

CAS

Center for
Advanced
Study

RESEARCH APPOINTMENTS / ASSOCIATES AND FELLOWS 2021 - 22



University of Illinois Urbana-Champaign



SEVEN WONDERS: REMAKING THE PAST • DEVELOPING THE THEORY FOR NEW PROBES OF QUANTUM MATERIALS • HEALTHY FOR WHOM? SOCIAL EQUITY IN THE DISTRIBUTION OF BICYCLING BENEFITS AND RISKS • ADVANCING AFFORDABLE HOUSING THAT SUPPORTS HEALTH AND WELLNESS • AI-DRIVEN CONSTRUCTION • AUTOMATED POLYMER SYNTHESIS TO ACCELERATE DISCOVERY • IN SEARCH OF NEUROENDOCRINE MECHANISMS OF HOST-PARASITE INTERACTIONS • PALMARES AFTER 1695: DIASPORIC INHERITANCE AND THE DEATHS AND AFTERLIVES OF ZUMBI • SOUTH POLE TELESCOPE DATA ANALYSIS • WHO BENEFITS FROM PRIVATE CLIMATE FINANCE? PRIVATE CLIMATE ADAPTATION FINANCE AND ITS IMPLICATIONS FOR THE DISTRIBUTION OF CLIMATE-RELATED RISKS IN INDONESIA • SKIN IN THE EARLY MODERN WORLD, 1450-1750: THE DEEP SURFACE • IMPACTS OF CONTINENTAL EVOLUTION ON GLOBAL CLIMATE CHANGE • MATHEMATICAL FRAMEWORKS FOR NEXT-GENERATION EMERGENCY MEDICAL SERVICES • INCOME AND HOUSING SUPPORT EXPERIMENTS AND CHILD NEGLECT • THE FRUITS OF ONE'S LABOR: UNCOVERING THE FACTORS THAT SHAPE SUSTAINED TECHNOLOGY ADOPTION TO REDUCE POST-HARVEST LOSS • THE SYNTAX AND TONE OF DHOLUO • TRANSFORMING OUR SOCIAL CONTRACTS • HEALTH-RELEVANT PROPERTIES OF AMBIENT PARTICULATE MATTER—TARGETED STUDIES IN AIR POLLUTED CITIES ACROSS THE WORLD • EXPANDING ACCESS TO LOW-ENERGY PHYSICS DERIVED FROM FIRST PRINCIPLES QUANTUM SIMULATIONS • TOWARD AN UNDERSTANDING OF GENTRIFICATION'S THIRD WAVE IN CHICAGO



Research Appointments 2021-22

Each year, 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 for Advanced Study's mission, these appointments provide incentives to pursue the highest level of scholarly achievement. They also provide faculty members with unusual opportunities to explore new ideas and demonstrate early results.

Along 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 campus and off-campus communities. Thus, each year brings together the established and the new in an ever-changing flux of ideas and disciplines.

In this brochure, we are pleased to introduce the projects of the 2021-22 Associates and Fellows.

CAS

CAS Review Committee

The review committee for the Associates and Fellows program consists of the Center for Advanced Study Professors. 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

May R. Berenbaum

entomology, chemical ecology

Antoinette Burton

British empire, colonial India,
race and sexuality mobility

David M. Ceperley

quantum Monte Carlo methods,
quantum many-body systems

Leon Dash

immersion journalism, domestic
and international reporting

Eduardo H. Fradkin

quantum field theory,
condensed matter physics

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

Martin Gruebele

computational modeling, laser
techniques, complex molecular
systems

Bruce Hajek

communications engineering,
stochastic methods

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

Catherine J. Murphy

nanomaterials, cellular imaging,
chemical sensing, photothermal
therapy

Tere O'Connor

dance, choreography, consciousness

Gene E. Robinson

genomics, social behavior,
social insects

Jay Rosenstein

journalism, film, documentaries

Jonathan Sweedler

bioanalytical chemistry, peptide
hormones, neurotransmitters,
neuromodulatory agents

Dale J. Van Harlingen

experimental low-temperature
physics, superconductivity,
microfabrication of superconductor
devices, scanning probe microscopy,
mesoscopic systems

Invitation to Apply

We invite the campus faculty to
submit proposals for the **2022-23**
academic year.

For more information, please
consult our website at
www.cas.illinois.edu

Application deadline:
October 5, 2021

Contents

- 02 **SEVEN WONDERS: REMAKING THE PAST**
Clara Bosak-Schroeder
Beckman Fellow
- 03 **DEVELOPING THE THEORY FOR NEW PROBES OF QUANTUM MATERIALS**
Barry Bradlyn
Beckman Fellow
- 04 **HEALTHY FOR WHOM? SOCIAL EQUITY IN THE DISTRIBUTION OF BICYCLING BENEFITS AND RISKS**
Lindsay Braun
Beckman Fellow
- 05 **ADVANCING AFFORDABLE HOUSING THAT SUPPORTS HEALTH AND WELLNESS**
Lynne M. Dearborn
Associate
- 06 **AI-DRIVEN CONSTRUCTION**
Mani Golparvar-Fard
Associate
- 07 **AUTOMATED POLYMER SYNTHESIS TO ACCELERATE DISCOVERY**
Damien Guironnet
Fellow
- 08 **IN SEARCH OF NEUROENDOCRINE MECHANISMS OF HOST-PARASITE INTERACTIONS**
Mark E. Hauber
Associate

- 09 **PALMARES AFTER 1695: DIASPORIC INHERITANCE AND THE DEATHS AND AFTERLIVES OF ZUMBI**
Marc Hertzman
Associate
- 10 **SOUTH POLE TELESCOPE DATA ANALYSIS**
Gilbert Holder
Associate
- 11 **WHO BENEFITS FROM PRIVATE CLIMATE FINANCE? PRIVATE CLIMATE ADAPTATION FINANCE AND ITS IMPLICATIONS FOR THE DISTRIBUTION OF CLIMATE-RELATED RISKS IN INDONESIA**
Sean Kennedy
Fellow
- 12 **SKIN IN THE EARLY MODERN WORLD, 1450-1750: THE DEEP SURFACE**
Craig Koslofsky
Associate
- 13 **IMPACTS OF CONTINENTAL EVOLUTION ON GLOBAL CLIMATE CHANGE**
Lijun Liu
Associate
- 14 **MATHEMATICAL FRAMEWORKS FOR NEXT-GENERATION EMERGENCY MEDICAL SERVICES**
Lavanya Marla
Fellow

- 15 **INCOME AND HOUSING SUPPORT EXPERIMENTS AND CHILD NEGLECT**
William Schneider
Beckman Fellow
- 16 **THE FRUITS OF ONE'S LABOR: UNCOVERING THE FACTORS THAT SHAPE SUSTAINED TECHNOLOGY ADOPTION TO REDUCE POST-HARVEST LOSS**
Sonali Shah
Associate
- 17 **THE SYNTAX AND TONE OF DHOLUO**
Aida Talic
Beckman Fellow
- 18 **TRANSFORMING OUR SOCIAL CONTRACTS**
Helga Varden
Associate
- 19 **HEALTH-RELEVANT PROPERTIES OF AMBIENT PARTICULATE MATTER—TARGETED STUDIES IN AIR POLLUTED CITIES ACROSS THE WORLD**
Vishal Verma
Fellow
- 20 **EXPANDING ACCESS TO LOW-ENERGY PHYSICS DERIVED FROM FIRST PRINCIPLES QUANTUM SIMULATIONS**
Lucas Kyle Wagner
Fellow
- 21 **TOWARD AN UNDERSTANDING OF GENTRIFICATION'S THIRD WAVE IN CHICAGO**
David Wilson
Associate

SEVEN WONDERS: REMAKING THE PAST*Clara Bosak-Schroeder**Beckman Fellow***Classics**

Hive, installation by Nancy Davidson and Lakshmi Ramgopal, Krannert Art Museum, University of Illinois, 2019. Photo by Della Perrone.

The field of classical studies is at an impasse, confronting white supremacist appropriations of Greek and Roman antiquity and racism and Eurocentrism within the profession itself. *Seven Wonders: Remaking the Past* retheorizes the classics and their legacy by investigating the seven great monuments of the ancient Mediterranean and their reinterpretation by modern and contemporary artists including Kara Walker, Diego Rivera, and Lakshmi Ramgopal.

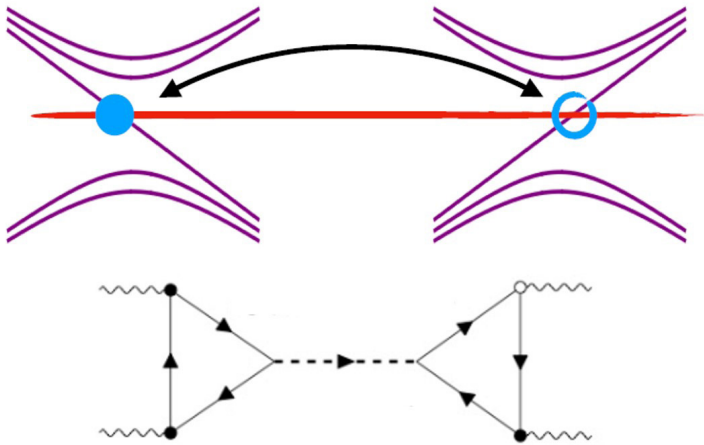
The seven wonders are themselves a legacy of the classical tradition, a canon of architectural achievements considered most impressive by ancient Greek writers and passed down to the present by Roman, medieval and Renaissance scholars. But this canon also disrupts the idea of Greece and Rome as the heart of cultural value by spanning a broader ancient Mediterranean that includes Africa and the Middle East. Pairing the seven wonders with their afterlives in the work of artists from marginalized standpoints is a unique way to counter white supremacist appropriations of ancient Mediterranean artworks and imagine a new future for classical studies, one that no longer upholds Greek and Roman material as the source of white superiority.

To understand how modern and contemporary artists have transformed the canonical seven wonders, Professor Bosak-Schroeder will use classical reception studies, which analyzes how ancient texts, artworks and ideas have been repackaged and recirculated in later periods. Imagined as a book, *Seven Wonders* also has the potential to become an interactive website and campus installation.

DEVELOPING THE THEORY FOR NEW PROBES OF QUANTUM MATERIALS

Barry Bradlyn
Beckman Fellow

Physics



The discovery of topological materials is one of the most transformative recent breakthroughs in condensed matter physics, revealing new conceptual surprises in established topics such as the phases of matter and the behavior of electrons in insulators. Mathematically, topology refers to a property that remains unchanged when a system is distorted in some way. Developments over the past decade have enabled proliferation of increasingly exotic topological materials, including insulators, superconductors and magnets. While many of these can be characterized by looking for experimental signatures of metallic surfaces on an insulating bulk, this approach is neither exhaustive nor unique.

In order to further study topological materials using bulk probes, and to exploit topological properties in devices, Professor Bradlyn has joined the newly established Center for Quantum Sensing and Quantum Materials (CQSQM) here at the University of Illinois, funded by the Department of Energy. The center brings experimental physicists and theorists together with the goal to develop new probes of quantum materials, and to use those probes to understand the properties of mysterious topological materials. During his CAS appointment, Professor Bradlyn and his colleagues will work towards this goal through a series of three concrete projects. First, they will develop the fundamentals of nonlinear response theory and apply them to proposed experiments using X-rays to probe topological crystalline insulators. Second, they will use a mix of experimental and theoretical tools to study the intriguing properties that emerge when ordered phase such as magnets and “charge-density waves” coexist with topology in materials. Finally, they will study surfaces of topological superconductors.

HEALTHY FOR WHOM? SOCIAL EQUITY IN THE DISTRIBUTION OF BICYCLING BENEFITS AND RISKS

*Lindsay Braun
Beckman Fellow*

Urban and Regional Planning



www.pedbikeimages.org / Adam Coppola Photography

Cities are increasingly investing in bicycle infrastructure to promote physical activity and associated health benefits. While these benefits are widely recognized, bicycling is also associated with health risks, including pollution exposure and injury. Previous research has analyzed these health tradeoffs, generally suggesting that the benefits of bicycling outweigh its risks. This research, however, has been limited in its treatment of social equity, estimating impacts at the population level (for an entire city) rather than considering spatial variations in risk that could arise from differential environmental conditions. Given that marginalized populations tend to be exposed to conditions that make them vulnerable to the risks of bicycling (such as poor bike lane access and close proximity to major roadways), these spatial variations are critical for social equity.

To address this gap, Professor Braun asks three research questions:

- How are pollution exposure and injury risks distributed across cities?
- How are these risks correlated with sociodemographic characteristics?
- How does this distribution of risk affect the health tradeoffs of bicycling?

This work will begin in Chicago, given its urban sensor network that collects real-time environmental data, but will then be extended to other cities. Using a variety of analytical tools and data sources, Professor Braun will be able to assess whether the tradeoffs of bicycling differ across population groups. The results will challenge universal statements about the benefits of bicycling and determine whether they are valid for marginalized populations, contributing to more equitable planning practices.

ADVANCING AFFORDABLE HOUSING THAT SUPPORTS HEALTH AND WELLNESS

Lynne M. Dearborn
Associate

Architecture



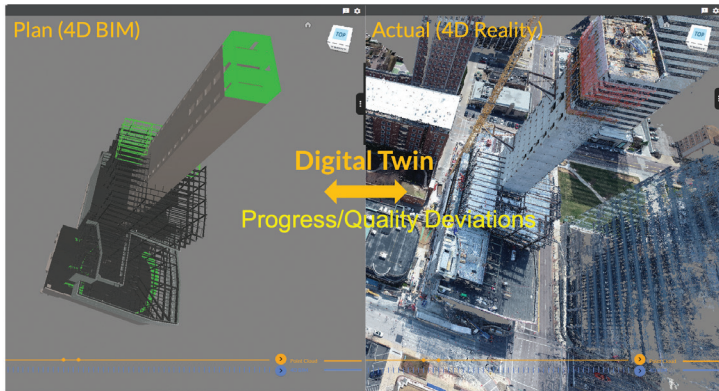
LIHTC-funded Healthy Housing Case Study - Cottages at Mile Branch in Covington, Louisiana. Photo credit: Lynne M. Dearborn

Our homes and neighborhoods have a powerful impact on our physical and mental health, with the potential to exacerbate chronic and acute health problems and cost the U.S. billions of dollars annually. Inferior building practices encourage dust, moisture, mold, structural hazards and many other detrimental design, construction and neighborhood conditions, resulting in housing that is a key negative determinant of health for vulnerable children and adults. The U.S. regulatory system for housing quality is a patchwork of federal, state and local regulations that rarely explicitly address occupant health, nor rapidly respond to growing knowledge of environmental risk factors. These conditions underpin the significance of Professor Dearborn's study examining the potential of the Low-Income Housing Tax Credit (LIHTC) to engender healthier housing for those low-income, disproportionately minority, female-headed and elderly households living in the most inadequate and unhealthy rental housing.

During her Center appointment, Professor Dearborn will complete field work documenting healthy affordable housing projects in states where her prior work identified LIHTC policies particularly supportive of location, design and construction features shown to improve occupant health. Her project addresses critical gaps in understanding how highly competitive housing funding mechanisms and associated policies improve housing quality. The project examines the efficacy of state-level housing funding policies to supply healthier housing and develops resources to advance planning, design and development of housing that supports occupant health and wellness.

AI-DRIVEN CONSTRUCTION

*Mani Golparvar-Fard
Associate*

Civil & Environmental Engineering

Professor Golparvar-Fard's project focuses on preliminary research and planning activities to create foundational ideas, technologies and technical workforces that allow Artificial Intelligence (AI) research to support safe, productive, efficient design, construction and maintenance of national buildings and infrastructure systems. The construction industry is ripe for transformation: inefficient, unsafe and unpredictable but increasingly digital and open to new technologies. Construction problems expose new challenges for AI, such as learning to solve many related small data problems; optimizing for application-specific objectives; leveraging both recognition and correspondence to recover geometry from images and learning from loosely structured text documents. Advances in these areas will form the basis for new approaches to multiple scientific

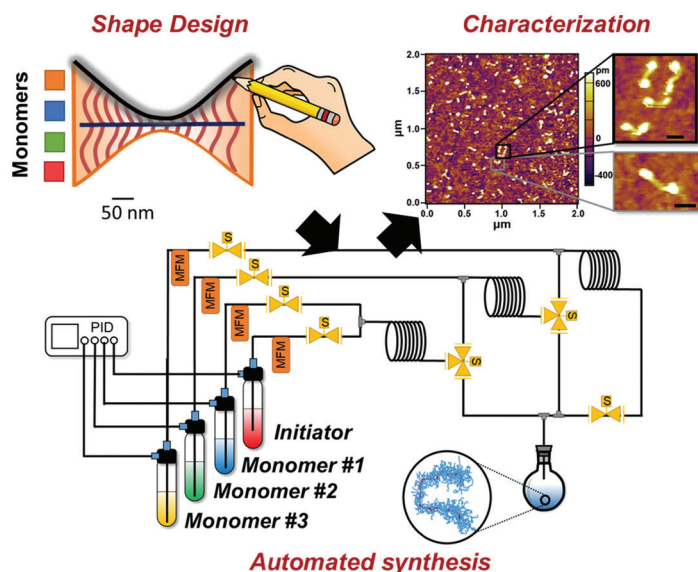
grand-challenges identified by the National Academy of Engineering, such as data-driven construction planning, monitoring work in progress and real-time worker safety assessment. Professor Golparvar-Fard plans to make preliminary advances to exemplify the opportunities and challenges of AI problems in the construction domain. Specific focus will be on image-based 3D reconstruction of interiors, material recognition, 3D pose estimation and semi-structured analysis of project schedule text data. The findings in this CAS study will be leveraged to establish the first Institute for AI in Construction. Research outcomes will be disseminated through publications, presentations and posting of datasets and software.

AUTOMATED POLYMER SYNTHESIS TO ACCELERATE DISCOVERY

Damien Guironnet
Fellow

Chemical & Biomolecular Engineering

Process flow diagram for the *design to synthesis* of macromolecules with specific shapes



Professor Guironnet proposes to build a fully automated polymer maker. This synthesizer will be built based on two synthetic methodologies his group has pioneered for the control of polymer shape, composition and molecular weight. The goal of this macromolecule maker is to accelerate discoveries for the synthesis of polymers mimicking the astonishing functions achieved by biopolymers (e.g., DNA, polypeptide, polysaccharide). From a broad perspective, biopolymers' specificities are enabled by the localization of a few chemical functionalities into a complex and precise spatial arrangement. Advances spanning multiple research fields have resulted in the establishment of atomistic structure-function relationships governing biopolymers.

Despite the depth of this knowledge, current polymerization methods fall short of matching the 3-dimensional molecular geometry of biopolymer. Therefore, mimicking most of the functions achieved by biopolymers (e.g., catalysis by enzymes) with synthetic polymer remains impossible today. The methodologies developed by Professor Guironnet and his lab enable, for the first time, the control of molecular geometry of synthetic polymers. The combination of these methodologies with the high throughput achieved by the proposed automated synthesizer will empower them to synthesize and investigate the functions of many polymers with precise and tunable 3D structures. Achieving catalytic activity with synthetic enzymes would represent an exceptional tour-de-force and open new possibilities in biomimicry.

IN SEARCH OF NEUROENDOCRINE MECHANISMS OF HOST-PARASITE INTERACTIONS

Mark E. Hauber
Associate

Evolution, Ecology & Behavior



Brown-headed Cowbirds parasitize other species of birds with their eggs.

Parental care, from humans to honeybees, is ubiquitous, but it is also costly. Some birds avoid these costs of parenting by engaging in obligate brood parasitism: they lay their eggs in other species' nests. In turn, many (but not all) hosts reject the odd egg. This represents an evolutionary conundrum: rejecting the parasite's egg should always be more adaptive than accepting it, but rejecting one's own egg erroneously can also be too detrimental. Professor Hauber aims to formalize and begin to test the hypothesis that the contrasting needs of a parent bird having to incubate its own eggs, while also rejecting parasitic eggs, are mediated by opposing hormonal mechanisms already involved in aggression and parental care. As part of this project, Professor Hauber plans to construct a testable theory of the endocrine bases of host defenses against

avian brood parasitism. In turn, he will assess experimental field data (collected by his lab) and comparative patterns (using a literature review) to evaluate directional predictions of the model. The project will have broad implications for behavioral ecologists studying coevolutionary arms-races as well as for comparative psychologists interested in concepts of self vs. non-self-discrimination.

PALMARES AFTER 1695: DIASPORIC INHERITANCE AND THE DEATHS AND AFTERLIVES OF ZUMBI

Marc Hertzman
Associate

History



On November 20, 1695, the Black Brazilian maroon Zumbi died defending Palmares, one of history's largest and longest-lasting fugitive slave settlements. Most histories of Palmares conclude here. Professor Hertzman's new book project, however, treats Zumbi's death and the destruction of Palmares as a starting point for new diasporas and forms of inheritance. Employing an innovative set of methodologies and sources, including demographic work, GIS mapping, oral history and thousands of written colonial documents, the project dramatically reimagines the meanings of fugitive slave communities. Palmares and other settlements have rightfully been understood as spaces of refuge and resistance. But unless descendants can trace lineage directly back to them through land possession or genealogy they have been implicitly defined as endpoints: slaves either lived out their days there or were recaptured or killed.

Professor Hertzman will advance a new framework that shows how such communities could also be points of origin generating new, previously overlooked, human diasporas and novel forms of inheritance. Treating the defeat of Palmares and Zumbi's death not just as conclusions, but also starting points allows for the tracing of more familiar material kinds of inheritance such as the transfer of wealth, alongside less recognized, even ethereal forms. By studying African and Afro-Brazilian religious beliefs and practices, place names and oral traditions alongside previously overlooked colonial documents, Professor Hertzman will show how memories of Zumbi and Palmares survived in multiple forms in the aftermath of 1695. Finally, he will show that a full reckoning with slavery's legacies and a truly comprehensive system of reparations are impossible without accounting for lineages and histories that derive from other, less commonly recognized forms of inheritance. By studying the forgotten aftermaths of 1695, the project transforms our understanding of fugitive slave communities and diaspora and reshapes conversations about reparations, not just in Brazil but across the Americas.

SOUTH POLE TELESCOPE DATA ANALYSIS

Gilbert Holder
Associate

Physics



CMB telescopes at the South Pole. Photo by Geoffrey Chen.

The South Pole Telescope is a 10m telescope at the geographic South Pole that is making sensitive high-resolution maps of the mm-wave sky. These maps will be used in a search for gravitational waves produced when the universe began, as well as to map the mass fluctuations on scales of billions of light years. Professor Holder is leading two major data analysis initiatives using data from the South Pole Telescope (SPT) that are each entering a key phase in the next year, as the SPT data are just now passing a threshold where the images of the cosmic microwave background are the lowest noise high-resolution maps made to date by any experiment.

The first initiative involves using images of the cosmic microwave background to identify locations where light from the early universe has been deflected from its original trajectory and thereby build up a map of the locations of large mass concentrations in the Universe. The low noise levels in the SPT data will produce mass maps that are the most sensitive such maps made to date by any experiment in the world. In parallel with this, Professor Holder and his research group are collaborating with another experiment, the BICEP/Keck experiment, to search for gravitational waves from the first moments of the creation of the Universe. The two experiments have complementary features that allow the combined search to be substantially more powerful than anything that has been done to to date.

WHO BENEFITS FROM PRIVATE CLIMATE FINANCE? PRIVATE CLIMATE ADAPTATION FINANCE AND ITS IMPLICATIONS FOR THE DISTRIBUTION OF CLIMATE-RELATED RISKS IN INDONESIA

*Sean Kennedy
Fellow*

Urban and Regional Planning



Farmers planting rice at Bontomanai village in Bantaeng, South Sulawesi, Indonesia on June 7, 2014. Photo by Tri Saputro/CIFOR.
<https://www.flickr.com/photos/cifor/35061298653/in/photostream/>

The archipelago nation of Indonesia is one of the most vulnerable to the impacts of climate change, including sea-level rise and increased severity of droughts and floods. These shocks have a disproportionate impact on the country's rural communities, which account for 30% of the population and play a vital role in its globalized agricultural sector. Recently, concerns regarding climate-related supply chain disruptions have informed a wave of corporate-led climate adaptation initiatives. Championed by global agribusinesses, many of these projects promote microfinance, increased market integration and risk insurance to improve smallholder resilience while managing climate-related supply chain risks. While intended to limit smallholder risk exposure, introducing these financial-based adaptation instruments also incorporates farmers into deeper and more complex market relations, potentially exposing smallholders to novel forms of financial risk while exacerbating existing social and environmental vulnerabilities.

To date, the extent to which private finance reduces or merely redistributes climate risks to more vulnerable groups has received limited attention. This study combines policy analysis, interviews and focus-group discussions to examine the implications of private climate finance for environmental governance and the distribution of climate risks in Indonesia. The study will produce a database of privately-financed adaptation projects to compare governance structures, implementation mechanisms and financial relationships across multiple projects. The study's emphasis on the intersection between climate adaptation efforts and the structural causes of climate vulnerability will illuminate how climate adaptation efforts (re)distribute risk, while supporting future research on how climate adaptation efforts work to ameliorate or deepen existing vulnerabilities in different contexts across Indonesia.

SKIN IN THE EARLY MODERN WORLD, 1450-1750: THE DEEP SURFACE

Craig Koslofsky
Associate

History



Memorial head (nsodie), late 1600s-early 1700s. Africa, West Africa, Ghana, Akan artist. Terracotta. The Cleveland Museum of Art, Edwin R. and Harriet Pelton Perkins Memorial Fund 1990.22.

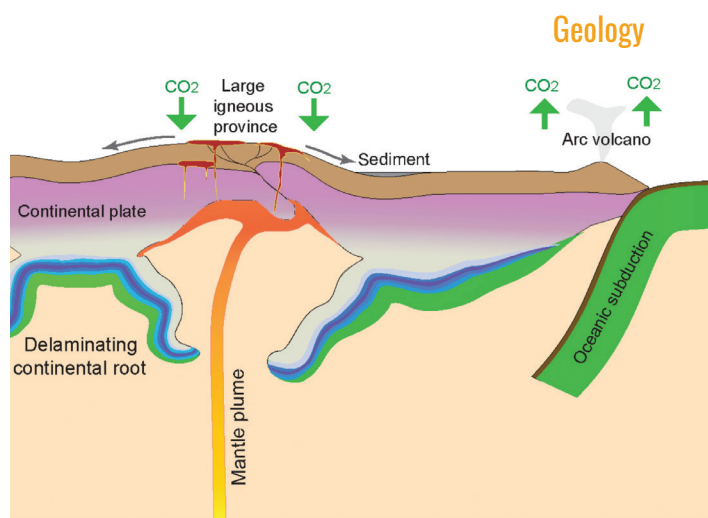
Professor Koslofsky's current book project on skin in the early modern world locates the origins of today's conceptions of skin color and race at the intersection of early modern European, African and American ways of marking and knowing skin. He will show how West African and Native American scarification, tattooing, dyeing and piercing challenged European ideas about skin marking as dishonorable. He will then examine the hybrid dermal practices of the age of Atlantic slavery, such as the branding of enslaved persons and the rise of the legal category of whiteness, to recast early modern skin color as a hybrid dermal practice.

To understand how early modern European, African and American ways of marking and knowing skin intersected, Professor Koslofsky builds on the concept of "epidermalization" introduced by Frantz Fanon in his germinal work *Black Skin, White Masks* (*Peau noire, masques*

blancs; 1952) Fanon created the term epidermalization to describe the reduction of an individual to his or her skin (itself a synecdoche for skin color). Fanon's approach allows us to see human skin as a place where history is made, in this case revealing how the early modern Atlantic reliance on skin color appropriated and inverted African and American dermal practices in the service of new social and economic ends, such as Atlantic slavery and settler colonialism. Working in the history of medicine and science, Professor Koslofsky's research shows how early modern ideas about skin developed within formal, structured bodies of knowledge such as law, medicine, natural philosophy and theology, but were never contained by the logic or boundaries of these fields. *Skin in the Early Modern World* follows the history of skin across these boundaries, revealing a fateful set of quotidian and embodied pathways to our modern, epidermalized world.

IMPACTS OF CONTINENTAL EVOLUTION ON GLOBAL CLIMATE CHANGE

Lijun Liu
Associate



Tectonic activities, such as oceanic subduction, mantle plumes and continental deformation, influence atmospheric CO₂ and long-term climate. Credit: Lijun Liu

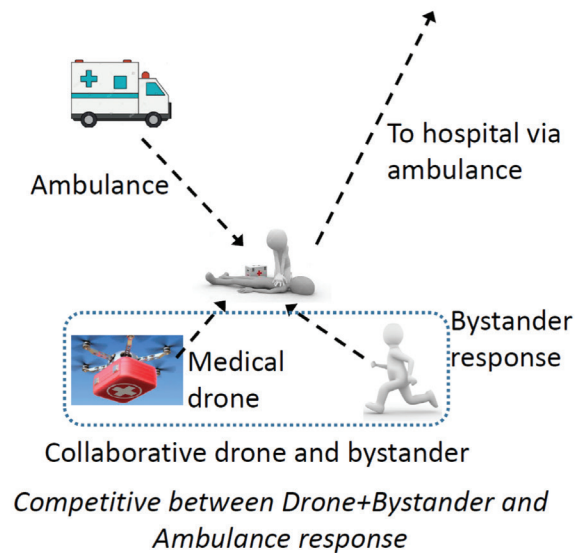
Continents—the oldest tectonic units on Earth—preserve a rich record for how the planet evolved over time. Since one billion years ago (1 Ga), the Earth has experienced two cycles of supercontinent formation and dispersal, these being Rodinia (~1.0 Ga) and Pangaea (~0.3 Ga). During this course, the geologic condition of Earth's surface changed dramatically. Prior to Phanerozoic (0.54 Ga to now), the surface of most continents was erosive, with little sedimentary record preserved today. During the early Phanerozoic (0.54-0.3 Ga), global continental elevation significantly dropped, resulting in substantial marine inundation and deposition. From the start of the Pangaea cycle, the continental environment shifted again towards erosion followed by sedimentation, but on a globally less consistent pace than during the Rodinia cycle. The global climate also switched from cold to warm multiple times since 1.0 Ga. Recent studies suggest that this long-term climate evolution is coupled with the tectonic history, which modulates the Earth carbon cycle through continental rifting, oceanic subduction and massive volcanic eruptions.

A continental lithosphere consists of a buoyant, thin crust on top and a denser, thick lithospheric mantle underneath, both formed billions of years ago. According to the theory of plate tectonics, the continental lithosphere passively drifts around at Earth's surface, without participating in the underlying mantle convection. This is traditionally thought to be due to the positive buoyancy and large strength of the lithosphere that prevent it from deforming internally or sinking into Earth's interior. However, increasing amounts of geologic and geophysical observations suggest that this is not the case. Professor Liu suggests the above tectonic and climate observations are related to temporal variations of the continental lithosphere, whose nature should differ from the traditional wisdom. During his Center appointment, he will implement a multidisciplinary geodynamic approach to better understand continental evolution and associated topographic and environmental impacts.

MATHEMATICAL FRAMEWORKS FOR NEXT-GENERATION EMERGENCY MEDICAL SERVICES

*Lavanya Marla
Fellow*

Industrial & Enterprise Systems Engineering



The ongoing fourth industrial revolution is transforming our world through a combination of technologies such as autonomous vehicles, real-time information-sharing, sharing economy and the Internet of Things, powered by big data analytics and artificial intelligence. Professor Marla's research will create advanced analytical models and algorithms that facilitate a systems perspective for these emerging services, with a specific focus on Next-Generation Emergency Medical Services. Both competitive and collaborative interactions arise due to the layering and integration of the new, upcoming, technologies on existing infrastructure. Societal and policy implications of such integration are poorly understood, and questions related to system redesign remain unanswered, due to the lack of advanced mathematical approaches.

This project will generate novel frameworks that intelligently meld queueing models, game-theoretic ideas and large-scale optimization approaches to answer these complex societal questions. To make the proposed methodologies practical, the approaches will be modularly designed such that scalability is retained as problem sizes increase. The proposed methodologies will be tested on US-based and global testbeds for data-driven validation and computation, collected during Professor Marla's international USIEF grant, and her advisory role in a World Bank-funded grant. Industry partners from Peel (Canada), Stockholm (Sweden) and Chennai (India) will implement the knowledge from this work.

INCOME AND HOUSING SUPPORT EXPERIMENTS AND CHILD NEGLECT

*William Schneider
Beckman Fellow*

Social Work



Child maltreatment—the overall term for child abuse and child neglect—is a pervasive problem in the United States. In 2018, state Child Protective Service (CPS) agencies received over 4.3 million allegations of child maltreatment, and approximately 648,000 children were found to be victims of maltreatment, with 1,770 child fatalities. Overall, nearly 37% of children will be the subject of a CPS investigation by the time they turn 18. With the exception of income maintenance to foster parents, nearly all of the \$21 billion per year that the federal and state governments spend on child maltreatment is focused on psycho-social and parent education interventions and treatment. These policies have proven quite effective in reducing child abuse. However, such interventions appear to have been much less effective at reducing child neglect. This is particularly notable given that child neglect makes up nearly 75% of all child maltreatment.

These disparate impacts may be because, to a large degree, child neglect is rooted in experiences of economic hardship rather than psychopathology. Individual-level and neighborhood studies of the association between economic hardship and child maltreatment may suffer from selection bias, as families who experience hardship may be negatively selected into maltreatment or greater contact with mandated reporters of maltreatment. During his CAS appointment, Professor Schneider will examine the causal effect of income and housing support policies on child neglect by linking individuals from Illinois administrative child welfare data to data from rigorous pre-existing employment and housing experiments. By doing so, the project will identify both causal effects of economic resources on neglect and actionable policy levers to reduce child neglect and inequality in child neglect.

THE FRUITS OF ONE'S LABOR: UNCOVERING THE FACTORS THAT SHAPE SUSTAINED TECHNOLOGY ADOPTION TO REDUCE POST-HARVEST LOSS

Sonali Shah
Associate

Business Administration



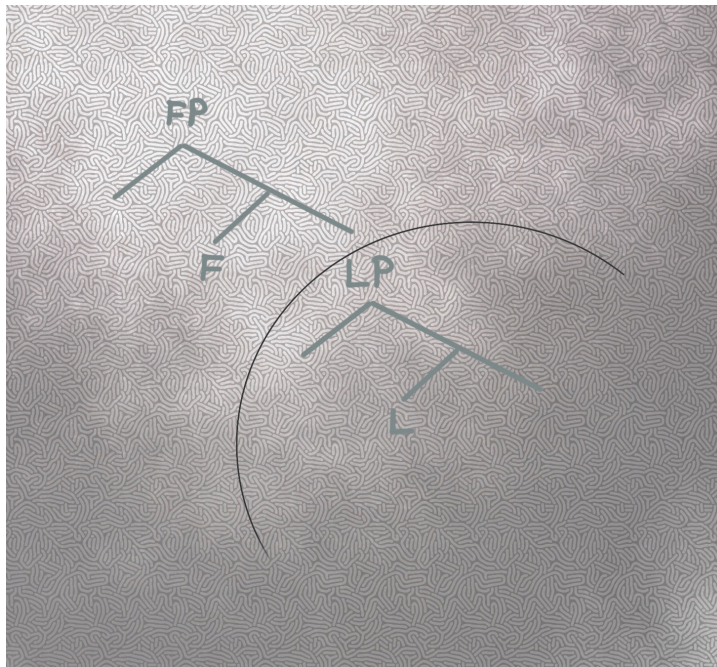
Post-harvest loss is a critical problem: as food travels from farms to markets to tables, one-third spoils before it is consumed. A significant portion of post-harvest loss is attributable to a lack of infrastructure in sub-Saharan Africa and Asia: without knowledge of and access to basic farming technologies, effective storage and price information, market actors—smallholder farmers, harvesters, traders, processors and exporters—face challenges at every step of food production and sale that reduce food available for consumption, while the food insecure go hungry. Post-harvest loss has detrimental effects on human health and well-being, the environment and the incomes of the roughly 70% of the population who rely on agriculture for their livelihoods.

Interventions designed to reduce post-harvest loss require market actors to adopt specific technologies and use those technologies for sustained periods of time—that is to say, technologies may need to be used multiple times within a single harvest season and again in subsequent seasons. Little research exists on the factors that shape sustained technology adoption decisions in any context, making it an area ripe for qualitative inquiry. Professor Shah seeks to uncover the factors that support the sustained adoption of technologies used to reduce post-harvest loss by smallholder farmers and other market actors. Addressing this question will help target interventions towards those individuals most likely to implement and diffuse them. This work builds on her experience as a qualitative scholar studying motivation, technology adoption and industry development. During her CAS appointment, Professor Shah will distill theoretical insights from interview data and contingent on COVID-19 constraints, travel to Tanzania to conduct additional interviews with smallholder farmers.

THE SYNTAX AND TONE OF DHOLUO

Aida Talic
Beckman Fellow

Linguistics



As humans, we have a unique ability to acquire and use language. This complex cognitive system all of us have raises questions of how it arises in all humans; why a child exposed to a language necessarily acquires that language, while a baby animal exposed to the same language never does; why languages share some universal properties and why they differ in systematic ways. Addressing these questions, generative linguists posit that human knowledge of language has two parts: (i) the innate part (Universal Grammar), which is invariant and shared by all humans and (ii) the acquired part, the development of which is guided by the innate knowledge. A major question that is still subject to ongoing research is what the innate part of our knowledge looks like—what is it that is the same for all humans and what leads to cross-linguistic differences.

One of the arguments for Universal Grammar comes from similarities across languages—language universals. However, given that some similarities may result merely from languages belonging to the same language family and sharing a common ancestor language, in our quest for universal properties that all languages share, it is crucial to investigate and analyze languages from unrelated families. Thus, in this project, Professor Talic plans to investigate several areas within the grammar of Dholuo from the Nilo-Saharan family and compare the findings with results from previous work on unrelated languages from Slavic, Germanic and Romance families. While there is some descriptive work on Dholuo, full descriptions of many phenomena are yet to be provided and there are very few papers in the generative literature where data from Dholuo is considered. She will investigate the structure of phrases projected by nouns and adjectives, as well as how syntax (the way we put words together) affects tonal contours in Dholuo.

TRANSFORMING OUR SOCIAL CONTRACTS

Helga Varden
Associate

Philosophy



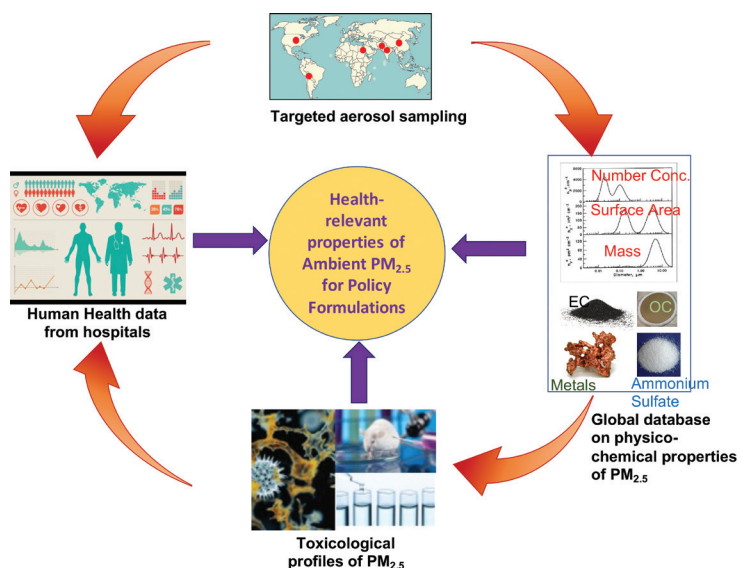
The public legal and political institutions—the social contracts—of many liberal democracies today are marked by deep, seemingly intractable problems of systemic injustice that track long histories of intersectional violent oppression. These institutions are supposed to enable us to interact as free and equal citizens, but their actual practices fall very short of these ideals. Without exception, they condone, facilitate and even participate in much wrongdoing against segments of their populations—wrongdoing that in a profound sense is not rational. In her analysis of totalitarianism, Hannah Arendt concludes that we need a new principle to govern our thinking about peaceful, flourishing co-existence on the planet. Professor Varden's new book, *Transforming Our Social Contracts*,

proposes that Kant's philosophy provides us with the principle we need—each person's right to freedom—but that we must take up all his relevant ideas, right his wrongs and develop his proposals further. *Transforming Our Social Contracts* aims to show what it looks like when we look our predecessors squarely and truthfully in the eyes and then try to transform their theories so that they can help us transform our actual societies and institutions. In this way, Professor Varden hopes to show that despite the many shortcomings and failures of the existing liberal theories and philosophical practices, freedom, human dignity and shared, accountable public governance are still ideals worth working toward by developing the tools these legal-political thinkers left us.

HEALTH-RELEVANT PROPERTIES OF AMBIENT PARTICULATE MATTER—TARGETED STUDIES IN AIR POLLUTED CITIES ACROSS THE WORLD

Vishal Verma
Fellow

Civil & Environmental Engineering



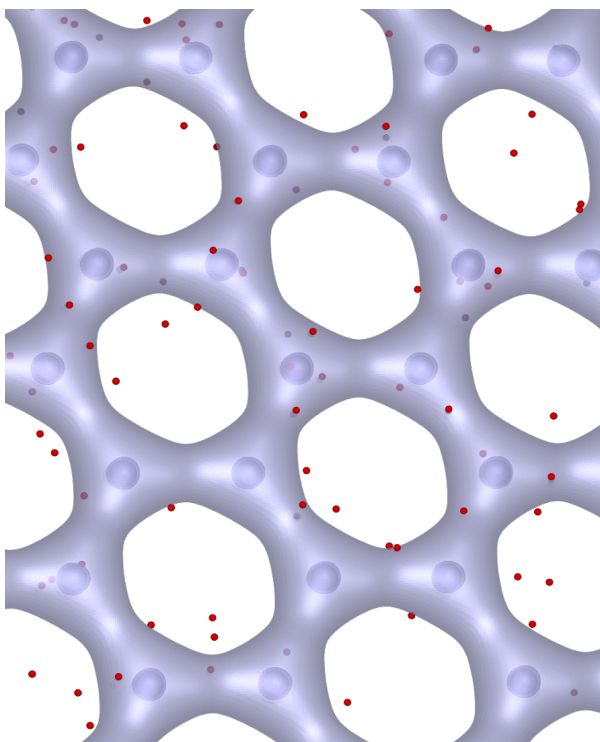
Worldwide, 4.2 million deaths were attributable to ambient PM_{2.5} pollution in 2015, which represented 7.6% of total deaths from all causes. Most of these deaths were in the developing countries of Southeast Asia and Africa. Unlike other air pollutants such as ozone, NO_x or SO₂, ambient PM_{2.5} is not a single chemical compound but rather a mixture of several chemical (both organic and inorganic) species. Currently, there are at least 10 properties of the ambient PM_{2.5} which can be relatively easily measured. However, the key knowledge on the most important property which is responsible for the observed health effects is still missing. There is also substantial spatial heterogeneity in the physical and chemical composition of the ambient PM_{2.5} across the world. Despite the available technologies to measure these properties, the regulatory standard to control PM_{2.5} pollution in both the developed and developing world is still solely based on mass concentrations of the particles.

During his CAS appointment, Professor Verma plans to develop a global cohort for the measurement of a comprehensive suite of ambient PM_{2.5} properties. He plans to develop an international collaboration with aerosol engineers, chemists, toxicologists and epidemiologists located in countries such as India, China, Pakistan, Bangladesh, Egypt and Sudan to launch an intensive PM_{2.5} sampling campaign. These countries are among the ones which are most badly impacted by air pollution. With his research team, he will build a global database on multiple properties of the ambient PM_{2.5} through these efforts, which will then be used in the follow-up epidemiological and toxicological studies to look at the association of each property with adverse health effects. The outcome of these studies will ultimately help to revisit the current mass-based standards and establish the most important property of the ambient PM_{2.5} related with the health effects.

EXPANDING ACCESS TO LOW-ENERGY PHYSICS DERIVED FROM FIRST PRINCIPLES QUANTUM SIMULATIONS

Lucas Kyle Wagner
Fellow

Physics



An important organizing principle in physics is that systems behave differently at different length and time scales. The diversity of these behaviors is due to the change in scale—electrons and nuclei interact with very high energies and small length scales, but we interact with collections of particles at large length scales and lower energy. A major contribution of condensed matter physics has been the accurate description of the collective motion of electrons and nuclei in different circumstances. An example of this is the transistor, applications of which have changed our society. Low-energy descriptions of silicon were critical to this and many other technological developments. Traditionally, low-energy descriptions have been developed using a combination of experiment, intuition, physical principles and guessing. However, in more complex situations, this approach faces challenges, since often not enough information is available.

More complex systems could be tackled, were it possible to derive the low-energy physics directly from quantum mechanics with electrons and nuclei interacting through electromagnetism. Recent developments have made it possible to attain much higher accuracy in the simulation of these systems, even up to 1000 interacting quantum particles. Professor Wagner's group has made progress in attaining accurate computer simulations of these systems and using these simulations to develop low-energy descriptions of materials. During his CAS appointment, he will focus on the physics of high-temperature superconducting materials and in bridging the gap from a promising method to a new tool for researchers to use. These tools lay the groundwork for new descriptions of complex quantum matter and new technological developments down the line.

TOWARD AN UNDERSTANDING OF GENTRIFICATION'S THIRD WAVE IN CHICAGO

David Wilson
Associate

Geography



America's cities undergo rapid change that we are only beginning to understand. At the core of this, America's cities experience a powerful but under-researched "third-wave" gentrification (a process of re-making neighborhoods for more affluent residents) that is defining something crucial: Loretta Lees's "gentrified city of today and tomorrow." Professor Wilson's research focuses on the social, psychic and economic impacts of this third wave gentrification in America's quintessential gentrifying city, Chicago. He will analyze the city's South Side, currently facing accelerating gentrification in many of its neighborhoods, in order to replenish our scant understanding of this third-wave gentrification. The following questions will be addressed:

1. Where and in what kinds of blocks and communities are current displaced residents being forced to live as a result of the new gentrification?
2. How have value orientations of the displaced (attachment to place and commitment to community and city engagement) changed as a result of forced relocation to new communities?
3. How are the value orientations of existing residents changing as gentrification deepens?
4. How are the daily life patterns of existing residents changing as gentrification deepens?

Today, Chicago's gentrification frontier, like in other major cities across America, confidently moves into heavily disinvested and neglected neighborhoods, particularly Bronzeville, Greater Grand Crossing and Near South Side, through bold, aggressive buy-ups of land and property. In this process, new pro- and anti-gentrification alliances, community tensions, governance tactics and definitions of poor race-class populations unfold that re-make people and spaces in unknown ways. What, then, is current gentrification delivering to Chicago and its most vulnerable populations? As the destructive histories of other major redevelopment initiatives in Chicago still linger (i.e., urban renewal and public housing), is current gentrification staking out a similar legacy?

SEVEN WONDERS: REMAKING THE PAST • DEVELOPING THE THEORY FOR NEW PROBES OF QUANTUM MATERIALS • HEALTHY FOR WHOM? SOCIAL EQUITY IN THE DISTRIBUTION OF BICYCLING BENEFITS AND RISKS • ADVANCING AFFORDABLE HOUSING THAT SUPPORTS HEALTH AND WELLNESS • AI-DRIVEN CONSTRUCTION • AUTOMATED POLYMER SYNTHESIS TO ACCELERATE DISCOVERY • IN SEARCH OF NEUROENDOCRINE MECHANISMS OF HOST-PARASITE INTERACTIONS • PALMARES AFTER 1695: DIASPORIC INHERITANCE AND THE DEATHS AND AFTERLIVES OF ZUMBI • SOUTH POLE TELESCOPE DATA ANALYSIS • WHO BENEFITS FROM PRIVATE CLIMATE FINANCE? PRIVATE CLIMATE ADAPTATION FINANCE AND ITS IMPLICATIONS FOR THE DISTRIBUTION OF CLIMATE-RELATED RISKS IN INDONESIA • SKIN IN THE EARLY MODERN WORLD, 1450-1750: THE DEEP SURFACE • IMPACTS OF CONTINENTAL EVOLUTION ON GLOBAL CLIMATE CHANGE • MATHEMATICAL FRAMEWORKS FOR NEXT-GENERATION EMERGENCY MEDICAL SERVICES • INCOME AND HOUSING SUPPORT EXPERIMENTS AND CHILD NEGLECT • THE FRUITS OF ONE'S LABOR: UNCOVERING THE FACTORS THAT SHAPE SUSTAINED TECHNOLOGY ADOPTION TO REDUCE POST-HARVEST LOSS • THE SYNTAX AND TONE OF DHOLUO • TRANSFORMING OUR SOCIAL CONTRACTS • HEALTH-RELEVANT PROPERTIES OF AMBIENT PARTICULATE MATTER—TARGETED STUDIES IN AIR POLLUTED CITIES ACROSS THE WORLD • EXPANDING ACCESS TO LOW-ENERGY PHYSICS DERIVED FROM FIRST PRINCIPLES QUANTUM SIMULATIONS • TOWARD AN UNDERSTANDING OF GENTRIFICATION'S THIRD WAVE IN CHICAGO

CAS

Center for
Advanced
Study



University of Illinois Urbana-Champaign
Levis Faculty Center—Suite 200
919 West Illinois Street
Urbana, IL 61801

Phone: 217.333.6729
www.cas.illinois.edu