[AIMS] Arizona Imaging and Microanalysis Society

Using light, electrons, ions, electromagnetism and x-rays




2016 AIMS Conference Program

Program, Abstracts & Biographical Information

March 24, 2016

South Ballroom
Student Union Memorial Center

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[AIMS] 2016 Program

| 8:00 - 8:45 | **Check-In**

| 8:30 – 8:45 | **Opening remarks:** Tom Zega - AIMS President

| 8:45 – 9:00 | **Neal Armstrong,** Office of Research Discovery at the University of Arizona
Topic: Imaging Cores at the University of Arizona

| 9:00 – 10:00 | Khanh Kieu, College of Optical Sciences at the University of Arizona
Topic: Development of compact ultrafast fiber lasers for nonlinear optical microscopy

| 10:00 – 11:00 | **Morning Break – Vendor Demonstrations/Poster Session**

| 11:00 – 12:00 | **C. Barry Carter**, Department of Materials Science & Engineering at the University of Connecticut – *MSA Tour Speaker*
Topic: The Future of TEM & Why We Must Remember the Past

| 12:00 – 1:00 | **Buffet Lunch** – Tucson Room

| 1:00 – 2:00 | **Poster Session/Vendor Demonstrations**

| 2:00 – 3:00 | **Carla Cabral**, Department of Neurology at the University of Arizona
Topic: What Lies Beneath: Uncovering Biology Using the Latest Methods for Tissue Clearing, Imaging and Analysis

| 3:00 – 3:30 | **Afternoon Break/Vendor Exhibits/Student Awards**

| 3:30 - 4:30 | **Nabil Bassim**, Molecular, Materials Science and Technology Division U.S. Naval Research Laboratory - *MAS Sponsored Speaker*
Topic: Solving Materials Problems Using Electron and Ion Microscopy

| 4:30 – 5:00 | **Student Awards**

| 5:15 – 6:00 | **Business Meeting - Annual society general meeting open to the public**

| 6:30 **–** **No Host Dinner** – TBA

[AIMS] Speakers

Khanh Kieu
College of Optical Sciences
University of Arizona

Development of compact ultrafast fiber lasers for nonlinear optical microscopy

Abstract: Mode-locked lasers which generate femtosecond or picosecond pulses are important tools in modern scientific research and technological applications. These lasers are notorious for their high cost, bulkiness, and complexity in day-to-day operation. I will review the most interesting compact mode-locked fiber laser systems that we have developed. In addition, I will discuss the application of these lasers in multiphoton microscopy of 2-dimensional layered materials (e.g., graphene and MoS_2), photonic devices as well as biological tissues.

Bio: Dr. Kieu is currently an assistant professor at the College of Optical Sciences, The University of Arizona. He received a B.S. with honor in Applied Physics in 2002 from the Institute of Fine Mechanics and Optics (St. Petersburg, Russia). His thesis work was in laser cleaning. In 2004, he received a M.S. with honor in Laser Technologies from the same institution for his research work in laser fabrication of micro-optical elements. Dr. Kieu moved to the USA in 2004 for his Ph.D. studies. Thereafter, he received a Ph.D. in Optical Sciences (in 2007) from the College of Optical Sciences, University of Arizona. In 2007, he joined Prof. Frank Wise group at Cornell University to do research in ultrafast fiber lasers. In 2009, Dr. Kieu came back to the College of Optical Sciences, University of Arizona, as a research faculty. He started his independent research group in September 2012.

C. Barry Carter – MSA Tour Speaker
Department of Materials Science & Engineering
Department of Chemical & Biomolecular Engineering
University of Connecticut

The Future of TEM & Why We Must Remember the Past

Abstract: The subject of this talk concerns the future of TEM: TEM is facing many challenges including the fact that the top-of-the-line microscopes are becoming more expensive and more complex even when they seem simpler because of the increasing use of computers and a clear affordable textbook (J). The techniques used by the different communities (physical sciences and life sciences) are also often converging especially for those specializing in 3D imaging, spectral imaging, low-dose imaging (we all should be) and aberration-corrected imaging. (Who is specializing in non-aberration-corrected imaging?) I'll illustrate the talk with some examples of using TEM to understand materials processing, especially when the materials are on the nanoscale, using TEM to understand materials for energy applications, and operando (today's in-situ) TEM studies. Throughout the talk, I'll emphasize how important it is to be using other microscopies to complement the TEM observations. My field of research is Ceramic Materials so I'll use my quartz crystal ball to suggest

some potential directions that TEM as a whole might follow in the next few years, and in so doing explain the title.

Bio: C. Barry CARTER is a Professor at the University of Connecticut in Storrs, CT. He holds a B.A., M.A. and Sc.D. from Cambridge University, an M.Sc. from Imperial College, London, and a D. Phil. From Oxford University. After 6 years in Oxford (3 as a postdoc.) he moved to Cornell where he spent 14 years leaving as a full Professor. He then spent 16 years as Professor and the 3M Endowed Multidisciplinary Chair in the Department of Chemical Engineering and Materials Science at the University of Minnesota and then 5 years as Head of UConn's Department of Chemical, Materials and Biomolecular Engineering. He is a CINT Distinguished Affiliate Scientist at Sandia National Lab (1 of 5). He had earlier held visiting positions at LANL (as the Bernd T. Matthias Scholar), Chalmers (as the 2004 Jubilee Professor), NIMS in Tsukuba (as Advisor to the Young Scientists Program), Bristol University (as a Visiting Professor), the Max Planck Institute in Stuttgart, the Institute for Physical Chemistry in Hannover and the Ernst Ruska Center in Jülich. He has been awarded a John Simon Guggenheim Fellowship, the Alexander von Humboldt Senior Award, the MSA Distinguished Scientist Award, the Ceramic Education Council (CEC-ACerS) Outstanding Educator Award, and was the 2015 Douglas Osheroff Lecturer, in UACJ, Mexico. He is a Fellow of ACerS, AAAS, MRS. MSA and RMS and an elected Member of CASE. He served as the 1997 President of MSA, as the General Secretary (2003-2010), the President (2011-2014) and Vice-President (2015-2018) of the International Federation of Societies for Microscopy (IFSM). He is best known as the co-author of two textbooks ***Transmission Electron Microscopy: A Textbook for Materials Science***, with Dave Williams (the "Companion Volume" will be published in July 2016) and ***Ceramic Materials; Science and Engineering*** with Grant Norton. He is the **Editor-in-Chief** of the **Journal of Materials Science**, a journal that was cited more than 36,000 times in 2014. As the Editor-in-Chief, he processes all of the 6,500 submissions that are received each year, distributing them to a team of 20 Editors. His research interests focus on the application of different microscopies to understand how the structure and chemistry of materials determine their properties and behavior. He is currently working on several projects including a study of the deformation of Ta and its growth in thin-film form, electrospinning of TiO_2, lithiation of nanomaterials, especially Sn whiskers and MoS_2, for battery applications, and how the crystallization dynamics control the properties of phase-change materials.

Carla Cabral
Department of Neurology
University of Arizona

What Lies Beneath: Uncovering Biology Using the Latest Methods for Tissue Clearing, Imaging and Analysis

Abstract: For over 100 years, scientists have been developing methods to render tissue transparent (clear) in order to better understand how cells and systems function and interact. Without clearing, light refracts off of the many components of tissue and makes it difficult to obtain a clean, clear, high-resolution image. One way to get around this limitation is to image very thin sections of tissue but this does not allow for a complete picture of what is happening inside the thicker, 3-dimensional area. Reconstruction of these thin images is possible but very time consuming, not entirely accurate and renders the tissue unusable for any other evaluation. Early clearing protocols overcame some of these issues but the technology of imaging was lagging in its ability to capture images deep within the tissue. Today, however, this field is growing at a rapid pace and we have several methods such as CLARITY, CUBIC and iDISCO that can render entire mouse brains transparent while maintaining structural integrity and compatibility with multiple rounds of immunostaining. Imaging technology has also advanced using multi-photon and light sheet microscopy as well as longer working distance objectives. When used together, these advances along with better image analysis software has allowed for unprecedented insight into intact biological systems.

Bio: Carla Cabral received her bachelor's degree from California University of Pennsylvania in California, Pennsylvania. Prior to working in research, Carla was a Certified Veterinary Technician for 10 years specializing in emergency medicine. Carla joined the Neurology department at the University of Arizona in 2011 where she primarily focused on characterizing a mouse model of ALS. In 2012, Carla joined the Koshy lab where she quickly became an integral part of multiple projects including understanding the neuron-parasite interaction at the cellular and molecular level.

Nabil Bassim – MAS Sponsored Speaker

Molecular, Materials Science and Technology Division
U.S. Naval Research Laboratory

Solving Materials Problems Using Electron and Ion Microscopy

Abstract: The microstructure of materials plays the most important role in their functionality. Imaging such materials in 2 and 3 dimensions, with an added focus on their chemistry and bonding behavior through spectroscopy is critical. In this talk, I will give an overview of the focused ion beam and transmission analytical electron microscopy performed in my research. Examples include multiple forms of tomography, direct-write ion patterning of metamaterials, 2-dimensional materials, bio-nanomaterials, and single-atom energy-dispersive spectroscopy.

Bio: Dr. Bassim received a B.S. in mechanical engineering from the University of South Florida in 1997 and a Ph.D. in materials science and engineering from the University of Florida in 2002. In 2003 he worked as an ASEE Postdoctoral Fellow at the Naval Research Laboratory, before moving to the National Institute of Standards and Technology from 2006-2007. In 2007, he returned to NRL as a staff scientist. His work primarily focuses on developing advanced electron microscopy and ion beam microscopy techniques and using those techniques to address unique nanomaterials problems. He is active in the Materials Research Society and the co-founder and co-organizer of the Focused Ion Beam – Scanning Electron Microscopy User Group.

http://www.microscopy.org/MandM/2016/

[AIMS] Student Abstracts

Title: **Neural activity affects astrocyte morphology in Drosophila melanogaster**
Authors: Julie A. Charlton, Cathy T. Tran, Sarah E. MacNamee, Leslie P. Tolbert, and Lynne A. Oland
Affiliation: University of Arizona

Abstract: The nervous system is composed of two different types of cells: neurons and glia. One type of glial cell, the astrocyte, is known to maintain a proper ionic balance in the central nervous system, take up neurotransmitters after synaptic signaling, and modulate synaptic activity. These functions are primarily accomplished through interdependent interactions between neurons and glial cells in which glial cells respond to the activity of neurons and modulate them accordingly. To better understand the underlying mechanisms and significance of neuron-glia interactions, we use the model system Drosophila melanogaster (fruit fly) to ask whether neuronal activity affects astrocyte morphology. Neuronal activity is manipulated in two ways: pharmacologically and genetically. In one set of experiments, we fed Drosophila larvae picrotoxin, a drug that blocks GABAa receptors and glutamate-gated chloride channels, for nine hours. This causes a shift in the balance of neuronal inhibition and excitation. To visualize the branching processes of glial cells, we used the genetic system FLP-OUT to label astrocytes with green fluorescent protein (GFP). In a second set of experiments, we simultaneously silenced neurons by expressing temperature-sensitive protein shibire that reduces synaptic activity via the Q-system and visualized astrocyte morphology with GFP expression via the GAL4/UAS system. Neurons were silenced after embryonic development to avoid disrupting critical early steps in wiring the developing brain. A heat-shock protocol was developed for shibire larvae that maximizes the period of diminished neuronal activity, maximizes larval survival, and minimizes time for possible compensatory changes in astrocytes. In both experiments, alteration of neuronal activity was assessed by larval locomotion contraction-counting assays. Volumes of FLP-OUT cells have been 3-D reconstructed in the software program AmiraTM. Astrocytes in picrotoxin-treated animals trend toward having smaller cell volumes than those in control animals, but more data is needed to determine statistical significance. GFP fluorescence in cross-sectioned shibire animals is less intense than control animals, so we currently are developing better labeling protocols. Our goal is to increase the size of our dataset to determine whether astrocyte size is significantly different in animals with altered neural activity.

Title: **Binding Forces of Single αMβ2 Integrin-Fibrinogen Interactions on Living Cells**
Authors: Wayne Christenson, Ivan Yermolenko, Tatiana Ugarova, and Robert Ros
Affiliation: Arizona State University

Abstract: Single Cell Force Spectroscopy (SCFS) can be used to measure the maximum adhesion force between cells and a surface, but determining the nature of discrete interactions within SCFS data can be challenging. We present a method for quantifying specific αMβ2 integrin and fibrinogen interactions on living cells using atomic force microscopy (AFM) based SCFS experiments. SCFS data from HEK 293 cells expressing αMβ2 leukocyte integrin (HEK Mac-1) and wild-type HEK 293 (HEK WT) cells on surfaces coated with fibrinogen were analyzed to identify specific “rupture events.” High force load ruptures (> 0.2 pN/nm) imply a connection of the integrin with the underlying actin cortex of the cell, while low force load (< 0.2 pN/nm) ruptures result from the formation of a membrane tether. For highly adhesive fibrinogen surfaces, we found 41% of all rupture events to have a high force load for HEK Mac-1 cells compared to only 9% of rupture events having a high force load for HEK WT data of the same surface. The high force load events in the HEK Mac-1 data showed a median rupture force of 55 pN, whereas the median rupture force of the HEK WT high force load events was 29 pN. After adding monoclonal antibody directed against the αM subunit of the integrin, HEK

Mac-1 cells showed similar rupture force values to that of the HEK WT. This analysis demonstrates the ability to quantify specific integrin-ligand interactions within SCFS data.

Title: **Compositional Analysis of Late-Victorian Uranium Glasses**
Authors: Alexandra Downs and Pamela Vandiver
Affiliation: University of Arizona

Abstract: Uranium glass is a striking material known for its brilliant yellow-green fluorescence under ultraviolet light. Since the Victorian era, the glass has found uses in household objects, as well as scientific tools. Often, the glass was formed into dish ware, lamps, jewelry, and consumer novelties. Glassmakers incorporated uranium into many different glass formulas, resulting in appearances ranging from transparent yellow and green, to opaque white, peach, and jade tones. In spite of the great public interest and collectors movements surrounding uranium glass, very little information exists regarding the compositions of the glasses. To provide insight into uranium glass production, this study examines the compositions of seven uranium glass samples found in an excavation of Boston and Sandwich Glass Co. during the late 1940's by F.H. Norton. Scanning electron microscopy and microprobe analysis resulted in a detailed compositional profile for each glass artifact.

Title: **An optical-quality glass surface that imparts spatial control of macrophage fusion: In vitro visualization of multinucleated giant cell formation**
Authors: James J. Faust, Wayne Christenson, Kyle Doudrick, Robert Ros and Tatiana P. Ugarova
Affiliation: Arizona State University and University of Notre Dame

Abstract: Macrophage fusion and the subsequent formation of multinucleated giant cells accompanies a number of pathological states in the human body. Despite the long-standing premise that fusion of mononucleated macrophages results in the formation of multinucleated giant cell, to date, no published study has shown such an event with living specimens. In this poster we demonstrate that glass surfaces adsorbed with carbon compounds can be utilized to monitor the events that accompany macrophage fusion and multinucleated giant cell formation. We show that surfaces adsorbed with two different types of carbon compounds potentiate macrophage fusion commensurate to levels observed with plastic surfaces (e.g., Permanox™). One carbon compound adsorbed to glass consistently promoted a ~20% increase in fusion compared to Permanox™ plastic, which corresponded to 48 ± 11% of fused macrophages. High rates of macrophage fusion enabled, for the first time, visualization of tandem macrophage fusion events that ultimately led to the formation of multinucleated giant cell, albeit stochastically across the surface of the dish. Macrophage fusion and multinucleated giant cell formation consisted of three independent phases: (1) fusion of mononucleated macrophages, (2); corresponded to the majority of fusion events which occurred between multinucleated macrophages and mononucleated macrophages, (3); corresponded to the coalescence of large multinucleated giant cells with one another. Thus, for the first time we reveal the morphological aspects of multinucleated giant cell formation and the fact that macrophage fusion, which leads to multinucleated giant cell formation, is a non-linear process. Finally, we provide evidence that carbon-decorated glass is compatible with common imaging techniques. We anticipate that this in vitro system will enable controlled studies related to macrophage fusion, and it may also bring macrophage fusion center-stage as a viable system to study membrane-membrane fusion.

Title: **Investigating the morphology of planar supported phospholipid bilayers composed of polymerizable and non-polymerizable lipids for biosensor platforms**
Authors: N. Malithi Fonseka, Boying Liang, Kristina S. Orosz, Craig A. Aspinwall, S. Scott Saavedra
Affiliation: University of Arizona

Abstract: Planar supported lipid bilayers (PSLBs) are widely used in membrane protein-based biosensor platforms. A key limitation of PSLBs composed of fluid lipids is their lack of stability due to the relatively weak non-covalent interactions between lipid molecules. While polymerization of PSLBs is one method to enhance stability, this reduces membrane fluidity. We have demonstrated that lipid bilayers composed of mixtures of polymerizable and non-polymerizable phospholipids exhibit enhanced stability while maintaining the fluidity necessary for the function of membrane-associated biomolecules. These studies suggest that these lipid

bilayers are phase segregated, forming polymerized and fluid domains. However, phase segregation was not observed with light microscopy techniques. Here, we investigate the morphology of mixed PSLBs composed of the polymerizable lipid bis-Sorbyl phosphatidylcholine (bis-SorbPC) and the non-polymerizable lipid diphytanoyl phosphatidylcholine (DPhPC) with atomic force microscopy (AFM). We observe nano-scale phase segregation of the two lipids. The lipid domains were identified by imaging PSLBs composed of varying molar ratios of the two lipids. DPhPC forms a continuous lipid matrix that is 0.4 nm thicker than the island-like poly(bis-SorbPC) domains. This agrees with the bilayer thicknesses of pure DPhPC and poly(bis-SorbPC) PSLBs measured with AFM under similar conditions. Furthermore, it was observed that the size of the poly(bis-SorbPC) domains increased with the percentage of poly(bis-SorbPC) in the PSLB. This work confirms that mixed lipid bilayers composed of poly(bis-SorbPC) and DPhPC form nano-structured membranes and provide guidance for creating mixed PSLBs suitable for bio sensing.

Title: **Investigations Using Solid Carbon Dioxide to Clean Basketry and Textiles**
Authors: Wendy Lindsey and Nancy Odegaard
Affiliation: University of Arizona

Abstract: Cleaning robust objects with solid CO2 is a well-recognized technique in diverse fields. Using artificial soiling and light microscopy, we investigated the application of CO2 snow cleaning to more delicate basketry. We examined the surface of the test basketry before soiling and after treatment, and compared the images to determine if it had been damaged. We found that CO2 snow did not damage the basketry. In addition, it was faster and more effective than traditional cleaning techniques, making it a viable new treatment option for delicate objects.

Title: **Iron Deposition and Ferritin Accretion in the Midgut of the Yellow Fever Mosquito, Aedes Aegypti**
Authors: Maria Love, Dawn L. Geiser, and Joy J. Winzerling
Affiliation: University of Arizona

Abstract: Dengue and Yellow Fever are caused by viruses transmitted by mosquitoes that each year infect 390 million and 200,000 people, respectively, and cause more than 2 million deaths. For mosquito eggs to develop and produce viable offspring, iron is required as an essential nutrient from the blood meal. Our previous research has shown iron from the blood meal is absorbed and transported by ferritin from the midgut to the ovaries in *Aedes aegypti* (yellow fever mosquito). Thus, understanding iron accumulation and utilization in the mosquito midgut is important to finding potential strategies to interfere with mosquito fecundity, decrease mosquito populations, and reduce transmission rates of vector-borne diseases. However, it is unknown where in the midgut iron accumulates after a blood meal. To demonstrate this, *Ae. aegypti* midguts were dissected from sugar fed, 24 h post-blood meal (PBM), and 72 h PBM animals to measure tissue iron accumulation after a blood meal by iron inductively coupled plasma mass spectrometry (ICP-MS). Dissected midguts were also stained with Prussian Blue to visualize ferric iron deposition. Our results indicate that iron is present in the midgut prior to a blood meal, accumulates at 24 h PBM, and decreases by 72 h PBM, and the deposition of ferric iron is observed throughout the tissue before and after a blood meal. Further, immunohistochemistry studies of the midguts show three different subunits of the iron storage and transport protein, ferritin. Coalescence of ferritin and iron in mosquito midguts confirms the rule of ferritin in this tissue for export of iron to other tissues, including the ovaries for oogenesis and ovarian homeostasis.

Title: **Ontogeny of the Hypoparyngeal and Salivary Glands in Honey Bees**
Authors: Rachna Nath, Chris Jernigen, Alan Rawls and Juergen Gadau
Affiliation: Arizona State University

Abstract: Parsing the underlying genetic mechanisms and adaptive regulation of phenotypic plasticity remains a major challenge for evolutionary and systems biology. Current studies point towards the modification of ancestral gene regulatory networks (GRN) that link signaling pathways to the transcription of genes required for cell function as well as the addition of novel genes and the gain of new gene functions. Adaptive phenotypic plasticity is the ability of an organism to produce different, adaptive phenotypes from the same genotype in

response to the environment. This can occur early in development leading to distinct morphological phenotypes (dung beetles, butterflies) or in adults where behavioral or physiological plasticity results in adaptation to different environments. Social insects are well known examples of both types of phenotypic plasticity. Exocrine glands perform crucial functions in insect societies and several exocrine glands like the hypopharyngeal gland in honey bees show phenotypic plasticity linked to age, caste and task. Honey bees have three exocrine glands in their head, the salivary (head part), hypopharyngeal and mandibular glands. Structural complexity of these exocrine glands in honey bee (*Apis mellifera*) has been defined by Noirot and Quennedey (1974) and also by Johan Billen (1986). Post embryonic development of these gland has also been studied by Emmert (1968) and the adult glands by Kratky (1931), Simpson (1962),Snodgrass (1956), Cruz Landim (1957 to 2010). But despite their importance, little is known about the gene regulatory network underlying the ontogeny and phenotypic plasticity in honey bees. Here we characterized the anatomical changes of these glands during metamorphosis (transition from larval to adult stage). The larval salivary gland is almost completely reorganized during metamorphosis whereas the other two glands have no progenitor in larvae and develop de novo. The goals of this study is to 1. describe in detail when, which structural and histological changes occur in glandular development during metamorphosis and 2. determine the gene regulatory network/s underlying gland development and phenotypic plasticity in adults, i.e. to link differential gene expression with the different caste and task phenotypes. Here, we present a detailed description and histology of the ontogeny of the salivary, hypopharyngeal and mandibular glands in *Apis mellifera,* using paraffin embedding with hematoxylin and eosin stain and microtubule and actin maturation using fluorescent conjugated antibodies, during metamorphosis of Apis mellifera.

Title: **Relationship between activity level and regional brain volume in *Temnothorax rugatulus* ants**

Authors: Varuska Patni
Affiliation: University of Arizona

Abstract: Eusocial hymenoptera (e.g. ants, wasps, bees) are not always as highly industrious and hard-working as they are traditionally believed to be. In fact, social insect colonies often have several workers that perform little to no tasks, spending most of their time inactive. Little is known about what creates these differences in activity levels among workers. The brain, which controls behavior, is a promising place to investigate as a source for these differences. Here, we investigate whether the mechanisms by which individuals sense and perceive their environment is associated with activity level variation among workers. Using *Temnothorax rugatulus* ants, we explore the hypothesis that inter-individual variation in activity level is associated with differences in the volumes of brain regions important for sensory input and processing. Current data supports there is no significant relationship in antennal lobe size between the active and lazy ant groups or in mushroom bodies between the two groups. The data suggests that differences in central processing of environmental stimuli are not reflected in anatomy of sensory input and processing regions.

Title: **Reverse Engineering the Physical Chemistry of Making Egyptian Faience with the Cementation Process**

Authors: Magnum Pina and Pamela Vandiver
Affiliation: University of Arizona

Abstract: The cementation process of making Egyptian faience, as reported by Hans Wulff from a workshop in Qom, Iran, has not been easy to replicate and various views have been set forth to understand the transport of materials from the glazing powder to the quartz bead surfaces. Replications of the process fired to 950^{o}C and underfired to 850^{o}C were characterized by electron beam microprobe analysis (EPMA), petrographic thin section analysis and scanning electron microscopy with energy dispersive x-ray analysis (SEM-EDS). Chemical variations were modeled using thermal data, phase diagrams and copper vaporization experiments. These replications were compared to 52 examples from various collections, including 20th century ethnographic collections of beads, glazing powder and ash, 12th century beads and glazing powder from Fustat (Old Cairo), and an earlier example from Abydos and probably from the New Kingdom.

Title: **Microstructure Analysis to Determine Space Weathering Rates in Mature Lunar Soils**
Authors: Claudia Ramirez and T.J. Zega
Affiliation: University of Arizona

Abstract: Understanding processes occurring on airless bodies provides insight to how planetary surfaces have changed over time. One important process is space weathering, which includes the irradiation of surface material by solar wind ions and also micrometeorite impacts. These mechanisms affect soil crystal structure and chemistry. This project analyzed three different soil types for space weathering features-- specifically, the presence of iron nanoparticles—to understand the rate at which space weathering occurs. The four lunar samples 79221, 14259, 61140, and 14141 were a mature mare soil, a mature highland soil, a submature highland soil, and an immature highland soil, respectively. All samples were embedded in epoxy, microtomed, and analyzed using transmission electron microscopy (TEM). HAADF (High-Angle Annular Dark Field) imaging was used because it is Z-contrast, which provides compositional information about the sample and enabled us to identify high-contrast Fe nanoparticles in the soil grains. From these images… the density of nanoparticles in a given grain were determined. From this analysis, it was observed that amount of nanoparticles increased with degree of maturity. We also measured the size distribution of nanoparticles in soils of different maturities. These data will provide insight into deriving a quantifiable rate of space weathering, which will ultimately lead to a greater understanding of the impact of space weathering on the evolution of planetary surfaces.

Title: **Understanding the Course of *Toxoplasma gondii* Host Cell Interaction in Infected Neurons**
Authors: Victoria R. Ramirez, Carla M. Cabral, and Anita A. Koshy
Affiliation: University of Arizona

Abstract: Toxoplasma gondii is an obligate, neurotropic intracellular parasite that is estimated to latently infect up to 30% of the world's population. There are three canonical strains of *T. gondii*: Type I, Type II, and Type III. Type II and Type III are capable of establishing chronic infection in the Central Nervous System (CNS). In the CNS, persistent infection is characterized by the formation of cysts in the brain. Research of toxoplasmosis in the murine CNS has revealed that *T. gondii* preferentially persists in neurons. Previously thought to overwhelmingly reside in the cell body of neurons, our recent research has shown cyst location not only in the cell body, but also within neuronal processes. Among Type II and Type III strains, differences in cyst diameter and distance from the soma were observed. As our new findings went against common dogma in terms of cyst location, we wanted to better understand how and why this might be occurring. To answer this, we decided to look at a time course to see if cyst location changes over time or possibly impacts host cell survival. In this study, passive CLARITY technique (PACT) was utilized to elucidate the interaction of *T. gondii* with neurons in 200 µm thick murine tissue sections. Parasite host cell entry and cyst formation as it pertains to the cell body and neuronal processes were assessed in mice 7 days post-infection (dpi), 12 dpi, 17 dpi, and 22 dpi. Confocal microscopy was used to image tissue sections and IMARIS software allowed three-dimensional visualization and analysis of infected neurons. At the four time points, differences were observed in cyst presence and location within neurons. A better understanding of *T. gondii*'s interaction with neurons over the course of infection will allow for enhanced understanding of strain-specific disease outcomes.

Title: **Subcellular Characters of Three Zygomycetous Fungi**
Authors: Isobel Romberger, Karissa Koessel, Archer Valecourt, Holly Mulvaney, Austin Holt, Karen Fisher and Robert W. Roberson
Affiliation: Arizona State University

Abstract: The zygomycetous fungi, (formerly Phylum Zygomycota) represent an extremely diverse group of fungi ranging from saprobes, to plant and insect pathogens, to the symbiotic mycorrhiza, are morphologically and ecologically distinct from other fungi. Molecular research, using data from a limited number of species, has failed to produce a monophyletic tree for the zygomycetes fungi, and instead strongly suggests that this group is polyphyletic, consisting of six distinct clades. Despite the molecular differences, however, these fungi are all filamentous non-flagellated fungi, which mark the major transition from the aquatic, zoosporic life styles observed in the earliest diverging fungal lineages such as the Chytridiomycota and Blastocladiomycota and the

rise of the nonflagellated, filamentous, multicellular Dikarya (Basidiomycota and Ascomycota). As part of an NSF-funded collaborative research effort to resolve the evolutionary relationships of the under-studied zygomycetes, which includes genome sequencing and analyses, discovery and description of zygomycete fossils, we have begun to elucidate the novel structural characteristics of the zygomycetous fungi using both light and electron microscopic techniques. Here we present our initial observations of three phylogenetically distinct fungi: *Cunninghamella echinulata* (Mucorales), *Conidiobolus coronatus* (Entomophthorales), and *Linderina pennispora* (Kickxellales).

Title: **The Regulation and Role of PKA in the TORC2 Chemotactic Pathway**
Authors: Maggie Scavello, Alexandra R. Petlick, Pouya Lotfi, Pascale G. Charest
Affiliation: University of Arizona

Abstract: Efficient directed migration requires tight regulation of chemoattractant signal transduction pathways in both space and time, but the mechanisms involved are not well understood. Here, we report findings identifying protein kinase A (PKA) as a key regulator of the chemotactic response in Dictyostelium. Our data indicate that PKA promotes adaptation of upstream RasG, Rap1, PI3K, and TORC2 signaling, which are involved in cAMP production and, thus, PKA activation. In addition, we found that PKA is necessary to properly localize the RasG, Rap1, PI3K, F-actin, and myosin responses in cells exposed to chemoattractant gradients. Therefore, our findings indicate that PKA both spatially and temporally controls critical chemotactic pathways through negative feedback loops, and that this regulation is critical for cells to interpret the direction of the gradient, polarize, and migrate towards a chemoattractant source.

Title: **Human Cytomegalovirus: Reorganizing Endocytic Trafficking for Receptor Activation**
Authors: Sebastian Zeltzer, Jason Buhler, and Felicia Goodrum
Affiliation: University of Arizona

Abstract: Human Cytomegalovirus (HCMV) infects the majority of the human population. Infection is life long and can lead to sever complications in the immune compromised. HCMV alters the endocytic and secretory pathways of infected cells forming a poorly understood organelle known as the Viral Assembly Compartment (VAC). The VAC is necessary for virus maturation and egress from the infected cell. Recent findings from our lab demonstrate that the VAC also acts as a holding place for internalized and active mitogenic receptors, such as epidermal growth factor receptor (EGFR). We have identified that infection alters EGFR endocytosis, activity levels, and even sorting relative to other host receptors, such as transferrin receptor. Downstream analysis of these events suggests they are important for informing the transcriptional environment necessary for viral production. Taken this demonstrates that HCMV alters endocytic trafficking for both virus production and to tune host signaling pathways critical for infection.

Title: **Ultrastructural characterization of Arabidopsis thaliana seedlings engineered to overexpress or down-regulate the proton pyrophosphatase AVP1**
Authors: Shangji Zhang and Roberto Gaxiola
Affiliation: Arizona State University

Abstract: Proton pyrophosphatase is a transmembrane protein that is highly conserved in the plant kingdom and has been implicated as a critical component in phloem sucrose loading and photosynthate partitioning in Arabidopsis. In the present study we have used transmission electron microscopy to comparatively survey the ultrastructure and organization of phloem cells in Arabidopsis wild-type and genetically-engineered mutants of AVP1.

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