calcisiltite, and gray orthoquartzitic sandstone. This sequence is interpreted to have formed during a regression in shallow marine, near-shore environments.

The Wells Creek Formation in Central Tennessee. Ray C. Gilbert, The New Jersey Zinc Company, Carthage, Tennessee. The Wells Creek Formation, as known from two surface exposures and about 600 drill penetrations in Central Tennessee, is the lowermost Middle Ordovician sediment. It typically contains a basal conglomerate in a green argillaceous dolomite overlain by a more massive dolomitic limestone. This formation fills the topographic lows in the topography developed on the post-Mascot erosion surface. The two units of the formation are distinct in some areas of the Central Basin but are inter-layered in other areas. The information was apparently deposited in a relatively shallow water under stable conditions. The correlation of the Wells Creek can be made only in a gross way, and the details of correlation must await a more complete knowledge of the regional distribution of the lowermost Middle Ordovician sediments.

Stones River Group Stratigraphy of Middle Tennessee. Alan K. Stagg, The New Jersey Zinc Company, Middle, Tennessee. The Stones River Group of Middle Ordovician age has been studied in some detail in those portions of the Central Basin of Tennessee in which it crops out. However, little information concerning this unit has been available in those areas where it occurs in the sub-surface; the data available have consisted primarily of cuttings from oil test wells which allowed only gross correlations. An extensive core drilling program by The New Jersey Zinc Co. in Middle Tennessee and portions of Southern Kentucky, which resulted in the discovery of major zinc deposits in the underlying Knox Dolomite, has afforded an opportunity to acquire detailed stratigraphic information on the Stones River Group in the sub-surface. Detailed stratigraphic correlations have been made which have resulted in the redefinition of the Wells Creek Formation, the recognition of an unconformity at the top of the Murfreesboro Formation, the identification of several distinct facies of the Pierce Formation, and the presence of a massive, mottled bed at or near the top of the Lebanon Formation in the northeastern part of the area. Tentative correlations with equivalent rocks in central Kentucky can be made from the information now available.

MATHEMATICS SECTION

GEORGE DAVIS SCIENCE, 120

JAMES M. DORAN, *Chairman*

Concerning E-Inversive, Rectangular Semigroups. David A. Smithey, Tennessee Technological University. This paper is an investigation of the set of idempotents for an E-inversive, Rectangular Semigroup. Necessary definitions will be stated and two lemmas will be proved. With the aid of these lemmas, the following theorems and a corollary will be proved.

Theorem 1. Let S be an E-inversive, Rectangular Semigroup. If x is an element of S², then there exists idempotents e and f in S such that x = ex = xf.

Theorem 2. Let S be an E-inversive, Rectangular Semigroup. Let E be the set of idempotents for S, let e be an element of S. Then E is left [right] zero if and only if eS = S² [eS = S²] and eS[e] is a group.

Derivation of Integral Identities Using Complex Integration. M. K. Jain, University of Tennessee at Martin.

We have used residue theorem to find the following results:

A. **If**

(i) $f(z)$ has a period $2\pi i$ and is analytic within and on a closed contour Γ consisting of a semicircle of radius R in upper half plane and real axis from $-R$ to $+R$,

(ii) $\lim_{R \rightarrow \infty} |R^{-1} f(Re^{i\theta})| = 0$ for $0 < \theta < \pi$

then

$$(1.1) \int_{-\infty}^{\infty} \frac{f(\log x) dx}{x(1+px)^2 + (\log x)^2} = \frac{f(\pi i) - f(\pi i - \log p)}{1-p} \frac{1}{\log p}$$

B. **If**

(i) $\lim_{R \rightarrow \infty} |R^{-1} f(Re^{i\theta})| = 0$

(ii) $\lim_{p \rightarrow 0} [p^2 f(pe^{i\theta})] = 0$

(iii) $f(z)$ is an entire function, then

$$(1.2) \int_0^{\infty} \frac{f(x) x^{p-1} dx}{p+x} = \frac{f(-p)\pi}{\sin \pi p} p^{-p-1}$$

Replacing p by L in (1.1) and $1/p$ by L in (1.2), where L is a linear operator associated with y with inverse L^{-1} , and applying the operators on $\phi(y)$ we have

$$(1.3) \int_0^{\infty} \frac{f(\log x)}{x(1+px)^2 + (\log x)^2} [\int_{-\infty}^{\infty} (-1)^n x^{n-1} \phi(y) dy] dx = f(\pi i) \int_{-\infty}^{\infty} L^n \phi(y) - \frac{f(\pi i - \log L)}{\log L} \phi(y)$$

and

$$(1.4) \int_0^{\infty} f(x) x^{p-1} [\int_{-\infty}^{\infty} (-1)^n x^{n-1} \phi(y) dy] dx = \frac{\pi}{\sin \pi p} [f(-L^{-1}) L^{-p} \phi(y)]$$

With $L = \lambda E^p$, where E is shift operator defined by $E\phi(y) = \phi(y+1)$,

(1.3) yields

$$(1.5) \int_0^{\infty} \frac{f(\log x)}{x(1+px)^2 + (\log x)^2} [\int_{-\infty}^{\infty} (-1)^n x^{n-1} \phi(y+pn) dx] = f(\pi i) \int_{-\infty}^{\infty} L^n \phi(y+pn) + \int_0^{\infty} \lambda^n f(\pi i - \log \lambda - n) \phi(y+pn) dx$$

where $\phi(0) = 0$ for $\lambda = 1$, and $\phi(0) = a$, a finite quantity for $\lambda < 1$.

$f(z) = e^{-az}$, a non negative integer, satisfies the conditions of result A, and substituting it in (1.5) we get

$$(1.6) \int_0^{\infty} \frac{[\int_{-\infty}^{\infty} (-1)^n \phi(y+pn) dx]}{x^{a+1} [x^2 + (\log x)^2]} = (-1)^a \int_{-\infty}^{\infty} \lambda^n \phi(y+pn) + (-1)^a \int_0^{\infty} \lambda^n \phi(y+pn) dx$$

Similar results can be obtained from (1.2). The technique can be used to obtain many more such identities.

Corollary to Theorem 2. If S is an E-inversive, Rectangular Semigroup, then S² is a group if and only if S contains exactly one idempotent.

Inflation of a Semigroup Whose Square is a Group or the Union of Two Groups. Reginald Mazeres, Tennessee Tech. This paper will prove two theorems. First, any semigroup whose square is a group is an inflation of its square. Second, any semigroup whose square is the union of two groups is an inflation of its square.

SCIENCE-MATHEMATICS TEACHERS ASSOCIATION

GEORGE DAVIS, SCIENCE, 120

JOHN R. FREEMAN, *Chairman*

Factors Related to New Physics Course Adoptions in High Schools. John F. Yegg*, Harvard Graduate School of Education, Cambridge, Massachusetts. Two related nationwide studies of decision-making in high school physics course adoption processes were conducted. In all, nearly 700 teachers who had attended (Harvard) Project Physics summer institutes were studied and relationships between a large number of variables and each teacher's adoption or non-adoption of the new course were sought. Analyses of cross tabulations of data revealed relationships well beyond the levels attributable to chance. A factor analysis of variables significantly related to course adoption identified five essentially independent groups of interrelated variables. In most cases the clusters of variables were even more strongly related to adoption than any of the components in the factor. Recommendations are made to facilitate the adoption of new science courses in the light of the findings of the study. (This work was supported in part by a research grant (GW 5210) from the National Science Foundation.) *Present address: Special Training division, Oak Ridge Associated Universities.

Development of an Auto-Tutorial Course in Nuclear Medical Technology. Jerry B. Minter and Robert M. Beñin, Special Training Division, Oak Ridge Associated Universities. The instructional content of the Special Training Division's four-week residence course in nuclear medical technology is being adapted to a multi-media, auto-tutorial format. The course is designed to be offered to medical technologists undergoing on-the-job training in nuclear medical technology. Instruction will be accomplished in a study carrel placed in the technologist's hospital. Several hospitals in the Oak Ridge area have requested that the course be field tested and evaluated in their facilities. This work is being done under the auspices of Grant No. 1 DO2 AH 01048-01 from the Bureau of Health Manpower Education of the Department of Health, Education, and Welfare.

"Tech Physics"—Developing a Course of Study in Physics for Technician Training in Two-Year Colleges. L. K. Akers and John F. Yegg, Special Training Division, Oak Ridge Associated Universities. A new course of study in physics at the two-year college level for future technicians is in an early stage of development under an NASW grant to the American Institute of Physics. The course is being designed to achieve utility for the broad spectrum of physics students in technical colleges through the use of the "modular" format. The teacher, in essence, is able to tailor his course to suit his students by selecting a sequence of semi-autonomous modules that focus on the objectives and needs of the students. The initial module development is being conducted in four "centers" throughout the country—one of them in Tennessee. This paper summarizes the effort that has been expended to date and focuses on the module development experiences at the Oak Ridge center. Cooperative efforts have already been established with some state two-year colleges; further collaborative efforts will be encouraged.

MEDICAL SCIENCES SECTION

GEORGE DAVIS SCIENCE, 131

B. R. JENNINGS, *Chairman*

Termination of Immune Tolerance to Rabbit Gamma Globulin in Mice with Rabbit Antibodies to Mouse Antigens. C. M. Haire, University of Tennessee. In the first month of life, 175 Tennessee Swiss mice were rendered tolerant to rabbit gamma globulin (RGG). At two months of age, the males and females were each divided into four experimental groups, which received six twice-weekly injections of either rabbit anti-mouse serum albumen (RAMSA), rabbit anti-mouse gamma globulin (RAMGG), rabbit anti-mouse lymphocytes (RAML), or normal rabbit gamma globulin (NRGG), all in the ultracentrifuged form. Titrated for anti-RGG, the mice receiving RAML globulin appeared to have escaped tolerance. The regimen was repeated at a higher dose, resulting in a more dramatic response.

To confirm the findings, the three groups of male mice not receiving RAML globulin, were each divided into two sub-groups, one receiving a six-dose regimen of NRGG and the other receiving RAML globulin. Again, the latter subgroups escaped tolerance to RGG.

Sources of Lead Contamination in Mainland Its Possible Consequences. Henry A. Moses, Linwood Townsed and Sharon Watkins. Meharry Medical College and Fisk University. Lead analyses were performed on rainwater samples collected over a four month period (from June 19, 1970 through September 20, 1970) in low-congested area while the rainwater from the high-congested area had a range of 7.8 to 172 micrograms of lead per liter.

Further, analyses were performed on selected foodstuffs, thought to be common among the diets of lower income urban residents, for the purpose of ascertaining the possible degree of lead intake of these residents. Lead was found in all of the foodstuffs analyzed with subterraneously grown vegetables being high on the list.

The implications of the results obtained show that these people may be on the brink of developing chronic lead poisoning. The biochemical implications of the consumption of lead are also discussed.

Comparative Rates of Infection in the Use of Indwelling Venous Catheters Versus Intravenous Needles. Claude P. Ledes, University of Tennessee, Memphis. Nosocomial infections caused by indwelling venous catheters among hospitalized patients represent a serious health problem. A number of studies have documented the rate of infection noted in the use of these batheters and a few studies have suggested that the indwelling intravenous needle may have a lower percentage of infectious complications. This is a unique study which compares both techniques in a large municipal hospital population. Two hundred medical and surgical ward patients were studied and 217 cultures made. Of these, 179 were catheters and 38 were scalp vein needles. There were 40 positive cultures, and two cases of sepsis, one fatal. The percentage of positive cultures for pathogens increased with the time the devices were in place. The percentage of pathogens recovered from cultured catheters was 11.7 and from scalp vein needles 2.6. It is suggested that the rate of sepsis is significantly lower with the use of needles, and the rate of positive cultures increases with the number of hours the intravenous device remain in place.

Anti-tumor Antibodies in the Sera of Mice Prior to the Observation of Spontaneous Mammary Tumors. James M. Mason and B. R. Jennings, Univ. of Tenn. Med. Units, Memphis, Tenn. A 0.2% sodium deoxycholate extract was prepared from washed mammary tumor cells taken from inbred Hale-Stoner strain Swiss mice. This extract reacted in agar-gel double-diffusion with the serum of a 14 month old female mouse without a tumor, forming a single precipitin line. This antigen was found to migrate toward the anode and to react with the serum from tumor-bearing mice using immunoelectrophoresis. Since antibodies migrate toward the cathode under these conditions (pH 8.6 and ionic strength = 0.235), it was possible to devise a system in which this antigen and antibody were migrated toward one another. This was observed to be a rapid and sensitive test for anti-tumor antibodies with precipitin lines usually forming within 30 min. Using this technique the sera of all eleven mice tested were shown to contain these antibodies before any developed a palpable mammary tumor. These antibodies were not found in the sera of young adult (approximately 3 month old) female mice of this strain.

Stable Tracers for Clinical Studies on Human Subjects. N. C. Dyer and A. B. Brill, Vanderbilt University. The use of radioactive tracers for the study of metabolic processes for normal and diseased states in human subjects is a well established practice. In human subjects who have a high risk to ionizing radiation exposure such as pregnant women and infants, the use of radioactive tracers is often not justified especially in situations where the results of the study will not be of direct benefit in the medical management of the subject.

We have developed techniques for stable tracer studies for use on such high radiation risk populations. With a stable tracer study, a non-radioactive, rare isotope is given to the subjects. Blood and biopsy samples are taken from the subjects and the amount of stable tracer is quantitated in the samples by neutron activation analysis. Since the irradiation of

the samples is done *in vitro*, there is no exposure of the patient to ionizing radiation. Stable tracer studies using ^{50}Cr on newborn infants with respiratory distress and ^{55}Fe for iron metabolism of pregnant women will be discussed.

PHYSICS AND ASTRONOMY SECTION

GEORGE DAVIS SCIENCE, 121

W. E. HUNT, Chairman

Understanding the Very Complicated Eclipsing Binary Star RS Canum Venaticorum. Douglas S. Hall, Dyer Observatory, Vanderbilt University. RS CVn suffers from a greater variety of complications than perhaps any other eclipsing binary. To explain to all of these I propose the following model. There is a region of tremendous sunspot activity darkening one hemisphere of the cooler star within $\pm 30^\circ$ of its equator. This explains (1) the wave-like distortion in the light curve outside eclipse, (2) why secondary eclipse has a 10% shorter duration than primary, and (3) why primary eclipse is about three times deeper than expected from the relative surface brightnesses of the two stars. If the cool star is rotating differentially, as our sun does, then the equatorial region will rotate slightly faster than an intermediate "co-rotating latitude" which rotates in synchronization with the orbital motion. This explains the migration of the wave-like distortion towards decreasing orbital phase, and also the variable depth of primary eclipse. Violent chromospheric activity associated with the sunspot region can explain the strong Ca II emission observed spectroscopically. Violent flare and/or prominence activity and consequent mass ejection can explain why the orbital period is so badly variable even though neither star fills its Roche lobe. The abrupt period change in 1964 was a decrease, consistent with the fact that the dark region was then on the leading hemisphere. To explain why the cool star has such violent sunspot activity and why it lies above the main sequence, I suggest that RS CVn is a very young binary with its cool component still in gravitational contraction. This research was supported in part by National Science Foundation Research Grant GP-9895.

The Nearly Contact Eclipsing Binary Star BV 346. Robert C. Tate and Douglas S. Hall, Dyer Observatory, Vanderbilt University. Edward W. Burke, Jr., King College. The eclipsing binary star BV 346 was observed photoelectrically in blue and yellow light on 17 nights in 1969 at the Kitt Peak National Observatory. Four minima were observed from which the period was found to be 1.4252387 . Communication with Dr. Strohmeier, Remes Observatory, Bamberg, Germany, provided 14 more minima which confirmed the period and improved the accuracy. The B and V light curves, corrected for atmospheric extinction and reduced to heliocentric time, were rectified for ellipticity and reflection, and solved for the elements in the usual way. Because the eclipses were shallow (0.5 from maximum to primary minimum) and became even more shallow after rectification, no unique solution could be found for the critical element k , the ratio of radii. We found, however, a family of solutions which faithfully represent the observations. Spectroscopic information provided by Dr. Popper, U.C.L.A. suggests a value of $k \approx 1$. The ratio of the depth of primary and secondary minimum indicates the system is composed of two main-sequence stars of spectral type B8 and B9. Although the value of k is not uniquely determined, it can be shown that, over the entire range of permissible solutions, the system is very nearly contact.

This research was supported in part by National Science Foundation Research Grant GP-19895

A Doughnut-Shaped Star in the Very Young Eclipsing Binary BM Orionis. Douglas S. Hall, Dyer Observatory, Vanderbilt University. A model is proposed to explain why the early B star is seen in the spectrum, whereas the light curve seems to predict an equally bright cooler star which should be seen alone at supposed totality. The cool star is assumed to be a disk-shaped object, similar in shape to that proposed by Huang for E Aurigae, seen nearly edge-on. By means of various restraints it is estimated that the disk covers about 55% of the B3 star at primary eclipse. This leads to the relative luminosities, the color of the disk, the relative geometrical dimensions, and the orbital inclination. The model with these parameters predicts

a theoretical light curve which represents the observation quite well.

The mass-luminosity relation applied to the B3 star, along with the mass function, leads to the following absolute dimensions: The B3 star has a mass of $5 M_\odot$, and a radius of only $2.5 R_\odot$; the disk has a mass of $3 M_\odot$, is $15 R_\odot$ in diameter, and $3 R_\odot$ in thickness.

A biconcave disk structure, such as calculated for the primeval solar disk or for pre-main-sequence stars undergoing rapid differential rotation, could satisfy the stringent requirement that the top and bottom of the proposed disk appear exactly flat in projection.

This research was supported in part by National Science Foundation Research Grant GP-19895

Investigation of the Effect of a Conduction Current on Elastic Waves in a Magnetized Steel Bar. F. L. Culp, Don Brown, and Dorris Tongate, Tennessee Technological University. A vertical arrangement of a soft steel magnetized bar sandwiched between two Cu-Be bars was employed to investigate the effect of conduction current on elastic waves in the steel bar. The steel bar was magnetized by a surrounding solenoid, while the elastic waves were generated by dropping a weight onto the top of the column-like assembly. The output of a pick-up coil which surrounded the steel bar was displayed on an oscilloscope screen and photographed. It was also investigated with a wave analyzer. Initial observations were made with no current in the steel bar. Spectrum analysis revealed principle frequency components of 5, 10, and 15 kHz, plus a weak 2 kHz signal. The first three signals were identified as standing waves in the steel bar, with the 5 kHz signal representing the fundamental frequency of the longitudinal wave. The 2 kHz frequency, also identified as a damped standing wave, was associated with the entire vertical assembly; hence, the wave crossed the boundaries between the steel bar and the Cu-Be bars. Observations were repeated under identical conditions with one exception—viz., a current of several amperes was sent through the steel bar. The presence of the current in the magnetized steel bar dramatically enhanced the 2 kHz signal, demonstrating that this frequency was able to pass through the Cu-Be-steel interfaces much more readily than before. Analysis of this effect suggests that the current changes the acoustic impedance in the steel bar by causing a change in the speed of the longitudinal elastic waves. The evidence indicates that a more direct experiment should be performed to test the above implication.

Level Schemes of ^{152}Gd and ^{152}Sm . A. V. Ramayya, J. H. Hamilton and K. R. Baker, Physics Department*, Vanderbilt University. Silgels and multiparameter coincidence experiments were performed on the decay of $^{12.6\text{y}}^{152}\text{Eu}$. Approximately 30 new γ -rays were observed in ^{152}Sm and ^{152}Gd . Of particular importance is the precise determination of the intensity of close lying lines. Three interband γ to β band transitions were confirmed in ^{152}Sm by our coincidence data as well as a transition from the 4^+_{γ} to the 3^- , $K=0$ octupole state. New levels not previously reported or confirmed by coincidence data include 1650.4, 1680.0, and 1757 keV in ^{152}Sm and 1282.5, 1318.6, and 1550.1 keV in ^{152}Gd .

Gamma-Gamma Directional Correlations of Transitions in ^{152}Te . K. R. Baker, J. H. Hamilton, A. V. Ramayya and G. Highland Physics Department, Vanderbilt University. Gamma-gamma directional correlation measurements were made on nine transitions in ^{152}Te with a NaI(Tl) - Ge(Li) detector arrangement and multichannel analysis. The multiple mixing ratios obtained were $\delta(646) = 0.000 \pm 0.001$, $\delta(714) = 1.5 \pm 0.6$, $\delta(723) = -3.2 \pm 0.2$, $\delta(1437) = 3.7 \pm 2.7$, $\delta(1489) = -3.3 \pm 0.9$, $\delta(968) = -0.03 \pm 0.06$, $\delta(1368) = -0.045 \pm 0.090$, $\delta(1045) = 0.041 \pm 0.047$, $\delta(1691) = -0.02 \pm 0.01$, and $\delta(2091) = 0.00 \pm 0.02$. The first δ is M3/E2, the next three are E2/M1, and the last five are M2/E1. The retardation (a factor of approximately 50) of the crossover to cascade transitions from the 2039-keV, third 2- level to the second and first 2- levels is essentially the same for both the M1 and E2 components. In addition, spin and parity assignment of 2- were made for the 2039- and 2092-keV levels.

A Black Box Experiment. Philip J. Lorenz and Roger L. Farrow, The University of the South. In the traditional general physics laboratory, students rarely have an opportunity to test hypotheses explicitly. In this exercise each student was provided with a metal can containing a simple mechanical system. His task was to fully describe its contents without opening, destructively testing or x-raying the can. A control can, i.e., a ground state system, was available. The techniques of a student in solving this problem are described.

ZOOLOGY SECTION

GEORGE DAVIS SCIENCE, 100

H. MALCOLM OWEN, Chairman

The Chiroptera of West Tennessee. Michael J. Harvey and Frank F. Graves, Jr., Memphis State University and the University of Montana. Collection and observation over the past several years have verified the presence of 12 species of bats in West Tennessee, herein defined as the area, including all or part of 21 counties, between the Mississippi and Tennessee Rivers. *Lasiurus borealis* and *Myotis austroriparius* were found to be common throughout the area, although there is only one published record of *M. austroriparius* from the entire state (Grainger County). Also present, but less common and at scattered localities, were *Myotis lucifugus*, *Myotis grisescens*, *Myotis keenii*, *Myotis sodalis*, *Lasionycter noctivagans*, *Pipistrellus subflavus*, *Eptesicus fuscus*, *Lasiurus cinereus*, *Nycticeius humeralis*, and *Plecotus rafinesquii*. Specimens were obtained primarily by mist-netting over ponds and watercourses. Caves and abandoned buildings in the area were also checked periodically for bats. Additional specimens were obtained from the Tennessee Department of Public Health. Several hundred individual bats have been banded with U. S. Fish and Wildlife Service bat bands and released. *M. grisescens* have been recovered as far away as 70 miles from the collection site.

*A Kyphotic Eastern Spiny Softshell Turtle, *Trionyx s. spinifer*.* James B. White and George G. Murphy, Middle Tennessee State University. A kyphotic adult female eastern spiny softshell turtle, *Trionyx s. spinifer*, was collected from the West Fork of the Stones River, Rutherford County, Tennessee, on 16 August 1971. The specimen weighed 2204 g. Measurements were as follows: plastron length, 19.5 cm; carapace (straight length) 25.6 cm; carapace (curved length) 32.6 cm; and height of apex of carapace above apex of pelvic bones, 6.0 cm. X-rays showed nine thoracic vertebrae rather than the typical ten. The fourth thoracic vertebra was abnormally long and arched. Fourth, fifth, and sixth pairs of ribs articulated with the anterior, middle, and posterior regions of the fourth thoracic vertebra. This abnormal rib articulation suggests a fusion of the fourth and fifth vertebrae. Muscles and visceral organs appeared normal and filled the cavity formed by the abnormal curvature of the carapace. The kyphotic conditions was probably the result of abnormal development of skeletal elements during embryonic development.

*Morphological Variations in Three Populations of the Banded Sculpin, *Cottus caroliniae* (Gil).* James O. Sweeney, Jr., Middle Tennessee State University. Sculpins were collected by seining from the following locations in Tennessee: West Fork of Stones River, Rutherford County (population A); Bashaw Creek, Coffee County (population B); and an unnamed spring in Lincoln County (population C). Average ray counts for the second dorsal fins of A (N=70), B (N=59), and C (N=75) were 17.17, 16.23, and 16.69, respectively. Average pectoral fin-ray counts for A, B, and C were 16.64, 15.83, and 15.88, respectively. Average anal fin-ray counts for A, B, and C were 13.07, 12.69, and 13.24, respectively. Average lateral line pore counts for A, B, and C were 33.48, 32.57, and 29.61, respectively. Total body length (mm) and weights (gm), respectively, of the largest sculpins taken were: 74 and 5.7 (A), 139 and 34 (B), and 139.484 (C). Vomerine and palatine dentition was poorly developed in A. Dentary and vomerine dentition was poorly developed in B. Variations in pigmentation and bands were observed. (This investigation is part of an in-progress thesis problem with the Biology Department, Middle Tennessee State University).

*A Systematic Study of Ground Squirrels (Genus *Spermophilus*) by Serum Protein Electrophoresis.* R. D. Ikenberry, East

Tennessee State University. Serum proteins of eight species representing five subgenera of ground squirrels were characterized by agar-gel electrophoresis. The serum protein patterns provided diagnostic features at the subgeneric, species group, species, and subspecies levels. Serum protein pattern similarity and difference indicated an arbitrary phylogeny. The subgenus *Otospermophilus* and *Callospermophilus* exhibited similar protein patterns. *Otospermophilus* was considered to exhibit the most generalized protein pattern. *Callospermophilus* exhibits specialization in the albumin and alpha globulin fractions. *Ammospermophilus* and *Xerospermophilus* differ from *Callospermophilus* in beta globulin characteristics. The subgenus *Ictidomys* shares characteristics of the other four subgenera and represents an intermediate group.

A Systematic Study of Six Genera of Squirrels by Serum Protein Electrophoresis. Jerry W. Wolfe and R. D. Ikenberry, East Tennessee State University. The serum of six genera of squirrels were characterized by agar-gel electrophoresis. Species specific protein fractions were used as taxonomic characters. A phylogeny was constructed in the form of a dendrogram utilizing the sum of character state differences expressed as operational taxonomic units (OTU). The phylogenetic relationships that are implied by this procedure are as follows: *Marmota* exhibits a close relationship to *Tamias*; *Glaucomys* exhibits a relatively primitive state and close relationship to *Tamias* and *Marmota*; *Sciurus* represents the most advanced character state with *Spermophilus* and *Tamiasciurus* representing intermediate positions in the phylogeny.

*Reproductive Behavior and Developmental Rates of the Wood Frog *Rana sylvatica*.* David Meeks, East Tennessee State University. This study reports on reproduction and development of *Rana sylvatica* near the southern limit of its distribution. Comparisons with equivalent studies in northern areas are made. Mass is much lower in this southern form. There is a three month larval period. Eggs hatched twenty days after the first egg mass was observed. No overwintering in the larval stage was noted; metamorphosis was completed in June at body lengths ranging from 17-19 mm.

Some Features of Incisor Tooth Development in Mice. Laurence R. Fitzgerald, University of Tennessee Medical Units. Early development of incisor teeth of mice shows several features which are not well known. A very primitive tooth-like structure, apparently a deciduous incisor, is formed before the permanent incisor. This toothlet has no enamel and no roots, and never erupts. It is always present in the maxilla, but is variable in occurrence in the mandible. The incisal end of the permanent incisor resembles a single cusp of a molar tooth, having the typical depression forming the "enamel-free" area. Characteristic mammalian dentin is the fourth of a series of types of dentin which appear in the tip of this tooth. The other types resemble at least superficially, dentin which may be phylogenetically primitive. The portion of the incisor containing the unusual types of dentin is worn away within a few hours after eruption, leaving the familiar chisel-shaped incisal edge. Lightly infested fish was 38.4 and the mean worm burden was 3.6.

*A Comparison of the Effects of Light and early Infections of *Posthodiplostomum Metacercariae* (Trematoda, Diplostomatidae) on the Fecundity of *Gambusia affinis affinis* (Osteichthyes, Poeciliidae).* Charles W. Holland. Female *Gambusia* of identical total length collected on the same day from one sample site were paired, with one member of the pair being classified as lightly infested and the other, heavily infested. In both light and heavy infections, 85 percent of the *Posthodiplostomum metacercariae* were found in the choroid and scleroid tissues. The remaining parasites were located in the loose ovarian connective tissue and occasionally attached to developing embryos. The fecundity of each member of a matched pair was entered as one observation into the appropriate infection group. The mean fecundity of the mean fecundity of heavily infested fish was 37.2 and the mean worm burden was 12.2. At 476 degrees freedom a t-test, $t(0.5)$, indicated no differences in mean fecundities.

*Microhabitat and Competitive Exclusion in the Genus *Desmognathus*.* J. W. Nagel, East Tennessee State Univ. Field studies on the dusky salamander (*Desmognathus fuscus*) and the seal salamander (*D. monticola*) in upper East Tennessee indicate that at lower elevations the two species coexist within

