CHEMICAL, MATHEMATICAL AND PHYSICAL SCIENCES

CMPSD No. 1

ISOLATION AND SCREENING FOR ANTI-PROTOZOAL ACTIVITY OF SOME NOVEL LECTINS

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Lectins represent a diverse class of non-enzymatic, sugar-binding proteins. Its bioactivities have been appreciated largely in the context of biological response modification, i.e. to amend host's defense system against infection and even cancer. Even much recently, some "dangerous" lectins, such as ricin from the castor plant, have been monitored for stockpiling under the BTWC regime. In this study, new lectins were isolated from *Schefflera odorata* ("lima-lima" plant) [mol. wt= 271 kDa], *Swietenia macrophylla* (king large leaf mahogany) [mol. wt= 295 kDa], *Lenzites sp.* (a mushroom) [mol. wt= 184 kDa]. Using modified microplate screens, these purified lectins were found to possess high cytotoxic activities against *Acantamoe ba sp.* (a keratitis-causing amoeba) and *Tetrahymena pyriformis* (a ciliate). Since carbohydrate-lectin interactions in protozoans play important, yet broad roles in cell recognition, adherence, cell division among others, taken together, our results indicate that lectins may also be further exploited as potential chemotherapeutics against certain parasitic diseases.

Keywords: lectins, Acantamoeba sp., Tetrahymena pyriformis

SUPERCRIFICAL CARBON DIOXIDE EXTRACTION OF LIPASE FROM GERMINATING COCONUT (Cocos nucifera)

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A new method of extracting partially purified lipase from haustorium of germinating coconut using supercritical carbon dioxide (SC-CO₂) is proposed. Using the Bradford method, the lipase extracted by SC-CO₂ revealed higher protein content, 6.5338 mg/ml, than the conventional method (phosphate buffer as extracting medium), 5.1837 mg/ml. In addition, the specific activity of SC-CO₂ lipase extract was higher, 21.2380 units/mg compared to conventional method lipase extract, 1.0619 units/mg.

The lipolytic activity of SC-CO₂ lipase extract is found to be significantly higher than the conventional method lipase extract in terms of incubation time, and is also observed to be not significantly different from the latter both in terms and temperature. Both extracts exhibited maximum lipolytic activity at a pH of 7.0 and a temperature of 40°C while their incubation time was 30 minutes.

High-Performance Liquid Chromatography (HPLC) showed that the SC-CO₂ lipase extract has a broader activity compared to that of lipase extracted from the conventional method. The free fatty acids in coconut oil that were hydrolyzed by the partially purified SC-CO₂ lipase extract were caprylic, capric, lauric, palmitic, stearic, and olcic acid. Lauric acid was the major fatty acid hydrolyzed of all fatty acids liberated.

Keywords: supercritical carbon dioxide, Bradford method, lipolytic, High Performance Liquid Chromatography

ISOLATION AND PURIFICATION OF THE OIL-BODY PROTEIN, OLEOSIN FROM COCONUT (Cocos nucifera L.) ENDOSPERM

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The oil body of plant seeds contains a triacylglycerol matrix surrounded by a monolayer of phospholipids embedded with a unique class of proteins called oleosins. These are small, largely hydrophobic and alkaline proteins that have been suggested to play roles in stabilization of oil bodies and receptor binding of lipase during triacylglycerol mobilization. Due to our interest in abundant seed proteins in coconut, we investigated the proteins associated with the oil bodies of C. mucifera. In this study, we describe the isolation of oleosin from the oil bodies of coconut and its characterization. Endosperm from mature coconut was ground in liquid nitrogen and subjected to repeated salt washing, floatation centrifugation through sucrose density gradients, and washing with chaotropic buffer containing urea resulting in a nearly homogeneous preparation of oil bodies, from which oleosin was extracted using diethyl ether. Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) showed an abundant protein with an approximate molecular weight of 14,400 that was retained after repeated washing with KCl and urea. This band was transferred to a PVDF membrane by Western blotting, cut, subjected to Nterminal sequencing. Results indicated the presence of more than one protein sequence, which could be isoforms that were inseparable by the conventional SDS-PAGE.

Oil body proteins were also resolved by SDS-PAGE using tricine as trailing ion, two-dimensional electrophoresis (2DE) using a chaotropic mixture of urea and thiourea in the solubilization buffer, fast protein liquid chromatography (FPLC) through a size-exclusion and ion-exchange column. These methods, however, still resulted in one band of 14,400 molecular weight with an isoelectric pH of 9.

This study was funded by the Department of Science and Technology – Philippine Council for Agriculture and Natural Resources Research and Development and the University of the Philippines Los Baños.

Keywords: triacylglycerol, Cocos mucifera, SDS-PAGE, 2DE, FPLC

CMPSD No. 4 MOLECULAR CLONING OF THE OLEOSIN GENE FROM THE COCONUT (Cocos nucifera) ENDOSPERM

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Oleosins are a unique class of hydrophobic proteins found in the oil bodies of diverse organisms. In plants, they are most abundant in the lipidstoring bodies of seeds comprising up to 8% of the total seed protein. In this study, we report the cloning of coconut oleosin cDNAs and the characterization of their nucleotide sequences.

A gene-specific primer was designed based on the conserved sequence of known oleosin genes. Using this, two gene isoforms coding for oleosin were isolated from the total mRNA of a six month after pollination-old coconut using reverse transcription-polymerase chain reaction (RT-PCR) with molecular sizes of approximately 500 (ole500+) and 300 (ole300) base pairs. These isoforms were ligated into the pGEMT® Easy Vector and maintained in *E. coli* DH5a cells.

Sequences of the six clones analyzed reveal that these are distinct and homologous to published oleosin gene sequences. The homology of the five ole500 sequences range between 60%-99.4% among each other and averages at 91%. These sequences show an average homology of 91% with the oil palm (*Elaies guineensis*) oleosin OPZE1A gene (Accession No. AF273023.1). The sequence for the ole300 clone is 96% homologous to the rice (*Oryza sativa*) 16 kDa oleosin isoform R16 gene. (Accession No. AF022148.1). The deduced amino acid sequences of these cDNAs were found to contain the conserved oleosin domain when searched against known oleosin proteins.

By Southern blot analysis, the ole500 cDNA was found to have two copies in the coconut genome. These results indicate the isolation of oleosin cDNA sequences which could be present as multiple copies in the coconut genome. The analysis of the sequences of the oleosin gene and its putative isoforms will provide the molecular basis for constructing vectors that will carry important hydrophobic proteins and designer oils in future genetic engineering studies and in studies to isolate sequences regulating the oleosin gene expression.

This study was funded by the Department of the Science and Technology – Philippine Council for Agriculture and Natural Resources Research and Development and the University of the Philippines Los Baños.

Keywords: oleosin, coconut, Cocos nucifera, isoforms, CDNA sequence

CMPSD No. 5 REMOVAL OF HEAVY METALS IN WASTEWATER USING BARKS OF INDUSTRIAL TREE PLANTATION SPECIES (ITPS)

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The use of barks as adsorbent of heavy metals in industrial wastewater will help in disposing the waste generated from the processing of logs, as well s provide alternative source of cheaper adsorbents for wastewater treatment. Tree plantations in the Philippines generate large volumes of waste whose utilization is often limited.

Eight ITPS barks, namely: Acacia mangium, Eucalyptus deglupta, Eucalyptus camaldulensis, Paraserianthes falcataria, Endospermum peltatum, Anthocephalus chinensis, Samanea saman and Gmelina arborea were shaken with a prepared mixture of metal solutions of lead [Pb(II)], copper [Cu(II)], chromium [Cr(VI)] and zinc [(Zn(II)]. The removal efficiency of these barks ranged from 14 to 64% for Cu(II), 32 to 61% for Cr(VI), 18 to 94% for Pb(II) and 10 to 50% for Zn(II). Likewise, wastewater from a galvanizing plant was tested and results showed that removal efficiency ranged from 61 to 81% for Cu(II), 83 to 90% for Cr(V1), 96 to 100% for Pb(I1) and 20 to 49% for Zn(II). A simulated column test conducted prior to the actual adsorption test using wastewater from the galvanizing plant showed that *E. peltatum* bark became saturated with heavy metals after six hours of contact with wastewater.

Barks of *E. camaldulensis*, *E. peltatum* and *G. arborea* were loaded in the wastewater treatment plant for 24 hours for maximum uptake of heavy metals. The amount of the adsorbed Zn(11) ranged from 4.72 to 4.95 mg/g bark.

Keywords: heavy metals, barks, tree plantation

CMPSD No. 6

PHYSICOCHEMICAL PROPERTIES OF SEED GUM FROM PARADISE FLOWER PLANT (Caesalpinia pulcherim a Linn.)

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The physicochemical properties such as moisture content, total ash, acid-insoluble residue, proteins, density, starch, pH, viscosity of gum derived from seeds of Paradise Flower Plant (*Caesalpinia pulcherima Linn.*) were determined. Stability tests such as boiling point and freezing point were also done on the gum samples. Results were compared to the properties of Guar gum.

Two varieties, namely; red-flowered and yellow-flowered Paradise Flower plant (Caballero) were used in the study. Fully mature seeds with brown seed coat and nearly mature seeds with greenish-brown seed coat were utilized.

Results of the analysis revealed the following values were moisture content, 10.5-12.94%, total ash 1.45-1.84, acid insoluble residue 3.89-4.88%, density 0.946-0.959 g/m, pH 5.52-5.53, viuscosity 3020-3416 cps, protein 4.20%, boiling point 89.33-89.67°C, freezing point 15.33-17.33°C. Gum content was calculated by subtracting from 100 the sum of the other specific tests. The gum extracted from different Caballero pods averaged 73.6% for fully mature red, 72.7% for fully mature yellow, 69.0% for nearly mature red, and 69.2% for nearly mature yellow. Predatory capacity of local population of *Mesocyclops* species were evaluated, for the first time in the Philippines, as biological control of *Aedes aegypti* (L.) mosquitoes. Under laboratory condition, *Mesocyclops* attacked the mosquito first instar larvae by the tail, side and head. Mean of first instar larvae consumed by *M. aspericornis* and *M. ogunnus* were 23.96 and 15.00 respectively. Analysis of variance showed that there was a highly significant difference between the mean number of first instar mosquito larvae consumed by *M. spericornis* and *M. ogunnus* which indicated that *M. aspericornis* is a more efficient predator of dengue mosquito larvae.

Larvitrap Index, Larval Density Index, and Larvitrap Density Index of Estero de Tanque showed that *Aedes aegypti* (65%) and *Aedes albopictus* (35%) were present in the area. House Index, Container Index and Breteau Index revealed that the area was sensitive for transmission of dengue. *Aedes* mosquitoes bred in indoor and outdoor containers such as plant vases, drums, used automobile tires, and plastic containers. KAP survey revealed that residents had insufficient information on dengue etiology, breeding sites, and biting habits of dengue mosquitoes.

Results of small scale field trials showed that the mean number of surviving larvae in experimental drums was 63.10 and 202.95 in control drums. T-test of means indicated that there was a significant difference between the mean number of surviving larvae in the drums with and without *M. aspericornis*. Findings indicated that *M. aspericornis* females are good biological control agents for they destroyed/consumed about two thirds of the wild, dengue mosquito larvae population.

Keywords: copepods, Mesocyclops, Aedis aegypti, dengue, mosqiotoes, biological control

Results show that gum from fully mature seeds from red or yellowflowered Caballero have similar physico-chemical properties to the Guar gum while gum from nearly mature seeds failed the standard of moisture content, total ash and acid-insoluble residue. Gum from fully mature seeds of both varieties yielded cosmetic and medicated emulsions with qualities such as appearance, texture, washability and spreadability, similar to those of the commercial preparations.

These results point out the possibility of utilizing the Paradise Flower Plant seeds for production of gum whose adhesive and stabilizing properties are very much needed in cosmetic and pharmaceutical world.

Keywords: gum, physico-chemical properties, caballero

CMPSD No. 7

ANALYSIS OF ALDEHYDES FROM EMISSIONS OF A DIESEL ENGINE USING DIESEL-COCONUT METHYL ESTER FUEL BLENDS

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Methylated esters from various vegetable oils have been used as additive to diesel fuel in order to improve their emissions. Although overall improvement in diesel emissions is observed, particular concern has been raised regarding the presence of various aldchydes in the emissions. In the Philippines, the use of coconut methyl esters (CME) is being supported by the government. This study, therefore, was conducted in order to determine the amount of formaldehyde and acetaldehyde that is emitted by a diesel engine using different CME-diesel fuel blends.

Emission samples were collected from a Kubota diesel engine using a dilution system. Electrical loads were applied to simulate actual conditions. The

following diesel-CME blends were tested: 100:0, 99:1, 98:2, 95:5, 80:20, 60:40 and 0:100. Emission samples were derivatized using O-(2,3,4,5,6-pentafluorobenzyl)hydroxylamine (PFBHA), and injected into a gas chromatogram/mass spectrometer (GC/MS).

Results showed that formaldehyde and acetaldehyde emissions were lowest when 100% CME was used. Acetaldehyde emissions were highest when using the 2% CME blend. It was also found that aldehyde emissions were highest when the engine was at idle, and lowest under maximum load.

The identification of other components in the emissions from diesel-CME blends will be presented.

Keywords: Emissions from diesel-coconut methyl ester blends, formaldehyde, acetyaldehyde, PFBHA

CMPSD Na. 8

IDENTIFICATION OF THE MAJOR ORGANIC EMISSION FROM A TWO-STROKE MOTORCYCLE ENGINE

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The volatile organic compounds (VOCs) and condensable fraction of emissions from a 2-stroke motorcycle using 8:1 gasoline:oil mixture were collected by solid phase microextraction (SPME) and dichloromethane (DCM) extraction, respectively, and then analyzed by gas chromatography-mass spectrometry (GC-MS). The VOC emission closely resembled the profile of the gasoline used indicating that much of the VOCs was unburnt gasoline. The condensable fraction, on the other hand, contained a large number of high molecular weight components which probably come from the oil that was used with the fuel.

Keywords: motorcycle emissions; volatile organic compounds; condensable emissions; gas chromatography-mass spectrometry

PACKAGING FILM FROM CARRAGEENAN

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A water-soluble, edible film was produced from carrageenan for packaging of spices used in instant noodles, casing for sausages and ham including wrapper for candies, frozen meat, vegetables and fruits.

The film is composed mainly of carrageenan. The physicochemical properties of the film are as follows: Thickness (mm) 0.062 ± 0.004 to 0.112 ± 0.007 ; Tensile strength (kg/mm²) 1.4465 to 3.875 ± 0.2 ; Breaking factor (kg/mm) - 0.241 ± 0.075 to 0.563 ± 0.05 ; Elongation (%) - 106 ± 0.56 to 187.3 ± 7.3 ; Tear strength (kg/mm) - 214 ± 1.1 to 3.053 ± 0.31 ; Elastic modulus - 0.006 to 0.0365; Degree of decomposition - 109.0 to 115.4 °C; and Moisture content (%) - 13.0 to 19.0.

Stability studies showed that carrageenan film when used as wrapper for candies and spices including casing for 'longanisa' did not produce any loss of product during six months of storage. There was also no significant change observed in saturation solubility.

Carrageenan film is a good packaging material for food. It is edible, watersoluble and does not generate garbage or waste. It is also an environmentfriendly product.

Keywords: carrageenan, packaging film, physico-chemical properties

CMPSD No. 10 A STUDY ON The Thermal INTRAMOLECULAR Cyclization OF 2-AMINOBIPHENYL

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A large number of pharmaceutical products are heterocyclic in nature and so there is considerable interest in the synthesis and properties of these systems. Many synthetic routes for nitrogen-containing heterocycles are available, however, thermal intramolecular cyclization reaction of 2-aminobiphenyl to yield carbazole, is investigated in this research.

Previous studies showed that no appreciable cyclization of 2aminobiphenyl occurs when the reaction tube is packed with non-catalytic glass beads. The use of catalysts such as CaO, molecular sieve and zeolite as well as changes in reaction temperatures gave revealing results.

The results of the study showed that CaO, zeolite, and molecular sieve are good catalysts for the thermal intramolecular cyclization of 2-aminobiphenyl, resulting to 100% conversion of the starting material to product, with the highest percent yield of carbazole obtained at a reaction temperature of 500°C.

Keywords: heterocycles, thermal cyclization, catalysts, carbazole

CMPSD No. 11 DEVELOPMENT OF METAL STRESSED Pseudomonas aeruginosa AND Saccharomyces cerevisiae AS BIOLOGICAL MODIFIER OF A CARBON PASTE ELECTRODE FOR VOLTAMMETRIC-BASED LEAD SENSOR

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The use of metal stressed Pseudomonas aeruginosa and Saccharomyces cerevisiae was investigated for its feasibility as a biological modifier of a voltammetric-based heavy metal biosensor, particularly lead. Pretreatment of the microorganisms were carried out by culturing the microorganism with the idea that the organisms will develop metal binding proteins to survive the harsh condition. After 48 hours of conditioning, microbial biomass was harvested and incorporated in a carbon paste electrode. Optimum conditions for Pb (II) analysis including the effect of pH, accumulation time. deposition potential, supporting electrolyte and lead concentration was investigated by differential pulse adsorptive stripping voltammetry (DPAdSV). Regeneration of electrode surface is done by dipping the used electrodes in 0.1 M EDTA for 10 minutes. Determination of Pb (II) from laboratory waste sample with the "yeast-trode" and "Pseudomonas-trode" by DPAdSV was comparable with the results using atomic absorption spectroscopy (AAS). By exploiting principles of biotechnology and electrochemistry, the yeast-trode and Pseudomonas-trode are cost-effective biosensor that can be configured for rapid environmental monitoring of water samples.

Keywords: Pseudomonas aeruginosa, Saccharomyces cerevisiae, biological modifier

BIOCATALYSIS AS AN IMPORTANT TOOL IN THE SYNTHESIS OF PHARMACEUTICALS

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Recently, there has been an increased interest in the preparation of pharmaceuticals in an enantiomerically pure form. It was found that only one of the two possible enantiomers is actually beneficial in its use as a drug while the other enantiomer is inactive or may even show lethal effects. One of the ways to prepare an enantiomerically pure product is to begin the synthesis with enantiomerically pure starting material. In the preparation of enantiomerically pure material, a technique called biocatalysis is applied. In this presentation, several biocatalytic processes will be illustrated with specific examples. The biotransformations employed are hydrolysis of esters with lipases, reduction of ketones with yeast, and dihydroxylation of aromatics with recombinant bacteria.



Keywords: biocatalysis, synthesis, pharmaceuticals, enantiomer, biotransformation

CMPSD No. 13 DETERMINATION OF THE CORRELATION FACTOR BETWEEN TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) AND ELUTION LEACHING PROCEDURE (ELP) RESULTS IN TESTING THE LEACHABILITY OF HAZARDOUS WASTES OF A PHILIPPINE GEOTHERMAL PLANT

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The Toxicity Characteristic Leaching Procedure (TCLP) is the leaching test adopted in the Philippines to determine the toxicity of hazardous wastes. A new law, however, would require industries to characterize hazardous wastes using Elution Leaching Procedure (ELP). This study was conducted to establish any correlation factor that would convert TCLP to ELP results to assist geothermal power plants in complying with the new regulations on hazardous waste management.

Geothermal scales and sludge collected from four different points of one geothermal power plant were subjected to TCLP and ELP extraction and filtration processes. The presence of cadmium (Cd), chromium (Cr), and lead (Pb) in the supernatant liquid were analyzed using Atomic Absorption Spectroscopy. The concentration values of Cd, Cr, and Pb were statistically treated to determine how the TCLP values correlated with ELP values, specifically for each metal.

Different concentration values were obtained from the TCLP and ELP runs. Initial experimental runs have indicated specific correlation factors for each of the characterized hazardous substances. The correlation factor to convert TCLP values to ELP values for Cd, Cr and Pb are 1.0093, 1.9924, and 0.08314, respectively. Further experimental runs are to be undertaken to test the validity and consistency of the correlation factor.

This research marked the first time that ELP was employed to determine the toxicity of Philippine geothermal wastes. The study has shown that a correlation factor between TCLP and ELP results could be established. These results would provide essential scientific basis for the formulation and implementation of the Philippine Hazardous and Radioactive Wastes Management Act of 2003.

Keywords: TCLP, ELP, hazardous wastes, geothermal waste

CMPSD No. 14 RECOVERY OF RARE EARTH ELEMENTS FROM BEACH SAND IN PALAWAN

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Allanite, a *sorosilicate* mineral containing rare earths, thorium and uranium, was found to occur in beach sand from Ombo, San Vicente, northern Palawan. Rare earths or rare earth elements (REE) are high value commodities used in high-technology applications, i.e., electronic and optoelectronic, stateof-the art magnetics, electric and electric-hybrid automobiles, fuel cells and auxiliary power units, computers, rechargeable batteries, aerospace applications including reflective coatings, anti-reflective coatings, electromagnetic interference (EMI) and radio frequency interference (RFI) shielding, magnetic resonance imaging (MRI) instruments and more. This preliminary study describes a metallurgical process initiated at the Philippine Nuclear Research Institute (PNRI) and partially funded by the Philippine Council for Advanced Science and Technology Research and Development (PCASTRD) with the objective of extracting, recovering and producing REE oxides from allanite in the beach sand. The highlight of this experiment is the development of a recovery process to produce relatively pure REE earth oxides, a pioneering work in the country.

Keywords: rare earths, rare earth elements, allanite, sorosilicate, uranium, thorium, rare earth oxides

CMPSD No. 15 SILICA GELS FROM RICE HULL: STRUCTURE, COMPOSITION AND WATER VAPOR ADSORPTION BEHAVIOR

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Silica gels prepared from rice hull were found to have properties comparable to two commercial silica gels and a silica gel prepared by the Industrial Technology Development Institute (ITDI), in terms of chemical and amorphous structure, surface area, desiccant characteristics and heats of adsorption. These properties were determined from infrared and x-ray diffraction spectra and from water vapor adsorption measurements. Microstructure comparison by electron microscopy showed greater uniformity in particle size and distribution for the rice hull silica gels. The acid treated rice hull gels may have potential as chromatographic material, based on less x-ray fluorescence detected elemental impurities, compared to the commercial and ITDI gels. The economic advantage of preparing silica gels (and other silica products) from rice hull could be considerable if the rice hull ash is obtained from properly designed burners using rice hull as a renewable energy source. Aside from production of cheap energy and silica products, the process will contribute to agricultural waste utilization and pollution abatement through reduction of emissions from the current practice of open field burning of rice hull.

Keywords: FTIR, rice hull, SEM, silica gel, XRD, XRF, water vapor adsorption

Research supported by the Department of Agriculture Bureau of Agricultural Research (DA BAR)

CMPSD No. 16 WATER SUBSTITUTION BY PYRIDINE IN COBALT (III)-SUBSTITUTED KEGGIN AND DAWSON TYPE HETEROPOLYANIONS

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Incorporation of transition metal cations in octahedral binding sites on the surface of lacunary heteropolyanions results in formation of complexes that bear many similarities to metal complexes of macrocyclic ligands like metalloporphyrins. Transition metal complexes of heteropolyanions then are considered purely inorganic analogs of porphyrins. The advantages in using them to study substitution reactions instead of metalloporphyrins are that they are robust in nature and their oxidation states can be easily manipulated.

The main objective of this research is to compare the rate of water substitution by pyridine in transition metal complexes of heteropolyanions such as $[a_1 - P_2 W_{17} Co^{11} (H_2 O) O_{61}]^7$, $[a_2 - P_2 W_{17} Co^{01} (H_2 O) O_{61}]^7$, and $[a - Si W_{11} Co^{01} (H_2 O) O_{30}]^3$ under specified conditions. About 0.002 M solutions of the heteropolyanions in 0.1M sodium acetate buffer, pH4.7 in 1M sodium perchlorate were prepared. These solutions were oxidized electrochemically at +1200 mV. The resulting reaction mixtures then were mixed with excess pyridine. In order to monitor the formation of the pyridine complex, the absorbance of the mixture at 626 nm was recorded for a period of 4 hours.

The observed first order rate constants for the substitution reactions were $[a_1 - P_2 W_{17} Co^m (H_2 O)O_{61}]^7 (3.0 \times 10^{-2}/\text{sec}) > [a-SiW_{11} Co^m (H_2 O)O_{30}]^6 (4.7 \times 10^{-4}/\text{sec}) > [a_2 - P_2 W_{17} Co^m (H_2 O)O_{61}]^7 (3.7 \times 10^{-4}/\text{sec})$. Substitution of water by pyridine in the heteropolyanions studied was found to proceed using a dissociative mechanism. Also, steric strain argument used to explain why the substitution rate constant in $[a_1 - P_2 W_{17} Co^m (H_2 O)O_{61}]^7$ was 80 X larger than in $[a_2 - P_2 W_{17} Co^m (H_2 O)O_{61}]^7$.

Keywords: heteropolyanions, pyridine, substitution, Keggin, Dawson

PERFORMANCE TESTING OF SMALL PLASTIC SCINTILLATOR TILES FOR THE GLOBAL LINEAR COLLIDER (GLC) ELECTROMAGNETIC CALORIMETER

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A bench test is presently conducted on the small NE102A plastic scintillator tile with a sensitive area of 4 cm x 4 cm and a thickness of 1 cm for the proposed Asian Global Collider (GLC) to determine the spectra of scintillator emiision $S(\tilde{e})$ at all points on the tile, wavelength shifting (WLS) fiber absorption (Fa \tilde{e}) and fiber emission (Fe(\tilde{e}).

The tile-fiber technique is employed in this study to facilitate the collection of the incident photon. Two scintillator tiles are fixed on top of the plastic bench with a collimated ⁹⁰Sr å-beam of source on an xy-axis moving platform. The photons hitting the scintillator are read out through wavelength shifting (WLS) fiber which is inserted into the plastic scintillator tile. The WLS fiber from each tile is connected to the PMT and is then channeled to an array of electronic modules and CAMAC for ADC measurement.

In this study, initial results of the bench test showed a very good light yield as observed in the oscilloscope. Photon peak and pedestal counts from ADC count distribution will soon be explored.

Keywords: Wavelength Shifting (WLS), plastic scintillator, CAMAC

COMPUTER SIMULATION OF THE STANDARD MODEL PROCESS et at THE PROPOSED GLOBAL LINER COLLIDER (GLC)

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The performance of the 3-T detector in measuring selected observables in the Standard Model process e+e- $\mu+\mu$ - at the proposed Asian Global Linear Collider (GLC) is being investigated by computer simulation in this study.

The center-of-mass energy is set initially at 500 GeV which is later increased to 1 TeV and 1.5 TeV. Electron-positron collisions inside the GLC detector are analyzed using the JLC Study Framework (JSF) and the PhysSim libraries. Event generation is done using the PYTHIA Monte Carlo generator while the JSF Quick Simulator (QuickSim) is used for detector simulation.

Data gathered from the generation and simulation of events are used to formulate event selection criteria for precision calculation of desired observables (forward-backward asymmetry ratio, etc.) in the above-mentioned process. The results of this study are then compared to results of known previous studies for verification. These will be useful in setting new parameters of the GLC detector for future operations.

Keywords: Standard Model, Global Linear Collider, JLC Study Framework (JSF)

CMPSD No. 19 GROWTH OF Y-DOPED Bi-2212 SINGLE CRYSTALS

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Superconducting single crystals of Bi-2212 doped with Yttrium were successfully grown by melting powder precursors of nominal composition Bi₂Sr₂Ca₂₀Y₂₁Cu₂O₂₀. The crystals were grown in an Al₂O₂ boat. The problem of incongruent melting of the Bi-2212 phase was solved by bringing the powder precursors to a temperature sufficient to melt it but not too high so as to destroy the Bi-2212 phase. Melting at 950°C for 5 hours followed by slow cooling to 880°C resulted in the melting of the charge near the surface, forming a thin layer of crystals, which were easily cleaved mechanically. The composition of the crystals was analyzed using Energy dispersive x-ray incident on smooth, defectfree and impurity free surfaces. Cation ratios of approximately Bi:Sr:Ca:Y:Cu::2.27: 1.92: 0.80: 0.34: 2.00, normalized to Cu = 2.00, were obtained. DC resistivity measurements revealed Tc ~ 80K. Morphology of the sample was investigated through SEM. The single crystals have a thin plate-like shape with sizes ~2 x 3 mm². The surfaces are smooth with dark luster. Layered growth behavior was also observed by focusing near the edges of the sample. These observations macroscopically reflect the layered structure of Y-doped Bi-2212 crystals. X-ray diffraction patterns showed (007) peaks, indicating that the c-axis of the unit cells is normal to the surface of the crystal. This also enabled calculation of the clattice parameter and it was found to be 30.58Å. This value is less than the cparameter of an undoped Bi-2212 single crystal where c= 30.77 Å. This slight reduction of c-parameter further supports the successful incorporation of Yttrium into the Bi-2212 crystal because this suggests the alteration of the crystal structure due to doping.

Keywords: superconductors, doping, single crystals, Bi-2212

CMPSD No. 20 HIGHLY TEXTURED Bi₂Sr₂CaCu₂0_{and} FILM SYNTHESIS UNTO SILVER SUBSTRATES BY ELECTROPHORETIC DEPOSITION

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Highly textured films of Bi₂Sr₂CaCu₂O_{and} on silver substrates were synthesized using an electrophoretic deposition process (EPD). The powders were initially pre-reacted using solid state reaction before deposition unto high purity silver sheets. The powders were milled then placed in an ethanol colloidal suspension with a ratio of 0.5g/L. A deposition voltage of 100 V/cm and a deposition time of 60 and 90 seconds were implemented. The deposited films were subjected to a short sintering time of 1.5 H at 870 °C in order to reduce film porosity and allow vacancy diffusion of the grains. X-ray diffraction (XRD) analysis shows significant peaks oriented along the c-axis. From the XRD pattern the c-axis parameters of the films were computed. It was observed that the films have a high relative intensity ratio between (001) and non (001) peaks. Surface image analysis shows that a reduction of crystallographic misorientations of the deposited particles has occurred. Plate-like particles were observed oriented parallel to the plane of the substrate indicating grain alignment along the c-axis plane. C-axis orientation and grain alignment indicates texturing of the deposited films.

Keywords: Electrophoretic Deposition, BSCCO/Ag Films, Textured Films

CMPSD No. 21 THE MACARTHUR-WILSON AND MONOMOLECULAR VOLUMETRIC MODELS FOR SATURATED FLUIDS AND GASES

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Volumetric equations are very important in the study of thermodynamics. In power generation, such as steam power plant and refrigeration cycles, which take into account the thermodynamic properties of water and steam, volumetric equation is needed to relate the volumetric properties of water and steam in computing the thermal and mechanical properties of the system. It allows for the computation of work, thermal efficiency, energy, and heat rate.

It is a must then that volumetric properties of gases and fluids be predicted as accurate as possible to achieve accurate computation of the different thermodynamic properties. This study is one such effort. It covers the examination and comparison of the Macarthur-Wilson model and the Monomolecular model aimed at determining which model is more viable in capturing the volumetric behavior of saturated fluids and gases. For testing purposes, the thermodynamic property tables of saturated liquid ammonia and water were used.

Most of the nonlinear models would require the presence of parameters that are to be estimated in the model. In estimating the parameters of the models, the classic NLIN (nonlinear) procedure of SAS (Statistical Analysis System) and the Gauss-Newton Method were employed.

Comparison was made based on the proscribed set of criteria, such as p-values, R^2 , sum of squares residuals and s^2 . The Macarthur-Wilson model and Monomolecular model unquestionably have a better model fit to the randomly chosen volumetric properties tables of saturated liquids. The study found out that the Monomolecular model is the more viable model in determining the thermodynamic property values of saturated liquid ammonia and water.

Keywords: Macarthur-Wilson Model, Monomolecular Model, Saturated Liquids, NLIN procedure, Gauss-Newton Method.

CMPSD No. 22 PHASE TRANSITIONS OF A SQUARE LATTICE ISING MODEL

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Ising model is used in studying thermodynamic properties, such as magnetization, magnetic susceptibility and specific heat capacity, of a ferromagnetic substance having strong anisotropy in one direction. Monte Carlo simulation was used to analyze first-order and second order phase transitions. Starting from a uniform configuration of spins, the temperature was then increased to 10K. The magnetization, energy, magnetic susceptibility and specific heat capacity were plotted with respect to temperature and the second-order phase transition is analyzed from these plots.

Simulation results showed that the plot for magnetic susceptibility versus temperature and specific heat capacity versus temperature has a peak at Tc. At the thermodynamic limit the plot would diverge at infinity. Meanwhile, first-order phase transition was analyzed by noting the hysteresis formed as the system was subjected to increasing and decreasing magnetic field, typically from -10 to 10 Oersted. The hysteresis loop was obtained by plotting the applied field versus the magnetization. At T<Tc, specifically at T=1K, there occurs a first-order phase transition as evident from an abrupt change of magnetization from 1 to -1 A/m. At T>Tc, specifically at T=5K, no first-order transition has occurred.

Keywords: Ising Model, Ferromagnetic, Monte Carlo, square lattice, magnetization, specific heat capacity, magnetic susceptibility, energy, hysteresis

CMPSD No. 23 LOW-FIELD AC SUSCEPTIBILITY BEHAVIOR OF P5-DOPED BI-2223

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The study of low field AC susceptibility is of considerable interest, since it provides crucial information on the response mechanism of superconductor to the externally applied electric and magnetic field. In the case of Bi-2223, we were mainly interested in studies on the nature of its AC losses mechanism.

Samples were grown using Pb-doped Bi-2212, Ca₂CuO₃ and CuO. X-ray diffraction pattern was measured and most of the observed peaks correspond to the Bi-2223 phase. This indicates the growth of Bi-2223 phase as a dominant phase. Weak impurity peaks from Bi-2212 intergrowth phases is also observed in XRD pattern. AC susceptibility measurements have been performed at varying field by using magnetic inductance bridge setup.

From AC susceptibility measurement, the transition width is ranged from 15K to 20K. At transition temperature a double-peak curve in the lower applied field was observed in imaginary part of AC susceptibility. This double peak curve is due to the presence of bulk and intergranular material. The peak near Tc is attributed to the intragrain transition that corresponds to hysteretic losses. While the second peak is attributed to intergranular shielding current that gives rise to the dissipation. A steep upturn at lower temperature is also observed at lower field.

When field is increased, the double peak curve collapses into a singlepeak curve. And this peak shifts to lower temperature. The shifting of this peak is due the creation of energy barrier impeding flux penetration to the volume of superconductor brought by increasing applied field. Moreover, the steep upturn gradually vanishes with increasing applied field.

The resulting behaviors were relatively well described by eddy currents generated by Faraday effect. Also, low field AC susceptibility can be used as a simple test to distinguish between an intragranular or intergranular transition.

Keywords: AC susceptibility, BSCCO, superconductivity

CMPSD No. 24 ON CYCLE DERIVATIVES OF COMPLETE GRAPHS, COMPLETE BIPARTITE GRAPHS, AND OTHER GRAPHS

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An edge joining two non-consecutive vertices of a cycle is called a chord. A cycle in a graph is called a *prime cycle* (also called *induced cycle*) if it is chordless. The *(first)cycle derivative* (or, *cycle derivative*, for short) of a graph G, denoted by G_{ρ} is obtained by treating the prime cycles of the graph G as vertices of G_{ρ} and where two vertices are adjacent if and only if they are prime cycles with a common edge. Here, we consider the cycle derivatives of fans F_{ρ} , wheels W_{ρ} , complete graphs K_{ρ} ladder $P_{\rho} \times P_{\rho}$, helm H_{ρ} , and the complete bipartite graph $K_{\rho \sigma}$.

1. (a) $F'_n = P_{n-1}$ for $n \ge 2$. (b) $(P_2 \times P_n)' = P_{n-1}$

(c)
$$W' = W$$
, where $n \ge 3$.

- (d) $H_n' = W_n$
- 2. K'_n is 3(n-3)-regular. Furthermore, K'_n is a hamiltonian graph for n=4, 5 only.
- 3. K'_n is culerian if and only if n is odd, $n \ge 3$.
- 4. K_{\perp}' is a regular eulerian graph, for $n \ge 2$.
- 5. Let $n \ge 3$. Then $K_{2,n}$ is a hamiltonian graph for n = 3, 4, 5, 6.

Keywords: prime or induced cycle, cycle derivative, regular graph, hamiltonian, eulerian

SUPERPOSITION OF INTERGRANULAR AND INTRAGRANULAR LOSSES TO THE ACHARMONIC SUSCEPTIBILITIES OF BULK YBCO

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AC harmonic susceptibilities (c_n ' and c_n " with n=2 to n=7) of a superconducting YBCO bulk sample, having a critical temperature (T₁) of 89K, were experimentally obtained through a mutual inductance bridge set-up. While models predict the generation of even harmonics only in the presence of a DC field superimposed on an AC field, data show both odd and even harmonic responses under purely AC magnetic fields. Harmonic responses were measured at constant excitation frequencies of 200Hz, 800Hz and 12800Hz and constant field amplitudes of 0.13mT, 1.84mT and 3.64mT.

The harmonic response, manifested as an oscillation from positive to negative values, exhibits strong field amplitude and frequency dependence. Both the magnitude and number of oscillations increase with an increase in either the amplitude or the frequency of the applied AC field. In general, however, the pattern of oscillation of a particular c_n and c_n is not actually distinct and may change with field amplitude and frequency.

Previous studies in the laboratory have confirmed the direct link between harmonic generation and intergranular and intragranular losses. The shapes of the harmonic responses would depend on the contribution of each loss. The data for the harmonic response can be accounted for by considering that the superposition of such contributions may vary, with a strong dependence on frequency and applied field, therefore giving rise to the different shapes of the harmonic response. To support this argument, the behavior of the intergranular and intragranular loss peaks in the out-of-phase fundamental susceptibility will also be closely inspected.

Keywords: YBCO, Harmonic Susceptibility, Even Harmonics, AC Susceptibility

ON THE GEODETIC COVERS AND GEODETIC BASES OF THE COMPOSITION $G[K_{\perp}]$

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Given a connected graph G and two vertices u and v in G, $I_G[u, v]$ denotes the set of vertices consisting of u, v and all vertices lying on some u - v geodesic of G. A subset S of V(G) is called a geodetic cover of G if $I_G[S] = V(G)$, where $I_G[S] = \dot{E}_{uvls}I_G[u, v]$. A geodetic cover of minimum cardinality is called a geodetic basis. In this paper, we give the geodetic covers and geodetic bases of the composition of a connected graph and a complete graph.

The major results obtained in this study are the following:

- (1) Let G and H be connected graphs with H a complete graph. Then g(G[H]) = 2 if and only if either g(G) = 2 and H = K, or G = K, and $H = K_{a}$.
- (2) Let G be a connected graph, A a geodetic cover of G and B a GIC set with respect to A. Then $Ex(G[K_m]) \cup [(B \setminus Ex(G)) \times \{v_0\}] \cup [(A \setminus B) \times V(K_m)]$ is a geodetic cover of $G[K_m]$ for every $v_0 \in V(K_m)$.
- (3) Let G be a connected graph and T a geodetic cover of $G[K_m]$. Then T_f is a geodetic cover of G and there exists a GIC set B with respect to T_f such that $T = Ex(G[K_m]) \cup [(T_f \setminus B) \times V(K_m)] \cup \{(u, v) \in T : u \in B \setminus Ex(G), v \in V(K_m)\}$.
- (4) Let G be a connected graph. Then $g(G[K_m]) = (m-1)|Ex(G)| + \min L$, where $L = \{m|A| (m-1)|B| : A \text{ is a geodetic cover in } G \text{ and } B \text{ is a maximum } GIC$ set with respect to $A\}$.
- (5) Let G be a connected graph and A a geodetic basis that is a GIC set in G. Then $Ex(G[K_m]) \cup [(A \setminus Ex(G)) \times \{v_0\}]$ is a geodetic basis of $G[K_m]$ for every $v_0 \in V(K_m)$.
- (6) Let G be a connected graph. If G has a geodetic basis that is a GIC set in G, then $g(G[K_m]) = g(G) + (m-1)|Ex(G)|$. In particular, if G has no extreme vertices, then $g(G[K_m]) = g(G)$.

Keywords: composition, convex set, geodetic basis, geodetic cover, geodetic number

^{*}Research supported in part by the PCASTRD-DOST

CMPSD No. 27 ON THE HULL SETS AND HULL NUMBER OF THE CARTESIAN PRODUCT OF GRAPHS

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Let G be a connected graph, V(G) the vertex set of G and $d_G(u, v)$ the length of a shortest path connecting vertices u and v in G. The couple $(V(G), d_G)$ is a metric space on V(G). Any u - v path of length $d_G(u, v)$ is called a u - v geodesic.

A subset C of V(G) is convex if for every two vertices $u, v \in C$, the vertex set of every u - v geodesic is contained in C. If u and v are in V(G), then the set $I_G[u, v]$ is the set of vertices consisting of u, v and all vertices lying on a u - v geodesic of G. If $C \setminus V(G)$, then the union of all sets $I_G[u, v]$ for $u, v \in C$ is denoted by $I_G[C]$. A set C is convex in G if $I_G[C] = C$. The convex hull of a subset C of V(G) is defined as the smallest convex set in G containing C. A subset C of V(G) is a hull set in G if the convex hull of C is V(G). The cardinality of a minimum hull set in G is called the hull number of G. The hull number of the Cartesian product of a nontrivial connected graph and K_2 was shown by Chartrand, et al.

In this paper, we give the hull number of the Cartesian product of any two connected graphs. Among others, we obtained the following main results:

- (1) Let G and H be connected graphs and $C \setminus V(G \times H)$. if C and C are hull sets in G and H, respectively, then C is a hull set in $G \times H$.
- (2) Let $G \times H$ be a connected graph and $C \setminus V(G \times H)$ a hull set in $G \times H$. Then C_c and C_s are hull sets in G and H, respectively.
- (3) Let G and H be connected graphs. If A and B are minimum hull sets in G and H, respectively, then there exists C \ V (G × H) such that C is a minimum hull set in G × H and |C| = max {|A|, |B|}.
- (4) Let G and H be two connected graphs. Then $h(G \times H) = \max\{h(G), h(H)\}$.

Keywords: Cartesian product, convex hull, convex set, hull number, hull set

*Research supported in part by PCASTRD-DOST

ON THE EDGE COVERING OF GRAPHS

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An edge in a graph G is said to cover the vertices with which it is incident. A subset U of E(G) is an edge cover of G if for each vertex

 $v \in V(G)$ there is an edge in U which covers v. The edge covering number of a graph G without isolated vertices is given by

 $e_c(G) = \min \{ |U| : U \text{ is an edge cover of } G \}.$

This study seeks to determine the edge covering number of some graphs. Among the major results obtained in this are the following:

- 1. If H is a spanning subgraph of G both of which without isolated vertices, then $e_c(H) \ge e_c(G)$
- 2. If H is an induced subgraph of G both of which without isolated vertices, then $e_c(H) \le e_c(G)$
- 3. Let G and H be graphs of orders m and n respectively such that $e_c(G)$ and $e_c(H)$ exist. Then

 $e_c(G+H) \leq e_c(G) + e_c(H)$

4. Let G and H be graphs of order n and m, respectively. such that $e_c(G)$ and $e_c(H)$ exist. Then

 $e_c(G \times H) \le m(n - e_cG) + e_c(H)(n - 2(n - e_cG))$

5. Let G and H be graphs without isolated vertices. Then.

 $e_c(G \times H) \le \min\{e_c(G) | V(H)|, e_c(H) | V(G)|\}$

6. Let G and H be graphs of order n and m respectively such that $e_c(G)$ and $e_c(H)$ exist. Then

$$e_c(G[H]) \le m(n - e_cG) + e_c(H)(n - 2(n - e_cG))$$

7. Let G and H be graphs without isolated vertices. Then

 $e_c(G[H]) \le e_c(G)|V(H)|$ and $e_c(G[H]) \le e_c(H)|V(G)|$

8. Let G be a graph of order n without isolated vertices. If G contains a spanning path, then $e_c(G) = \lceil n/2 \rceil$.

.9. Let G be a nontrivial connected graph. Then $e_c(G) = |E(G)|$

if and only if G is the star $K_{1|E(G)|}$.

Keywords: edge cover, edge covering number, sum, Cartesian product, composition, spanning

CMPSD No. 29 ANOTHER LOOK AT THE CONVEXITY IN GRAPHS

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The concept of convexity in graphs is discussed in the book by Buckley and Harary. This concept was also investigated by Harary and Nieminen. For a nontrivial connected graph G, Chartrand, Wall and Zhang defined the convexity number of G, denoted by con(G), as the maximum cardinality of a proper convex set in G; that is,

 $con(G) = max \{ |C|: C \text{ is convex in } G \text{ and } C \downarrow V(G) \}.$

A convex set C in G with |C| = con(G) is called a maximum convex set. The concepts of convex set and convexity number were also investigated recently by Canoy and Garces. They characterized convex sets in the join, composition, and the Cartesian product of two connected graphs and then determined their respective convexity.

In this paper, we characterize the convex sets in the corona of graphs, the conjunction of graphs, and in the graphs obtained from the complete graph by deletion of proper complete sub-graphs. Further, we determine their corresponding convexity numbers and the convexity numbers of the wheel, generalized wheel, and the gluing of some graphs.

Keywords: graph, convex, maximum convex set, convexity number, corona, conjunction

ON CONVEX BASIC GRAPHS

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Given a connected graph G, the distance d(x,y) is defined as the length of a shortest path connecting vertices x and y of G. Any x-y path of length d(x,y)is called an x-y geodesic. A subset C of V(G) is convex if for every pair of vertices x, y in C, the vertex set of every x-y geodesic is contained in C. The cardinality of a maximum convex proper subset of V(G) is called the convexity number of G and is denoted by con(G).

A graph G is convex basic if the convex subsets of the vertex set V(G) of G are all trivial, that is, either a empty, a singleton, a doubleton that forms an edge, or V(G). In this paper we give some characterizations of the convex basic graphs. Specifically, we will relate convex basic graphs with the concept of convexity number of a graph. Convex basic graphs resulting from the sum, composition, and Cartesian product of graphs are also characterized. Furthermore, in this study we show that for any positive integer p the set of all connected graphs with independence number p contains only a finite number of convex basic graphs.

Keywords: graph, convex, geodesic, convexity number, convex basic, independence number

CMPSD No. 31 ON THE STRUCTURE OF THE SEDENION AND OCTONION LOOPS

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The sedenion loop S_L is the loop of order n = 32 generated by the 16 basis elements of the sedenion algebra S. This real algebra S is the Cayley-Dickson double of the octonion algebra O (or Cayley numbers). It contains the octonions, quaternions, and complex numbers as subalgebras and as such it has a rich structure that is beginning to find numerous applications in both pure and applied mathematics as well as in theoretical physics. Because of this, several studies are now being undertaken to determine its properties and its relations to other mathematical structures.

This paper deals with the determination of the subsystem structure of the sedenion loop S_L (using the software FINITAS) which contains the octonion loop O_L of order m =16 as a subsystem. The result of this study has shown that S_L has exactly 67 subsystems all of which are normal. Of these 15 are non-abelian NAFILs of order 16 (8 are isomorphic to O_L and 7 to a new NAFIL loop), 35 groups of order 8 (isomorphic to the quaternion group), 15 groups of order 4 (isomorphic to the cyclic group of order 4), one group of order 2 (isomorphic to the cyclic group of order 1) (the trivial group).

A very important finding is our *discovery* of a previously unidentified NAFIL (Non-Associative Finite Invertible Loop) of order 16. This loop has almost all of the properties of the octonion loop except that it does not satisfy the Moufang identity. Thus, we have called it the "pseudo-octonion loop." Its role within the sedenion algebra has been shown to be associated with the existence of its zero-divisors. This is a very significant contribution to the development of loop theory and non-associative algebras.

Keywords: sedenion loop, sedenion algebra, octonion algebra, Non-Associated Finite Invertible Loop

SPECIAL ISOTOPES OF THE CYCLIC GROUP C_N AND THEIR USE IN THE CONSTRUCTION OF CERTAIN FACTORABLE GROUPS, LOOPS, AND QUASIGROUPS

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The *Cayley table* of a finite group, loop, or quasigroup is a *Latin square*. If we subject such a Latin square to a permutation of its rows, its columns, or its symbols (or any combination of the three operations) we obtain another Latin square called an *isotope*. Thus, starting from a given Latin square, we can produce other Latin squares which are isotopes of the original one. These isotopes form an *equivalence class*; and any one of these isotopes can be chosen as a representative of the class.

An analysis of the Cayley tables of composite groups of small order shows that most of them are built up of Latin square blocks that are isotopes of the cyclic group C_n of order n. This is true, for instance, of the dihedral and dicyclic groups.

This study is concerned with the determination of certain special isotopes of the cyclic group C_n of order n and their properties (using the software FINITAS) with the aim of compiling a library of such isotopes in the form of *Latin square blocks*. Using a method based on the *block product method* of constructing factorable finite algebras, we show how various finite groups, loops, and quasigroups can be constructed using such Latin square blocks. Moreover, we also show how the properties of these blocks determine the properties of the constructed systems. As an important example, we construct the octonion loop O_L of order m = 16 using blocks belonging to the class of isotopes of the cyclic group C_A of order 4.

Keywords: Cayley table, finite group, quasigroup, Latin square

CMPSD No. 33 MEASURING DEVELOPMENTAL INSTABILITY IN DRAGONFLIES

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Developmental stability can be sensitive indicator of the physiological state of individuals in natural populations. As such, it has potential as indicator of environmental stress, and is inexpensive and easily measured. Dragonflies are indicators of environmental health as they are common inhabitants of freshwater streams, rivers, and other places where water can be found to lay their eggs and the development of nymphs under water. Development of nymphs can be affected by environmental stress and developmental stability is expressed by measuring fluctuating asymmetry (FA), the variance in random deviations from perfect bilateral symmetry. In these insects FA in wing cell characters have different "windows of opportunity" in relation to environmental stress.

Visualizing FA in this species of organisms involved the use of scatter plots of right side versus left sides of wing venational characters. Frequency distributions of wing character asymmetry (R-L) were employed to show whether the characters were asymmetric around zero. Kurtosis test statistics were employed to detect deviations of frequency distributions from normality in the direction of platykurtosis (broad-peaked or bimodal) and leptokutosis (narrowpeaked and long-tailed). This was done to detect the presence of antisymmetry. Significance tests for difference between the right and left sides of wing venational characters through ANOVA of |R-L| variation was also done. Scatter plots of trait FA |R-L| versus trait size among the eight species of dragonflies was plotted to detect size-dependency of FA levels. Several FA measures were employed including mean trait asymmetry [mean(R-L)], [mean(|R-L|)/(((R+L)/2] and [mean|R-L|/mean(((R+L)/2]), between-sides variance [var(R-L)] and average sum of mean squared deviations from symmetry ("($(R-L)^2/N$).

Results showed that wing venational characters of the eight species of dragonflies were asymmetric around zero and the frequencies of the deviation from symmetry for each character (R-L) were normally distributed as shown by the kurtosis test statistics. Not all characters showed significant deviations from symmetry and FA levels differed between and among the characters considered. The results also indicated size-dependent trait FA with higher character asymmetry in *N. palliata*, which has higher meristic counts compared to the other species. Differences in FA levels between agricultural and natural populations of dragonflies were also observed indicating that FA can explain developmental instabilities, character-specific homeostasis and organism-wide homeostasis and can be utilized in investigating effects of environmental stress to living organisms.

Keywords: physiological state, fluctuating asymmetry, , deviations, ANOVA, dragonflies, homeostasis

CMPSD No. 34

SOLVING HARD COMPUTATIONAL PROBLEMS BY IN SILICO MOLECULAR CATALYSIS

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Enormously difficult computational tasks are now hallmarks of several newly emerged disciplines such as molecular genetics (genomics), information technology among others. The combinatoric nature of solutions varies with operand complexities and grows exponentially with the size of the problem thus making it impossible to draw solutions within a reasonable time frame. This paper describes a computational approach inspired by molecular catalysis. A distributed stochastic algorithm simulates reaction systems wherein molecules (data) and the interactions (reactions) among them are driven by an algorithm. Tested by solving in tandem with deterministic algorithms, this novel method was demonstrated to have superior processing rate for the combinatronics of radiation hybrid (RH) mapping of the human genome, finding the Hamiltonian cycle of the traveling salesman and resource retrieval in the world wide web.

Keywords: combinatorial problems, metaheuristics, radiation hybrid mapping, traveling salesman

CHARACTERIZATION OF NON-ABELIAN NAFIL LOOPS OF ORDER 7

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A non-associative finite invertible loop (NAFIL) is a loop in which every element has a unique two-sided inverse. NAFIL loops form a class that includes the familiar Moufang, Bol, and IP loops with many applications in both pure and applied mathematics as well as in theoretical physics.

In 1999, all non-isomorphic NAFIL loops of orders 5, 6, and 7 were determined for the first time by PUP researchers using the program SEM/SATO in collaboration with Prof. Hantao Zhang of the University of Iowa, U.S.A. The result of this determination showed that: there is exactly one NAFIL of order 5 (non-abelian), 33 of order 6 (7 abelian and 26 non-abelian), and 2,333 of order 7 (16 abelian and 2,317 non-abelian).

The NAFIL loops of orders 5, 6, and 7 (abelian) were then characterized in 2001 using the software FINITAS Version 1.1X. Because of the limitations of Version 1.1X of FINITAS, the 2,317 non-abelian NAFIL loops of order 7 were not successfully characterized.

This paper deals with the characterization of all non-abelian NAFIL loops of order 7 (using the latest version of the software FINITAS V1.1) in terms of their *Basic Properties* and *Special Properties*.

Keywords: NAFIL, non-isometric loop, non-Abelian

CMPSD No. 36 VERTEX COVER OF THE PRODUCT AND SUM OF GRAPHS

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Let G be a graph. A set U of vertices in G is a vertex cover of G if every edge in G is incident with a vertex in U. The vertex covering number of G. denoted by $\alpha(G)$, is given by $\alpha(G) = \min\{|U|: U \text{ is a vertex cover of } G\}$. The vertex covering number of the product of two graphs is at least equal to the product of the order of one of the graphs and the vertex covering number of the other graph. For the planar grid $P_m \times P_n$, the prism $C_m \times P_n$, and the *n*-cube Q_n , we have $\alpha(P_m \times P_n) = \lfloor mn/2 \rfloor$, $\alpha(C_m \times P_n) = n \lceil m/2 \rceil$, and $\alpha(Q_n) = 2^{n-1}$. If $G_1, G_2, ..., G_m$ are graphs of orders $n_1, n_2, ..., n_m$, respectively, then $\alpha\left(\sum_{i=1}^m G_i\right) = \sum_{i=1}^m \alpha(G_i) + \sum_{i=1}^m [n_i - \alpha(G_i)] - \max\{n_i - \alpha(G_i)\}_{i=1}^m$.

In particular, $\alpha(K(p_1, p_2, ..., p_n)) = \sum_{i=1}^n p_i - \max\{p_1, p_2, ..., p_n\}$ for the complete *n*-partite graph $K(p_1, p_2, ..., p_n)$.

Keywords: vector cover, vector covering number, product of graphs, sum of graphs