CAS

Center for
Advanced
Study

Research Appointments / Associates and Fellows 2014 - 15

University of Illinois Urbana-Champaign

Death and Ritual in Flavian Epic • Accelerating the Fourth Paradigm: Data-Intensive Astronomical Research• Rural U.S.-residing, Mexican-born Females and Breast Cancer Screening: Interaction between Hispanic Beliefs and Structural Factors • *In Vivo* Targeting via Bioorthogonal Chemistry • A Computational Approach to Redistricting Reform • Control and Motion-Planning Algorithms for Robotic Falcons to Prevent Airport Bird Strikes • Ecological Determinants of Luteal Reproductive Function • Unifying Theory of Universal Quake Statistics: From Nanocrystals to Earthquakes • New Signatures of Neutrinos in Cosmology • "El Legado de España": The Discourse of Hispanism in Cuba, Puerto Rico, and the Philippines in the American Empire • Topological Order and Symmetry Breaking in Condensed Matter Physics • Sharp Bounds for Small Moments of Multidimensional Weyl Sums • Networking at the Speed of Light • Analysis of Surface Water Waves • Designing Next-Generation Computing • Sanctified in Water, Sealed in Stone: The Italian Baptistery 1000-1500 • Making a Home in the Heartland: Immigration and Global Labor Mobility • Writer, Painter, Banker, Thief: The American Arts Colony in the Public Account • Sprayed: A Cultural History of Agent Orange in the United States and Vietnam • Molecular Design and Engineering of Advanced Functional Materials • The Haunted Empire: The Russian Literary Gothic and the Imperial Uncanny, 1793-1844 • Emblematic Practices: Emblems and Culture in Early Modern Germany • Testing of New Phylogenetic Network Methods with Appropriate Empirical Biological Datasets • An Untitled Novel on Pre-colonial Dahomey (West Africa)

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Research Appointments 2014-15

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 2014-15 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

Laura H. Greene
experimental condensed matter physics, high-temperature superconductors

Bruce Hajek
communications engineering, stochastic methods

Frederick E. Hoxie
federal Indian policy, Native American history

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 2015-16 academic year. For more information, please consult our website at www.cas.illinois.edu

Application deadline:
Tuesday, October 7, 2014

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Death and Ritual in Flavian Epic

Antonios Augoustakis
Associate

Department of the Classics

Ceremony of the cult of Isis **(fresco, Pompeii). Image by Erich Lessing/ART RESOURCE, NY.**

During his Center appointment Professor Augoustakis will continue work on a monograph providing the first systematic analysis of scenes of death, lament, and ritual practices in three epic poems: *Punica*, by Silius Italicus; *Thebaid,* by Publius Papinius Statius; and *Argonautica,* by Valerius Flaccus. The poems were produced during the so-called *Flavian* period of Latin literature (69-96 CE), when epic poetry experienced a renaissance under the three Roman emperors, Vespasian and his sons, Titus and Domitian.

Punica narrates the events of the Second Punic War, the long conflict between Romans and Carthaginians in the late third century BCE. *Thebaid* recounts the mythological civil war of Thebes, when the sons of Oedipus turn against one another because of the refusal of Eteocles to yield the throne of Thebes to his twin brother, Polynices. *Argonautica* memorializes the trip of Jason to the land of the Colchians to claim back the Golden Fleece.

Why death and ritual? Death and dying occupy a prominent role in Latin literature: from gladiators dying a dis/honorable death in the arena to soldiers fighting for their country to members of the elite committing suicide as a means of resistance against the increasing autocracy of the emperor. Professor Augoustakis will interpret scenes of death and burial in these poems, (a) elucidating their significance in developing the poems' plotlines and (b) interpreting their sociocultural background and the development of Roman cultural practices. Close analysis of such ritual, and the literary descriptions of ritual in particular, will add a critical dimension to our understanding of Roman culture in general. Professor Augoustakis plans to complete the monograph by the summer of 2016.

Rural U.S.-residing, Mexican-born Females and Breast Cancer Screening: Interaction between Hispanic Beliefs and Structural Factors

Venera Bekteshi

Fellow

School of Social Work

Mammography remains the most effective screening technique for timely diagnosis and, consequently, effective treatment of breast cancer. Immigrant Latina women utilize mammography at lower rates than non-Hispanic white women and remain at higher risk of presenting with late-stage breast cancer. Why is this so? During her Center appointment Professor Bekteshi will investigate how structural contests specific to Mexican-immigrant women in new-growth areas of Illinois (e.g., health insurance, income level, transportation challenges, documentation status, daily discrimination and poor treatment from healthcare professionals) interact with cultural factors to affect rates of mammography screening. She will also investigate the effect of emotional and belief pathways of traditional Latino culture.

For example, *fatalismo,* the traditional belief that there is little an individual can do to alter fate (and, by extension, prevent cancer), has been linked with fear that a cancer diagnosis will limit one's ability to enjoy time with children and future family generations. Several views embedded in Latino tradition, including humility, modesty, and discomfort over disclosing personal information, have all been associated with embarrassment, which is one of the most commonly cited emotional barriers to mammography among Latinas.

Professor Bekteshi's study begins a research trajectory that ultimately will address (a) the importance of support systems, including social and family support, in overcoming barriers to mammography participation among Mexican-immigrant Latinas in central Illinois, (b) the role of healthcare professionals in addressing these barriers, and (c) gaps in the healthcare system that may lead to poor interaction with healthcare professionals. The results will contribute to the comprehensive knowledge that is needed for identifying solutions to reduce and eliminate this health disparity.

Accelerating the Fourth Paradigm: Data-Intensive Astronomical Research

Robert J. Brunner
Associate

Department of Astronomy

Sky survey of the COMA cluster of galaxies. Image by B. Jeter and R.J. Brunner, original data courtesy of the SDSS.

The standard cosmological model posits that 95 percent of the matter-energy budget in the universe consists of two unknowns: dark matter and dark energy. To gain a better understanding of the nature of these two dark components, scientists usually construct a three-dimensional map of visible matter: first obtaining two-dimensional images of the sky, and then obtaining spectra of the objects identified and determining source classifications and *redshift* line-of-sight distances.

Inherent limitations to this approach argue for a new way to obtain cosmological measurements directly from imaging data, and this is the current focus of Professor Brunner's research. During his Center appointment he plans to explore how probabilistic techniques can be used to classify sources and estimate distances, and subsequently be applied to make precise cosmological measurements.

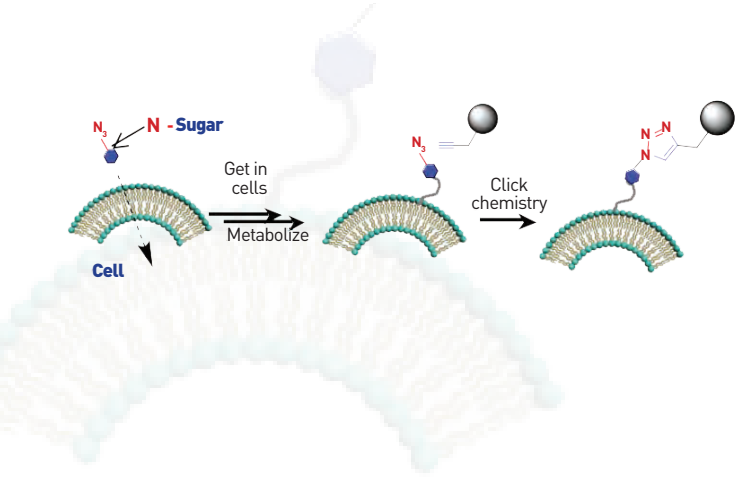
Professor Brunner proposes to develop three distinct machine-learning techniques for generating probabilistic classifications. He will then develop a meta-classifier that combines the three techniques and accelerate their implementations to scale efficiently to the petascale regime. Finally, he will apply the resulting data-software instrument to determine new, more precise cosmological constraints using data from the Dark Energy Survey (DES).

The project is timely for several reasons. In Fall 2014 the first season of data from the DES will be fully processed and calibrated, and the second year of data will begin to be acquired. As other scientists look to use DES data, they will be needing accurate, probabilistic source classifications and distance estimates. Thus, Professor Brunner plans to distribute his work via the official DES project archive, where it can be used by scientists worldwide.

In Vivo Targeting via Bioorthogonal Chemistry

Jianjun Cheng
Associate

Department of Materials Science and Engineering



Cell surfaces often possess one or more types of proteins that are specific to a given cell or to a type of disease. These proteins are known as *antigens.* Another type of protein, *antibodies,* can interact specifically with and bind to antigens. Antigen/antibody interaction has been widely used for the selective targeting of cells, organs, and diseases in a biological system. But this approach has several drawbacks, including undesired immune responses and the difficulty of producing and handling antibodies. Also, antigens originate within the cell, and there is no current strategy to introduce external antigens for subsequent targeting by antibodies.

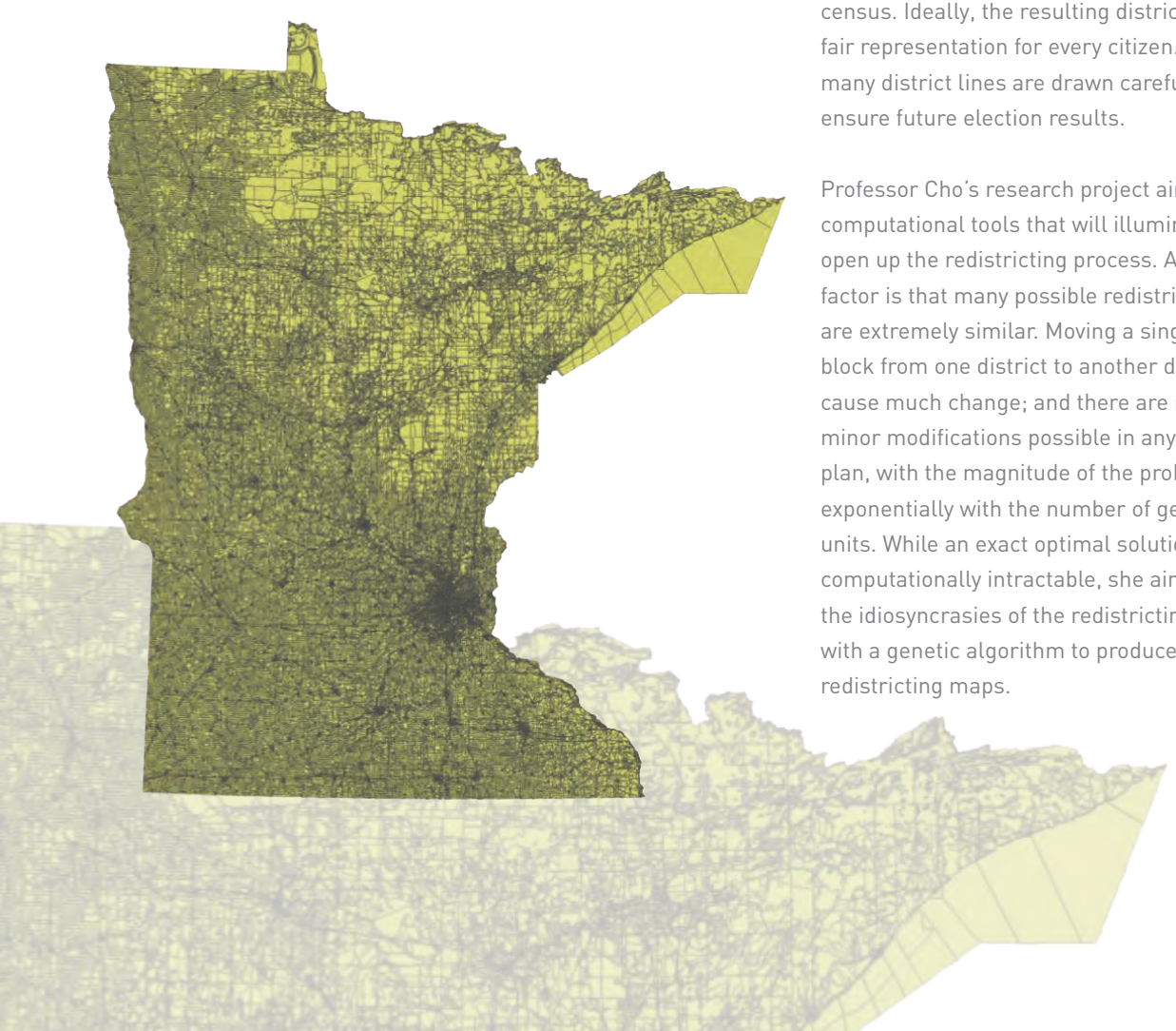
During his Center appointment Professor Cheng and his team plan to develop a new *in vivo* targeting technology facilitated by bioorthogonal chemistry. Specifically, the research goal is to mediate the highly specific presentation of the azide group on targeted cell surfaces for targeting by alkyne-containing substrate.

If demonstrated *in vivo,* the new targeting concept should result in a paradigm shift, using a chemical reaction instead of complex biological macromolecule interactions such as antibody/antigen. The technology can be applied to the development of disease-targeting small molecule conjugates, and also potentially used to design patient-specific nanomedicine. It should also find broad application in cell differentiation, cell sorting, targeting cell recognition, gene and drug delivery, and drug discovery and development.

A Computational Approach to Redistricting Reform

Wendy K. Tam Cho
Associate

Department of Political Science



Legislative redistricting occurs every ten years in the United States, following the decennial census. Ideally, the resulting districts provide fair representation for every citizen. In practice, many district lines are drawn carefully to favor or ensure future election results.

Professor Cho's research project aims to provide computational tools that will illuminate and open up the redistricting process. A complicating factor is that many possible redistricting plans are extremely similar. Moving a single census block from one district to another does not cause much change; and there are many such minor modifications possible in any redistricting plan, with the magnitude of the problem rising exponentially with the number of geographic units. While an exact optimal solution is computationally intractable, she aims to combine the idiosyncrasies of the redistricting process with a genetic algorithm to produce near-optimal redistricting maps.

During her Center appointment Professor Cho and her research group will extend their library of scalable parallel genetic algorithms for computational analysis of ways to optimize the process of redistricting. They will formulate the redistricting problem as a discrete optimization problem, introduce quantitative measurements to score maps on a variety of redistricting criteria, and develop and apply new algorithms using optimization tools. High-performance computing will allow them to examine the problem at considerably finer spatial scales than ever before.

The project lies at the threshold of applying statistical and mathematical modeling and computing technology to achieve societal tasks. Instead of tinkering with endless possibilities, Professor Cho will develop computationally intensive models to synthesize and organize massive amounts of computation/data to help evaluate redistricting schemes and tailor them to our notions of fairness and democratic rule.

Control and Motion-Planning Algorithms for Robotic Falcons to Prevent Airport Bird Strikes

Soon-Jo Chung

Beckman Fellow

Department of Aerospace Engineering

Top: Bird strikes on aircraft. Bottom: Solution provided by fully autonomous robotic falcon.

Bird and other wildlife strikes on aircraft endanger passengers and cost $1.2 billion annually worldwide in damage to civil and military aviation. Now imagine a future with aerial robots that can fly like falcons, perch on airport fences, and effectively scare birds away from airfields. Professor Chung's long-term goal is to realize that future by establishing a new aerial robotic system and enabling technologies derived from the key control and sensing mechanisms that underlie natural flyers, thereby providing highly maneuverable aerial robotic platforms.

During his Center appointment Professor Chung aims to develop bird-like flapping robots that can be deployed in swarms to fend off "antagonists." The project builds on his previous work on the control of flapping-wing aircraft using coupled limit cycles, and on the dynamics and control of flexible, articulated-wing aircraft. He will also explore new strategies for herding, applying tools in control theory and real-time optimization.

Society as a whole stands to benefit from robotic birds that can effectively prevent bird strikes. Articulated-winged flapping aerial robots equipped with sensors could also allow access to areas that humans cannot reach (e.g., partially collapsed mines) and make revolutionary advances in the monitoring and recovery of critical infrastructures such as nuclear reactors, power grids, bridges, and borders.

The transformative nature of the research will contribute broadly in robot locomotion and biomimetic control as well as in distributed control theory that concerns many degrees of freedom (e.g., boundary control for flexible robotic arms). The research will also derive a mathematical tool that can test various biological hypotheses in animal and human movements and in motor disorders such as Parkinson's disease.

Ecological Determinants of Luteal Reproductive Function

Kathryn Clancy
Beckman Fellow

Department of Anthropology

Rural Polish farmer.

Miscarriage is a normal and natural component of reproductive function in women. While half of miscarriages result from chromosomal abnormalities in a fetus that would not make it to term, we can explain few of the reasons for the remaining, non-chromosomal losses. We do know that the second half of the menstrual cycle (the luteal phase) is when the critical events of early pregnancy occur, and that reproductive functioning during this phase can be suppressed when women experience energetic or immunological stress. This knowledge frames the current research project undertaken by Professor Clancy.

During her Center appointment Professor Clancy will conduct field research among women at the Mogielica Human Ecology Study Site in rural Poland, as part of a longitudinal, ecological study of the endometrium in a non-industrialized population. The project is the first-ever study of women's systemic reproductive functioning over an entire menstrual cycle: it includes demography, anthropometry, psychometrics, daily urine collection for reproductive hormones and stress biomarkers, and endometrial ultrasounds. Women in the sample population are under some energetic constraint (e.g., moderate physical activity during the harvest season, potential systemic inflammation resulting from the farm environment), which will make it easier to document variations in their environment and responses.

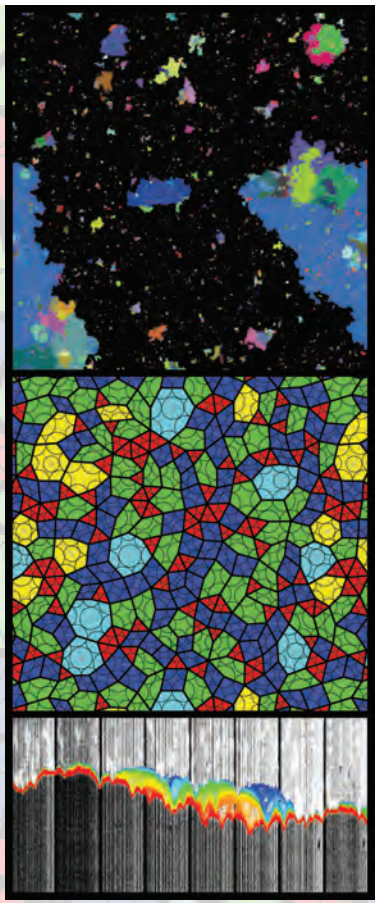
The results from Professor Clancy's early work have led to new insights into how bodies allocate energy to ovarian and uterine processes. For this project, Professor Clancy aims to (a) characterize the relationship between ovarian and endometrial function among women in a moderately constrained environment, (b) model the associations between biomarkers of ecological stressors and ovarian and endometrial function, and (c) advance our understanding of how developmental milestones correlate with adult reproductive function.

Unifying Theory of Universal Quake Statistics: From Nanocrystals to Earthquakes

Karin Dahmen

Associate

Department of Physics



Many systems respond to small forcings with large fluctuations, often with sudden snaps/cracks or crackles that can span many orders of magnitude in size. Examples range from the crackling noise emitted when milk invades rice crispies to sudden rearrangements in densely packed granular materials to events such as earthquakes, landslides, and snow avalanches. Similar sudden responses are seen in other contexts, including magnetization avalanches in magnetic materials, resistivity fluctuations in superconductors, and blackouts of power grids. A better predictive and physical understanding of these kinds of sudden responses would be quite useful in a wide range of applications.

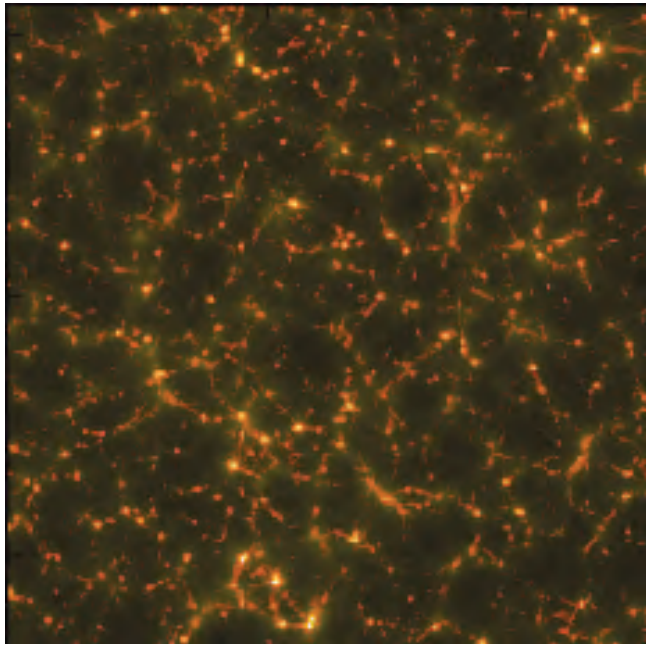
Recently Professor Dahmen's research group has contributed simple models that offer this promise, showing, for example, that their simple model for the jerky deformation characteristics of materials describes the statistical properties of fluctuations in slowly compressed crystalline pillars. The model allows many predictions that can be tested.

During her Center appointment Professor Dahmen will co-organize and participate in an extended interdisciplinary research workshop at the Kavli Institute of Theoretical Physics, University of California–Santa Barbara. The workshop presents a unique opportunity for Professor Dahmen to collaborate with experts on a broad range of different systems and expand her group's model and test its predictions using experiments, simulations, and observations. The workshop will also explore potential applications of the results to materials testing and hazard prevention.

New Signatures of Neutrinos in Cosmology

Neal Dalal
Fellow

Department of Astronomy



Simulation volume: red = density of dark matter; green = density of neutrinos.

Neutrinos appear to be among the most numerous particles in the universe; and because neutrinos have mass, they can have a profound effect on the evolution of structure in the universe. Conversely, measuring how large-scale structure in the universe evolves over cosmic time provides one of the most promising methods to determine neutrino masses. An obstacle, however, is that we currently do not know how to compute neutrino effects on large-scale cosmological structure except in certain limited regimes.

During his Center appointment Professor Dalal will continue his group's work on a promising new method to resolve this obstacle. The method involves combining techniques from traditional N-body simulations (Lagrangian methods) with techniques from hydrodynamical simulations (Eulerian methods) – in essence describing neutrinos not as discrete particles but as a fluid governed by fluid equations. The method has yielded the first code in the world capable of consistently computing cosmological structure formation, including the effects of neutrinos.

The current project will apply the code to run simulations that map out the effects of massive neutrinos as a function of the mass hierarchy. A crucial aspect is that the simulated volume must be large enough to encompass the *free-streaming scale*, the typical distance traveled by neutrinos since the Big Bang, while having sufficiently fine spatial resolution to detect individual galaxy halos.

Preliminary results of smaller-scale simulations suggest that the spatial distribution of galaxies provides a new signal of neutrino masses. If correct, this result would imply that galaxy surveys will be able to measure the masses of neutrinos, thereby opening a new window onto neutrino physics and filling in one of the final remaining pieces of the Standard Model of particle physics.

"El Legado de España": The Discourse of Hispanism in Cuba, Puerto Rico, and the Philippines in the American Empire

Augusto Espiritu

Associate

Department of History, Department of Asian American Studies

H*ispanism* is a pan-national discourse characterized by an idealized affiliation with the Spanish race and shared heritages of Catholicism, Spanish civilization, and traditions of protest. In exploring this discourse, Professor Espiritu has been intrigued by the interrelationships among Hispanism, colonialism, and national identity. His book project focuses on the intellectual life of three U.S. acquisitions resulting from the Spanish-American War: Cuba, the Philippines, and Puerto Rico.

The book addresses three questions. First, why did intellectuals living under these U.S. colonial or post-colonial regimes embrace the discourse of Hispanism, especially as a critique of Americanization? Second, why did they evoke "Spain" in their search for national identity? The abuses of the Spanish colonial system, so recently experienced in these locations, could reasonably have discredited Spain as a source for national cultural reconstruction. And third, why does Hispanism continue to persist even today?

In answering these questions, Professor Espiritu portrays Cubans, Puerto Ricans, and Filipinos as thinkers capable of profound intellectual endeavors. He presents external factors that constrained their individual expression – colonialism, war, exile, racism, and class prejudice – and the ways they sought to overcome these challenges, through a nationalism that was empowering and liberating and also subject to its own excesses.

The book engages the grand themes of modernity, construction of national identity, resistance to imperial hegemony, and the impact of racial and gendered ideologies on colonial subjects. It offers a broad view of the different ways in which colonized peoples confronted policies of assimilation and cultural Americanization, and an appreciation for why certain political or cultural discourses have continued to appeal to Latin American and Asian intellectuals.

Sharp Bounds for Small Moments of Multidimensional Weyl Sums

Kevin Ford
Associate

Department of Mathematics

The study of Diophantine equations (i.e., integer solutions of polynomial equations and systems of equations) has a long history going back thousands of years. One of the most powerful techniques for analyzing Diophantine equations is a collection of ideas that expresses solutions in terms of integrals of functions called *Weyl sums;* one component of this method is a mean value for Weyl sums, known as *Vinogradov's Mean Value.*

Recent collaborative work in this area has resulted in new methods for analyzing the integer solutions of the type of equations known as *Vinogradov's system.* The results led to sharp estimates for the number of solutions of the system for a wide range of *s* (the number of variables in the system) and settled a longstanding conjecture on the subject, which had been open since the 1930s. Subsequent work proved sharp bounds and the main conjecture for such systems when *s* is large.

During his Center appointment Professor Ford will contribute in this area through his continuing collaboration with professors Scott Parsell (West Chester University) and Sean Prendiville and Trevor Wooley (University of Bristol, U.K.). Their project will focus on establishing the main conjecture for such systems when *s* is small. At the heart of their method will be the *efficient congruencing* innovation developed by Professor Wooley, its adaptation to the realm of small *s* in Vinogradov's Mean Value, and its extension to the multidimensional setting. One of their first tasks is to create a new "p-adic" theory where equations are replaced by congruences.

Their research results are expected to have application to the theory of more general types of equations, to the distribution of prime numbers, and to other questions in number theory.

Topological Order and Symmetry Breaking in Condensed Matter Physics

Eduardo H. Fradkin
Associate

Department of Physics

The main directions of Professor Fradkin's research are the theory of topological phases in condensed matter and the theory of electronic liquid crystal phases. One exciting feature of his research is that it combines fundamental problems in quantum mechanics and quantum field theory with experiments at the leading edge of technology. The recent discovery of materials known as *topological insulators*, for example, has opened the possibility of creating a topological quantum computer by combining topological materials with superconductors and high-temperature superconductors.

Over the past decade Professor Fradkin has been working on the theory of high-temperature superconductors within the conceptual framework of electronic liquid crystal phases – that is, phases whose microscopic constituents are electrons that carry both charge and spin. He and his colleagues have concluded that these phases must also include novel phases in which the superconducting state itself might also behave as a nematic fluid. A natural consequence of this concept is that these phases, instead of competing with each other, might instead be intertwined, which means that different orders may arise with similar strengths.

The concept of electronic liquid crystal phases thus appears to be closely related to the existence of novel phases that exhibit a combination of topological order and symmetry breaking. This is the direction of work Professor Fradkin will pursue during his Center appointment. He plans to develop a theory of the interplay and phase transitions between topological order and symmetry breaking in condensed matter. Of particular interest is investigating the mechanisms that may bring about topological phases in three-dimensional systems and fully characterizing their edge states. He also plans to investigate the interplay and associated phase transitions from (and/or inside) topological phases to states with spontaneously broken symmetries.

Networking at the Speed of Light

Philip Brighten Godfrey
Beckman Fellow

Department of Computer Science

A good Internet experience requires *responsiveness*, especially with human applications like web browsing and interacting in real time with voice and video. Even tens of milliseconds of delay can affect perceptions of the "latency" lag and lead to significant reductions in website revenue. During his Center appointment Professor Godfrey will work to establish speed-of-light latency as a grand challenge for the computer networking research community. The goal is to achieve responsiveness close to the underlying physical limits.

Professor Godfrey's agenda includes conveying this long-term vision to the research community, conducting measurement studies to map out latency problems and opportunities, and developing new technologies to reduce latency.

First he will develop an understanding of why latency is generally inflated by more than an order of magnitude beyond the ideal. He will build a comprehensive picture of each layer of the network architecture, including the physical location of fiber lines, routing paths within those lines, and transport protocols used to establish end-to-end communication. He will then compare the baseline ideal speed-of-light latency with measured latency and correlate the results with the various Internet Service Providers (ISPs) involved. A continual release of this data analysis is expected to promote competition among ISPs to reduce latency.

Two additional elements of this project will result in direct contributions. Professor Godfrey is exploring the use of *redundant requests* to achieve consistently low latency in Domain Name System resolution, storage services, and multipath routing, which will result in open-source software that accelerates web applications. He will also develop and release open-source software that makes control decisions based on real-time analytics of performance outcomes. While this software represents a radically new architecture, it works within existing protocols and requires changes on the sender side only.

Analysis of Surface Water Waves

Vera Mikyoung Hur
Beckman Fellow

Department of Mathematics

Credit: istock photo.

***S**urface water waves* encompass a wide range of phenomena, ranging in length scale from ripples driven by surface tension to rogue waves and tsunamis. The phrase describes the situation where water lies below a body of air and is acted upon by gravity and possible surface tension.

While water waves have stimulated a considerable part of historical developments in the theory of wave motion, they present profound and subtle difficulties for rigorous analysis, modeling, and numerical simulations. Notably, the interface between the water and the air is a free boundary, *a priori* unknown and to be determined as part of the solution. Free boundaries are mathematically challenging in their own right. In addition, boundary conditions at the free surface are severely nonlinear, presenting further challenges.

During her Center appointment Professor Hur will address several issues in the mathematical aspects of surface water waves. She plans to develop new tools in partial differential equations and other branches of mathematics, and also extend and combine existing tools, to focus on:

- Global regularity versus finite-time singularities for the initial value problem.
- Existence of traveling waves and their classification.
- Stability and instability of traveling waves.

Her project emphasizes large-scale dynamics and genuinely nonlinear behaviors, such as breaking and peaking, which ultimately rely on analytical proofs for an acute understanding.

Progress in Professor Hur's research is expected to help resolve several longstanding open problems in the area, while also leading to applications in related, interfacial fluids problems and in numerical simulations and engineering.

Designing Next-Generation Computing

Yi Lu
Fellow

Department of Electrical and Computer Engineering

We are witnessing a great wave of digitized data, with widespread use of smart phones, increasing scientific and medical data generated in digital format, and the variety of information collected in cyber-physical systems. Typically the data are generated more dynamically and at a much higher rate than previously, and they demand more intelligent interpretation and retrieval mechanisms.

The computing system that has arisen in response is *the cloud.* This legacy architecture was based originally on proprietary search engines, e-commerce systems, and grid computing. It has since been upgraded with *ad hoc* changes, but fundamental problems remain in the areas of scalability, response quality and speed, and energy consumption.

During her Center appointment Professor Lu will work toward designing a computing system that is amenable to big data, is scalable and energy-efficient, and has performance guarantees.

The project consists of four parts:

1. Design novel task-scheduling architecture and algorithms to improve response time by orders of magnitude without sacrificing quality or consuming extra resources. An equivalent interpretation is achieving the same response time and quality with only a fraction of the energy consumption.
2. Design data-placement architecture and algorithms to improve interpretation and retrieval, and to achieve scalability of the system.
3. Measure and analyze workload to understand characteristics in production clusters, with efficient tracing to allow fast and reliable evaluation of a large system in a small testbed.
4. Balance loads to reduce the power-conversion loss (currently as high as 10-15 percent before computation even takes place) using a series-stacked power-delivery architecture.

In pursuing her project goals, Professor Lu is collaborating with colleagues in power electronics, circuits, medical imaging, and genomics.

Sanctified in Water, Sealed in Stone: The Italian Baptistery 1000-1500

Areli Marina
Associate

Art History Program

Parma, Baptistery (interior), begun 1196.

During Christianity's early centuries, freestanding baptistery buildings provided the requisite separate settings for the ritual initiation of adult converts into the Christian congregation. By 1000, however, most Western Europeans were baptized as infants. The liturgical requirements that formerly demanded independent structures for Christian initiation no longer applied. Consequently, the baptismal ritual was simplified and decentralized. Separate baptismal halls became redundant. Yet although construction of monumental, independent baptisteries stopped elsewhere in Europe, more than 80 of them were built in Italy from the eleventh through the fifteenth centuries, including some of the peninsula's most celebrated monuments. What accounts for their resurgence?

Professor Marina presents the first comprehensive explanation for, and interpretation of, the resurgence of independent baptisteries, along with source material that can serve as a point of departure for future study. By extracting baptisteries from architectural history's developmental narrative and considering the impact local and regional conditions had on their design, production, and reception, she demonstrates that Italy's post-millennial baptistery boom is really three separate phenomena with discrete geographical and temporal boundaries. All are the product of Italy's peculiar ecclesiastical and political fragmentation and distinctive traditions of architectural patronage. Her conclusions are based on study of an expanded corpus of more than 80 baptisteries located within the frontiers of modern Italy and also in Italian settlements on the eastern side of the Adriatic.

In the book manuscript Professor Marina plans to complete during her Center appointment, she also debunks the myth of a universal baptistery "building type" and reframes the discussion of the baptistery's architectural signification. By addressing both the material reality and diverse cultural functions of baptisteries, Professor Marina aims to arrive at a subtler understanding of their multiple roles in forging Italy's distinctive civilization.

Making a Home in the Heartland: Immigration and Global Labor Mobility

Faranak Miraftab
Associate

Department of Urban and Regional Planning

During her Center appointment Professor Miraftab plans to complete her book manuscript, *Making a Home in the Heartland: Immigration and Global Labor Mobility.* In the book she weaves together interviews she collected in Illinois, Mexico, and Togo, charting the processes that capture and consume migrants' labor and also those that produce and sustain the global mobility of labor.

In the early 1990s, Cargill, Inc., faced a dwindling local labor force willing to accept the low-wage, high-risk jobs available at its meat-packing plant in Beardstown, Illinois, and began recruiting workers among French-speaking Africans (predominantly Togolese), Spanish-speaking Latinos (predominantly Mexicans), and, to a smaller extent, African-American Detroiters. The dramatic and rapid diversification of Beardstown was not an easy transition. But today, Beardstown's economic gains contrast sharply with adjacent dying rust-belt towns, and there has been a significant social transformation: almost every residential block is integrated, multi-racial soccer leagues play in the open fields, and cultural identities are celebrated in public spaces.

In her book, Professor Miraftab queries the global cost of this midwestern revitalization: What are the global conditions that produce the migrant labor force that finds its way to Beardstown? What conditions make it possible for these workers to continue in their low-wage, high-risk jobs? And finally, how do these new workers negotiate inter-racial and inter-immigrant relationships outside the workplace?

Professor Miraftab answers these questions through an ethnographic approach that exposes (a) production of migration through processes of dispossession and displacement and (b) social reproduction of migrant labor force through transnational practices of care work. To make their wages viable, for example, workers tap into free or inexpensive familial and community care through networks that continue to connect Beardstown with Mexico and Togo and effectively subsidize the wages Cargill pays. The book will be published by Indiana University Press as part of its book series, Global Research Studies.

Research in Geometric Representation Theory

Thomas Nevins
Associate

Department of Mathematics

The mathematical field of *representation theory* studies algebraic models of symmetry. Beginning in the late 1970s, the geometric construction of algebraic models of symmetry resulted in a fundamentally new subject known as *geometric representation theory.* The leading role in this developing area has been played by the algebraic theory of differential equations, as mediated by the structure of $\mathcal{D}$-modules.

Much of Professor Nevins' recent work has aimed at expanding the toolkit of $\mathcal{D}$-modules to more general contexts, with applications to a broad new range of problems in geometric representation theory. Jointly with Professor Kevin McGerty (Mathematical Institute, Oxford University) he extended the Beilinson-Bernstein localization theorem for $\mathcal{D}$-modules from its original context to a much more general setting. They established precise relationships between a piece of the category of (twisted) G-equivariant $\mathcal{D}$-modules on a variety X with an action of a reductive group G and modules over a quantum Hamiltonian reduction of X. During his Center appointment Professor Nevins plans to continue this collaboration and establish a general structure theory for the entire category of G-equivariant $\mathcal{D}$-modules, and then apply it.

Also during his Center appointment, Professor Nevins plans to continue a wider collaboration to prove a now-standard expectation in symplectic topology, i.e., that the Fukaya categories of certain real symplectic manifolds should be realized by categories of deformation-quantization modules. The next steps in this area are to develop the deformation theory of cell categories and to construct a period map. Accomplishing these steps will provide a concrete characterization of Fukaya categories.

The two projects are closely related: each makes manifest a structure indicated by Morse theory, and thus together they express a satisfying underlying unity to emergent phenomena in the study of $\mathcal{D}$-modules.

Writer, Painter, Banker, Thief: The American Arts Colony in the Public Account

Catherine Prendergast
Associate

Department of English

Yaddo arts colony.

The oldest American literary, musical, and visual arts colonies – Yaddo, MacDowell, Byrdcliffe, and Carmel-by-the-Sea – were founded in the first decade of the twentieth century. Typically the founders were business magnates in the second tier. Unable to afford such grand gestures as endowing urban institutions like the Metropolitan Museum of Art, they could, however, plan a colony, buy up cheap land in rural areas, and impose a kind of cultural manifest destiny that legitimated, in their views, hard-nosed business dealings with local residents.

Locals in the towns where these colonies were founded, however, viewed the colonies as taking up precious land while providing nothing in return. Residents used the courts, the newspapers, and even acts of civil unrest to demand that the colonies respond to them as a non-abstract public. These local challenges resulted in robust public conversations about how the arts are supported and whom they should serve.

Professor Prendergast brings together the cultural and economic histories of these colonies and the people who surrounded them in her book-length project, *Writer, Painter, Banker, Thief.* She asks: Who invests in a cultural activity at a given point in time, and why? Her method looks at sites of cultural investments causing conflict between individuals in powerful positions and those who feel the cost of their largesse.

During her Center appointment she will complete her research, which includes local newspaper and town archives along with the colonies' records, and write the final chapters of the manuscript. She expects the resulting book will offer lessons for understanding the current moment in the United States, when arts institutions find themselves in vulnerable financial straits and needing to articulate their worth to a skeptical public.

Sprayed: A Cultural History of Agent Orange in the United States and Vietnam

Leslie J. Reagan
Associate

Department of History

U.S. Air Force C-123 spraying defoliant along a highway in Vietnam (Department of Defense file photo, May 1966).

During the Vietnam War, the U.S. military sprayed herbicides over Vietnam and also Cambodia and Laos. Agent Orange, the most infamous of these, was designed to kill the jungle, thus exposing the hidden enemy, and was sprayed on crops to "deny" them food. From the earliest spraying to the present, people complained of its lasting effects on the environment and also its effects on their own bodies.

Agent Orange consists of two herbicides: 2,4-D and 2,4,5-T. It is the second compound that contains dioxin and is associated with human respiratory problems, cancers, miscarriages, and congenital malformations. In the 1970s, 2,4,5-T was used in U.S. national forests and on residential lawns to clear unwanted trees and weeds. Wherever Agent Orange and 2,4,5-T were used, they sparked protests.

Professor Reagan's book project, *Sprayed: A Cultural History of Agent Orange in the United States and Vietnam* investigates the herbicide's transnational sociopolitical and cultural history. Her inquiry is both historical and contemporary.

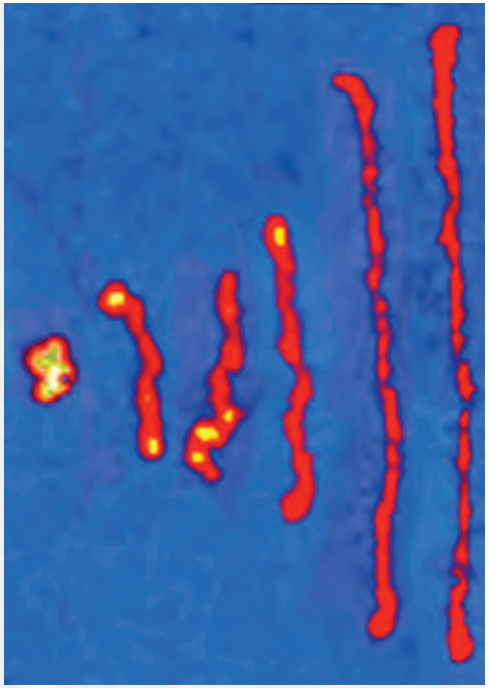
Although Agent Orange was banned, it has a long life that continues into the present in the environment, in the changed landscape, and in human bodies that cough, erupt with sores, suffer cancers, and are born misshapen. It continues, too, in memory and culture.

In *Sprayed* Professor Reagan finds that the story is more than the victimization of American veterans; it is a shared history with the people of Vietnam. Part I provides a chronological history of U.S. use of Agent Orange both in the Vietnam War and at home. Part II moves to Vietnam, describing how Agent Orange arose as a political issue there in the 1980s, and analyzing visual and cultural representations of Agent Orange in museums and film.

Molecular Design and Engineering of Advanced Functional Materials

Charles M. Schroeder
Beckman Fellow

Department of Chemical and Biomolecular Engineering



Single polymers stretching in flow, imaged using fluorescence microscopy.

The forefront of chemical science research lies in the manipulation and analysis of single molecules. To this end, the ability to control molecular processes holds the key to developing new materials with desired functionalities. Major challenges in the field of materials chemistry include the ability to: (a) control the underlying structure of materials during flow processing and (b) synthesize "precise" materials with defined shapes and structures. During his Center appointment Professor Schroeder will continue to lead his group's research efforts to achieve these abilities.

One area of focus extends the field of single-polymer dynamics to new materials, including flexible chains, copolymers, and branched polymers, to gain improved ability to control the properties of materials during processing. In this effort, the group is using single-molecule imaging to study polymer dynamics, directly "watching" polymer motion during processing. This work will bridge the gap between molecular phenomena and bulk-scale behavior.

Another focus involves "grabbing onto" single polymer molecules using microfluidic trapping. With this technique, single polymers or nanoparticles in free solution are confined and manipulated using the action of gentle fluid flow in a microfluidic device. The technique offers the promise of synthesizing new materials by fluidic-directed assembly or fine-scale patterning of nanomaterials.

In coupling molecular-scale characterization with synthesis, the group aims to produce synthetic biopolymers that have new structures, tunable material properties, and novel functions – ultimately creating new template-based synthesis schemes that mimic the control found in nature, thereby offering a powerful approach to the design and engineering of new materials.

The Haunted Empire: The Russian Literary Gothic and the Imperial Uncanny, 1793-1844

Valeria Sobol
Associate
Department of Slavic Languages and Literatures

Hammershus, on the Danish island of Bornholm, is the setting of the first Russian Gothic tale, *The Island of Bornholm* (1793), by Nikolai Karamzin.

Russian Gothic literature (1793-1844) consistently depicts the empire's peripheries as haunted landscapes. These areas become settings for what Professor Sobol calls *the imperial uncanny* – the experience of danger and uncertainty in ambiguous colonial spaces within Russia's borders. The Gothic genre aesthetically enacts these tensions and offers a powerful critique of empire through the popular form of an entertaining, suspenseful narrative.

Professor Sobol's book-length project focuses on two geographical spaces in Russian Gothic literature: the Baltic/Scandinavian "North" and the Ukrainian "South." Both areas were relatively late additions to the Russian empire and thus preserved an aura of exoticism during the period under study. The North/South paradigm offers an alternative to the prevailing stereotype of "Russia between East and West."

The book pays particular attention to the specifics of the location and the imperial context of Gothic events in these narratives. Where in imperial geography does the Gothic encounter take place? What is the power relationship between the participants of the encounter? Are they ethnically marked? and Why is it that particular ethnicities are portrayed as sources of Gothic horror?

Ultimately, Professor Sobol aims to reconstruct a uniquely Russian tradition of the imperial uncanny – a fictional space into which the Russian empire projected its colonial fantasies and anxieties and where, through the use of Gothic tropes, it created the apparitions and monsters that continue to haunt Russia's historical imagination. As the current Russian-Ukrainian crisis has demonstrated, the Russian imperial uncanny is still at work today. Professor Sobol's study points to a long history of Russia's imperial anxiety and ambition derived from its inability to fully accept the otherness of its formerly colonized neighbors.

Emblematic Practices: Emblems and Culture in Early Modern Germany

Mara Wade
Associate

Department of Germanic Languages and Literatures

Emblem showing motto, pictura, and subscriptio (Peter Isselburg, *Emblemata Politica*, 1617).

The *emblem*, consisting of both textual and visual elements, is capable of expressing highly complex ideas in compact and compelling forms. In Europe during the sixteenth and seventeenth centuries, emblems focused the articulation of new ideas, and familiar texts and images were reassembled to create new meanings. They gave impetus to intellectual exchange and social conviviality, becoming significant agents of cultural transfer and spreading over the entire continent from 1531 well into the eighteenth century.

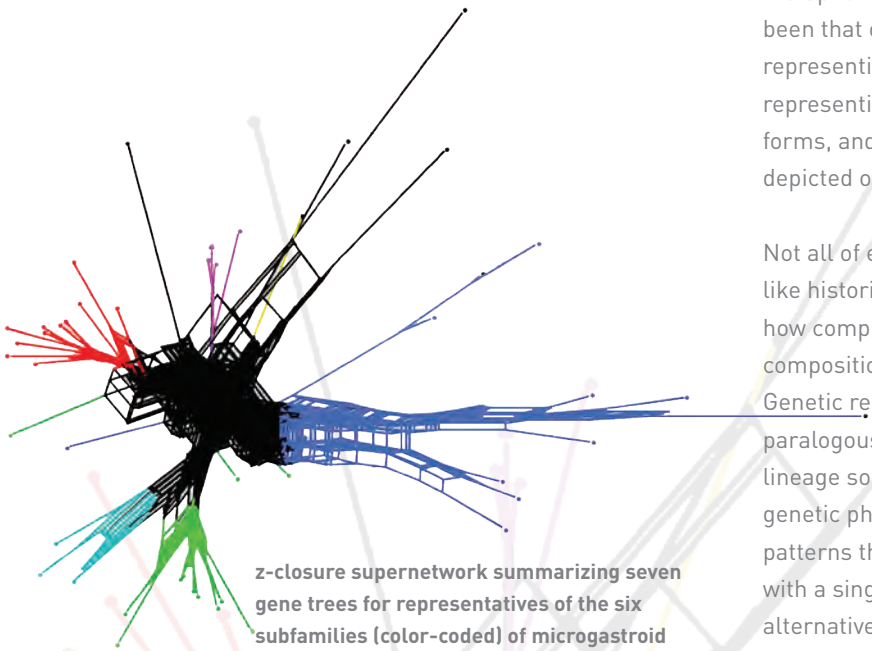
Professor Wade's book-length project initiates a new kind of research in emblem studies that is based on a cross-section of cultural practices in German-speaking lands of this period. She seeks to discover and define the underlying "emblematic turn," the new cultural framework of the early modern period employed for the articulation of all manner of cultural expressions at court, in the academy, and among educated elites in towns.

The book is conceived in five core chapters: the new emblematic way of thinking and its practices; the seventeenth-century culture of conversation, through reflections of gender and emblematics; the role of emblems in institutions and intellectual communities; the use of emblems to create memory; and the use of emblems to create dynastic identity in ephemeral performances at court. During her Center appointment Professor Wade will define the final shape of the book, establish the theoretical framework for the five core chapters, and identify and study new sources.

As part of this project, Professor Wade seeks new ways in which existing digital projects might aggregate their accumulated data and expertise to unite very large sets of cultural data to support expanded study of the literature, art, and culture of the early modern period.

Testing of New Phylogenetic Network Methods with Appropriate Empirical Biological Datasets

James B. Whitfield
Associate
Department of Entomology



z-closure supernetwork summarizing seven gene trees for representatives of the six subfamilies (color-coded) of microgastroid parasitoid wasps.

Since the days of Darwin, the prevailing metaphor for the evolution of life on Earth has been that of a phylogenic tree, with the trunk representing the earliest life on Earth, branches representing the evolutionary lineages of life forms, and the world's present-day species depicted on the tips of branches.

Not all of evolution, however, produces tree-like historical patterns. It is now being realized how complex genomes really are, both in their composition and in their evolutionary histories. Genetic recombination, gene conversion between paralogous gene copies, operon formation, lineage sorting among alleles – these and other genetic phenomena can produce conflicting patterns that cannot be summarized effectively with a single evolutionary tree. A promising alternative is using phylogenic *networks* to help reconstruct relationships among organisms and interpret their genomic data.

During his Center appointment Professor Whitfield will serve as *biological problem collector* in an international collaboration with mathematicians, computer scientists, and other biologists to develop practical network methods that answer the questions biologists are asking. He will supply real biological datasets to test several of the mathematicians' network approaches. For example, Eubacteria and Archaea display an unusually high level of gene-sharing, with complex genomic relationships. Network visualization tools for these relationships are already under development, but how will the methods scale up to larger problems as new sequenced genomes accumulate? Only tests with real data will tell.

In addition to validating or invalidating the network methods being developed, the project will result in a greatly expanded research base of test datasets that will benefit network research for years to come. It is also likely that the collaboration will lead to new network methods not yet conceived.

An Untitled Novel on Pre-colonial Dahomey (West Africa)

David Wright
Associate

Department of English

King's symbols from the Abomey Tapestry.

Professor Wright is writing a novel that recovers the story of Adandozan, the forgotten King of Dahomey. The work builds on his recently completed novel, *All the Best Things Thus*, in which Adandozan plays a secondary role, to explore the complicated and complicitous role that Africans played in the trans-Atlantic slave trade.

For more than 200 years, the kings of Dahomey (now Benin) ruled over the stretch of West Africa known as the Slave Coast for the quantity of human chattel originating from the region. But in the Age of Revolution, anticipating the eventual end of slavery, King Adandozan attempted to shift the Dahomeyan economy toward what he saw as the more stable product of palm oil. The attempt proved his undoing.

In 1818 Adandozan was unseated by his brother Guézo in a coup. Instead of killing the deposed king or selling him into slavery, Guézo exiled Adandozan to an isolated section of the palace and told the people his predecessor was insane. Adandozan's emblem was unstitched from the royal tapestry, and Guézo directed that his name never be spoken aloud again – which, in this oral culture, effectively removed Adandozan's memory from history.

Professor Wright has traveled to the region to conduct research and to deepen his understanding of the local Yoruba and Fon cultures. Experiencing the specific geography, interacting with local people, and witnessing traditional ceremonies will inform how he imagines the characters and will direct how he proceeds with his writing. During his Center appointment Professor Wright intends to organize and study his collected research and construct a good first draft.

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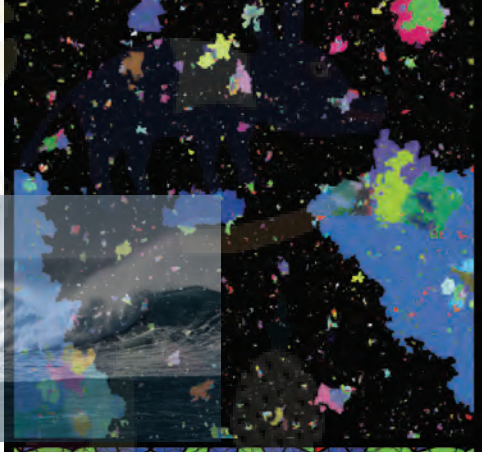
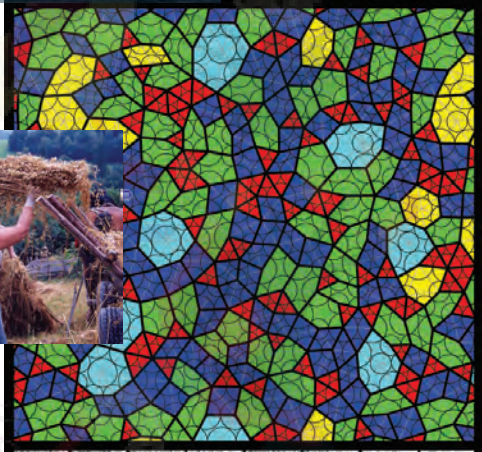


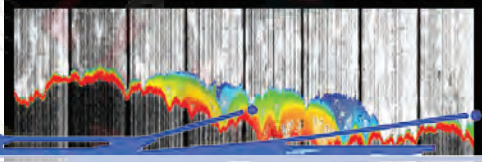

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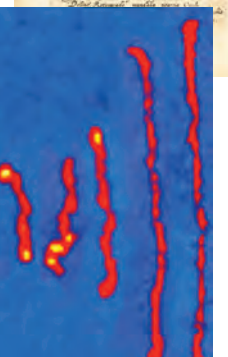
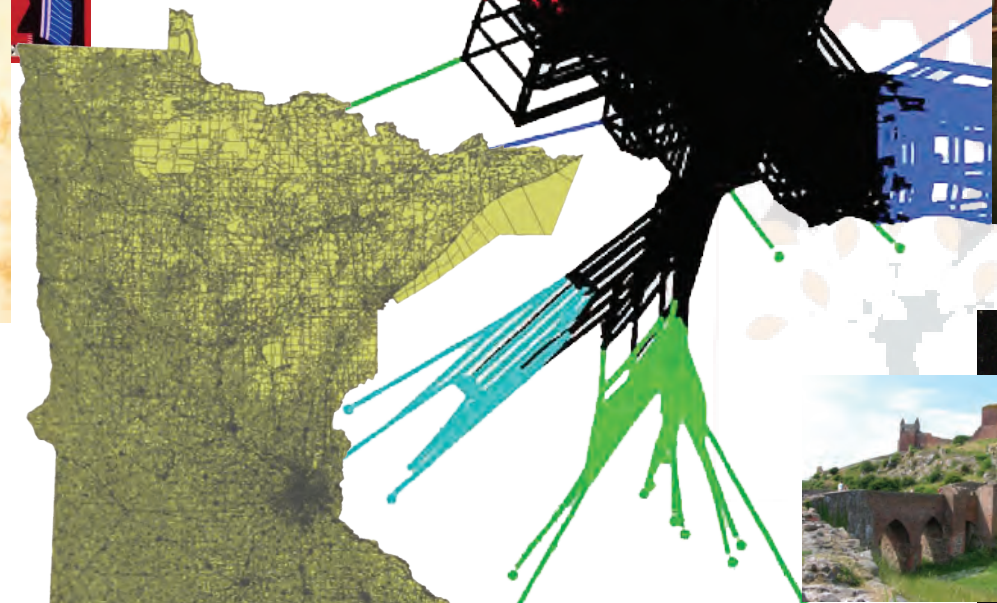

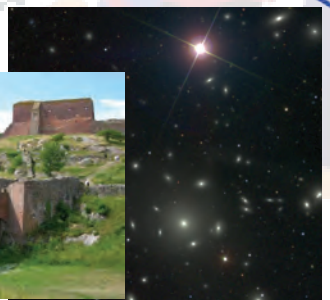


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Research Appointments 2014-15

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 2014-15 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

Laura H. Greene
experimental condensed matter physics, high-temperature superconductors

Bruce Hajek
communications engineering, stochastic methods

Frederick E. Hoxie
federal Indian policy, Native American history

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 2015-16 academic year. For more information, please consult our website at www.cas.illinois.edu

Application deadline:
Tuesday, October 7, 2014

Contents

Death and Ritual in Flavian Epic

Antonios Augoustakis
Associate

Department of the Classics

Ceremony of the cult of Isis **(fresco, Pompeii). Image by Erich Lessing/ART RESOURCE, NY.**

During his Center appointment Professor Augoustakis will continue work on a monograph providing the first systematic analysis of scenes of death, lament, and ritual practices in three epic poems: *Punica*, by Silius Italicus; *Thebaid,* by Publius Papinius Statius; and *Argonautica,* by Valerius Flaccus. The poems were produced during the so-called *Flavian* period of Latin literature (69-96 CE), when epic poetry experienced a renaissance under the three Roman emperors, Vespasian and his sons, Titus and Domitian.

Punica narrates the events of the Second Punic War, the long conflict between Romans and Carthaginians in the late third century BCE. *Thebaid* recounts the mythological civil war of Thebes, when the sons of Oedipus turn against one another because of the refusal of Eteocles to yield the throne of Thebes to his twin brother, Polynices. *Argonautica* memorializes the trip of Jason to the land of the Colchians to claim back the Golden Fleece.

Why death and ritual? Death and dying occupy a prominent role in Latin literature: from gladiators dying a dis/honorable death in the arena to soldiers fighting for their country to members of the elite committing suicide as a means of resistance against the increasing autocracy of the emperor. Professor Augoustakis will interpret scenes of death and burial in these poems, (a) elucidating their significance in developing the poems' plotlines and (b) interpreting their sociocultural background and the development of Roman cultural practices. Close analysis of such ritual, and the literary descriptions of ritual in particular, will add a critical dimension to our understanding of Roman culture in general. Professor Augoustakis plans to complete the monograph by the summer of 2016.

Rural U.S.-residing, Mexican-born Females and Breast Cancer Screening: Interaction between Hispanic Beliefs and Structural Factors

Venera Bekteshi

Fellow

School of Social Work

Mammography remains the most effective screening technique for timely diagnosis and, consequently, effective treatment of breast cancer. Immigrant Latina women utilize mammography at lower rates than non-Hispanic white women and remain at higher risk of presenting with late-stage breast cancer. Why is this so? During her Center appointment Professor Bekteshi will investigate how structural contests specific to Mexican-immigrant women in new-growth areas of Illinois (e.g., health insurance, income level, transportation challenges, documentation status, daily discrimination and poor treatment from healthcare professionals) interact with cultural factors to affect rates of mammography screening. She will also investigate the effect of emotional and belief pathways of traditional Latino culture.

For example, *fatalismo,* the traditional belief that there is little an individual can do to alter fate (and, by extension, prevent cancer), has been linked with fear that a cancer diagnosis will limit one's ability to enjoy time with children and future family generations. Several views embedded in Latino tradition, including humility, modesty, and discomfort over disclosing personal information, have all been associated with embarrassment, which is one of the most commonly cited emotional barriers to mammography among Latinas.

Professor Bekteshi's study begins a research trajectory that ultimately will address (a) the importance of support systems, including social and family support, in overcoming barriers to mammography participation among Mexican-immigrant Latinas in central Illinois, (b) the role of healthcare professionals in addressing these barriers, and (c) gaps in the healthcare system that may lead to poor interaction with healthcare professionals. The results will contribute to the comprehensive knowledge that is needed for identifying solutions to reduce and eliminate this health disparity.

Accelerating the Fourth Paradigm: Data-Intensive Astronomical Research

Robert J. Brunner
Associate

Department of Astronomy

Sky survey of the COMA cluster of galaxies. Image by B. Jeter and R.J. Brunner, original data courtesy of the SDSS.

The standard cosmological model posits that 95 percent of the matter-energy budget in the universe consists of two unknowns: dark matter and dark energy. To gain a better understanding of the nature of these two dark components, scientists usually construct a three-dimensional map of visible matter: first obtaining two-dimensional images of the sky, and then obtaining spectra of the objects identified and determining source classifications and *redshift* line-of-sight distances.

Inherent limitations to this approach argue for a new way to obtain cosmological measurements directly from imaging data, and this is the current focus of Professor Brunner's research. During his Center appointment he plans to explore how probabilistic techniques can be used to classify sources and estimate distances, and subsequently be applied to make precise cosmological measurements.

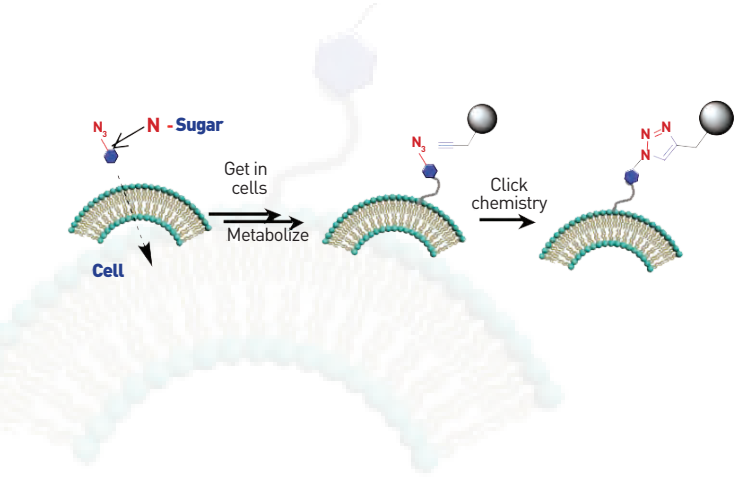
Professor Brunner proposes to develop three distinct machine-learning techniques for generating probabilistic classifications. He will then develop a meta-classifier that combines the three techniques and accelerate their implementations to scale efficiently to the petascale regime. Finally, he will apply the resulting data-software instrument to determine new, more precise cosmological constraints using data from the Dark Energy Survey (DES).

The project is timely for several reasons. In Fall 2014 the first season of data from the DES will be fully processed and calibrated, and the second year of data will begin to be acquired. As other scientists look to use DES data, they will be needing accurate, probabilistic source classifications and distance estimates. Thus, Professor Brunner plans to distribute his work via the official DES project archive, where it can be used by scientists worldwide.

In Vivo Targeting via Bioorthogonal Chemistry

Jianjun Cheng
Associate

Department of Materials Science and Engineering



Cell surfaces often possess one or more types of proteins that are specific to a given cell or to a type of disease. These proteins are known as *antigens.* Another type of protein, *antibodies,* can interact specifically with and bind to antigens. Antigen/antibody interaction has been widely used for the selective targeting of cells, organs, and diseases in a biological system. But this approach has several drawbacks, including undesired immune responses and the difficulty of producing and handling antibodies. Also, antigens originate within the cell, and there is no current strategy to introduce external antigens for subsequent targeting by antibodies.

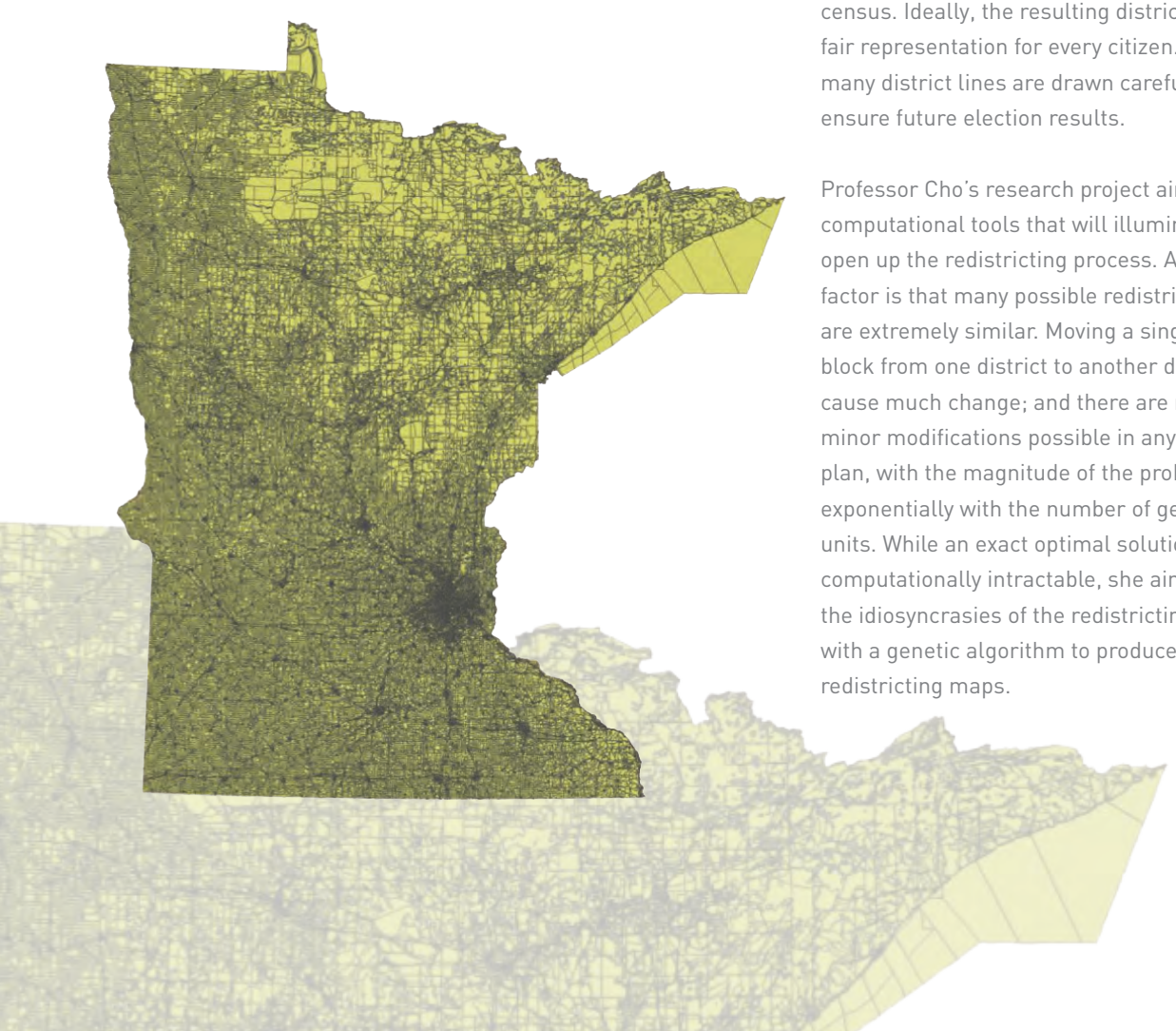
During his Center appointment Professor Cheng and his team plan to develop a new *in vivo* targeting technology facilitated by bioorthogonal chemistry. Specifically, the research goal is to mediate the highly specific presentation of the azide group on targeted cell surfaces for targeting by alkyne-containing substrate.

If demonstrated *in vivo,* the new targeting concept should result in a paradigm shift, using a chemical reaction instead of complex biological macromolecule interactions such as antibody/antigen. The technology can be applied to the development of disease-targeting small molecule conjugates, and also potentially used to design patient-specific nanomedicine. It should also find broad application in cell differentiation, cell sorting, targeting cell recognition, gene and drug delivery, and drug discovery and development.

A Computational Approach to Redistricting Reform

Wendy K. Tam Cho
Associate

Department of Political Science



Legislative redistricting occurs every ten years in the United States, following the decennial census. Ideally, the resulting districts provide fair representation for every citizen. In practice, many district lines are drawn carefully to favor or ensure future election results.

Professor Cho's research project aims to provide computational tools that will illuminate and open up the redistricting process. A complicating factor is that many possible redistricting plans are extremely similar. Moving a single census block from one district to another does not cause much change; and there are many such minor modifications possible in any redistricting plan, with the magnitude of the problem rising exponentially with the number of geographic units. While an exact optimal solution is computationally intractable, she aims to combine the idiosyncrasies of the redistricting process with a genetic algorithm to produce near-optimal redistricting maps.

During her Center appointment Professor Cho and her research group will extend their library of scalable parallel genetic algorithms for computational analysis of ways to optimize the process of redistricting. They will formulate the redistricting problem as a discrete optimization problem, introduce quantitative measurements to score maps on a variety of redistricting criteria, and develop and apply new algorithms using optimization tools. High-performance computing will allow them to examine the problem at considerably finer spatial scales than ever before.

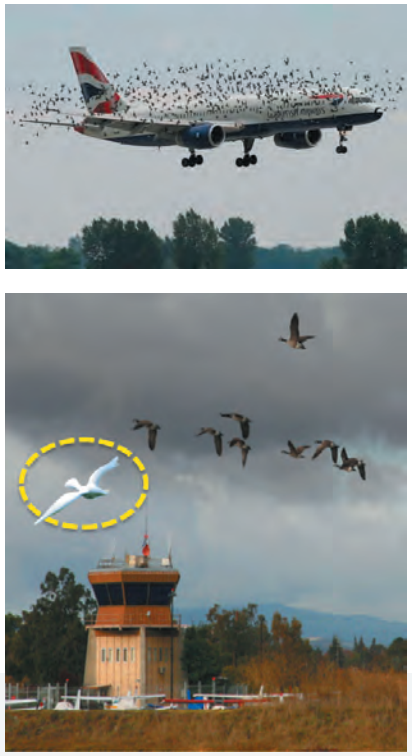
The project lies at the threshold of applying statistical and mathematical modeling and computing technology to achieve societal tasks. Instead of tinkering with endless possibilities, Professor Cho will develop computationally intensive models to synthesize and organize massive amounts of computation/data to help evaluate redistricting schemes and tailor them to our notions of fairness and democratic rule.

Control and Motion-Planning Algorithms for Robotic Falcons to Prevent Airport Bird Strikes

Soon-Jo Chung

Beckman Fellow

Department of Aerospace Engineering



Top: Bird strikes on aircraft. Bottom: Solution provided by fully autonomous robotic falcon.

Bird and other wildlife strikes on aircraft endanger passengers and cost $1.2 billion annually worldwide in damage to civil and military aviation. Now imagine a future with aerial robots that can fly like falcons, perch on airport fences, and effectively scare birds away from airfields. Professor Chung's long-term goal is to realize that future by establishing a new aerial robotic system and enabling technologies derived from the key control and sensing mechanisms that underlie natural flyers, thereby providing highly maneuverable aerial robotic platforms.

During his Center appointment Professor Chung aims to develop bird-like flapping robots that can be deployed in swarms to fend off "antagonists." The project builds on his previous work on the control of flapping-wing aircraft using coupled limit cycles, and on the dynamics and control of flexible, articulated-wing aircraft. He will also explore new strategies for herding, applying tools in control theory and real-time optimization.

Society as a whole stands to benefit from robotic birds that can effectively prevent bird strikes. Articulated-winged flapping aerial robots equipped with sensors could also allow access to areas that humans cannot reach (e.g., partially collapsed mines) and make revolutionary advances in the monitoring and recovery of critical infrastructures such as nuclear reactors, power grids, bridges, and borders.

The transformative nature of the research will contribute broadly in robot locomotion and biomimetic control as well as in distributed control theory that concerns many degrees of freedom (e.g., boundary control for flexible robotic arms). The research will also derive a mathematical tool that can test various biological hypotheses in animal and human movements and in motor disorders such as Parkinson's disease.

Ecological Determinants of Luteal Reproductive Function

Kathryn Clancy
Beckman Fellow

Department of Anthropology

Rural Polish farmer.

Miscarriage is a normal and natural component of reproductive function in women. While half of miscarriages result from chromosomal abnormalities in a fetus that would not make it to term, we can explain few of the reasons for the remaining, non-chromosomal losses. We do know that the second half of the menstrual cycle (the luteal phase) is when the critical events of early pregnancy occur, and that reproductive functioning during this phase can be suppressed when women experience energetic or immunological stress. This knowledge frames the current research project undertaken by Professor Clancy.

During her Center appointment Professor Clancy will conduct field research among women at the Mogielica Human Ecology Study Site in rural Poland, as part of a longitudinal, ecological study of the endometrium in a non-industrialized population. The project is the first-ever study of women's systemic reproductive functioning over an entire menstrual cycle: it includes demography, anthropometry, psychometrics, daily urine collection for reproductive hormones and stress biomarkers, and endometrial ultrasounds. Women in the sample population are under some energetic constraint (e.g., moderate physical activity during the harvest season, potential systemic inflammation resulting from the farm environment), which will make it easier to document variations in their environment and responses.

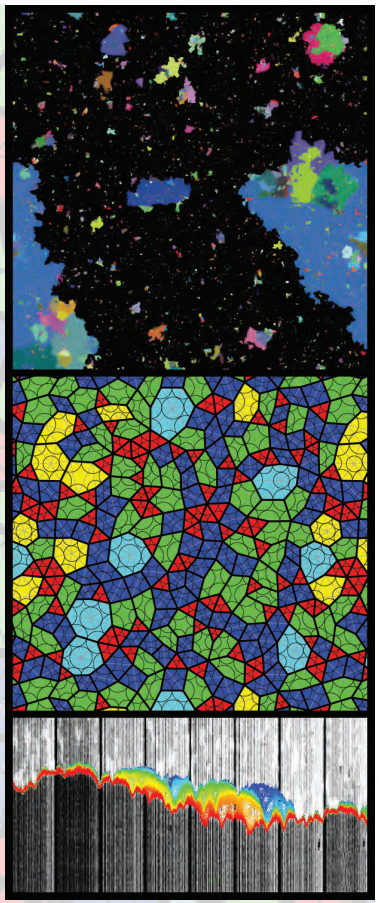
The results from Professor Clancy's early work have led to new insights into how bodies allocate energy to ovarian and uterine processes. For this project, Professor Clancy aims to (a) characterize the relationship between ovarian and endometrial function among women in a moderately constrained environment, (b) model the associations between biomarkers of ecological stressors and ovarian and endometrial function, and (c) advance our understanding of how developmental milestones correlate with adult reproductive function.

Unifying Theory of Universal Quake Statistics: From Nanocrystals to Earthquakes

Karin Dahmen

Associate

Department of Physics



Many systems respond to small forcings with large fluctuations, often with sudden snaps/cracks or crackles that can span many orders of magnitude in size. Examples range from the crackling noise emitted when milk invades rice crispies to sudden rearrangements in densely packed granular materials to events such as earthquakes, landslides, and snow avalanches. Similar sudden responses are seen in other contexts, including magnetization avalanches in magnetic materials, resistivity fluctuations in superconductors, and blackouts of power grids. A better predictive and physical understanding of these kinds of sudden responses would be quite useful in a wide range of applications.

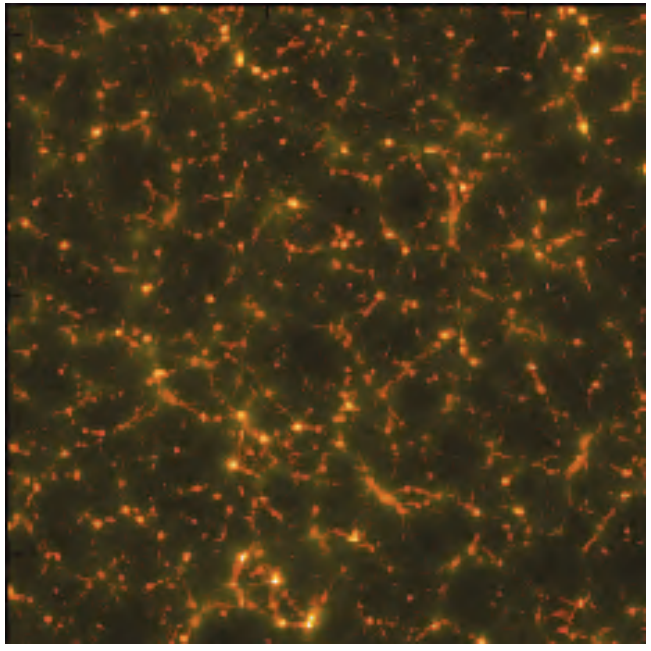
Recently Professor Dahmen's research group has contributed simple models that offer this promise, showing, for example, that their simple model for the jerky deformation characteristics of materials describes the statistical properties of fluctuations in slowly compressed crystalline pillars. The model allows many predictions that can be tested.

During her Center appointment Professor Dahmen will co-organize and participate in an extended interdisciplinary research workshop at the Kavli Institute of Theoretical Physics, University of California–Santa Barbara. The workshop presents a unique opportunity for Professor Dahmen to collaborate with experts on a broad range of different systems and expand her group's model and test its predictions using experiments, simulations, and observations. The workshop will also explore potential applications of the results to materials testing and hazard prevention.

New Signatures of Neutrinos in Cosmology

Neal Dalal
Fellow

Department of Astronomy



Simulation volume: red = density of dark matter; green = density of neutrinos.

Neutrinos appear to be among the most numerous particles in the universe; and because neutrinos have mass, they can have a profound effect on the evolution of structure in the universe. Conversely, measuring how large-scale structure in the universe evolves over cosmic time provides one of the most promising methods to determine neutrino masses. An obstacle, however, is that we currently do not know how to compute neutrino effects on large-scale cosmological structure except in certain limited regimes.

During his Center appointment Professor Dalal will continue his group's work on a promising new method to resolve this obstacle. The method involves combining techniques from traditional N-body simulations (Lagrangian methods) with techniques from hydrodynamical simulations (Eulerian methods) – in essence describing neutrinos not as discrete particles but as a fluid governed by fluid equations. The method has yielded the first code in the world capable of consistently computing cosmological structure formation, including the effects of neutrinos.

The current project will apply the code to run simulations that map out the effects of massive neutrinos as a function of the mass hierarchy. A crucial aspect is that the simulated volume must be large enough to encompass the *free-streaming scale*, the typical distance traveled by neutrinos since the Big Bang, while having sufficiently fine spatial resolution to detect individual galaxy halos.

Preliminary results of smaller-scale simulations suggest that the spatial distribution of galaxies provides a new signal of neutrino masses. If correct, this result would imply that galaxy surveys will be able to measure the masses of neutrinos, thereby opening a new window onto neutrino physics and filling in one of the final remaining pieces of the Standard Model of particle physics.

"El Legado de España": The Discourse of Hispanism in Cuba, Puerto Rico, and the Philippines in the American Empire

Augusto Espiritu

Associate

Department of History, Department of Asian American Studies

H*ispanism* is a pan-national discourse characterized by an idealized affiliation with the Spanish race and shared heritages of Catholicism, Spanish civilization, and traditions of protest. In exploring this discourse, Professor Espiritu has been intrigued by the interrelationships among Hispanism, colonialism, and national identity. His book project focuses on the intellectual life of three U.S. acquisitions resulting from the Spanish-American War: Cuba, the Philippines, and Puerto Rico.

The book addresses three questions. First, why did intellectuals living under these U.S. colonial or post-colonial regimes embrace the discourse of Hispanism, especially as a critique of Americanization? Second, why did they evoke "Spain" in their search for national identity? The abuses of the Spanish colonial system, so recently experienced in these locations, could reasonably have discredited Spain as a source for national cultural reconstruction. And third, why does Hispanism continue to persist even today?

In answering these questions, Professor Espiritu portrays Cubans, Puerto Ricans, and Filipinos as thinkers capable of profound intellectual endeavors. He presents external factors that constrained their individual expression – colonialism, war, exile, racism, and class prejudice – and the ways they sought to overcome these challenges, through a nationalism that was empowering and liberating and also subject to its own excesses.

The book engages the grand themes of modernity, construction of national identity, resistance to imperial hegemony, and the impact of racial and gendered ideologies on colonial subjects. It offers a broad view of the different ways in which colonized peoples confronted policies of assimilation and cultural Americanization, and an appreciation for why certain political or cultural discourses have continued to appeal to Latin American and Asian intellectuals.

Sharp Bounds for Small Moments of Multidimensional Weyl Sums

Kevin Ford
Associate

Department of Mathematics

The study of Diophantine equations (i.e., integer solutions of polynomial equations and systems of equations) has a long history going back thousands of years. One of the most powerful techniques for analyzing Diophantine equations is a collection of ideas that expresses solutions in terms of integrals of functions called *Weyl sums;* one component of this method is a mean value for Weyl sums, known as *Vinogradov's Mean Value.*

Recent collaborative work in this area has resulted in new methods for analyzing the integer solutions of the type of equations known as *Vinogradov's system.* The results led to sharp estimates for the number of solutions of the system for a wide range of *s* (the number of variables in the system) and settled a longstanding conjecture on the subject, which had been open since the 1930s. Subsequent work proved sharp bounds and the main conjecture for such systems when *s* is large.

During his Center appointment Professor Ford will contribute in this area through his continuing collaboration with professors Scott Parsell (West Chester University) and Sean Prendiville and Trevor Wooley (University of Bristol, U.K.). Their project will focus on establishing the main conjecture for such systems when *s* is small. At the heart of their method will be the *efficient congruencing* innovation developed by Professor Wooley, its adaptation to the realm of small *s* in Vinogradov's Mean Value, and its extension to the multidimensional setting. One of their first tasks is to create a new "p-adic" theory where equations are replaced by congruences.

Their research results are expected to have application to the theory of more general types of equations, to the distribution of prime numbers, and to other questions in number theory.

Topological Order and Symmetry Breaking in Condensed Matter Physics

Eduardo H. Fradkin

Associate

Department of Physics

The main directions of Professor Fradkin's research are the theory of topological phases in condensed matter and the theory of electronic liquid crystal phases. One exciting feature of his research is that it combines fundamental problems in quantum mechanics and quantum field theory with experiments at the leading edge of technology. The recent discovery of materials known as *topological insulators*, for example, has opened the possibility of creating a topological quantum computer by combining topological materials with superconductors and high-temperature superconductors.

Over the past decade Professor Fradkin has been working on the theory of high-temperature superconductors within the conceptual framework of electronic liquid crystal phases – that is, phases whose microscopic constituents are electrons that carry both charge and spin. He and his colleagues have concluded that these phases must also include novel phases in which the superconducting state itself might also behave as a nematic fluid. A natural consequence of this concept is that these phases, instead of competing with each other, might instead be intertwined, which means that different orders may arise with similar strengths.

The concept of electronic liquid crystal phases thus appears to be closely related to the existence of novel phases that exhibit a combination of topological order and symmetry breaking. This is the direction of work Professor Fradkin will pursue during his Center appointment. He plans to develop a theory of the interplay and phase transitions between topological order and symmetry breaking in condensed matter. Of particular interest is investigating the mechanisms that may bring about topological phases in three-dimensional systems and fully characterizing their edge states. He also plans to investigate the interplay and associated phase transitions from (and/or inside) topological phases to states with spontaneously broken symmetries.

Networking at the Speed of Light

Philip Brighten Godfrey
Beckman Fellow

Department of Computer Science

A good Internet experience requires *responsiveness*, especially with human applications like web browsing and interacting in real time with voice and video. Even tens of milliseconds of delay can affect perceptions of the "latency" lag and lead to significant reductions in website revenue. During his Center appointment Professor Godfrey will work to establish speed-of-light latency as a grand challenge for the computer networking research community. The goal is to achieve responsiveness close to the underlying physical limits.

Professor Godfrey's agenda includes conveying this long-term vision to the research community, conducting measurement studies to map out latency problems and opportunities, and developing new technologies to reduce latency.

First he will develop an understanding of why latency is generally inflated by more than an order of magnitude beyond the ideal. He will build a comprehensive picture of each layer of the network architecture, including the physical location of fiber lines, routing paths within those lines, and transport protocols used to establish end-to-end communication. He will then compare the baseline ideal speed-of-light latency with measured latency and correlate the results with the various Internet Service Providers (ISPs) involved. A continual release of this data analysis is expected to promote competition among ISPs to reduce latency.

Two additional elements of this project will result in direct contributions. Professor Godfrey is exploring the use of *redundant requests* to achieve consistently low latency in Domain Name System resolution, storage services, and multipath routing, which will result in open-source software that accelerates web applications. He will also develop and release open-source software that makes control decisions based on real-time analytics of performance outcomes. While this software represents a radically new architecture, it works within existing protocols and requires changes on the sender side only.

Analysis of Surface Water Waves

Vera Mikyoung Hur
Beckman Fellow

Department of Mathematics

Credit: istock photo.

***S**urface water waves* encompass a wide range of phenomena, ranging in length scale from ripples driven by surface tension to rogue waves and tsunamis. The phrase describes the situation where water lies below a body of air and is acted upon by gravity and possible surface tension.

While water waves have stimulated a considerable part of historical developments in the theory of wave motion, they present profound and subtle difficulties for rigorous analysis, modeling, and numerical simulations. Notably, the interface between the water and the air is a free boundary, *a priori* unknown and to be determined as part of the solution. Free boundaries are mathematically challenging in their own right. In addition, boundary conditions at the free surface are severely nonlinear, presenting further challenges.

During her Center appointment Professor Hur will address several issues in the mathematical aspects of surface water waves. She plans to develop new tools in partial differential equations and other branches of mathematics, and also extend and combine existing tools, to focus on:

- Global regularity versus finite-time singularities for the initial value problem.
- Existence of traveling waves and their classification.
- Stability and instability of traveling waves.

Her project emphasizes large-scale dynamics and genuinely nonlinear behaviors, such as breaking and peaking, which ultimately rely on analytical proofs for an acute understanding.

Progress in Professor Hur's research is expected to help resolve several longstanding open problems in the area, while also leading to applications in related, interfacial fluids problems and in numerical simulations and engineering.

Designing Next-Generation Computing

Yi Lu
Fellow

Department of Electrical and Computer Engineering

We are witnessing a great wave of digitized data, with widespread use of smart phones, increasing scientific and medical data generated in digital format, and the variety of information collected in cyber-physical systems. Typically the data are generated more dynamically and at a much higher rate than previously, and they demand more intelligent interpretation and retrieval mechanisms.

The computing system that has arisen in response is *the cloud.* This legacy architecture was based originally on proprietary search engines, e-commerce systems, and grid computing. It has since been upgraded with *ad hoc* changes, but fundamental problems remain in the areas of scalability, response quality and speed, and energy consumption.

During her Center appointment Professor Lu will work toward designing a computing system that is amenable to big data, is scalable and energy-efficient, and has performance guarantees.

The project consists of four parts:

1. Design novel task-scheduling architecture and algorithms to improve response time by orders of magnitude without sacrificing quality or consuming extra resources. An equivalent interpretation is achieving the same response time and quality with only a fraction of the energy consumption.
2. Design data-placement architecture and algorithms to improve interpretation and retrieval, and to achieve scalability of the system.
3. Measure and analyze workload to understand characteristics in production clusters, with efficient tracing to allow fast and reliable evaluation of a large system in a small testbed.
4. Balance loads to reduce the power-conversion loss (currently as high as 10-15 percent before computation even takes place) using a series-stacked power-delivery architecture.

In pursuing her project goals, Professor Lu is collaborating with colleagues in power electronics, circuits, medical imaging, and genomics.

Sanctified in Water, Sealed in Stone: The Italian Baptistery 1000-1500

Areli Marina
Associate

Art History Program

Parma, Baptistery (interior), begun 1196.

During Christianity's early centuries, freestanding baptistery buildings provided the requisite separate settings for the ritual initiation of adult converts into the Christian congregation. By 1000, however, most Western Europeans were baptized as infants. The liturgical requirements that formerly demanded independent structures for Christian initiation no longer applied. Consequently, the baptismal ritual was simplified and decentralized. Separate baptismal halls became redundant. Yet although construction of monumental, independent baptisteries stopped elsewhere in Europe, more than 80 of them were built in Italy from the eleventh through the fifteenth centuries, including some of the peninsula's most celebrated monuments. What accounts for their resurgence?

Professor Marina presents the first comprehensive explanation for, and interpretation of, the resurgence of independent baptisteries, along with source material that can serve as a point of departure for future study. By extracting baptisteries from architectural history's developmental narrative and considering the impact local and regional conditions had on their design, production, and reception, she demonstrates that Italy's post-millennial baptistery boom is really three separate phenomena with discrete geographical and temporal boundaries. All are the product of Italy's peculiar ecclesiastical and political fragmentation and distinctive traditions of architectural patronage. Her conclusions are based on study of an expanded corpus of more than 80 baptisteries located within the frontiers of modern Italy and also in Italian settlements on the eastern side of the Adriatic.

In the book manuscript Professor Marina plans to complete during her Center appointment, she also debunks the myth of a universal baptistery "building type" and reframes the discussion of the baptistery's architectural signification. By addressing both the material reality and diverse cultural functions of baptisteries, Professor Marina aims to arrive at a subtler understanding of their multiple roles in forging Italy's distinctive civilization.

Making a Home in the Heartland: Immigration and Global Labor Mobility

Faranak Miraftab
Associate

Department of Urban and Regional Planning

During her Center appointment Professor Miraftab plans to complete her book manuscript, *Making a Home in the Heartland: Immigration and Global Labor Mobility.* In the book she weaves together interviews she collected in Illinois, Mexico, and Togo, charting the processes that capture and consume migrants' labor and also those that produce and sustain the global mobility of labor.

In the early 1990s, Cargill, Inc., faced a dwindling local labor force willing to accept the low-wage, high-risk jobs available at its meat-packing plant in Beardstown, Illinois, and began recruiting workers among French-speaking Africans (predominantly Togolese), Spanish-speaking Latinos (predominantly Mexicans), and, to a smaller extent, African-American Detroiters. The dramatic and rapid diversification of Beardstown was not an easy transition. But today, Beardstown's economic gains contrast sharply with adjacent dying rust-belt towns, and there has been a significant social transformation: almost every residential block is integrated, multi-racial soccer leagues play in the open fields, and cultural identities are celebrated in public spaces.

In her book, Professor Miraftab queries the global cost of this midwestern revitalization: What are the global conditions that produce the migrant labor force that finds its way to Beardstown? What conditions make it possible for these workers to continue in their low-wage, high-risk jobs? And finally, how do these new workers negotiate inter-racial and inter-immigrant relationships outside the workplace?

Professor Miraftab answers these questions through an ethnographic approach that exposes (a) production of migration through processes of dispossession and displacement and (b) social reproduction of migrant labor force through transnational practices of care work. To make their wages viable, for example, workers tap into free or inexpensive familial and community care through networks that continue to connect Beardstown with Mexico and Togo and effectively subsidize the wages Cargill pays. The book will be published by Indiana University Press as part of its book series, Global Research Studies.

Research in Geometric Representation Theory

Thomas Nevins
Associate

Department of Mathematics

The mathematical field of *representation theory* studies algebraic models of symmetry. Beginning in the late 1970s, the geometric construction of algebraic models of symmetry resulted in a fundamentally new subject known as *geometric representation theory.* The leading role in this developing area has been played by the algebraic theory of differential equations, as mediated by the structure of $\mathcal{D}$-modules.

Much of Professor Nevins' recent work has aimed at expanding the toolkit of $\mathcal{D}$-modules to more general contexts, with applications to a broad new range of problems in geometric representation theory. Jointly with Professor Kevin McGerty (Mathematical Institute, Oxford University) he extended the Beilinson-Bernstein localization theorem for $\mathcal{D}$-modules from its original context to a much more general setting. They established precise relationships between a piece of the category of (twisted) G-equivariant $\mathcal{D}$-modules on a variety X with an action of a reductive group G and modules over a quantum Hamiltonian reduction of X. During his Center appointment Professor Nevins plans to continue this collaboration and establish a general structure theory for the entire category of G-equivariant $\mathcal{D}$-modules, and then apply it.

Also during his Center appointment, Professor Nevins plans to continue a wider collaboration to prove a now-standard expectation in symplectic topology, i.e., that the Fukaya categories of certain real symplectic manifolds should be realized by categories of deformation-quantization modules. The next steps in this area are to develop the deformation theory of cell categories and to construct a period map. Accomplishing these steps will provide a concrete characterization of Fukaya categories.

The two projects are closely related: each makes manifest a structure indicated by Morse theory, and thus together they express a satisfying underlying unity to emergent phenomena in the study of $\mathcal{D}$-modules.

Writer, Painter, Banker, Thief: The American Arts Colony in the Public Account

Catherine Prendergast
Associate

Department of English

Yaddo arts colony.

The oldest American literary, musical, and visual arts colonies – Yaddo, MacDowell, Byrdcliffe, and Carmel-by-the-Sea – were founded in the first decade of the twentieth century. Typically the founders were business magnates in the second tier. Unable to afford such grand gestures as endowing urban institutions like the Metropolitan Museum of Art, they could, however, plan a colony, buy up cheap land in rural areas, and impose a kind of cultural manifest destiny that legitimated, in their views, hard-nosed business dealings with local residents.

Locals in the towns where these colonies were founded, however, viewed the colonies as taking up precious land while providing nothing in return. Residents used the courts, the newspapers, and even acts of civil unrest to demand that the colonies respond to them as a non-abstract public. These local challenges resulted in robust public conversations about how the arts are supported and whom they should serve.

Professor Prendergast brings together the cultural and economic histories of these colonies and the people who surrounded them in her book-length project, *Writer, Painter, Banker, Thief.* She asks: Who invests in a cultural activity at a given point in time, and why? Her method looks at sites of cultural investments causing conflict between individuals in powerful positions and those who feel the cost of their largesse.

During her Center appointment she will complete her research, which includes local newspaper and town archives along with the colonies' records, and write the final chapters of the manuscript. She expects the resulting book will offer lessons for understanding the current moment in the United States, when arts institutions find themselves in vulnerable financial straits and needing to articulate their worth to a skeptical public.

Sprayed: A Cultural History of Agent Orange in the United States and Vietnam

Leslie J. Reagan
Associate

Department of History

U.S. Air Force C-123 spraying defoliant along a highway in Vietnam (Department of Defense file photo, May 1966).

During the Vietnam War, the U.S. military sprayed herbicides over Vietnam and also Cambodia and Laos. Agent Orange, the most infamous of these, was designed to kill the jungle, thus exposing the hidden enemy, and was sprayed on crops to "deny" them food. From the earliest spraying to the present, people complained of its lasting effects on the environment and also its effects on their own bodies.

Agent Orange consists of two herbicides: 2,4-D and 2,4,5-T. It is the second compound that contains dioxin and is associated with human respiratory problems, cancers, miscarriages, and congenital malformations. In the 1970s, 2,4,5-T was used in U.S. national forests and on residential lawns to clear unwanted trees and weeds. Wherever Agent Orange and 2,4,5-T were used, they sparked protests.

Professor Reagan's book project, *Sprayed: A Cultural History of Agent Orange in the United States and Vietnam* investigates the herbicide's transnational sociopolitical and cultural history. Her inquiry is both historical and contemporary.

Although Agent Orange was banned, it has a long life that continues into the present in the environment, in the changed landscape, and in human bodies that cough, erupt with sores, suffer cancers, and are born misshapen. It continues, too, in memory and culture.

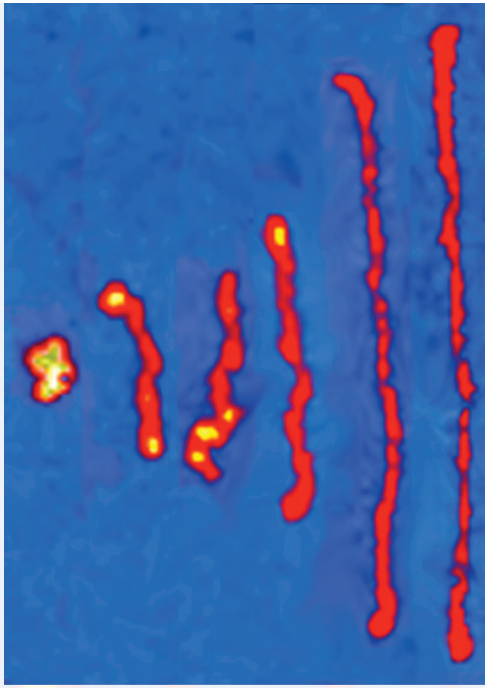
In *Sprayed* Professor Reagan finds that the story is more than the victimization of American veterans; it is a shared history with the people of Vietnam. Part I provides a chronological history of U.S. use of Agent Orange both in the Vietnam War and at home. Part II moves to Vietnam, describing how Agent Orange arose as a political issue there in the 1980s, and analyzing visual and cultural representations of Agent Orange in museums and film.

Molecular Design and Engineering of Advanced Functional Materials

Charles M. Schroeder

Beckman Fellow

Department of Chemical and Biomolecular Engineering



Single polymers stretching in flow, imaged using fluorescence microscopy.

The forefront of chemical science research lies in the manipulation and analysis of single molecules. To this end, the ability to control molecular processes holds the key to developing new materials with desired functionalities. Major challenges in the field of materials chemistry include the ability to: (a) control the underlying structure of materials during flow processing and (b) synthesize "precise" materials with defined shapes and structures. During his Center appointment Professor Schroeder will continue to lead his group's research efforts to achieve these abilities.

One area of focus extends the field of single-polymer dynamics to new materials, including flexible chains, copolymers, and branched polymers, to gain improved ability to control the properties of materials during processing. In this effort, the group is using single-molecule imaging to study polymer dynamics, directly "watching" polymer motion during processing. This work will bridge the gap between molecular phenomena and bulk-scale behavior.

Another focus involves "grabbing onto" single polymer molecules using microfluidic trapping. With this technique, single polymers or nanoparticles in free solution are confined and manipulated using the action of gentle fluid flow in a microfluidic device. The technique offers the promise of synthesizing new materials by fluidic-directed assembly or fine-scale patterning of nanomaterials.

In coupling molecular-scale characterization with synthesis, the group aims to produce synthetic biopolymers that have new structures, tunable material properties, and novel functions – ultimately creating new template-based synthesis schemes that mimic the control found in nature, thereby offering a powerful approach to the design and engineering of new materials.

The Haunted Empire: The Russian Literary Gothic and the Imperial Uncanny, 1793-1844

Valeria Sobol
Associate

Department of Slavic Languages and Literatures

Hammershus, on the Danish island of Bornholm, is the setting of the first Russian Gothic tale, *The Island of Bornholm* (1793), by Nikolai Karamzin.

Russian Gothic literature (1793-1844) consistently depicts the empire's peripheries as haunted landscapes. These areas become settings for what Professor Sobol calls *the imperial uncanny* – the experience of danger and uncertainty in ambiguous colonial spaces within Russia's borders. The Gothic genre aesthetically enacts these tensions and offers a powerful critique of empire through the popular form of an entertaining, suspenseful narrative.

Professor Sobol's book-length project focuses on two geographical spaces in Russian Gothic literature: the Baltic/Scandinavian "North" and the Ukrainian "South." Both areas were relatively late additions to the Russian empire and thus preserved an aura of exoticism during the period under study. The North/South paradigm offers an alternative to the prevailing stereotype of "Russia between East and West."

The book pays particular attention to the specifics of the location and the imperial context of Gothic events in these narratives. Where in imperial geography does the Gothic encounter take place? What is the power relationship between the participants of the encounter? Are they ethnically marked? and Why is it that particular ethnicities are portrayed as sources of Gothic horror?

Ultimately, Professor Sobol aims to reconstruct a uniquely Russian tradition of the imperial uncanny – a fictional space into which the Russian empire projected its colonial fantasies and anxieties and where, through the use of Gothic tropes, it created the apparitions and monsters that continue to haunt Russia's historical imagination. As the current Russian-Ukrainian crisis has demonstrated, the Russian imperial uncanny is still at work today. Professor Sobol's study points to a long history of Russia's imperial anxiety and ambition derived from its inability to fully accept the otherness of its formerly colonized neighbors.

Emblematic Practices: Emblems and Culture in Early Modern Germany

Mara Wade
Associate

Department of Germanic Languages and Literatures

Emblem showing motto, pictura, and subscriptio (Peter Isselburg, *Emblemata Politica*, 1617).

The *emblem*, consisting of both textual and visual elements, is capable of expressing highly complex ideas in compact and compelling forms. In Europe during the sixteenth and seventeenth centuries, emblems focused the articulation of new ideas, and familiar texts and images were reassembled to create new meanings. They gave impetus to intellectual exchange and social conviviality, becoming significant agents of cultural transfer and spreading over the entire continent from 1531 well into the eighteenth century.

Professor Wade's book-length project initiates a new kind of research in emblem studies that is based on a cross-section of cultural practices in German-speaking lands of this period. She seeks to discover and define the underlying "emblematic turn," the new cultural framework of the early modern period employed for the articulation of all manner of cultural expressions at court, in the academy, and among educated elites in towns.

The book is conceived in five core chapters: the new emblematic way of thinking and its practices; the seventeenth-century culture of conversation, through reflections of gender and emblematics; the role of emblems in institutions and intellectual communities; the use of emblems to create memory; and the use of emblems to create dynastic identity in ephemeral performances at court. During her Center appointment Professor Wade will define the final shape of the book, establish the theoretical framework for the five core chapters, and identify and study new sources.

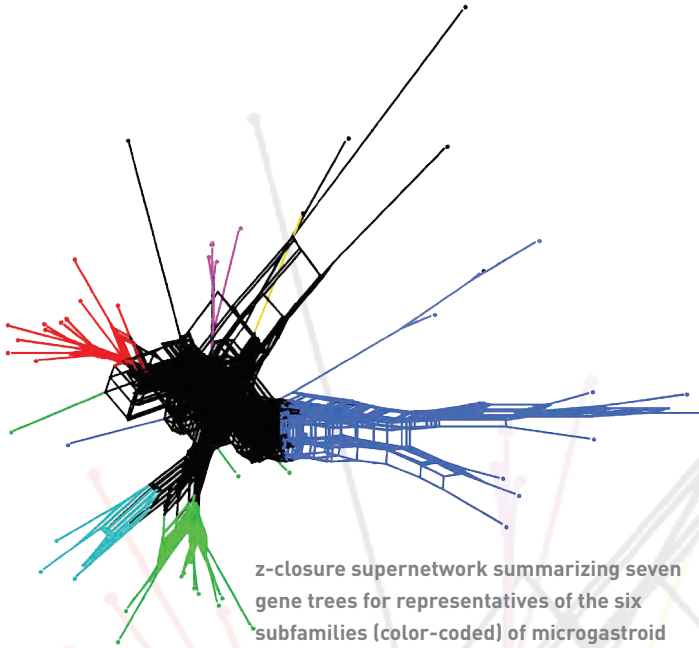
As part of this project, Professor Wade seeks new ways in which existing digital projects might aggregate their accumulated data and expertise to unite very large sets of cultural data to support expanded study of the literature, art, and culture of the early modern period.

Testing of New Phylogenetic Network Methods with Appropriate Empirical Biological Datasets

James B. Whitfield

Associate

Department of Entomology



z-closure supernetwork summarizing seven gene trees for representatives of the six subfamilies (color-coded) of microgastroid parasitoid wasps.

Since the days of Darwin, the prevailing metaphor for the evolution of life on Earth has been that of a phylogenic tree, with the trunk representing the earliest life on Earth, branches representing the evolutionary lineages of life forms, and the world's present-day species depicted on the tips of branches.

Not all of evolution, however, produces tree-like historical patterns. It is now being realized how complex genomes really are, both in their composition and in their evolutionary histories. Genetic recombination, gene conversion between paralogous gene copies, operon formation, lineage sorting among alleles – these and other genetic phenomena can produce conflicting patterns that cannot be summarized effectively with a single evolutionary tree. A promising alternative is using phylogenic *networks* to help reconstruct relationships among organisms and interpret their genomic data.

During his Center appointment Professor Whitfield will serve as *biological problem collector* in an international collaboration with mathematicians, computer scientists, and other biologists to develop practical network methods that answer the questions biologists are asking. He will supply real biological datasets to test several of the mathematicians' network approaches. For example, Eubacteria and Archaea display an unusually high level of gene-sharing, with complex genomic relationships. Network visualization tools for these relationships are already under development, but how will the methods scale up to larger problems as new sequenced genomes accumulate? Only tests with real data will tell.

In addition to validating or invalidating the network methods being developed, the project will result in a greatly expanded research base of test datasets that will benefit network research for years to come. It is also likely that the collaboration will lead to new network methods not yet conceived.

An Untitled Novel on Pre-colonial Dahomey (West Africa)

David Wright
Associate

Department of English

King's symbols from the Abomey Tapestry.

Professor Wright is writing a novel that recovers the story of Adandozan, the forgotten King of Dahomey. The work builds on his recently completed novel, *All the Best Things Thus*, in which Adandozan plays a secondary role, to explore the complicated and complicitous role that Africans played in the trans-Atlantic slave trade.

For more than 200 years, the kings of Dahomey (now Benin) ruled over the stretch of West Africa known as the Slave Coast for the quantity of human chattel originating from the region. But in the Age of Revolution, anticipating the eventual end of slavery, King Adandozan attempted to shift the Dahomeyan economy toward what he saw as the more stable product of palm oil. The attempt proved his undoing.

In 1818 Adandozan was unseated by his brother Guézo in a coup. Instead of killing the deposed king or selling him into slavery, Guézo exiled Adandozan to an isolated section of the palace and told the people his predecessor was insane. Adandozan's emblem was unstitched from the royal tapestry, and Guézo directed that his name never be spoken aloud again – which, in this oral culture, effectively removed Adandozan's memory from history.

Professor Wright has traveled to the region to conduct research and to deepen his understanding of the local Yoruba and Fon cultures. Experiencing the specific geography, interacting with local people, and witnessing traditional ceremonies will inform how he imagines the characters and will direct how he proceeds with his writing. During his Center appointment Professor Wright intends to organize and study his collected research and construct a good first draft.

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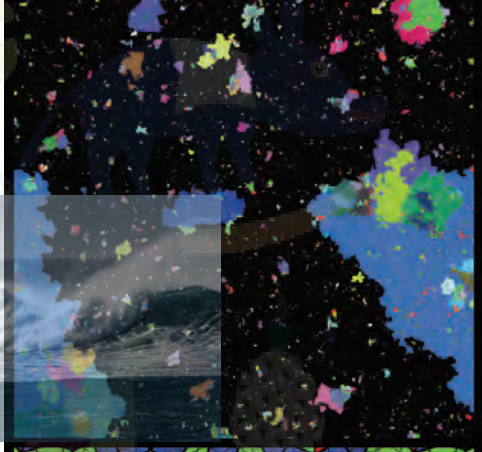
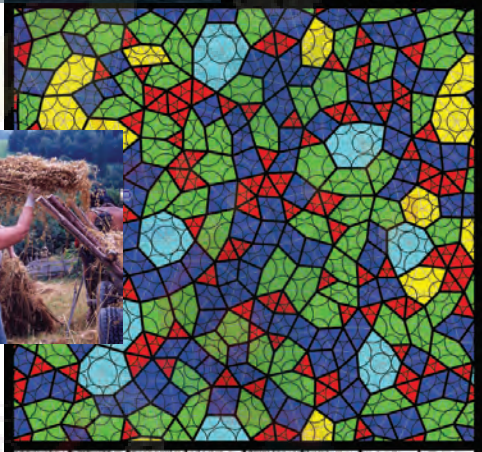


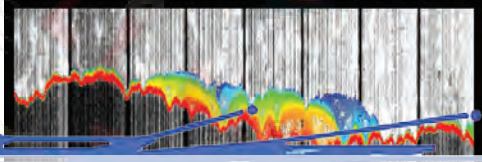

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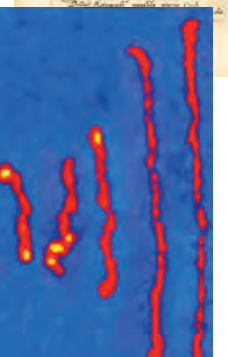
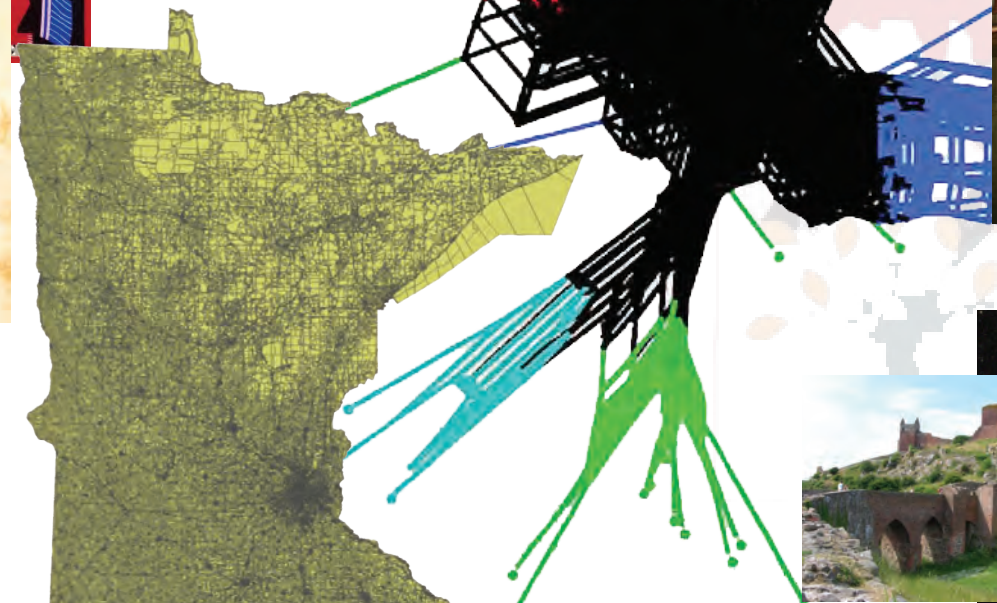

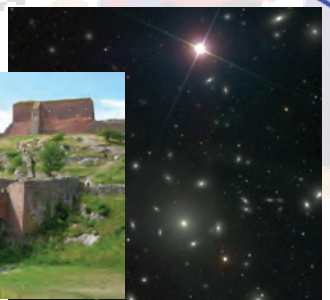


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