CAS

Center for
Advanced
Study

Research Appointments / Associates and Fellows 2015 - 16

University of Illinois Urbana-Champaign

Applied Configuration Spaces • This I Believe • Multilingualism in Africa: Sociolinguistic and Cognitive Dimensions • Computational Electromagnetics for Quantum Optics and Casimir Force Study • Big Data Fusion and Analytics for Resorting and Improving Urban Infrastructure • The Camera Politic: American Presidents and the History of Photography from the Daguerreotype to the Digital Revolution • Advanced biomaterials for cancer research and therapy • Interplay of Symmetry, Geometry, and Topology in Crystalline Phases of Matter • Computational Spectral Imaging: Theory, Algorithms, and Fundamental Performance Limits • Genomics with Semiconductor Nanotechnology • *The Cultural Geography of Firearms: Illinois as a Microcosm of the Nation* • Evolutionary Annotation of Regulatory Sequences • Capitalizing on Internet Technology to Support Families with Young Children with Autism and Other Developmental Disabilities • *The Illinois and the Edge Effect: Bison Algonquians in the Tallgrass Prairie Borderlands, 1200-1850* • A Strange New World: Untimeliness, Futurity, and David Bergelson • Strongly Coupled Electron Matter • Topological phases of matter and quantum anomalies • *Ecce Corpus: Beholding the Body in Anglo-Saxon England* • *The Social Differentiation of Literary Genres, 1800-1950* • Observing the Birth of the Universe: Building and deploying a new camera for the South Pole Telescope

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Research Appointments 2015-16

Each year, the tenured and untenured University of Illinois faculty are invited to submit scholarly/creative proposals for consideration by the Center's permanent Professors. Faculty members with winning proposals are appointed Associates and Fellows and awarded one semester of release time to pursue their projects in the coming academic year.

In accordance with the Center's mission, these appointments provide an incentive to pursue the highest level of scholarly achievement. They also provide faculty members with an unusual opportunity to explore new ideas and demonstrate early results.

With the Professors, Associates and Fellows form the intellectual core of the Center for Advanced Study community.They participate in a yearly roundtable discussion of research interests, are invited to participate in CAS events, and have opportunities to present their work to the CAS community.Thus, each year brings together the established and the new in an ever-changing flux of ideas and disciplines.

We are pleased in this brochure to introduce the projects of the 2015-16 CAS Associates and Fellows.

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CAS Review Committee

The review committee for the Associates and Fellows program consists of the Center for Advanced Study Professors. These senior scholars represent a wide range of disciplines. Their permanent appointment to the Center is among the highest forms of campus recognition.

James D. Anderson
education policy, education desegregation, African-American public education

Renée L. Baillargeon
early conceptual development, infant cognition

Tamer Başar
distributed decision making, robust estimation and control, dynamic games, network economics

May R. Berenbaum
entomology, chemical ecology

Bruce C. Berndt
analytic number theory, Srinivasa Ramanujan

David M. Ceperley
quantum Monte Carlo methods, quantum many-body systems

Leon Dash
immersion journalism, domestic and international reporting

Matthew W. Finkin
labor and employment law, legal issues in higher education

Martha U. Gillette
cellular neuroscience, circadian rhythm

Nigel Goldenfeld
condensed matter physics, evolution, microbial ecology, statistical mechanics

Bruce Hajek
communications engineering, stochastic methods

Frederick E. Hoxie
federal Indian policy, Native American history

Thomas S. Huang
image processing, pattern recognition, computer vision, human-computer interaction, image and video databases

Brigit P. Kelly
poetry

Anthony James Leggett
low-temperature physics, superconductivity

Stephen P. Long
environmental physiology, global atmospheric change, C4 photosynthesis

Michael S. Moore
law and philosophy, jurisprudence, criminal law, ethics and meta-ethical philosophy, philosophy of punishment and responsibility, philosophical psychology

Tere O'Connor
dance, choreography, consciousness

Gene E. Robinson
genomics, social behavior, social insects

John A. Rogers
soft materials, conformal electronics, nanophotonic structures, microfluidic devices, microelectromechanical systems, injectable optoelectronics

Jay Rosenstein
journalism, film, documentaries

Klaus Schulten
condensed matter physics, biomolecular modeling, vision, photosynthesis, force generation, membrane channels, cellular organization

Jonathan Sweedler
bioanalytical chemistry, peptide hormones, neurotransmitters, neuromodulatory agents

Maria Todorova
history, Balkans, nationalism

Lou van den Dries
model theory, o-minimality

Dale J. Van Harlingen
experimental low-temperature physics, superconductivity, microfabrication of superconductor devices, scanning probe microscopy, mesoscopic systems

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Invitation to Apply
We invite the campus faculty to submit proposals for the 2016-17 academic year. For more information, please consult our website at www.cas.illinois.edu

Application deadline:
October 6, 2015

Contents

Applied Configuration Spaces

Yuliy Baryshnikov
Associate

Department of Mathematics

The project deals with ***Applied Configuration Spaces***, an area in Applied Topology, a fast developing part of Algebraic Topology.

Algebraic topology was born as a supporting discipline, aimed at creating a foundation for intuitive notions immensely useful in dynamical systems and complex analysis, dealing with shapes defined up to very broadly understood reparametrizations or continuous deformations.

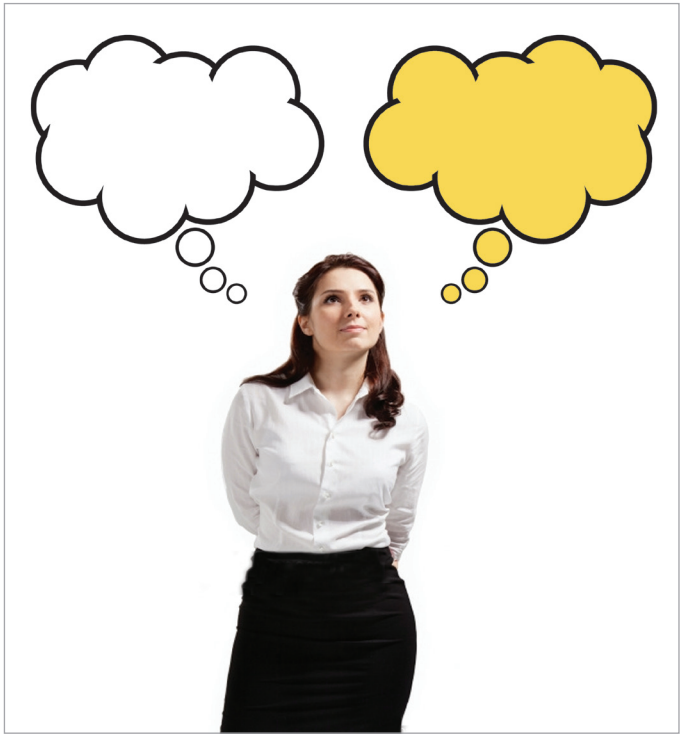
The development of the area over the course of the twentieth century saw an enormous amount of groundbreaking and beautiful discoveries, ever trending towards more and more abstract apparatus. Nevertheless, algebraic topology remains indispensable for many several communities neighboring mathematics, such as biology, engineering, computer science, data analysis, economics, to name a few.

The past decade has seen a surge of renewed interest in applied topology. Some of the developments (such as Topological Data Analysis) were amply documented; some others, including the areas of applied topology more related to physical, not virtual world, are in need of summarizing monograph. The goal of this project is to fill that broad gap.

This I Believe

Howard Berenbaum
Associate

Department of Psychology



During his Center appointment, Professor Berenbaum will work on a book project exploring the ***nature of beliefs*** – what they are, how they develop, and how they change. The range of beliefs to be explored include those considered psychotic (e.g., I am visited by Martians every evening), those considered by most scientists to be peculiar, but not psychotic (e.g., carrying around a rabbit's foot will bring good luck), those that are central to our views of ourselves (e.g., I am brave, good looking, and above average), those that are central to our views of our place in the universe (e.g., a benevolent G-d watches over me), and those that are relevant to public policy (e.g., there is no such thing as global warming). More mundane beliefs (e.g., it takes a bit more than two hours to drive from Champaign to Chicago) will also be examined – they are particularly relevant to the book because they raise the question of if/how beliefs can be distinguished from knowledge. The centerpiece of the book will be the presentation of a unified model, based on research in the behavioral and related sciences, that can account for the formation and change of all beliefs. The book will conclude with a discussion of the implications of what is known about beliefs for the well-being of individuals, societies, and the planet.

Most of the research to be reviewed will be psychological/psychiatric, ranging from social psychology to neuroscience. In addition, other areas of scholarship will be examined, including sociology, anthropology, communications, and public policy. All of the scholarly work will be done in Champaign-Urbana. Professor Berenbaum hopes to complete the bulk of the work between May 2015 and August 2016.

Multilingualism in Africa: Sociolinguistic and Cognitive Dimensions

Eyamba G. Bokamba
Associate

Department of Linguistics

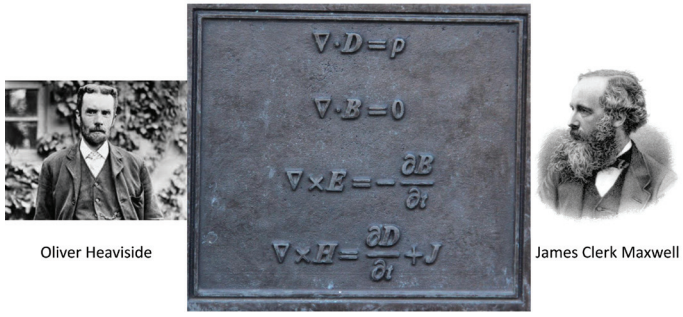
Multilingualism — the existence of three or more languages as media of daily (oral) communication for a given society or speaker — is one of the most important enduring realities of human history, and yet paradoxically, remains the most understudied and the least understood phenomenon in linguistics. This situation is the consequence of social scientists' embrace of the ideology of one nation, one language that promoted monolingualism as the norm, rather than as a construct, in the interest of nation-building, national unity and cohesion in 17th- and 18th- century Europe. This ideology in turn led to the suppression and lack of cultivation of minority or ethnic languages as media of communication in public domains (e.g., government, education, judiciary, mass media). In contrast, multilingualism was portrayed as a divisive force in that effort, and the monolingualism ideology was extended to Europe's former colonies across the globe in the 19th century for the same reasons. Since then, research on multilingualism has been marginalized in linguistic and other social sciences, thus perpetuating its misunderstanding and undermining the quest for the development of a truly comprehensive theory of language knowledge and function that can be achieved not only by studying monolingual and bilingual (i.e., knowledge of two languages), as it is largely done currently, but also necessarily multilingual competence (knowledge of three or more languages) in pervasively multilingual societies.

To begin to rectify the scholarly ignorance and misperceptions on multilingualism, and thereby advance linguistic scholarship as characterized above, this project furthers the author's on-going research on multilingualism as an organically multi-faceted phenomenon, with an emphasis on Africa as a case study that will culminate in the publication of a book under contract with Cambridge University Press titled *Multilingualism in Africa: Sociolinguistic and Cognitive Dimensions*. The principal aims of this research project during the Center appointment are two-fold: (1) to conduct library/archival research on the multilingualism's sub-phenomena of language spread of selected African linguae francae (e.g., Arabic, Bamana, Hausa, Kiswahili, Lingála, and isiZulu); and (2) to research multilingual competence (i.e., the acquisition and utilization of multiple languages) by Africans.

Computational Electromagnetics for Quantum Optics and Casimir Force Study

Weng C Chew
Associate

Department of Electrical and Computer Engineering



Oliver Heaviside

James Clerk Maxwell

Quantum theory has played an important role in the development of new technologies such as lasers, transistors, light emitting diodes (LED) among others. More recently, it is important in quantum transport, quantum information, quantum cryptography, and Casimir force. Much of quantum information is done via quantum optics, which requires the quantization of electromagnetic fields.

Electromagnetic field has been quantized successfully in the lossless regime. More recently, it has been quantized for lossy dispersive media as well. The quantization is via the use of Green's function, the point source response of a system. Green's functions of highly complex geometry and media can be found via the use of ***computational electromagnetics methods*** (CEM). Hence, CEM is highly important even in the quantum regime.

During his Center appointment, Professor Chew's research group will study the use of CEM for calculating the Green's functions for highly complex geometries as found in many real world applications. We will also study the use of these Green's functions to calculate important parameters such as density of states, local density of states of quantum optics systems. These parameters are related to many quantum information systems, Casimir force as well as heat transfer problems. Because of the prowess of CEM, it is possible to study cavity quantum electrodynamics (QED) of highly complex systems.

In addition, the research group will study computational electromagnetics methods with no low frequency or long wavelength catastrophe. Because of the scale invariance of the formulation, it can be used for sub-wavelength simulation when electromagnetic fields are interacting with extremely small, sub-wavelength structures such as quantum dots and atoms. It will also make easy the coupling of Maxwell's equations to Schrodinger equation systems as encountered in quantum dots and atoms.

Big Data Fusion and Analytics for Resorting and Improving Urban Infrastructure

Nora El-Gohary
Fellow

Department of Civil and Environmental Engineering

According to the American Society of Civil Engineers (ASCE)'s report card, the overall grade for America's infrastructure received a grade D+ (poor), with bridges receiving a grade C+ (mediocre), and with one in nine of the nation's bridges being structurally deficient. A $20.5\billion annual investment in the construction and maintenance of bridges is needed to eliminate the nation's bridge deficient backlog by 2028, while only $12.8 billion is being invested currently. Under such conditions, one of the 14 grand challenges of the 21st century as identified by the US National Academy of Engineering is 'Restoring and Improving Urban Infrastructure' to support our society and economy, especially in urban areas with high density populations.

One specific challenge in this area is how to optimize decisions related to restoring and improving urban infrastructure in a cost-effective and sustainable way. "Big Data" technology could help address this challenge. For example, big data analytics tools could allow for the extraction and analysis of actionable information or knowledge from large, diverse, distributed, and heterogeneous data sets that exist in the infrastructure domain, which would transform the way infrastructure systems – including bridges – are operated and maintained. Efficient management of transportation infrastructure, including bridges, calls for an effective decision-making process for understanding the contributing factors to deterioration and for selecting and prioritizing the operations necessary to maintain the reliability of a system.

Optimal operation and maintenance decisions can only be achieved if we can integrate scattered big data from multiple sources and turn the resulting massive amounts of data into useful information and crucial knowledge that we can act upon. The sheer size of the data in the infrastructure domain, in addition to its scatteredness (across multiple sources) and heterogeneity (in both format and semantics) significantly complicates the process of data fusion and analysis. During her Center appointment, Professor El-Gohary will investigate the methods for bridge data fusion and analytics and how they could be integrated into a bridge operation and maintenance decision-making framework.

The Camera Politic: American Presidents and the History of Photography from the Daguerreotype to the Digital Revolution

Cara A. Finnegan
Associate

Department of Communications

Image from the White House Flickr photostream, Pete Souza.

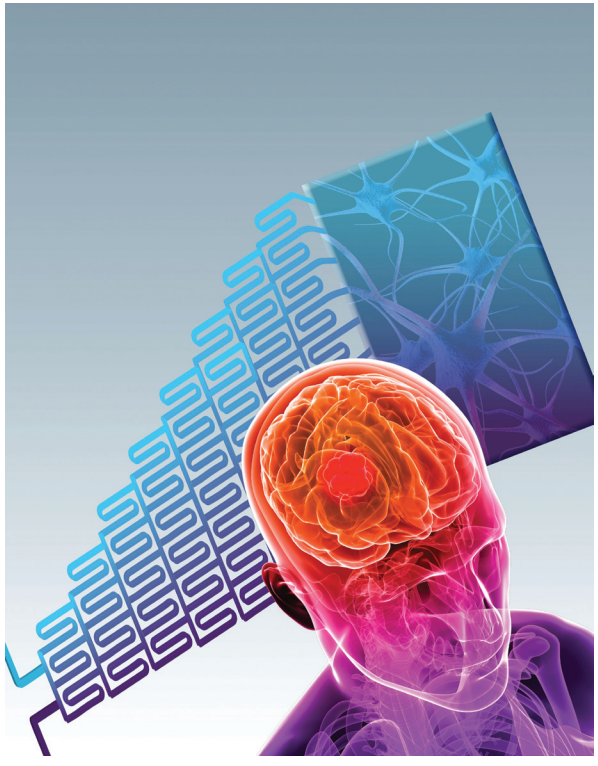
More than six years into the Obama presidency, the White House *Flickr* photo stream contains over five thousand images made by White House photographers, offering viewers a shrewdly curated, "behind-the-scenes" look at the President of the United States. By communicating his visual image to the public in ways that bypass traditional media almost entirely, Barack Obama has changed the history of presidential image-making and, in the process, has been a key participant in a dramatic change in the history of photography. But Obama is not the first president to shape photography in the public sphere. The history of the presidency offers other examples of presidents responding to similarly dramatic technological change in the development of photography.

During her Center appointment, Professor Finnegan will work on her new book project, *The Camera Politic*, which analyzes this largely unexplored history to investigate how presidents have shaped photography since its inception 175 years ago. This book will extend existing scholarship in two ways. First, by accounting for both the specificity of photographic production and the broader cultural power of photographic circulation and reception, Professor Finnegan complicates traditional distinctions between photographer and subject as well as between vernacular and elite. Challenging the truism that what made photography distinctive was its role as a "democratic" art of "the people," she contends that a history of photography told through the lens of its most elite producer, subject, and consumer gives us powerful insight into how generations of Americans were taught by those in political power to understand photography's role in public life. Second, by extending political communication scholarship back into the pre-television era and moving beyond the characterization of photography as a political tool, the project also expands our knowledge of the relationship between presidents and media. It invites us to move beyond narrow, instrumental views of photography to think more broadly about how presidents participate in public culture and how, by virtue of their status as symbols of the nation, presidents' interactions with photography constitute the nation's interactions.

Advanced biomaterials for cancer research and therapy

Brendan Harley
Beckman Fellow

Department of Chemical and Biomolecular Engineering



Scientists, engineers, and physicians have for decades worked to better understand the onset, progression, and treatment of disease. A critical bottleneck is the complexity that arises from the non-uniform properties of tissues and organs of our bodies. Tissues can vary in time – such as during development or with disease – or in space – such as across tumors and musculoskeletal tissues. Professor Harley's lab is developing approaches to engineer biomaterials that replicate these complex environments. Such materials may be implanted in the body to aid healing, or used outside of the body to better understand disease onset and treatment.

The future of cancer research is not testing immortalized cell lines in Petri dishes. It is instead developing ***tumor avatars*** for each patient that can be grown, studied, and treated outside the body. Professor Harley's efforts focus on developing tools to advance our understanding of glioblastoma multiforme (GBM), the most common, aggressive, and deadly form of brain cancer. His lab has partnered with collaborators at the Mayo Clinic and Washington University in St. Louis to develop a class of optically-translucent biomaterials to rapidly predict how GBM cells respond to current-generation therapies. They recently showed how versions of this biomaterial that mimic the tumor margins can predict response and relapse potential following treatment with conventional inhibitor therapies when using patient-derived cell lines.

During Professor Harley's Center appointment, he will address the next critical step for this project: integrating biopsy specimens isolated directly from a patient. The CAS fellowship will provide a critical period of teaching release that will enable extended periods of collaborative interactions as well as protected writing and reflection time necessary for this significant advance.

Interplay of Symmetry, Geometry, and Topology in Crystalline Phases of Matter

Taylor L Hughes
Beckman Fellow

Department of Physics

The word "topological" has permeated condensed matter physics over the last decade. The discovery of new quantum electronic phases of matter such as topological insulators, and the promise of a fault-tolerant topological quantum computation architecture, which utilizes topological phases of matter as robust quantum bits and logic processors has transformed the field. Twenty-five years after the discovery of the quantum Hall insulator, the first example of a topological phase, a second topological revolution began with the prediction, and experimental discovery, of a new class of phases that require additional symmetries for their stability. An exciting outcome of these developments was the prediction that some phases could be stabilized by ordinary crystal symmetries like reflection or rotation symmetry. However, one might be pessimistic that these phases could be stabilized since real material samples are typically disordered and do not exactly preserve the symmetries required for topological protection. Surprisingly this issue was immediately obviated when the first experimental results on ***PbxSn1–xTe alloys*** showed remarkably clear and robust topologically protected features, despite the fact that it is a disordered alloy. These results have opened up a frontier of exciting possibilities for new topological phases of matter and phenomena protected by crystal symmetries.

There is currently not a complete theoretical framework that enables the understanding of this unexpected robustness. For now the community has resorted to using the mantra "the symmetry is protected on average" as an explanation. Unfortunately there is not an explicit qualitative or quantitative understanding of that statement, and thus understanding the effects of disorder in these systems is of paramount importance, especially if their properties become useful for technological applications. During his Center appointment, Professor Hughes will use numerical and analytical techniques in order to develop such a framework so that he can determine the phase diagrams and useful properties of topological crystalline phases of matter. In addition to the effects of disorder, he will consider the impact of strong electron interactions in these materials, where a recent breakthrough from his research group has indicated that some topological phases require interactions to exist. He is now in the process of trying to understand the physical properties of these systems, as well as searching for candidate materials that could realize these interesting phases.

Computational Spectral Imaging: Theory, Algorithms, and Fundamental Performance Limits

Farzad Kamalabadi
Associate

Department of Electrical and Computer Engineering

Spectral imaging, the simultaneous imaging and spectroscopy of a radiating scene, is a fundamental diagnostic technique in the physical sciences with widespread application. The limits of the attainable temporal, spatial, and spectral resolutions of conventional spectral imaging techniques are imposed by their reliance on purely physical measurement systems such as two-dimensional detectors which are intrinsically limited in capturing inherently three-dimensional data. On the other hand, recent developments in computational spectral imaging techniques offer the prospect of transcending these physical limitations by combining information from different multiplexed measurements and/or by incorporating additional prior (statistical) knowledge (in the form of spatial and spectral distributions) about the objects of interest into the image formation process.

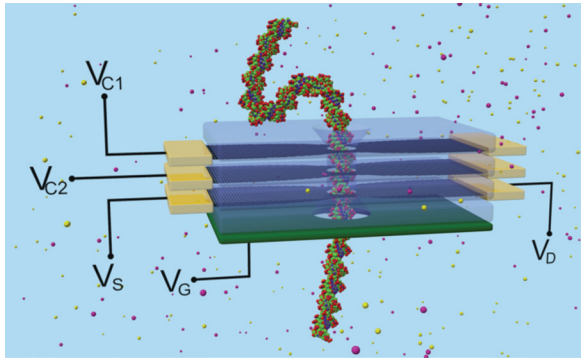
The overarching goal of the proposed research is to develop a class of novel spectral imaging techniques to overcome the temporal, spectral, and spatial resolution limitations of conventional spectral imaging systems. Each development is based on the computational imaging paradigm, which involves distributing the spectral imaging task between a physical and a computational system and then digitally forming images of interest from multiplexed measurements by means of solving an inverse problem. The development of each computational imaging technique requires the following three steps. First, a novel optical system is designed with the goal of overcoming the resolution limitations of conventional systems. Second, the associated inverse problem for image reconstruction is formulated by combining multiplexed measurements with an image formation model based on an estimation-theoretic framework. Third, computationally efficient algorithms are designed to solve the resulting nonlinear optimization problems.

Since an inversion is required for the reconstruction of the spectral imaging information from incomplete and imperfect measurements, a rigorous theory is essential for quantitative evaluation of the performance of the techniques. Therefore, in addition to the development of each technique, Professor Kamalabadi aims to attain fundamental performance bounds in order to characterize the estimation uncertainties and quantify performance limits, as well as to attain insights that would guide optimal system design. Finally, he plans to investigate and illustrate the effectiveness of the proposed computational spectral imaging techniques in applications involving remote sensing of space plasmas in general, and the solar atmosphere in particular. With the emerging trend toward distributed sensing from diverse platforms, it is anticipated that such novel approaches to spectral imaging will have a profound and timely impact on many sensing applications.

Genomics with Semiconductor Nanotechnology

Jean-Pierre Leburton
Associate

Department of Electrical and Computer Engineering



Schematic diagram of a four-layer device containing two grapheme layers (dark) biased at VC1 and VC2 to control the translational motion of DNA through the nanopore. A third grapheme layer (VDS) measures the sheet current. Finally, a heavily doped back gate (green) lies underneath the sheet current layer to control its conductivity. Oxide barriers (transparent) between different grapheme layers provide electrical isolation.

Over the past few years the need has grown for low-cost, high speed, and accurate biomolecule sensing, propelling the so-called third generation of genome sequencing devices. Many associated technologies have been developed, but recent advances in semiconductor nanotechnology have opened new avenues in the field. While it is possible to fabricate solid-state structures with dimensions comparable to the separation between atoms in bio-molecular systems, progress in mesoscopic physics has demonstrated sensing capabilities of nanoscale capacitors corresponding to a fraction of the electron charge. This in principle enables probing single biomolecules electrically.

In this context, the idea of engineering nanopores (i.e., small aperture of nanometer feature sizes in ultra-thin solid-state membranes to mimic the operation of biological ion channels in living cells) has emerged to investigate biological processes with semiconductor nanotechnology. Indeed, the versatility of semiconductor materials in terms of conduction polarity by selective n-or p-doping, as well as their ability to tailor space charge at the surface provide electrical detection sensitivity for biological objects with new means to shape the electrostatic landscape close to the membrane.

During his Center appointment, Professor Leburton will explore the use of ***multi-layer semiconducting graphene membranes*** as bio-nanoelectronic devices with enhanced performances and functionality for sensing and manipulation of biological information. Stacking nanoscale layers with different doping, different dielectric properties or individual electrical tunability results in additional degree of freedom for the control, manipulation and detection of bio-molecules along the artificial ion channels. In this scenario, graphene layers manipulate the molecule, while others can locally sense its chemical structure through the charge of its constituents, thereby integrating different functions in a single membrane.

This explorative research will be theoretical in nature by using computational tools that integrate electronic device with atomistic and molecular biophysics simulation into a multi-scale self-consistent scheme.

The Cultural Geography of Firearms: Illinois as a Microcosm of the Nation

Charles Ledford

Fellow

Department of Journalism

John Boch, president of the Illinois group Guns Save Life, leads one of the group's monthly meetings in Rantoul, IL. From the video H*andguns and Humor in the Heartland*, Charles "Stretch" Ledford.

The story of guns in America is far more complex than the loudest voices at the extremities at either side of the issue would have us believe. It is also more complex than most voices in the popular media would have us believe. Professor Ledford has explored the issue since joining the Illinois faculty in the fall of 2011. He has spoken with mothers and friends of fallen children in Chicago, with a woman in southern Illinois who was hit in the face by a stray round from an AR-15 fired from a gun range a half-mile away and with the small-town firearms dealer who legally sold guns to an individual who subsequently used them in a mass shooting. These are the stories of a nuanced cultural geography, a fulcrum upon which America's national gun debate balances.

As a multimedia journalist, Professor Ledford produces video, audio and photographs tailored to the emerging niche of visually-driven digital journalism. At the University of Illinois, his creative endeavor and research agenda examines a uniquely American issue, the role of firearms in a constitutional democracy. During his Center appointment, he will continue to develop this latest project, *The Cultural Geography of Firearms: Illinois as a Microcosm of the Nation.*

Evolutionary Annotation of Regulatory Sequences

Jian Ma
Fellow

Department of Bioengineering

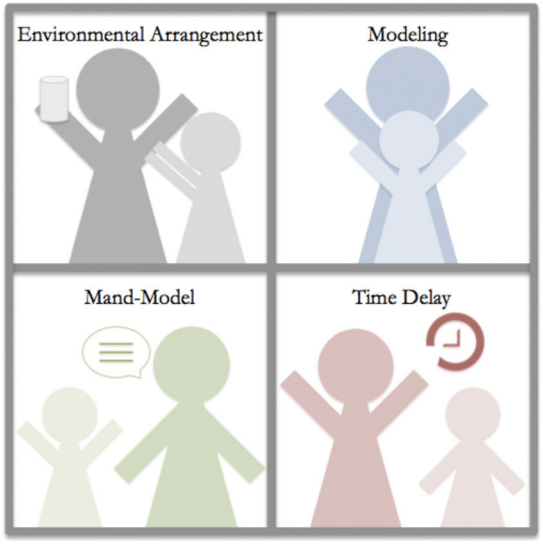
Why are humans different from other mammalian species? This question is as compelling as any in science, but has been extremely difficult to answer. It is known that the distinctive features of human biology are largely the result of evolutionary changes to our genome. But most of the exact connections between genomic change and phenotypic innovation remain unclear. Professor Ma's long-term goal is to utilize comparative genomics to better understand the relationship between genomic differences and phenotypic diversity across mammalian species, which will in turn help understand the human genome and identify key genetic variants related to diseases.

At the level of gene transcription, gene expression is controlled via transcriptional regulatory proteins that selectively bind to regulatory elements in non-coding regions of the genome. It is acknowledged that genetic changes in these gene regulatory elements are a major cause of phenotypic differences between human and other mammalian species. Despite the recent advancement in both experimental and computational methods to identify potential regulatory elements, we know very little about when these elements came to the human genome during evolution (e.g. did they emerge before human-chimpanzee divergence or before human-macaque divergence?), how they have evolved, and what would be their distinct functional impacts on human biology. Currently there is no existing method that can comprehensively annotate the detailed history of regulatory elements. To tackle this challenge, Professor Ma and his research team will develop new algorithms to trace the history of regulatory elements in mammalian evolution. He will then annotate and validate the evolution of regulatory elements in the human genome by combining functional genomics with cross-species sequence comparisons. The project is highly interdisciplinary, involving research in genomics, computer science, evolutionary biology, and molecular biology. The research will have the potential to help discover regulatory elements that contribute to species-specific traits in mammalian evolution and human biology.

Capitalizing on Internet Technology to Support Families with Young Children with Autism and Other Developmental Disabilities

Hedda Meadan-Kaplansky
Associate

Department of Special Education



Professor Meadan-Kaplansky and her research team have been developing and piloting an Internet-based intervention program, the Internet-based Parent-Implemented Communication Strategies (i-PiCS). The goal of this intervention is to teach and coach parents of young children with disabilities to implement evidence-based strategies to improve the social-communication skills of their young nonverbal children with autism and other developmental disabilities.

The novelty of this intervention program is reflected in three areas: the population targeted, the primary goal pursued, as well as the framework that has guided the development of training and coaching. The target population includes underserved children (i.e., young nonverbal children with autism and other developmental disabilities) and underserved and hard-to-reach families (i.e., low income families living in rural or remote areas).

The primary goal focuses on overcoming the persistent barriers that parents of young children with disabilities encounter when attempting to access and receive services in their homes. These barriers include reduced frequency and intensity of treatment due to the cost and time required to travel to homes. To place this intervention program in a larger context, Professor Meadan-Kaplansky's team has developed a training and coaching framework replete with a decision tree that can guide researchers and service providers in developing an effective training and coaching model. A considerable amount of data will be collected by the 2015-16 academic year. During her Center appointment, Professor Meadan-Kaplansky will analyze this data, generate manuscripts to disseminate the findings, and revise the intervention program before implementing it with a larger group of families.

The Illinois and the Edge Effect: Bison Algonquians in the Tallgrass Prairie Borderlands, 1200-1850

Robert Michael Morrissey
Associate

Department of History

"Chasse générale au boeuf mais à pied," in Antoine-Simon Le Page du Pratz, *Histoire de Louisiane* (Paris, 1758). Rare Book and Manuscript Library, University of Illinois.

This is a new history of the middle of the North American continent from the standpoint of the Native American people who controlled it from well before contact through the early 19th century. Beginning in the 1400s, the Illinois rose to power by exploiting unique social and ecological opportunities in-between the woodlands of the east and the plains of the west. Becoming North America's only "bison Algonquians," they built power based on bison hunting and the slave trade, and settled the largest population center on the continent in the 1680s.

At the core of this project is an examination of the relationship between humans and non-human animals in an important North American borderland, where foreign people, but also foreign animals, interacted in new ways. Indeed, the Illinois and other Native people came to the prairies in the wake of climate change precisely because of animals, and they built an entire lifeway as pedestrian bison hunters in a distinctive landscape. They put bison at the center of their cultural and spiritual lives, as revealed through archaeology, abundant contact-era linguistic evidence, and often-ignored material culture. European colonists brought not only new species to the tall-grass prairies, but also wholly new ideas about the relationship between people and non-human nature. From 1500 forward, then, human interactions with wild animals, game, and newly arriving livestock changed more in a few centuries than they had for millennia. Animals' social, cultural, and economic functions were reshaped by commodification and the market. As this happened, humans continually remade the societies they had built around intimate and cooperative interactions between species. The premise of this book is that human-animal relations provide the best lens for understanding—and telling—colonial history from the perspective of the Illinois.

A Strange New World: Untimeliness, Futurity, and David Bergelson

Harriet Murav
Associate

Department of Slavic Languanges and Literatures

The author, David Bergelson, and his son, Lev, taken in Berlin in 1921 or 1922.

***A** Strange New World: Untimeliness, Futurity, and David Bergelson* focuses on the experience of anachronism and distorted temporality as an emotional, sensory, and existential condition in both the world and the work of the Yiddish author David Bergelson (1884-1952). The first part of the 20th century was marked by scientific, technological, and artistic innovation, social transformation, political upheaval, and violence, when time itself seemed to break apart. Freud and Henri Bergson, the two great modern theorists of time, memory, and consciousness, and contemporaries of the Yiddish author, provide the conceptual framework for this project, and Russian and Yiddish modernism, the cultural context.

By situating Bergelson in the philosophical and artistic experimentation and the political and technological change of his era, Professor Murav's study can add a new comparative and interdisciplinary dimension to the study of Yiddish, and a new ethnic dimension to the study of modernism. Bergelson reframes the stagnation and obsolescence of the shtetl as the gateway for activating the unrealized potentialities of the discarded past. In our own time scholars and creative artists are returning to Bergson for new insights about time, and the relation between the mind, the body, and the surrounding world. This project establishes his significance for Yiddish, thus introducing a network of convergences and parallels previously unexplored.

A Strange New World adds to the growing discussion about the texture of time, its evocation in art, and its potentiality from the perspective of the early 20th century. Professor Murav's emphasis on futurity also helps balance the humanities today, dominated by a sense of futility. Many theorists see the past only as a source of the traumatic wound that we are compelled to repeat. In contrast, the Yiddish author Bergelson did not lose faith in life and the human capacity for creativity beyond the technology of death.

Strongly Coupled Electron Matter

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Strongly coupled systems pose a distinct problem for theoretical physics. In such systems the physics arises from collective organization rather than from a sum of the constituents. A classic problem of strong coupling is high-temperature superconductivity. Bardeen-Cooper-Schrieffer solved the problem of superconductivity in metals by appealing to a simple organizing principle of metals: all the physics of the normal state is controlled by the properties of free particles. A similar simplification cannot be made for the cuprate superconductors as these systems are doped Mott insulators, a state of matter in which the electron interactions dominate. Precisely what to do in this intractable parameter space is the key problem facing theorists in the field. If a fixed point at strong coupling exists, then definitive progress can be made.

Professor Phillips will use his Center appointment to pursue two projects which are central to the physics of strong electron correlation in copper-oxide superconductors: 1) a demonstration that the local Mott physics in the normal state of the cuprate superconductors is controlled by a non-trivial IR fixed point and 2) an exploration of superconductivity at such a fixed point. The second project will be solved by borrowing ideas from string theory in which the strong correlations will be replaced by an essentially free gravity problem. This synergy between concepts and tools developed first in high-energy physics and their eventual application to solid state systems is a distinct feature of Professor Phillips's work.

Topological phases of matter and quantum anomalies

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Topological phases in condensed matter physics are states of matter whose existence relies essentially on quantum mechanics and which do not have any analogue in classical physics. They are characterized by, among others, peculiar dissipationless electronic transport phenomena and their exotic excitations that may obey an unusual form of exchange statistics. These properties make topological phases of matter as promising candidates for future electronics with low energy cost and an ideal platform for stable, decoherence-free, quantum computers.

During his Center appointment, Professor Ryu and his research team will develop a theoretical understanding of topological phases of matter that can arise in the presence of and/or because of strong electron correlations, by using the concept of *quantum anomalies*. Quantum anomalies are exotic phenomena where symmetries of the system, which we naively expect are respected, are actually destroyed by quantum mechanical effects. These extremely quantum mechanical phenomena can occur typically in topological phases of matter, and in fact they are often allowed only within topological phases. Thus quantum anomalies can be used as a useful diagnostic tool to detect topological phases both in theoretical studies and in experiments.

By developing new theoretical methods that allow Professor Ryu and his group to treat interaction effects in topological phases, he will look for new kinds of topological phases of matter and novel fundamental topological effects in condensed matter systems.
In particular, he will develop a theoretical tool which can identify new topological phases which are fully interacting and whose topological properties are protected by non-local and/or antiunitary symmetries such as parity and time-reversal symmetry. He will also study anomalous commutation relations obeyed by electron position operators (the coordinate non-commutativity) that arise in three-dimensional topological insulators and suggest a peculiar uncertainty relation of electron coordinates. Their possible connection to collective dynamics of interacting topological insulators will be explored.

Ecce Corpus: Beholding the Body in Anglo-Saxon England

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Associate

Department of English

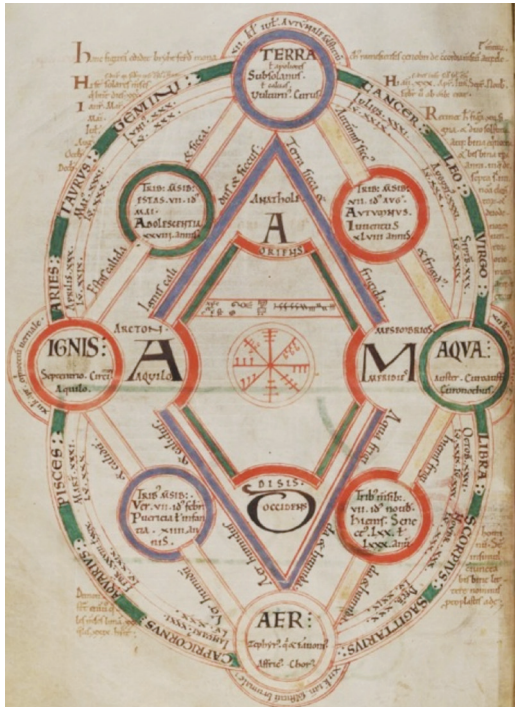

Diagram by the 10th-century monk Byrhtferth depicting "the harmony of the months and the elements" [*de concordia mensium atque elementorum*], MS 17 f.7v. Reproduced by permission of the President and Fellows of St John's College, Oxford.

Humanities scholarship is in the midst of a new materialist revolution, and recent developments in neuroscience and cognitive theory have forced us to discard old assumptions about the materialist bases of subjectivity. In *Ecce Corpus: Beholding the Body in Anglo-Saxon England,* Professor Trilling argues that Anglo-Saxon texts have something to teach us about different ways of imagining the self, speaking to us from a time prior to Descartes' cogito and the mind-body dualism that has subsequently dominated Western culture.

Since the early 1990s, studies of the body have been dominated by poststructuralist notions of discourse, gender, and subjectivity, rendering the body a product of various social and cultural discourses. Recent trends in critical theory, however, have drawn from scholarship in neuroscience and related fields to rethink the relationships between materiality and subjectivity. In genres as diverse as hagiography, legal discourse, heroic poetry, historiography, and medical writing, *Ecce Corpus* reveals the bodies that precede discourse in the Anglo-Saxon world and asks what new materialist notions of subjectivity can tell us about their textual representations. Yet the goal is not simply to better understand the Anglo-Saxon world through modern theoretical concepts; rather, Professor Trilling uses the medieval world to question and expand the assumptions of modern theorists. By training contemporary theoretical insights about materiality on an archive from more than 1000 years ago, *Ecce Corpus* challenges the notion that "new materialisms" are really "new" after all.

The Social Differentiation of Literary Genres, 1800-1950

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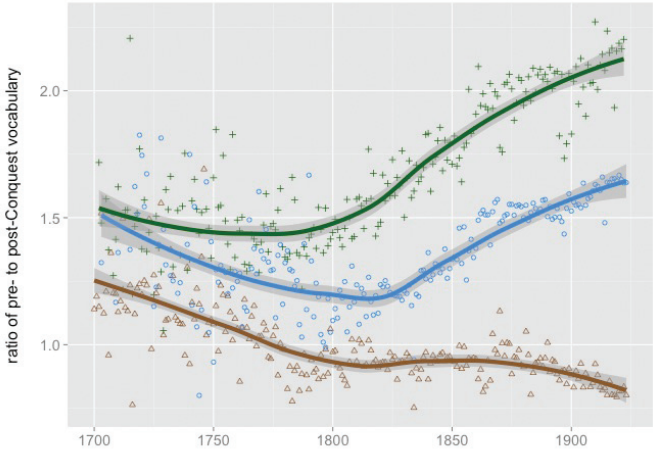


Differentiation of genres in a collection of 872,000 English-language volumes between 1700 and 1923. Each point represents the ratio between occurrences of words that entered English before 1150, and those that entered 1150-1699, in all the text published in a genre in a given year.

Our accounts of literary history suffer from two oversights. One problem is that we simply haven't read much of the material published in the last two hundred years. Another is that our narratives tend to look for "turns" and "movements" that can be dramatized with a small number of examples. Long gradual changes can be misrepresented or missed entirely.

Since an overview is exactly what we've been missing, large digital libraries give literary historians an opportunity to reconsider the basic outlines of our subject. The special character of literary language, for instance, was a much-debated question in 20th-century literary theory. We can now approach that as a concrete historical problem: Professor Underwood has shown that literary language becomes steadily, and dramatically, less like the language of nonfiction over the course of the 19th century.

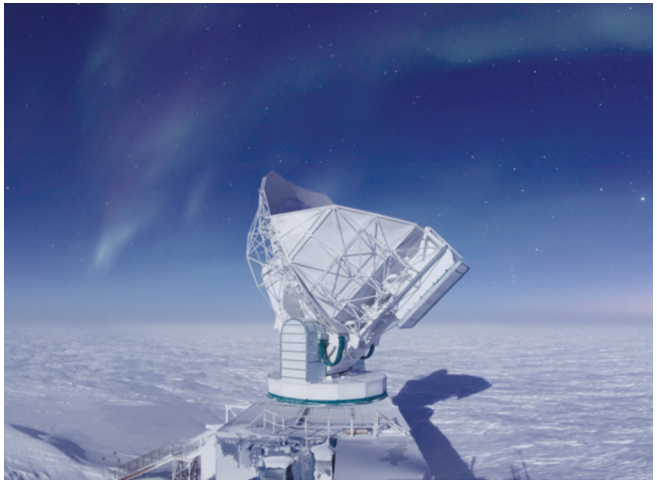
But scholars won't long be content with a purely linguistic description of literary change. To understand the broad trends that are now visible, we also need a way of connecting social concepts to our new wealth of textual evidence. During his Center appointment, Professor Underwood will work on a book that models a solution to that methodological problem.

Professor Underwood will focus on genre as a case study. Some pieces of the problem will be familiar to scholars. We've known since Richard Altick, for instance, that reading audiences started to specialize in the later 19th century. And we know that by the early 20th century this had produced a generic stratification of literature, distinguishing, for example, the serious novel from "genre fiction." By connecting these pieces to other trends (for instance, to the emergence of literary language itself), it will be possible to get a longer perspective on the problem and a better social explanation. In doing this, Professor Underwood also wants to demonstrate the value of new methodological resources. A change has taken place in the culture of statistical modeling (as Leo Breiman argued fifteen years ago), and this change has made modeling a more useful interpretive lever than humanists yet recognize.

Observing the Birth of the Universe: Building and deploying a new camera for the South Pole Telescope

Joaquin Vieira
Beckman Fellow

Department of Astronomy



The 10 meter South Pole Telescope at the NSF Amundsen-Scott South Pole Station.

Professor Vieira builds telescopes and cameras to study the origin and evolution of the universe. As an observational cosmologist, he spends most of his time studying the ***cosmic microwave background*** (CMB)—the relic thermal radiation from the Big Bang—to observe the universe as it was over 13 billion years ago. The technology involved in CMB research has strong overlap with material science, electrical engineering, and condensed matter physics.

Professor Vieira's group is an integral part of the South Pole Telescope (SPT) project. The SPT is a 10-meter telescope located at the geographic South Pole and optimized for precision imaging of the CMB. Over the last decade, SPT has placed unique constraints on the nature of dark energy, precisely measured the amplitude of matter fluctuations in the universe, discovered a new population of distant galaxies, and measured the cosmic gravitational lensing of the CMB. The team is currently building a new state-of-the-art camera for SPT to detect and characterize the polarization of the CMB. This measurement will constrain the epoch of cosmic inflation and the mass of the neutrino particle. The scientific goal is to answer the most basic and profound question ever posed by humanity: How did the Universe begin?

During his Center appointment, Professor Vieira will spend time developing new instrumentation, building cryogenic optics and electronics for SPT, and deploying the camera to the South Pole in Winter 2015/16.

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ratio of pre- to post-Conquest vocabulary
genre
poetry
fiction
nonfiction
1700
1750
1800
1850
1900
V_{C1}
V_{C2}
V_S
V_G
V_D
Environmental Arrangement
Modeling
Mand-Model
Time D
ILLINOIS
GUNS
GSL
TERRA
IGNIS:
AER:
Oliver Heaviside
James Clerk Maxwell
$\nabla \cdot D = \rho$
$\nabla \cdot B = 0$
$\nabla \times E = -\frac{\partial B}{\partial t}$
$\nabla \times H = \frac{\partial D}{\partial t} + J$