### 4th Annual Postdoctoral Symposium at Georgia Tech
21st September 2017, hosted by Postdocs@Tech

Presentation Abstracts (*By request, abstract is not published.*)

<table>
<thead>
<tr>
<th>#</th>
<th>Title</th>
<th>Presenter</th>
<th>College</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Design of Solid CO2 Adsorbents for Direct Air Capture to Enhance Performance and Stability</td>
<td>Simon Pang</td>
<td>Engineering</td>
<td>4</td>
</tr>
<tr>
<td>T2</td>
<td>Polymerization and Assembly of Plausible Proto-peptides</td>
<td>Moran Frenkel-Pinter</td>
<td>Sciences</td>
<td>5</td>
</tr>
<tr>
<td>T3</td>
<td>Synergy between phage and host immunity as a mechanism of phage therapy against antibiotic-resistant infections</td>
<td>Joey Leung</td>
<td>Sciences</td>
<td>6</td>
</tr>
<tr>
<td>T4</td>
<td>Propane dehydrogenation on MOF-derived iron carbide catalysts</td>
<td>Michele Sarazen</td>
<td>Engineering</td>
<td>7</td>
</tr>
<tr>
<td>T5</td>
<td>Trajectory Learning using Generalized Cylinders</td>
<td>Reza Ahmadzadeh</td>
<td>Computing</td>
<td>8</td>
</tr>
<tr>
<td>T6</td>
<td>Towards Autonomous Vehicles: Emergent Benefits, Collective Risks</td>
<td>Skanda Vivek</td>
<td>Sciences</td>
<td>9</td>
</tr>
<tr>
<td>T7</td>
<td>Investigating new RF-to-DC Converters for Efficient Energy Harvesting in Wide Power Range</td>
<td>Ulkuhan Guler</td>
<td>Engineering</td>
<td>10</td>
</tr>
<tr>
<td>T8</td>
<td>In Search of the Goldilocks of Black Holes</td>
<td>Karan Jani</td>
<td>Sciences</td>
<td>11</td>
</tr>
<tr>
<td>T9</td>
<td>Boosting Next-Gen Battery and Water Electrolysis Development: A Tailored Perovskite Nanofiber Catalyst for Oxygen Evolution</td>
<td>Bote Zhao</td>
<td>Engineering</td>
<td>12</td>
</tr>
<tr>
<td>T10</td>
<td>The Microbiome of the Georgia Aquarium Ocean Voyager Exhibit</td>
<td>Nastassia Patin</td>
<td>Sciences</td>
<td>13</td>
</tr>
<tr>
<td>T11</td>
<td>Using Swarms of Simple, Inexpensive Robots to do Complex, Valuable Tasks</td>
<td>Sean Wilson</td>
<td>Engineering</td>
<td>14</td>
</tr>
<tr>
<td>T12</td>
<td>Engineering Leviriridae PP7 capsid protein as peptide display platform</td>
<td>Liangjun Zhao</td>
<td>Sciences</td>
<td>15</td>
</tr>
<tr>
<td>T13</td>
<td>Searching for the full symphony of binary black holes</td>
<td>Juan Calderon Bustillo</td>
<td>Sciences</td>
<td>16</td>
</tr>
<tr>
<td>T14</td>
<td>Of Whales and the Web: Hunting for Data in Nineteenth-Century American Literature</td>
<td>Brad Rittenhouse</td>
<td>IAC Liberal Arts</td>
<td>17</td>
</tr>
<tr>
<td>Title</td>
<td>Author(s)</td>
<td>Department</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td>---------------------------</td>
<td>-----------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>T16 Bacterial socialism and antibiotic resistance</td>
<td>Sheyda Azimi</td>
<td>Sciences</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>T17 CURE (Challenging Unreal and Real Environments) for Visual Recognition</td>
<td>Dogancan Temel</td>
<td>Engineering</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>T18 The Black Snake in Watercolor: Water Protector Movements and the Material Rhetorics of Ledger Art</td>
<td>Chelsea Murdock</td>
<td>IAC Liberal Arts</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>T19 Network Analysis of Plasmodium cynomologi Infection and Re-infection Challenge</td>
<td>Maren Smith</td>
<td>Engineering</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>T20 Illuminating the Role of Heme and Hemoglobin in Alzheimer's Disease</td>
<td>Rebecca Donegan</td>
<td>Sciences</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>T21 Defect immune signal transmission in elastic solids using topologically protected modes</td>
<td>Raj Kumar Pal</td>
<td>Engineering</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>T22 Meniscus-Assisted Solution Printing of Large-Grained Perovskite Solar Cells</td>
<td>Ming He</td>
<td>Engineering</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>T23 Non-covalent terminators and supramolecular polymers: Precise control over length and viscoelasticity</td>
<td>Suneesh Karunakaran</td>
<td>Sciences</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>T24 Doctor Faustus and the Age of Man to Come</td>
<td>McKenna Rose</td>
<td>IAC Liberal Arts</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>P1 Green and Affordable Ligand-Free Palladium-Catalyzed Suzuki Coupling Reactions in Water</td>
<td>Zhao Lee</td>
<td>Sciences</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>P2 Highly stretchable and transparent transistors for future intelligent electronics</td>
<td>Guoyan Zhang</td>
<td>Engineering</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>P3 Template-Guided Assembly of Silk Fibroin on Cellulose Nanofibers for Robust Nanostructures with Ultrafast Water Transport</td>
<td>Rui Xiong</td>
<td>Engineering</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>P4 Fast computations with surface deformations</td>
<td>Balazs Strenner</td>
<td>Sciences</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>P5 The Aberrant Chaperone-Client Interactions of Grp94 and Myocilin</td>
<td>Dustin Huard</td>
<td>Sciences</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>P6 Protons Enhance Conductivities in Lithium Halide Hydroxide / Lithium Oxyhalide Solid Electrolytes by Forming Rotating Hydroxy Groups</td>
<td>Kostiantyn Turcheniuk</td>
<td>Engineering</td>
<td>31</td>
<td></td>
</tr>
</tbody>
</table>
Arsenic adsorption on $\alpha$-MnO$_2$ nanofibers and the significance of (100) facet as compared with (110) 

Epsin 1 and 2, regulators of VEGFR3 recycling, play a role in lymphatic function 

Goldilocks Black: Tuning Light Absorption with A Donor-acceptor Approach for High Contrast, Color-Neutral Electrochromic Polymers 

Assessment and Control of a Cavitation-Enabled Therapy for Minimally Invasive Myocardial Reduction 

Property improvements for Cu-Nb composite wires: the power of material design based on multiscales and multiphysics modeling 

Wireless, Intraoral Hybrid Electronics for Real-Time Quantification of Sodium Intake Toward Hypertension Management 

Entering the new multimessenger era in Astrophysics: from Gamma Ray Bursts to Gravitational Waves 

Triboelectric Nanogenerators for Ultra-high Resolution Mass Spectrometry Characterization of Depsipeptides Mixtures 


Quest for Connection: From Animal Cooperation to Robotic Space Exploration 

A novel optimization approach for disease diagnosis 

Focused ultrasound immunomodulation of intracranial malignancies 

DEVELOPMENT AND MOLECULAR UNDERSTANDING OF PLASMONIC PHOTOTHERMAL THERAPY (PPTT) IN COMBATING CANCER 

Native and Nonnative Intuitions on the Phonology of Binomial Locutions 

Using Patient Decision-Aids for Genetic Testing 

A Digital Humanist Goes to Business School 

Potty Mouths: Examining Toxic Language in Online Gaming Environments
Abstracts

Abstract: T1

**Design of Solid CO$_2$ Adsorbents for Direct Air Capture to Enhance Performance and Stability**

Simon H. Pang, Ryan P. Lively, Christopher W. Jones

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Research efforts in CO$_2$ capture technologies have dramatically increased due to interest in reducing the effect of anthropogenic emissions on atmospheric CO$_2$ concentrations. Much of this research has focused on capture from large point sources such as flue gas, and commercial scrubbers currently use aqueous solutions of amines for this process. Direct capture of CO$_2$ from ambient air is proposed as a complementary technology that has the advantage of not being confined to these flue gas point sources and thus is more versatile in its deployment. However, at an ultradilute concentration of 400 ppm, the driving force for adsorption is low, necessitating the development of adsorbents that may be different from those used in flue gas capture. Additionally, these adsorbents must be stable under oxidizing conditions due to the presence of oxygen in the feed stream and the potential for oxygen to contact the adsorbent material during high temperature regeneration.

These restrictions necessitate the development and study of new adsorbent materials for direct air capture. By using aminopolymers supported in structured porous solid adsorbents, we reduce the energy cost associated with heating an aqueous solution to regenerate the adsorbent. We find that changing the molecular structure of the aminopolymer allows for more efficient CO$_2$ capture, and perhaps more importantly, improves the stability of these materials under high temperature oxidizing conditions. Our experiments suggest that these new CO$_2$ adsorbents may allow for longer sorbent working lifetimes due to an increased tolerance to sorbent regeneration conditions and will have larger adsorption swing capacities, both of which will drive down the cost associated with CO$_2$ capture.
Polymerization and Assembly of Plausible Proto-peptides

Moran Frenkel-Pinter, Sheng-Sheng Yu, Martin D. Solano, Jay G. Forsythe, Facundo M. Fernandez, Martha A. Grover and Nicholas V. Hud

Presented by: Moran Frenkel-Pinter  moranfp@gatech.edu
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A primary challenge of origins of life research is to find a plausible prebiotic route for the formation of peptides. Although the synthesis of various amino acids under prebiotic conditions is now generally accepted, their subsequent oligomerization into peptides is more difficult to explain. Recently, a simplified route to the formation of peptides has been reported, which involves subjecting a mixture of hydroxy acids and amino acids, both of which were likely present on the prebiotic Earth, to repetitive wet-cool/dry-hot cycles. It has been proposed that the resulting depsipeptides, containing both ester and amide linkages, might have constituted part of the primordial proto-peptides population. We have chemically synthesized short depsipeptides and are now testing if these oligomers possess the characteristics that would have allowed them to be selected by chemical evolution based on self-assembly propensity, stability and functionality. Specifically, we have synthesized a simple depsipeptide library, ranging from dimers to octamers, which contain an O-terminal glycolic acid (the hydroxy acid analog of glycine) in order to promote polymerization via ester bond formation.

We have found that applying dry-hot conditions drives oligomerization and we were able to show a structural shift that coincides with polymer growth. We have also found that there is a negative correlation between peptide length and polymerization rate. We will discuss investigations of depsipeptide stability and self-assembly propensity by a variety of spectroscopy- and microscopy-based methods, such as circular dichroism and electron microscopy.
Synergy between phage and host immunity as a mechanism of phage therapy against antibiotic-resistant infections

Joey Leung, Dwayne Roach, Devika Singh, Laurent Debarbieux, and Joshua S. Weitz

Presented by: Joey Leung     cyleung2001@gatech.edu
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The rise of antibiotic resistance in pathogenic bacteria has become a major public health crisis. Bacteriophage, or just phage, are viruses that exclusively infect bacteria. Phage exhibit antibacterial properties as they can infect and kill bacterial cells, prompting interest in the use of phage as an alternative treatment for bacterial infections [1]. The idea of using phage in therapy has been around for nearly a century, but the mechanism(s) that make phage effective as therapeutic agents remain poorly understood. For example, mathematical models and laboratory experiments show that combining phage and bacteria often leads to coexistence of both populations. Therefore, a potential resolution to the tension between the clinical aims of phage therapy and models of phage-bacteria interactions is the hypothesis that phage works synergistically with host immunity to eliminate bacterial pathogens. To study how host immune response contributes to the success of phage therapy, we combined mathematical modeling and animal experiments of phage therapy in a mouse model of acute bacterial pneumonia [2]. In the experiments, we measure the bacterial abundance during the infection with and without phage therapy in both normal and immune-deficient hosts. Our mathematical model accounts for the interactions between pathogenic bacteria, phage and host immune response [2, 3]. Our model predicts that deficiency in immune activation is detrimental to the efficacy of phage therapy. Importantly, our model shows that synergy between phage and components of the host immune system is necessary for effective phage therapy. These predictions are in accordance with observed phage therapy performance in animal experiments. This phage-immune synergy is caused by the phage reducing bacterial densities to levels manageable by host immunity, as well as host immunity preventing the growth and dominance of phage-resistant bacteria. We also investigate the level of host immunity required to achieve phage-immune synergy, and show that phage therapy may still work in hosts with limited immune deficiency even with emerging phage resistance.

References:
Abstract: T4

Propane dehydrogenation on MOF-derived iron carbide catalysts

Michele L. Sarazen and Christopher W. Jones

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The dehydrogenation of light alkanes, sourced from cracking of traditional petrochemical feedstocks and from emerging shale gas, represents an attractive route to alkenes (ethene, propene, butenes), which are the building blocks for valuable polymers and chemicals. Catalysts for alkane dehydrogenation must be active, but also selective, because several undesired side reactions, such as hydrogenolysis, isomerization, and coke formation. Recent studies in our group have found that iron/phosphorous catalysts supported on alumina are active for propane dehydrogenation (PDH) and are reasonably selective to propene [1]. In situ X-ray absorption spectroscopy indicated the precatalyst (FePO4/Fe2O3) is initially reduced under H2 and then proceeds through an induction period under propane flow during which iron carbide is formed as the active and selective phase of the catalyst.

Here, we aim to generate the iron-carbide phase directly. Carbon-supported iron carbide from pyrolysis of Fe-containing metal organic frameworks (MOFs; mainly, Fe-BTC) have been reported as active and stable catalysts for Fischer-Tropsch synthesis at 613 K [2-3]; however, the temperature of pyrolysis was found to influence the iron-carbide phase and the size of the nanoparticles formed. The state of these catalysts under the higher temperature reduction and reaction conditions needed for PDH (773-873 K) is investigated here. We have found that the reactivity and selectivity of these MOF derived iron-carbide catalysts are dependent on the temperature of pyrolysis and reaction and correlate these results to differences in phase or structure as determined from various characterization techniques. This work demonstrates how using MOFs as precursors may allow the synthesis of unique catalyst structures that can be designed to obtain desired rates and product selectivities of hydrocarbon processes.

Learning from Demonstration (LfD) provides the ability to interactively teach robots new skills, eliminating the need for manual programming of the desired behavior. By observing a set of human-provided demonstrations, LfD approaches learn a model and generalize the encoded skill to novel situations autonomously. These capabilities make LfD a powerful approach that has the potential to enable even non-experts to teach new skills to robots with little effort. However, despite the existence of several trajectory-based LfD approaches, the vast majority of the existing robotic platforms rely on motion-level actions that are either hand-coded or teleoperated by experts, highlighting the need for further advances in this area. Existing trajectory learning representations are limited by a number of challenges. First, the number of parameters and the need to tune them for different types of trajectories present a challenge to many users, especially non-experts. Second, most available approaches require near-optimal demonstrations in order to perform effectively, while the redundancy and complexity of the current robotic platforms (i.e. high degrees of freedom) demand a significant level of expertise to perform near-optimal demonstrations. Third, because of the assumption on near-optimal trajectories, few techniques support robust methods of refinement of the resulting model, assuming instead that the input demonstrations should be treated as the only input to the system. Finally, many existing techniques fail to generalize over start/end states, limiting the technique's ability to generalize to new situations. In this paper, we present a novel LfD approach that addresses the above challenges through the use of a geometric representation composed of a regular curve and a surface in 3D Cartesian space. The presented approach requires minimal parameter tuning and can reproduce a variety of successful movements inside the boundaries of the encoded model by exploiting the whole demonstration space. To tackle the problem of generalization over terminal states, we use nonrigid registration to transfer the encoded model accordingly. This generalization approach preserves the main characteristics of the demonstrated skill while achieving the goal of the task. To overcome the issue of sub-optimal demonstrations, our approach enables the user to improve the learned model through physical motion refinement. We validate our approach through several real-world experiments.
Towards Autonomous Vehicles: Emergent Benefits, Collective Risks

Skanda Vivek, David Yanni, Peter J. Yunker, Jesse L. Silverberg

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Autonomous vehicles are poised to bring substantial improvements to traffic flow, from their ability to sense and rapidly respond to their environment. Inevitably, however, the software enabling these functions has a greater “surface area” for weakness to be exploited. While attacks narrowly aimed at individual vehicles will continue to occur, another class of hacks that weaponizes emergent collective motion appears just as inevitable. Recent progress in non-equilibrium statistical physics has led to the understanding that certain fundamental principles underlie collective behavior in seemingly disparate “active” systems such as schools of fish, flocks of birds, and bacteria even though at the individual scale, these systems are extremely different. Thus, the physics of active matter offers a framework for understanding how collective motion can be weaponized without knowing the details of a specific software exploit a priori. Here, we study the emergent collective motion of human and autonomously-driven vehicles. Our approach combines empirical measurements from highway traffic videos and simulations of an active matter model. We first focus on the benefits of autonomous driving where fast reaction times and uniform driving speeds enable smooth traffic flow, even at high densities. Just as “white hat” hackers work to proactively identify software vulnerabilities, we shift our attention to study how immobilized hacked vehicles disrupt traffic. One possibility is that hacked vehicles are critically disabled causing them to become immobile obstacles on the road. We find this situation leads to interesting connections in the physics of clogging, random pinning, and percolation. We show that by confining autonomous vehicles to subsets of available lanes, reduced benefits from autonomous vehicles can be retained, while strongly mitigating the effects of a “bricking” attack. This type of bricking attack would cause significant social harm. Emergency vehicles would be unable to respond to calls for help, food shipments to grocery stores would be delayed, and long-distance commuters would be unable to get to work. Working on these questions through the lens of the anticipate-and-inoculate mindset used here has the potential to identify how other emergent collective phenomena can be weaponized and preemptively disarmed. Ultimately, this approach should lead to safer roads and a greater good.
Investigating new RF-to-DC Converters for Efficient Energy Harvesting in Wide Power Range

Ulkuhan Guler, Maysam Ghovanloo

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Significant achievements in wireless communication and powering have increased demand for small, portable, and autonomous devices that monitor, control, communicate, sense, and share. These devices are used in Internet of things (IoT) applications, including smart homes, wearables, and smart cities. A key requirement for a subset of these devices is to remain “always on” for continuous monitoring, which requires an uninterrupted supply of energy. RF energy harvesting shows potential to address such requirements by harvesting energy from WiFi and GSM (and/or digital TV) from indoor and outdoor environments, respectively. Moreover, in some healthcare applications, inclusion of a battery is not an option because of the extremely small size of sensors. Apart from wireless sensor nodes (WSNs), systems that do not require battery charging more frequently than once a week can potentially be recharged from RF sources. However, the availability of the RF energy heavily depends on the distance between the harvester and the source. Because of variability in power ranges, energy harvesters tailored to a particular power range are not preferred in wirelessly powered mobile applications. Proper operation of active circuits in a wirelessly powered system requires both sufficient power flow and voltage. Passive wireless systems, operating in the high-frequency band, pose a challenge: generating sufficient amount of supply voltage from very low-input-power flow. The answer involves implementation of a new class of power-sipping, voltage multiplying power management blocks, which have a wide variety of applications from implantable microelectronic devices (IMD) to IoTs and radio-frequency identification (RFID). We pursue our research on new power management ICs, specifically RF-to-DC converters, which increase the feasibility of energy harvesting with net-zero energy consumption, i.e. without draining power from battery, in low- (<100µW) and mid-power (100µW to ~10mW) ranges, and operates with low-input power signals in the frequency range of 100 MHz to several GHz in remotely powered systems. Moreover, the output voltage of the RF-to-DC converter is adjustable with incorporation of a basic control circuitry, which decides the number of rectifying stages according to a predefined supply voltage value and incoming signal power level. Our research also covers the investigation of flexible and smart antennas, which should be compatible with the specific wireless application.
Abstract: T8

**In Search of the Goldilocks of Black Holes**

Karan Jani

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Physics, College of Sciences

Black holes are the only objects in the universe whose masses, in principle, can vary between 30 orders of magnitude yet their entire behavior is governed by simple geometrical expression. Small black holes can be produced by stellar processes such as the death of stars, while the supermassive black holes found at centers of galaxies are billions of times that of our Sun. But it was only in 2015 when the direct detection of gravitational waves by the LIGO experiment provided the first concrete evidence that black holes 60 times the mass of our Sun exist. Since then the researchers at Georgia Tech along with other LIGO collaborators led a survey of volume containing over 100 million galaxies looking for gravitational waves from black holes between the stellar and supermassive limits. A black hole in this intermediate mass range could be formed from the very first stars to more exotic scenarios such as Dark Matter. In this talk, I narrate what we have learned from such state-of-the-art survey so far.
Rechargeable metal–air batteries and water splitting are highly competitive options for a sustainable energy future, but their commercialization is hindered by the absence of cost-effective, highly efficient and stable catalysts for the oxygen evolution reaction (OER). Here we report the rational design and synthesis of a double perovskite PrBa0.5Sr0.5Co1.5Fe0.5O5+x nanofiber as a highly efficient and robust catalyst for the oxygen evolution reaction. Co-doping of strontium and iron into PrBaCo2O5+x is found to be very effective in enhancing intrinsic activity (normalized by the geometrical surface area, ~4.7 times), as validated by electrochemical measurements and first-principles calculations. Further, the nanofiber morphology enhances its mass activity remarkably (by ~20 times) as the diameter is reduced to ~20 nm, attributed to the increased surface area and an unexpected intrinsic activity enhancement due possibly to a favourable eg electron filling associated with partial surface reduction, as unravelled from chemical titration and electron energy-loss spectroscopy. Markedly enhanced oxygen evolution reaction capability is shown when compared to existing catalysts. The new nanofiber’s mass-normalized catalytic activity improved about 72 times greater than the initial powder catalyst, and 2.5 times greater than the state of the art noble metal-based catalyst (i.e., iridium oxide), which is considered a state of the art catalyst by current standards. This work not only results in a highly efficient and durable electrocatalyst for OER, which may have important technological implications, but also offers new insight into the development of advanced materials by nanostructure engineering for other applications of energy storage and conversion.
Abstract: T10

The Microbiome of the Georgia Aquarium Ocean Voyager Exhibit

Nastassia V. Patin, Zoe A. Pratte, Matthew Regensburger, Eric Hall, Kailen Gilde, Alistair D. M. Dove, Frank J. Stewart

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Biological Sciences, College of Sciences

All environments on Earth have distinct communities of microorganisms, or “microbiomes,” that are integral to ecosystem function. Microbiomes regulate processes like nutrient cycling and the health of higher organisms, and often contain thousands of different species. However, most microbes have yet to be cultured in a laboratory; instead, we rely on DNA and RNA sequencing to answer basic questions about who is present and what their functional roles are. The Georgia Aquarium Ocean Voyager (OV) exhibit is a semi-controlled environment that mimics the basic physical and chemical parameters of the open ocean. It contains approximately 6.5 million gallons of artificial seawater with nutrient levels similar to those of an oligotrophic ocean basin. However, several important features differentiate the water column from a natural environment, including extensive filtration, sulfur-based denitrification, and ozone treatment. The exhibit also contains large marine animals, including fish, sharks, and manta rays, but very few invertebrates or algal species. We present a 14-month time series of the OV microbiome and show that it is subject to bloom events featuring two heterotrophic bacterial species that are present only at very low levels in ocean environments. The relative abundances of these species are inversely correlated, suggesting they occupy a similar ecological niche in the water column. We reconstructed the genomes of these species and highlight some interesting physiological characteristics. Notably, both bloom species contain genes for cyanophycin, an unusual amino acid polymer found frequently in cyanobacteria but rarely in heterotrophic bacteria. Cyanophycin is thought to act as a nitrogen and carbon storage compound, and the OV microbiome members have genes for both its synthesis and degradation. We also compared the OV microbiome with that of ocean environments with similar chemical features and found they differ dramatically, reflecting the inherently artificial nature of aquarium habitats. These findings have implications for large-scale aquaculture and demonstrate the opportunities for studying microbial ecology and evolution in a closed aquatic system.
Abstract: T11

Using Swarms of Simple, Inexpensive Robots to do Complex, Valuable Tasks.

Sean Wilson

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Electrical & Computer Engineering, College of Engineering

Swarms of inexpensive robots are capable of performing collective tasks over large domains and time scales. However, as the size of the swarm increases, it becomes infeasible for a central entity to control the actions of the swarm. This creates a need for decentralized strategies that are scalable to any swarm size, robust to individual robot failure, and have provable guarantees on the emergent performance of the swarm as a whole.

It is difficult to envision individual rules that will result in a desired group behavior. Biological systems such as ant colonies, bee hives, wolf packs, and micro organisms organize themselves in decentralized ways to perform extremely valuable and complicated tasks such as collective transport, herding, foraging, and site selection. Through collaboration with experts that study the behaviors of these organisms, it is possible to extract the useful behaviors from these biological systems and apply them in analogous swarm robotic scenarios. This type of research is mutually beneficial as biologists gain access to robots that can performed the theorized behavior repeatedly in a controlled way, while roboticists gain insight to model swarm behaviors they would not otherwise.

Since there is a mutual goal between biologists and swarm roboticists to understand the fundamental individual actions that cause predicted group behaviors to emerge, my research focuses on bridging that gap and working directly with biologists to solve these problems. To do this, it is important to model and understand the behaviors that drive the biological system then test them through repeated implementation in robots. After gaining a better understanding of the biological system, which may perform sub-optimally, the newly learned biological behaviors can then be expanded upon in robotic swarms to produce more rigorous results about the emergent behavior of the robotic collective.

Recent technological advances allow physical swarms of robots to become a reality. However, a swarm of robots is still expensive to produce, time consuming to maintain, and can typically become specialized to a desired task. Part of my current research is on developing affordable and accessible robots for swarm tasks that can also be used individually for education and outreach purposes. I am also currently supervising and developing the Robotarium project at Georgia Tech which aims to democratize swarm robotic access through a remotely accessible testbed.
Abstract: T12

**Engineering Leviviridae PP7 capsid protein as peptide display platform**

Liangjun Zhao, Jiri Schimer, MG Finn

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Virus-like particles are useful in a variety of ways in the field of nanomedicine. These nanoscale and self-assembled protein particles can tolerate significant genetic and chemical modifications and possess powerful multivalent display capabilities. Here, we describe our efforts to genetically and chemically modify the Leviviridae PP7 capsid protein as a platform for the presentation of functional peptides. We successfully displayed peptides from 1 kDa (cell penetrating peptide) to 14 kDa (double functional Z-domain) in size on the surface of the PP7 particle as C-terminal genetic fusions to the coat protein. In addition, a dimeric construct allowed the presentation of an epitope loop in the region between capsid monomers or the simultaneous presentations of two epitopes from the Zika virus at different positions on the icosahedral structure. To further functionalize the PP7 particle, unnatural amino acids were incorporated to allow site-specific installation of other molecules onto the particle surface. These results will allow us and others to use PP7 particle as a robust platform for the development of therapeutic and diagnostic agents.
Gravitational waves are perturbations of the space-time that travel at the speed of light. Although these were predicted in 1916 by Einstein's General Relativity, it took 100 years for scientists to obtain direct proof of its existence and open the era of Gravitational Wave Astronomy. Up to now, the LIGO Scientific Collaboration has reported the detection of 3 gravitational wave signals emitted by 3 binary black holes. These share the common properties of being almost equal-mass systems, and being lighter than 80 solar masses.

The way LIGO identifies gravitational waves is very similar to that of the popular Shazam app: the incoming signal is compared with a bank signal models, called templates. Similar to a symphony played by an orchestra, a gravitational wave signal can be thought of as a superposition of signals from several instruments, out of which one dominates. Currently, LIGO templates do only consider this dominant component. This makes unlikely the detection of more exotic sources than the ones already detected, for which the other components (known as higher modes) might be important. This is, more asymmetric and heavier sources, some of which are key to explain possible channels of black hole formation.

In this talk, I will present a novel search for the full gravitational wave emission of binary black holes and discuss the new science that detections of higher modes could allow.
Abstract: T14

**Of Whales and the Web: Hunting for Data in Nineteenth-Century American Literature**

Brad Rittenhouse

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Literature, Media, & Communication - Writing Program, College of Liberal Arts (Ivan Allen College)

In my presentation or poster, I will give a brief overview of both my qualitative and quantitative literary research. In the former, I look to show not only that data (as present-day observers would identify it) was not only present in nineteenth-century American literature, but that it was in fact a driving force behind the innovative literary aesthetics so associated with the epochal creative outpouring of the American Literary Renaissance. More specifically, I show how aesthetic techniques not only reproduce contemporary practices of data management and transmission, but also creatively anticipate digital logics and structures prominent in present-day information science. So, for instance, while Herman Melville, in his American classic Moby-Dick, primarily reproduces the forms and strategies of descriptive biology, encyclopedias, and libraries to aggregate and organize a wealth of cetological knowledge, his counterpart, Walt Whitman, imagines logics of data management that actually anticipate current-day technologies like relational databases and lossless compression.

In addition, I will talk about my quantitative work, which utilizes high-powered computing to investigate the Wright American Fiction library, a digital corpus of nearly 3,000 late nineteenth century works of American fiction. During the course of this research, I have developed a curatorial methodology by which computers can be used to identify the types of data-driven prose I look at in my more traditional literary scholarship. This method facilitates not only the targeted exploration of significant archives, but also the recovery of works that may have been ignored or overlooked by human readers. The encyclopedic works I look at in my traditional literary scholarship are often associated with Western, white men. The overwhelmingly masculinized informational subjects of canonical encyclopedic writers like Melville, Thomas Pynchon, and David Foster Wallace—cetology and descriptive biology, rocketry and ballistics, and pharmacology and chemistry, respectively—often serve as a barrier to human critics considering other kinds of writers and subject matters for consideration in this prestigious sub-genre. In this portion of the talk, I will show how the method was used to recover the work of Emma Wellmont, a nearly forgotten temperance writer who, though writing in a tradition that is often seen as sentimental and unserious, was nonetheless producing writing that, quantitatively, looked very similar to the works of Whitman and Melville. Ultimately, I hope to show how machine methodologies can be used to help human readers explore a fuller range of human involvements, interests, and identities in our canons and criticism.
Abstract: T15

EnerCage Technology: a Fully Wireless Solution to Power up and Communicate with Headstage/Implant Devices for Bio-Applications

S. Abdollah Mirbozorgi, Maysam Ghovanloo

Presented by: Seyedabdollah Mirbozorgi smirbozorgi3@gatech.edu Electrical & Computer Engineering, College of Engineering

EnerCage- HomeCage (HC) system is a smart experimental arena that can wirelessly power up and communicate with a wide variety of devices, attached to or implanted in small animal subjects, such as rodents, for monitoring or modulating neural activity, vital signs, or other physiological parameters of interest in vivo, while the animals are awake and freely-behaving within a standard homecage environment. Wireless and battery-less data acquisition and stimulation are quite important in experiments involving small animals to do it in a transparent way that minimizes the impact on their behavior.

We have designed, developed, and characterized EnerCage-HC system including different EnerCage-compatible wireless headstage modules for robust and efficient wireless power/data delivery, biological data acquisition, and electrical/optical neuromodulation within the EnerCage-HC platform. The EnerCage-HC system with these initial set of EnerCage-compatible headstage modules is expected to reduce some of the most labor-intensive, costly, and least scientifically appealing aspects of the longitudinal behavioral studies on freely-behaving small animal subjects. These wirelessly-powered and communicated headstages have been carefully selected to cover a wide range of most popular scientific and industrial research applications in areas, such as behavioral neuroscience, electrophysiology, genetics, phenotyping, new drug development, cancer research, and new medical device development. Moreover, there is a huge demand for experiments conducted on rodents, particularly rats and mice, with a large worldwide market with 10s of millions of animals used annually for various research purposes.

We are developing the EnerCage technology that will improve the quality of the collected data and reproducibility of a range of experiments in behavioral research by: 1) leveraging an enriched untethered environment within standard homecages that, 2) can deliver efficient power and establish robust bidirectional data connectivity, 3) to automatically collect high-throughput physiologically-relevant data, 4) or modulate neural activity or other organ function via electrical, optical, or pharmacological interventions, 5) over extended periods (24/7), 6) while minimizing manual handling and time consuming observations by the research personnel, which are sources of stress and bias on the animal subjects and experiment outcomes, respectively.
Abstract: T16

**Bacterial socialism and antibiotic resistance**

Sheyda Azimi, Aled E. L. Roberts, Alan McNally & Stephen P. Diggle

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Pseudomonas aeruginosa is an opportunistic pathogen that chronically infects cystic fibrosis (CF) lungs and chronic wounds by forming biofilms. Emergence of phenotypically diverse isolates within P. aeruginosa biofilms has been already reported. However, the dynamics between isolates evolved within biofilms and the possible effects on the progression of chronic infection and treatment outcomes are poorly understood. Here we tested how the P. aeruginosa strain PAO1 evolves in biofilms over 50 days using a bead biofilm model and a synthetic sputum medium. Our long term evolution experiment showed that within biofilms, the emergence of distinct P. aeruginosa morphotypes evolve. We studied the interactions between various selected evolved morphotypes to understand how this can affect the phenotype of a diverse population. We tested the dynamics of these morphotypes in biofilms and planktonic cultures. We observed varying levels of cooperation and conflict in biofilms between certain morphotypes. We tested the antibiotic tolerance of evolved populations and individual morphotypes, and observed increased tolerance to certain antibiotics, despite no previous introduction to antibiotics. Whole genome sequencing analysis of morphotypes identified new genomic signatures involved in the interactions between morphotypes that ultimately result in higher levels of antibiotic tolerance. Investigating interactions between morphotypes found in evolved populations will help form new strategies for treatment and control of biofilms, and also provide explanations as to how and why phenotypic diversity and antibiotic resistance evolves during long term chronic infection.
Abstract: T17

CURE (Challenging Unreal and Real Environments) for Visual Recognition

Dogancan Temel and Ghassan AlRegib

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Automatically recognizing objects in our surroundings can increase the quality of life for humanity by enabling applications including but not limited to visual recognition for visually impaired and sign detection for autonomous vehicles. The reliability of these applications is solely dependent on the reliability of the core technologies that process and analyze sensed information. Therefore, algorithmic solutions behind the core technologies have to be robust even under challenging conditions to reliably utilize them in our daily lives.

In our research, we investigate the robustness of object recognition applications and traffic sign detection algorithms. To investigate robustness, we need to test existing approaches with a comprehensive dataset. Unfortunately, existing datasets are limited in terms of challenging conditions. To identify the shortcomings of existing methods and find a cure, we introduced a series of datasets named as Challenging Unreal and Real Environment (CURE) datasets. Object recognition (OR) dataset is called CURE-OR-1M, which includes 1 million images and traffic sign detection (TSD) dataset is called CURE-TSD. To the best of our knowledge, CURE-TSD and CURE-OR are the most comprehensive publicly available datasets in their fields, which include controlled challenging environmental conditions.

We tested off-the-shelf applications with the CURE-TSD dataset and organized an IEEE competition to test competing algorithms with the CURE-TSD dataset. Based on our preliminary results, we show that challenging environmental conditions can significantly degrade the performance of existing solutions and degradation level depends on the challenge type. Based on the IEEE competition, we also show that detecting challenging environmental conditions and performing challenging-specific operations to minimize the effect of challenges can be a cure to obtain a relatively robust performance. Ongoing experiments with CURE datasets will lead to a better understanding of strengths and weaknesses of existing solutions, which will eventually be used to make reliable vision-based solutions a reality.
The Black Snake in Watercolor: Water Protector Movements and the Material Rhetorics of Ledger Art

Chelsea J. Murdock

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This presentation considers the material-rhetorical labor of Native American ledger art as perceived by various Indigenous creators, and the way that ledger art acts as a mediation of protest and protection work. A form of Native expression which utilizes materials such as composition paper and land deeds to mediate tribally-situated visual narratives, ledger art has often been discussed as a medium through which artists record their personal stories and mediate the experiences of their community. Through utilizing a recursive and relational methodology of story, this presentation will focus primarily on the material-rhetorical presence of ledger art associated with the Keystone XL and Dakota Access water protector movements, noting specifically how Indigenous resistance and survivance is mediated through this narrative art form.
Network Analysis of Plasmodium cynomologi Infection and Re-infection Challenge

Maren Smith, Mary Galinski, Chester Joyner, Mark Styczynski

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Plasmodium vivax is a significant source of malaria infection in South America and Asia, exposing an estimated 2.5 billion people to potential illness. Plasmodium cynomologi infection of Rhesus macaques (Macaca mulatta) is an excellent non-human primate model system for P. vivax malaria, enabling the study of host response to infection in ways that are not feasible in humans. In this work, we study the host gene expression and immune profile response to P. cynomolgi over an infection time-course including an acute peak of parasitemia and a relapse infection, followed by two rounds of re-infection: first with the homologous P. cynomologi strain, then with a heterologous P. cynomologi strain. Weighted Gene Correlated Network Analysis (WGCNA) was used to identify correlated gene expression modules from RNAseq data from initial infection, homologous reinfection, and heterologous reinfection. Modules from each dataset were then correlated to parasitemia, and blood markers such as white blood cell count and hemoglobin level, to identify those most related to malaria pathology. To determine whether gene expression patterns are conserved during multiple malaria exposures, modules identified during initial infection, homologous reinfection, and heterologous reinfection were compared for overlap. The immunological processes represented by each module were also assessed using bioinformatics. Initial infection modules showed enrichment for similar processes as both rounds of reinfection. Specifically for T-cell processes, B-cell processes, NK cell processes, and cell cycle regulation. These results indicate that both the innate and adaptive immune response may be involved in malaria control. However, more immune processes were enriched in modules identified during initial and heterologous reinfection, suggesting that a second exposure to a previously seen strain produces a different immune response than to a new strain. These results are consistent with lower parasitemia and symptomology seen during homologous reinfection. Network analysis, therefore, potentially reveals the adaptive immune response to initial malaria infection, and illustrates how genetic diversity of malaria strains help them evade the immune system.
Illuminating the Role of Heme and Hemoglobin in Alzheimer's Disease

Rebecca K. Donegan, Sitara B. Sankar, Levi B. Wood, and Amit R. Reddi

Presented by: Rebecca Donegan  rdonegan3@gatech.edu
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Alzheimer’s Disease (AD) affects 1 in 10 people over the age of 65. Despite the high rate of occurrence, AD pathogenesis is still poorly understood. The conventional hallmark of AD is extraneuronal plaques, predominantly formed from the aggregation of the amyloid beta peptide (Aβ). These plaques have long been alleged as the cause of neuronal loss in AD, however their presence is found in aging brains of those without dementia and they can appear in brains decades before dementia symptoms occur. As research in AD pathogenesis has expanded to consider the role of soluble species of Aβ, both intra and extracellularly, the potential for a relationship between inflammation and AD has come to light. Glial hyper-activation and dysfunction, and inflammatory signaling have all been linked with AD pathogenesis. Hemoglobin (Hb) has been found to be upregulated in the AD brain, and though Hb and its cofactor heme have immunomodulatory functions, their effect on the immune response in the brain is not well studied. Our work has found that Hb and heme interact with Aβ, affect its aggregation morphology, mediate the uptake of Aβ via microglia and modulate the Aβ induced inflammatory response of astrocytes. These findings point to the therapeutic potential of targeting heme and Hb signaling in the treatment or prevention of AD.
Abstract: T21

Defect immune signal transmission in elastic solids using topologically protected modes

Raj Kumar Pal, Javier Vila, Massimo Ruzzene

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Wave propagation plays a key role in energy and information transmission in multiple fields in science and engineering, ranging from optics to electronics to thermal, acoustic and elastic media. It governs the working principle in devices like optical communication circuits (filters, circulators, isolators), thermal dissipation media (heat sinks), acoustic sensor and transducers, surface acoustic wave devices for signal processing and sensors to opto-mechanical components for high-precision metrology. In the past two decades, meta-materials and meta-surfaces exploiting periodic media has emerged as a platform to realize unique wave manipulation phenomena, including negative refraction, one-way or non-reciprocal propagation, focusing and cloaking. However a key limitation of many of these designs, across various physical fields, is their sensitivity to defects and imperfections, which are inevitably introduced due to manufacturing flaws and operating conditions, and these defects significantly deteriorate the performance of the devices. To overcome this seemingly fundamental limitation, topologically protected wave or information transmission has emerged as a promising candidate in the last few years. By exploiting abstract mathematical properties associated with the topology of the band associated with the wave, one can ensure robust wave or information transmission even in the presence of defects. Originally envisioned in quantum mechanical systems, we have developed classical analogues of these concepts, which allow us to have robust signal transmission in solids. Our theoretical and experimental results will illustrate how superior wave transmission can be obtained by exploiting concepts of topological protection. Our design allows energy transport with unprecedented levels of robustness and it indeed challenges conventional notions, thereby opening the possibility for wave based devices with new functionalities.
Meniscus-Assisted Solution Printing of Large-Grained Perovskite Solar Cells

Ming He, Yanjie He, Mostafa A. El-Sayed, Jinsong Huang, and Zhiqun Lin

Solution printing is a promising low-cost, energy-efficient, and high-throughput route to large-area electronic devices. A key problem of solution printing is the lack of controlling on film morphology, which is not only encountered for organic or inorganic electronics, but also for perovskite solar cells. In this context, we demonstrate that the crystallization of perovskite films can be rationally controlled by implementing the meniscus effect with solution printing. Central to this strategy is the solvent evaporation-triggered outward convective flow that facilitates the diffusion of perovskite solutes towards the crystal grains by offsetting the dragging force, eventually promoting the growth of microscale perovskite crystals with preferred crystal orientations at low temperatures (i.e., 60 oC). We successfully scrutinize the perovskite crystal growth kinetics during meniscus-assisted solution printing (MASP), in which a two-stage growth kinetics of perovskite crystals is identified, providing guides to precisely control the crystal morphology and crystallinity of perovskite films for high-performance optoelectronic devices by solution printing. The perovskite films produced by MASP exhibit excellent optoelectronic properties with efficiencies approaching 20% in planar perovskite solar cells. We anticipate this MASP strategy to promote the future development and application of perovskites in low-cost, large-area, and flexible optoelectronic devices.
Simon L. Lewis and Mark A. Maslin date the start of the Anthropocene, the age in which humans exert the greatest geological force on the environment, to 1610. In their article, “Defining the Anthropocene,” Lewis and Maslin, “assess anthropogenic signatures in the geological record against the formal requirements for the recognition of a new epoch” (171). If, as they suggest, the Golden Spike can be dated to 1610, then Early Modern English drama may speak to some of the terminal consequences of the age of man to come. In light of their connection, I argue that Christopher Marlowe’s Dr. Faustus is not only a high-water mark of humanism, but also an exemplary instance of the human becoming a climatological force. Even before we meet him, for instance, Faustus is “swoll’n” (Prologue 20) and then later “glutted” (1.1.80) by a fantasy of accumulation that includes, but is not limited to, pearl, gold, silk, fruits, all the secrets of foreign kings, war machines, and Germany. So that Mephistopheles will “bring him” (2.1.101) grapes from the southern hemisphere and move trees at his command, Faustus signs his name in blood to a deed of gift. Faustus’s famous signature is itself a sedimentary layer in the literary historical archive that is freighted with both the citation of the Faustbook that precedes Marlowe’s play, as well as the destructive environmental conditions—expansion, extraction, and extinction—in which Marlowe’s text unfolds from the Early Modern period to the present. And while he may satisfy his appetite at the expense the environment he inhabits, Faustus is eventually incorporated into the deleterious environmental forces that, quite literally, undo him. That Faustus falls victim to a storm of his own making, presages the dangers of our own climatological moment.
Green and Affordable Ligand-Free Palladium-Catalyzed Suzuki Coupling Reactions in Water

Zhao Li, Carol Gelbaum, William L. Heaner IV, Jason Fisk, Arvind Jaganathan, Bruce Holden, Gregory T. Whiteker, Pamela Pollet, and Charles L. Liotta

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The ligand-free Pd-catalyzed Suzuki reactions in water offered a prospective protocol for developing green cross-coupling processes. As of today, the ligand-free catalytic systems in hot water have proven to be successful on mL scales (up to 1 mmol of substrates with 1–5 mL of water). Few practical examples of larger-scale reactions have been reported. We have successfully conducted a wide range of heterogeneous Pd-catalyzed Suzuki reactions between aryl bromides and arylboronic acids/esters in water with no added ligand at the 100-mL scale using 20-40 mmol of aryl bromides. Besides the issues often encountered during the scale-up study, a series of key parameters affecting the reaction outcome have been investigated and identified. Our results clearly indicated that the reaction parameters (i.e. pH) necessary to achieve high yields are substrate-dependent. We have also found that Suzuki reactions of substrates containing basic nitrogen centers in pure water with no co-solvent or added ligand can produce quantitative yields of desired products. Extra protection-deprotection strategies can be avoided. Recently, the ligand-free/aqueous catalytic system has been further simplified. We have observed that Suzuki reactions of arylboronic acids with a series of aryl bromides containing aliphatic amines and pyridines were successfully coupled in water without added ligand and added base. These base-free and ligand-free Suzuki reactions were found to be partially or entirely taking place under acidic conditions. Our discovery of acidic Suzuki reactions may expand the breath of functional groups which could be present on the substrate, especially the ones sensitive to bases. Our exploration of the sustainable ligand-free Suzuki reactions in water and the achievement of ca. 100 successful coupling examples should be of significant interest to both academic and industrial researchers. The scale-up of those heterogeneous reactions offers an operational approach to the development of green Suzuki reaction processes in water without expensive ligands. Using water as solvent and conducting the Suzuki reactions in the absence of added ligands and without protecting the basic nitrogen centers of substrates make our protocol greener than the conventional approaches.

Publications
• J. Org. Chem. 2016, 81, 8520-8529.
Highly stretchable and transparent transistors for future intelligent electronics

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Stretchable microelectronics has garnered significant attention from research and industry due to its essential role in the realization of large-area wearable, epidermal and biomedical electronic applications. Approaches for stretchable electronics have been intensively investigated: geometric structure design has been used to impart stretchability to brittle materials and intrinsically elastic electrode or semiconductor materials have been used directly as device components. Among these strategies, most efforts so far have concentrated on the design and preparation of an intrinsic elastic active layer with high charge carrier mobility. Despite significant technological advances in the realm of stretchable circuits, the development of stretchable electronics remains limited either by the elaborate synthesis process of intrinsically elastic semiconducting/conducting polymers or multi-step manufacturing processes. Thus, a simple and practical approach to stretchable devices is required. Here, we describe a self-organized versatile conjugated polymer film through interpenetrating polymer network (IPN) formation to significantly improve mechanical ductility and optical transparency, without affecting the film electronic conductivity, even under 100% strain. The IPN formed within the semiconducting films is crucial for the obtained enhanced ductility and charge-carrier mobility. Based on this versatile semiconducting film, we explored a new practical approach to directly integrate all the stretchable components for a large area transistor array through a simple single, mechanical peel-off step and solution processing. We demonstrate robust transistor arrays exhibiting charge carrier mobilities above 1.0 cm²/V·s with excellent durability, even under 100% strain. In addition, commercial p-channel and n-channel conjugated polymers confirmed the generality of this method. With future technological advances in the realms of wearable devices and circuits, the IPN strategy and process protocols are expected to bring stretchable electronic systems to a practical level and represent promising directions for the industry-scale roll-to-roll production of stretchable and wearable electronic devices.
Abstract: P4

**Fast computations with surface deformations**

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Deforming surfaces is a common phenomenon in several areas of pure and applied mathematics and physics. For example, a thin layer of fluid in a flat container can be thought of as a 2-dimensional surface, and mixing the fluid can be interpreted as deforming this surface. Taffy pullers, which are machines consisting of a few rotating rods and are used to stretch taffy, can also be studied through deformations of surfaces.

There are various computational problems related for deformations of surfaces. Is the deformation mixing up the whole surface or only part of it? How fast is the mixing? In the already mentioned applications, answers to these questions help finding optimal fluid mixers and taffy pullers.

In our work, we give an algorithm that solves the computational problems above in quadratic-time, whereas previous algorithms were at least exponential-time. Unlike some algorithms that serve only theoretical purpose, our algorithm is practical to implement and works fast in practice.
The Aberrant Chaperone-Client Interactions of Grp94 and Myocilin

Dustin J. E. Huard, Vincent M. Crowley, Amirthaa Suntharalingam, Moya O. Tomlin, Yuhong Du, Chad A. Dickey, Laura Blair, Haian Fu, Brian S. J. Blagg, Raquel L. Lieberman

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Gain-of-function mutations in the olfactomedin domain of the protein myocilin result in the toxic accumulation of amyloid-containing myocilin aggregates, hastening the onset of the prevalent ocular disorder primary open-angle glaucoma. The absence of myocilin does not cause disease, and therefore strategies aimed at eliminating myocilin could be therapeutically relevant for glaucoma. We have shown that the ER-resident chaperone Grp94, in its effort to triage misfolded myocilin, enhances its aggregation in vitro and retention in vivo, and that knocking down or pharmacologically inhibiting Grp94 facilitates clearance of aggregated myocilin. We have therefore exploited this aggregation enhancement property to develop a high-throughput screening assay for the identification of small molecule inhibitors of Grp94. When applied to a focused library containing nucleotide binding site- and C-terminal-directed Grp94 inhibitors, our assay successfully identified those compounds that target the chaperone active site. Post-assay aggregate analysis, in combination with in vivo screens for cellular toxicity and induction of heat shock response, and structural characterization of binding mode employing protein crystallography, have revealed a promising lead for the development of myocilin-glaucoma therapeutics.
Protons Enhance Conductivities in Lithium Halide Hydroxide / Lithium Oxyhalide Solid Electrolytes by Forming Rotating Hydroxy Groups

Kostiantyn Turcheniuk, Ah-Young Song, Yiran Xiao, Punith Upadhya, Anirudh Ramanujapuram, Jim Benson, Alexandre Magasinski, Marco Olguin, Lamartine Meda, Oleg Borodin, Gleb Yushin

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Li halide hydroxides (Li2OHX) and Li oxyhalides (Li3OX) have emerged as new classes of low-cost, lightweight solid state electrolyte (SSE) compounds showing promising Li-ion conductivities. However, their typical syntheses often bring contaminations and uncontrollable escape of volatiles. In addition, the similarity in the lattice parameters between Li2OHX and Li3OX combined with insufficient rigor in material characterization often lead to erroneous interpretations of the reported material compositions. Finally, moisture remaining in the synthesized products or cell assembling environment, leaks in the electrochemical cells and variability in the equivalent circuit models may additionally contribute to significant errors in the reported properties. Thus, there remains a controversy about the real values of Li-ion conductivities in these SSEs. Here, we present an ultra-fast synthesis and comprehensive material characterization methods and ionic conductivities of contaminant-free Li2OHCl, Li2.1OH0.9Cl, Li2.4OH0.6Cl, Li2.7OH0.3Cl and Li2OHBr. Using a powerful combination of experimental and numerical approaches, we demonstrate that the presence of H in these SSEs yields significantly higher Li+ ionic conductivity. Born-Oppenheimer molecular dynamics (BOMD) simulations showed excellent agreement with experimental results and revealed an unexpected mechanism for faster Li+ transport. It involves rotation of a relatively short OH-group within the SSEs, which opens lower-energy pathways for the formation of Frenkel defects and highly-correlated Li+ jumps. We anticipate that our findings will reduce the existing confusions and show new avenues for tuning SSE compositions for further improved Li-ion conductivities.

References:
The adsorption behavior of arsenic (As) on specific crystalline phases of manganese dioxide (MnO2) remains unclear. In this study, we evaluated the ability of α-MnO2 nanofibers (MO-2) to remove both arsenite (As(III)) and arsenate (As(V)), using experimental and computational methods. The maximum adsorption capacity values of As(III) and As(V) on MO-2 were 117.72 and 60.19 mg/g, respectively, which is higher than values reported for α-MnO2, β-MnO2 and γ-MnO2. In particular, because MO-2 has much higher adsorption capacity for As(III) than As(V), it can be effectively applied in removal of As(III) from groundwater, and a pre-oxidation process is not required. Fixed-bed tests showed that about 800 mL As(III)- or 480 mL As(V)-contaminated water could be treated before breakthrough, and MO-2 can be effectively regenerated using only 12 mL of eluent. This means we can concentrate the As(III) and As(V) by factors of 66.6 and 40.0, respectively. According to density functional theory (DFT) calculations, As(III) and As(V) form stable complexes on (100) and (110) facets of α-MnO2. Moreover, the surface complexes of As(III) and As(V) on (100) facet are more stable than (110). Electron transfer from As(III) on (100) is greater than (110) facet. These phenomenon are may due to the fact that (100) has lower surface energy than (110). Partial density of state (PDOS) analysis further confirmed that As(III, V) are chemisorbed on MO-2, which agreed with the Dubinin-Radushkevich model.
Abstract: P9

**Epsin 1 and 2, regulators of VEGFR3 recycling, play a role in lymphatic function**

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Background: Balance of tissue fluid and fat tissue is regulated by lymphatic vessels (LVs), the sewage channels of the body, consisting of lymphatic capillaries and collecting LVs. In collecting LVs, lymphatic valves ensure efficient forward transport of lymph. When lymph transport becomes dysfunctional (e.g. in obesity and lymphedema), fluid and fat tissue accumulate and stagnate, urging the generation of new LVs, i.e. lymphangiogenesis, a process regulated by VEGFR3 signaling. Epsin 1 and 2, which regulate the clathrin-mediated internalization and degradation of VEGFR3, are important for lymphatic valve formation during embryonic lymphangiogenesis. Whether epsins play a role in lymphatic function in adulthood and diseases is unknown.

Methods: We investigated this question using two different double knock-out mouse models: 1) global epsin 2-/− with epsin 1 deleted from birth in lymphatic endothelial cells (LEC-DKO) and 2) global epsin 2-/− with epsin 1 deleted upon tamoxifen induction (LEC-iDKO). We measured lymphatic function in vivo using near-infrared imaging on their tails.

Results and future directions: Our data showed that deletion of epsins from birth in LEC-DKOs hindered lymph transport through collecting LVs, lowering lymphatic packet frequency, LV emptying rate, and LV effective pumping pressure. Instead of utilizing the collectors, lymph primarily cleared through small lymphatic capillaries. However, LEC-specific epsin 1 deletion in adult LEC-DKOs did not affect their lymphatic function in vivo. In conclusion, epsins are crucial for lymphatic development in embryo and while not embryonic lethal, produce functional consequences that persist until adulthood. However, deletion of epsins in adult mice without lymphangiogenic needs does not affect lymphatic function. This suggests that epsins are important for initial valve formation in lymphangiogenesis rather than in maintenance of valve function. Next we will explore how valve defect due to deletion of epsins in embryonic development presents in adult LEC-DKOs by testing valve morphology and valve function of isolated collecting LVs, and whether the deletion of epsins in LEC-iDKOs immediately prior to when a lymphangiogenic need arises, e.g. in obesity or lymphedema models, would be detrimental for the lymphatic healing process, particularly as it relates to the maturation of new functional collecting vessels.
Assessment and Control of a Cavitation-Enabled Therapy for Minimally Invasive Myocardial Reduction

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Hypertrophic Cardiomyopathy (HCM), which occurs in 1/500 individuals worldwide can lead to sudden death in adults without prior symptoms. Echocardiography is commonly used to diagnose hypertrophic cardiomyopathy. Current treatment involves invasive and high-risk procedures such as surgery or catheter-based ablation of septum to potentially prevent left ventricular outflow tract obstruction. A novel technique, called Myocardial Cavitation-Enabled Therapy (MCET), has been proposed as a means to achieve minimally invasive myocardial reduction, i.e. heart tissue ablation. MCET aims to target hypertrophic heart muscle over time without substantial tissue scarring. The treatment employs contrast echocardiography at higher than diagnostic pressure amplitudes to produce scattered microlesions (clusters of dead cells) by cavitating contrast agent microbubbles.
Abstract: P13

Wireless, Intraoral Hybrid Electronics for Real-Time Quantification of Sodium Intake Toward Hypertension Management

Yongkuk Lee, Connor Howe, Saswat Mishra, Dong Sup Lee, Musa Mahmood, Matthew Piper, Youngbin Kim, Katie Tieu, Hun-Soo Byun, James Coffey, Mahdis Shayan, Youngjae Chun, Richard M. Costanzo and Woon-Hong Yeo

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Recent advances in the development of non-invasive, portable, and wearable devices offer monitoring various types of health information including biopotentials, temperatures, glucose levels, and physical activities. The growing demand for such applications has naturally induced attention towards the oral area, which is a great resource for disease diagnostics and health management. However, existing devices using plastic circuit boards and rigid sensors are not suitable for designing oral electronics. A user-comfortable system that makes direct integration in the oral cavity requires an ultrathin, low-profile, and soft electronic platform along with miniaturized imperceptible sensors. Here, we introduce a stretchable hybrid electronic system that has an exceptionally small form factor, enabling an active, long-range wireless monitoring of sodium intake in the oral cavity. Computational study and experimental validation establishes fundamental aspects of design factors for a tissue-friendly configuration, integrated with a stretchable circuit and microstructured sodium sensor. Analytical calculation and experimental study enables a reliable wireless circuitry that accommodates dynamic mechanical strain and stress. Furthermore, the assessment of material properties ensures not only the device biocompatibility but also biological comfort of the device with significant reduced thermal loading. Systematic in vitro modeling provides the functionality of a flexible, membrane sodium sensor in the intraoral electronics. In vivo demonstration with human subjects captures the device feasibility for a real-time, wireless quantification of sodium intake, which is widely applicable for management of hypertension and diabetes.
Abstract: P14

The new multimessenger era in Astrophysics of Gravitational Waves and Gamma Ray Bursts

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Gamma-ray bursts are the most energetic explosions in the universe. Those Jets of high-energy gamma rays travel at the speed of light to reach the Earth and inform us about their sources. They are thought to be released during the core collapse of a massive stars or the merging of neutron stars. We will present the kinds of information that can be obtained from those events, how to detect them, what can be done to understand them better and what would happen if one of those “explosions” was close to the Earth. The knowledge about the process of emission of gamma-ray burst has improved in the last decade, thanks to new dedicated satellites designed to detect them. With the advent of this new era in gravitational-wave observations, we should soon be able to observe gamma-ray bursts in different, complementary ways: especially using Gravitational Waves. Indeed those massive stars produce deformation of the Space Time of the Universe that could been detected by the Laser Interferometer Gravitational-Wave Observatory. The multi messenger era will help us solve a lot of mysteries on the fundamental properties of those progenitors. I will show the kind of analysis I realized to achieve this goal in the LIGO team of Georgia Tech and the consequences for the future of those detections.
The presence of perchlorate salts on Mars suggests a possible energy resource for microorganisms. Perchlorate Reducing Microorganisms (PRM) are seemingly ubiquitous on Earth as they have been isolated from a variety of environments and they are also phylogenetically diverse, occurring in both the Bacterial and Archaeal domains. Surprisingly, little evidence exists documenting the existence of PRM in settings where naturally occurring perchlorate (ClO$_4^-$) is abundant. Hence, finding these two entities together in a relevant analog environment on Earth would make for an excellent model for this kind of ecosystem on Mars. Furthermore, this finding could help to shed light on the evolutionary history of microbial perchlorate reduction. Here, we present evidence that PRM co-exist with naturally occurring perchlorate in the Pilot Valley basin of the Great Salt Lake Desert, and offer this as a potential model for perchlorate-driven ecosystems in paleolake basins on early Mars. Pilot Valley is a closed basin paleolake that contains perchlorate-rich sediments. Using sediment samples obtain from the basin, two sets of microcosm experiments were established at 0.1% and 100-ppm final perchlorate concentrations. Bulk DNA was extracted from the six most concentrated microcosms and 16S-sequenced on the Illumina MySeq platform. Quantitative PCR analyses of the chlorite dismutase (cld) gene and the perchlorate reductase (pcrA) gene were conducted using DNA from the same six high concentration samples. Perchlorate was measured on all microcosms by sequential ion chromatography-mass spectroscopy/mass spectroscopy (IC-MS/MS). Chloride concentrations were measured using Ion Chromatography to rule out sample contamination. Results from both utilization experiments show statistically significant reductions in perchlorate across all microcosms. qPCR results show copy numbers of the cld gene that correspond to a PRM abundance ranging between 0.5 and 4% of the total microcosm population. Further, 16S sequencing results show a small population of known PRM present in the microcosms at approximately 1%. These results suggest that PRM co-exist with the naturally occurring perchlorate present in the Pilot Valley sediments. These results could explain the perchlorate concentration gradient seen across the Pilot Valley study transect, though further study is necessary to verify that PRM are actively utilizing the perchlorate in the basin sediments.
Cooperation is one of nature's most powerful resources. The interaction between low talented individuals results in performances by far exceeding the sum of the singles' skills. Often times, collaboration is the key to survival. Diluting predators chances of success by synchronized movements are typical in fishes. Monarch butterflies can travel 3000 miles thanks to the colony effect on suppression of orientation errors. A large number of technologies have collaborative principles at its core. For example, high penetration of renewable energies in the future electrical power grid will be made possible thanks to a balanced interaction of distributed producers.

Due to the importance of collaboration, algorithms and protocols exploiting interactions within large teams of robots have been deeply investigated. The main goals are simple, reliable and cheap robotic platforms whose global performance is amplified by mutual interactions. In particular, cooperation becomes essential in "multi-agent distributed systems", where minimal supervision from external operators is allowed.

However, maintenance of connectivity in distributed robotic systems is not trivial. Large networks of satellites might be interrupted by celestial objects temporarily obscuring their fields of view. Interruptions can also occur during nominal functioning. In exploratory robotics, agents with limited sensing ranges might fall to far apart during their explorative motion. Interruptions due to changes in the environment, adversarial attacks and hardware failures need to be properly addressed. For these reasons, network self-healing properties become a priority in a swarm of robots.

From a mathematical standpoint, "graph theory" represents a powerful tool, largely applied to the study of the interactions between a set of individuals. Appearance and disappearance of links connecting robots can be described as the hopping between different graph models. In this context, theories on switching processes can be used to obtain formal results on the evolution of networks properties and performances.

In conclusion, cooperation is the key to achieve complex results when limited skills and resources are available. However, since a team performance depends upon robots' collaboration, maintenance of connectivity becomes fundamental property. The design of network self-healing behaviors, capable to guarantee connectivity within a robotic swarm still represent a challenge in the robotics community.
Focused ultrasound immunomodulation of intracranial malignancies

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A major revolution in the field of oncology has been brought about by immunotherapy with the use of monoclonal antibodies, immune checkpoints inhibitors and cancer vaccines. However due to i) the limited antigen presentation, ii) the limited infiltration of activated immune cells in the tumor microenvironment and iii) the limited penetration of immunotherapeutic agents in the tumor core the therapeutic efficacy against brain tumors remains limited. Research by us and others has shown that Focused Ultrasound (FUS), a noninvasive technology to deliver thermal and mechanical energy deep into the brain, can promote the bidirectional transport of molecules and immune cells across the biological interfaces of the brain, including the blood brain barrier. Our aim in this study is to test if controlled focused ultrasound stimuli can promote immune cell infiltration within the tumor microenvironment. To test our hypothesis, we utilized an orthotopic, immunocompetent murine glioblastoma model (GL261-luc2/C57BL/6) and a custom-built MRI-guided FUS system that allowed for controlled FUS-exposures (sonications). One week after the sonications, the changes in the immune cell subpopulations in the tumor microenvironment and systemically (superficial cervical lymph nodes and spleens) were evaluated and compared with non-exposed mice. The immune cell subpopulations, such as T helper cells (CD4⁺), cytotoxic T cells (CD8⁺), T regulatory cells (CD4⁺ FoxP3⁺) and activated natural killer (NK) cells were analyzed using flow cytometry. Moreover, we assessed the expression of immunoinhibitory receptors and specifically the PD-1 and TIM-3 coexpression (PD-1⁺ /TIM3⁺ ) in the tumor-infiltrating T cells. Finally, we evaluated changes in the subset of myeloid-derived suppressor cells (MDSC; CD11b⁺ Gr1⁺). Our preliminary results show a decrease of immunosuppressive populations both in the tumor microenvironment and systemically, whereas an increase of cytotoxic immune cells was recorded in the spleen. These data support our hypothesis and further suggest that FUS could be used to shift the intra-tumoral immune balance in favor of enhanced tumor control in glioblastomas.
DEVELOPMENT AND MOLECULAR UNDERSTANDING OF PLASMONIC PHOTOTHERMAL THERAPY (PPTT) IN COMBATING CANCER

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In cancer plasmonic photothermal therapy (PPTT), gold nanoparticles (AuNPs) are used to convert light energy into localized heat leading to cancer cell death. Among plasmonic nanoparticles, gold nanorods (AuNRs) have been widely used as they absorb near-infrared (NIR) laser light (safe to biological system). Herein, 1) we developed a new AuNRs formulations techniques, yielding better generation of AuNRs, enhanced cancer cell targeting, and thus is more selective and efficient. On the other hand, the detailed mechanism of PPTT, remains poorly understood. Thus, 2) upon PPTT we used Surface Enhanced Raman Spectroscopy (SERS) to detect time-dependent changes in the intensities of the vibration frequencies of molecules. We complemented the study of changes in SERS spectra with metabolomics, proteomics, western blots through network analysis. It showed several apoptosis pathways (favorable death pathway compared to necrosis) were activated, which are consistent with the proposed role of altered phenylalanine metabolism in inducing apoptosis. 3) Studying the AuNPs’ effect on mechanical properties of cancer cells. The ability of targeting AuNRs to cancer cell integrins and the introduction of PPTT stimulated broad regulation on the cytoskeleton, which provides the evidence for a potential medical application for controlling cancer metastasis. 4) Moving from cells to animals, In Xenograft mice we explored the death pathway using proteomic analysis and immunohistochemistry in mouse tumor tissues, indicated that PPTT trigger cancer death via apoptosis with no remarkable toxicity to mice, even after 15 months from treatment. 5) Furthermore, the feasibility of PPTT has been verified on natural tumors in dogs and cats without any relapse or toxicity effects even after 1 year of treatment. In conclusion, together these data on cells, mice, cats and dogs demonstrated that our AuNR-PPTT inducing apoptosis is effective and safe for cancer therapy provides a strong framework for translation this approach to the clinic.
Native and Nonnative Intuitions on the Phonology of Binomial Locutions

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Binomial locutions (e.g., spic and span; hanky-panky) are lexicalized sequences of two or more constituents whose irreversible order is determined by semantic and phonological factors (Benor & Levy, 2006; Cooper & Ross, 1975). As an extension of early work (Birdsong, 1979) the present experimental study examines speakers’ sensitivities to proposed phonological constraints on constituent ordering in binomials. Intuitions for preferred constituent order by native English and French speakers, and those of advanced L2 English and L2 French speakers, were elicited with a computer-based judgment task, using pairs of nonsensical sequences, structured in such a way that one expression conforms to a specific constraint, and the other violates it (e.g., rigster and ragster vs. ragster and rigster). The constraints in question involve quality and number of consonants, and quality and length of vowels in constituent elements of binomials. Experimental results revealed that the intuitions of native English speakers were generally more in line with the proposed constraints than those of native French speakers. Further, the intuitions of advanced nonnative speakers of both languages were overall not significantly different from those of natives, suggesting that subtle nativelike sensitivities to the phonological constraints in question may be acquired. A planned analysis revealed that intuitions are similar for coordinated type (e.g., wheeling and dealing) and hyphenated-type (e.g., razzle-dazzle) items, a heretofore unexplored distinction. A further analysis showed that participants displayed sensitivities to vowel quality and number of final consonants. The result concords with accounts on invariable word order that derive from principles of phonoiconicity and markedness (Birdsong, 1979; Sobkowiak, 1993).
Using Patient Decision-Aids for Genetic Testing

Russell Kirkscey

Many people face decisions about medical treatment options during their lives. Health care providers may choose to use patient decision aids (PDAs) to help people understand health care possibilities. PDAs function as deliberative rhetoric when they address benefits and disadvantages about treatment options. Medical organizations recommend a neutral, balanced presentation of positive and negative arguments. However, communication challenges remain in creating appropriate ways for health care providers to give patients equal, unbiased information. I have developed a framework for the rhetorical analysis of PDAs that includes the medical knowledge of health care providers, the embodied knowledge of patients, and a discussion of the interaction between the two modes of understanding.

This study examines balanced argumentation in four PDAs that address cancer genetic testing. The document authors introduce benefits and disadvantages to both positive and negative test results and provide information that may assist persons in understanding the issues surrounding the problematic integration of medical and embodied knowledge. The samples offer four benefits of testing while acknowledging the roles of embodied and medical knowledge in deliberation. However, the document authors construct 10 disadvantages against choosing genetic testing. Furthermore, while three authors acknowledge that genetic testing alone may not provide sufficient data to inform treatment, only one author introduces other challenges to medical knowledge such as the incorrect interpretation of results and the small chance for treatment of certain cancers.

This research contributes to the refinement of theory and practice associated with many aspects of patient-provider decision-making. Additionally, scholars can extend and adapt this framework to a variety of medical situations where participants must weigh the consequences of treatments.
A Digital Humanist Goes to Business School

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This poster looks at the value of introducing business students to humanist traditions and ideas. I do so by presenting a case study from my business communication course on an interdisciplinary unit. Reading Grant McCracken's Chief Culture Officer, we consider and evaluate his thesis that a cultural critic should occupy the C-suite. Debunking the argument that personality, charisma, or good instincts are what lead to success for figures such as Steve Jobs, Martha Stewart, or Geoffrey Frost, students learn how cultural criticism can play an invaluable role in business. Combining readings from cultural studies, anthropology, and marketing, students engage with the McCracken's proposition that humanist thought can add value and profit to businesses. The case study concludes by looking at how students communicate often undervalued humanist ideas to others within the company in the form of video ethnographies. Ethnography bridges the divide between humanist research practices and qualitative market research by demonstrating how astute cultural studies observations can yield profitable results. This poster presentation includes an outline of the unit, a bibliography, assignment design, and process documents.