

IAS

INSTITUTE FOR
ADVANCED STUDY



Report for the Academic Year
2019–2020

Cover: Scholars in the School of Social Science ANNE-CLAIRE DEFOSSEZ (left) and ALDEN H. YOUNG (right) participate in a seminar on the year's theme, "Economy and Society" in December.

Opposite: Fuld Hall

COVER PHOTO: ANDREA KANE

Table of Contents



Reports of the Chair and the Director	2
The Institute for Advanced Study	3
School of Historical Studies	4
School of Mathematics	13
School of Natural Sciences	21
School of Social Science	29
Special Programs and Outreach	32
Record of Events	36
	56
	Acknowledgments
	63
	Present and Past Directors and Faculty
	64
	Founders, Trustees, and Officers of the Board
	and of the Corporation
	65
	Administration
	67
	Independent Auditors' Report

Reports

OF THE CHAIR AND OF THE DIRECTOR

While the extraordinary circumstances of the 2019–20 academic year tested the Institute’s resilience, the bonds of our community have never been stronger. Despite physical distancing and other effects of the pandemic, commitment to our mission remained unwavering. The search for fundamental knowledge continued to lead us through some dark moments and, with the world depending on the sciences and humanities for clarity and grounding, Institute scholarship played a critical and unique role.



Through all of this, I was and am deeply grateful for the dedication of our Trustees, Faculty, Members, and staff who have risen to meet current challenges. I am also proud of the visionary support we have received from donors and global community partners to expand innovation and support our core programs.

In 2020, I was honored to chair the second IAS Einstein Gala, along with James Simons, IAS Trustee Emeritus, in honor of Sir James Wolfensohn, the Board’s longest-serving Chair (1986–2007). This event, while postponed from its original date in March, raised \$2.3 million for IAS. Jim was presented with the Bamberger Medal—the Institute’s highest honor—in recognition of his unparalleled stewardship and vision for the Institute. Sadly, both Jim and his wonderful wife, Elaine, passed away this year. They will be remembered not only for their hard work and dedication on behalf of IAS, but also for their many gifts to the world.

We were pleased to welcome Ann-Kristin Achleitner as a Trustee on October 26, 2019. Ann-Kristin is an economist and a Professor of Entrepreneurial Finance in the School of Management at the Technical University of Munich, with an expansive knowledge of financing innovation at a global scale.

In May 2020, Trustee Eric Schmidt was recognized for his many years of dedicated service to the Board as he transitioned to emeritus status. The generosity of Eric and his wife Wendy through the Schmidt Family Foundation has enabled scholarship of the highest caliber while also being instrumental in recruiting and supporting the most promising young talent to the Institute.

Now more than ever, basic research is needed to spark new revolutions that provide long-term utility, technologies, and tools to enrich and mend our society. The Institute will continue to lead the way forward.

Charles Simonyi
Chair of the Board

On March 23, 2020, for the first time in our history, the Institute decided to close its campus to all non-essential personnel. Despite the unprecedented challenges of the pandemic, scholarship continued apace, and seminars, public lectures, and concerts found new virtual and outdoor venues. The resilience of our scholars was extraordinary, and the uplifting spirit of our community did not wane throughout this difficult period.

On May 20, 2020, IAS celebrated its ninetieth anniversary. On that date, we reflected on and toasted the more than eight thousand IAS researchers, past and present, who boldly followed their intuition, took risks, and have achieved new fundamental insights across the sciences and humanities.

At the invitation of the National Academy of Sciences, the Institute participated in the development of a global policy statement in support of basic research that was adopted by fourteen national science academies on May 28, 2020. This announcement affirmed the relevance of basic research in addressing global challenges, and the Institute is proud to champion this ongoing mission.

We were pleased to welcome five new Professors in 2019–20: Suzanne Conklin Akbari in the School of Historical Studies, Jacob Lurie in the School of Mathematics, Alondra Nelson in the School of Social Science, and Jim Stone and Misha Tsodyks in the School of Natural Sciences. These accomplished scholars have brought new fields and depth of study to IAS—from computational social science to theoretical neuroscience.

The year was not without loss, as we mourned the death of Freeman Dyson on February 28, 2020. Freeman was a visionary thinker who embraced the stunning diversity of the universe with unique spirit. His creativity and keen intellect will continue to challenge and inspire future generations.

In four particularly uplifting moments of the year, Camillo De Lellis was awarded the 2020 Bôcher Memorial Prize; Enrico Bombieri received the 2020 Crafoord Prize in Mathematics; Karen Uhlenbeck was recognized with the 2020 Steele Prize for Lifetime Achievement; and Rashid Sunyaev was awarded the 2019 Dirac Medal—and the list goes on.

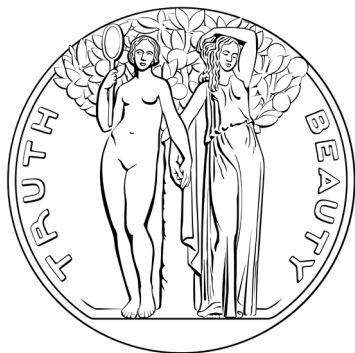
For the Institute and our world, the brightest days are still ahead.

Robbert Dijkgraaf
Director and Leon Levy Professor



The Institute for Advanced Study

It was founding Director Abraham Flexner's belief that if the Institute "eschews the chase for the useful, the minds of its scholars will be liberated, they will be free to take advantage of surprises, and someday an unexpected discovery, apparently leading nowhere, will be found to be an indispensable link in a long and complex chain that may open new worlds in theory and practice."



THE INSTITUTE FOR ADVANCED STUDY is an international center for theoretical research and intellectual inquiry that creates time and space for solitary work as well as dialogue among some 250 visiting researchers each year from more than 100 institutions around the world and at various stages in their careers. From postdocs with new perspectives and tools, to established experts who create and advance fields of inquiry, the Institute's focused yet freely inquisitive atmosphere enables advancement in unforeseeable ways, leading to societal innovation and new understanding.

Research spans four Schools—Historical Studies, Mathematics, Natural Sciences, Social Science—and is focused on long-term and fundamental outcomes with no concern for immediate application. IAS is a scholar's paradise—a campus of unparalleled energy and curiosity, free of external pressures and academic restraints where exceptional minds have limitless opportunity to explore what is not yet known. Thirty-four Nobel Laureates, forty-two of the sixty Fields Medalists, and nineteen of the twenty-two Abel Prize Laureates, as well as many winners of the Wolf and MacArthur prizes, have been affiliated with the Institute. Albert Einstein, Kurt Gödel, Hetty Goldman, George F. Kennan, Erwin Panofsky, John von Neumann, and Hermann Weyl were among the first in a long line of distinguished Institute scientists and scholars to produce a deeper understanding of the physical world and of humanity.

At the Institute, everything is designed to encourage scholars to take their research to the next level. Members carry out their work in a setting where human scale has been carefully maintained to encourage the sharing of ideas, serendipitous interaction, and friendship. During the 2019–20 academic year, the Institute adopted special measures in support of public health, ensuring that scholars both local and remote were safely able to push the boundaries of knowledge forward.

Faculty and Members experience precious freedom at the Institute, an independence enabled by the generosity of the Institute's founders and subsequent benefactors, which leads to pioneering theories and the development of new knowledge. In the words of mathematical physicist Robbert Dijkgraaf, current IAS Director and Leon Levy Professor: "What do we know? What do we yet need to understand? How should we try to comprehend it? Fundamental research at the Institute furthers our grasp of a world of diverse facts, structures, ideas, and cultures. We share the conviction of our founders that such unrestricted deep thinking will change this world, but where and how is always a surprise."

School of Historical Studies

The School of Historical Studies, established in 1949 with the merging of the School of Economics and Politics and the School of Humanistic Studies, actively promotes interdisciplinary research and cross-fertilization of ideas, thereby encouraging the creation of new historical enterprises.

FACULTY

Suzanne Conklin Akbari

Yve-Alain Bois

Angelos Chaniotis

Nicola Di Cosmo

*Luce Foundation Professor
in East Asian Studies*

Jonathan Haslam

George F. Kennan Professor

Myles W. Jackson

Sabine Schmidtke

Francesca Trivellato

Andrew W. Mellon Professor

PROFESSORS EMERITI

Glen W. Bowersock

Caroline Walker Bynum

Giles Constable

Patrick J. Geary

Jonathan Israel

Peter Paret

Heinrich von Staden

THE SCHOOL OF HISTORICAL

Studies bears no resemblance to a traditional academic history department, but rather supports all learning for which historical methods are appropriate. Its Faculty and Members embrace a historical approach to research throughout the humanistic disciplines, from socioeconomic developments, political theory, and modern international relations to the history of art, science, philosophy, music, and literature. In geographical terms, the School concentrates primarily on the history of Western, Near Eastern, and Far Eastern civilizations, with emphasis on Greek and Roman civilization, the history of Europe (medieval, early modern, and modern), the Islamic world, and East Asia. Support has been extended to the history of other regions, including Central Asia, India, and Africa.

The Faculty and Members of the School do not adhere to any one point of view but practice a range of methods of inquiry and scholarly styles, both traditional and innovative. Uniquely positioned to sponsor work that crosses conventional departmental and professional boundaries, the School actively promotes interdisciplinary research and cross-fertilization of ideas, thereby encouraging the creation of new historical enterprises.

Professor **Suzanne Akbari**'s work

currently centers on the global turn in Medieval Studies. She is co-PI on "The Book and the Silk Roads," a Mellon-funded collaborative project on the material history of manuscripts ranging from the Mediterranean and the Horn of Africa to Kashmir and Dunhuang. Akbari organized a project workshop on "Forms of the Book in East Asia and Environs," co-sponsored by Princeton's Program in Buddhist Studies, in November 2019, as well as a project colloquium on "Medieval Ethiopia" held at the University of Toronto in October 2019. She presented project results at the Freie Universität, Berlin (October) and at USC's Center for the Premodern World (February 2020), accompanied by a workshop on "Medieval Objects in a Global Context" at the Getty Research Center. Her article "Where is Medieval Ethiopia? Mapping Ethiopic Studies within Medieval Studies" appears in *Toward a Global Middle Ages* (edited by Bryan Keene, Getty Publications, 2019). Akbari is also a collaborator on a second project focused on the global turn in Medieval Studies, "Practices of Commentary," funded by the Canadian Social Sciences and Humanities Research Council, for which she is editing a special issue of *The Medieval Globe* and has

In 2019–20, Member BETH PLUMMER (speaking) researched the continued presence of nuns and mixed confessional convents in Protestant cities and territories of the German-speaking parts of the Holy Roman Empire as a complex lived experience of religious reform, hybrid devotional practice, and confessional accommodation during the sixteenth century. Plummer gave an Early Modern Studies seminar titled "No Better than a Brothel" in October 2019.



ANDREA KANE

published “Ekphrasis and Commentary in Walter of Chatillon’s *Alexandreis*” in *Zeitsprünge* (2020). Akbari’s collaborative work arising from these projects includes “One Loveheart Emoji at a Time: The Building of Affective Community in a Digital Medieval Studies Lab,” published in *Digital Humanities Quarterly* (2020).

Akbari is also engaged in public-facing humanities work, including a biweekly podcast on “great books” called *The Spouter-Inn*, as well as short pieces on Melville’s *Moby Dick* and Indigenous essay-writing appearing on LitHub. She published *The Oxford Handbook to Chaucer*, co-edited with James Simpson (Oxford University Press, 2020), and *How We Read: Tales, Fury, Nothing, Sound*, with Kaitlin Heller (punctum books, 2019). During 2019–20, Akbari co-convoked the Medieval Seminar with IAS Member Cord Whitaker on “Race, Racialization, and Periodization.” The seminar was attended not only by medievalists but also by IAS Members in Islamic Studies and Art History as well as faculty from the region. Other IAS-based activities include a lecture for the Friends titled “What is the Value of the Humanities?” (December 2019) and a roundtable on “What Is Global History?” organized by Francesca Trivellato (February 2020). Other local lectures included “Binary Time: Repetition and Cycle in Medieval Universal Histories,” at Princeton, and “See You in Hell: Chaucer’s Claudian,” at the University of Pennsylvania. Her current book projects include *Small Change: Metaphor and Metamorphosis in Chaucer and Christine de Pizan* and *The Shape of Time: Medieval World Histories and the Idea of Periodization*.

Professor **Yve-Alain Bois** continued to lead the Art History seminar, which transitioned to a virtual format in light of the Covid pandemic. Several art history scholars presented work during these seminars, including Marius Hauknes, who spoke on a recently discovered fresco cycle in the outskirts of Rome; Heidi Gearhart, on medieval artists’ and artisans’ individuality and signature; Isabelle Marchesin and Charlotte Denoël, on the Hildesheim bronze door; Laura Weigert, on Fouquet’s mysterious model for his *Madonna Lactans* and other famous

altarpieces; Alla Vronskaya, once on the architecture of El Lissitzky, and again on Lissitzky’s colleague Ladovsky’s time on the Soviet “space perception laboratory”; and Anthony Petro, on the culture wars and religious imagery during the 1980s and 90s.

Bois paused work on the second volume of the catalogue raisonné of

2020) and completed the study of more than 1000 graffiti, game boards, and masons’ marks from Aphrodisias (Asia Minor). He participated in the excavation in Aphrodisias in August 2019, studying new epigraphic finds and working on a corpus of inscriptions. He also worked on his book *Epigraphic Research at Aphrodisias, 1995–2015*. The collective volume *Unveil-*



Friends of the Institute for Advanced Study Member CORD WHITAKER specializes in nineteenth- and twentieth-century African American medievalism—in literature, history, and other disciplines. In November 2019, Whitaker spoke on “Black Metaphors: How Modern Racism Emerged from Medieval Race-Thinking—and Why It Matters.”

Ellsworth Kelly in order to prepare a graduate seminar at Princeton University, which was itself planned as preparation for the Mellon Lectures initially scheduled for the spring 2020 at the National Gallery. The six Mellon lectures, on the axonometric representation of space—a topic that crosses many disciplines, from history of art and architecture to history of science and technology—were postponed several times because of Covid-19 and are now scheduled for fall 2022.

In view of this postponement, Bois returned to the Kelly project and spent the summer of 2020 finishing the manuscript. Revisions will likely continue through the end of 2020.

The main focus of Professor **Angelos Chaniotis**’s work remains the study of inscriptions and the information they provide for Greek social, cultural, and religious history. He co-edited *Supplementum Epigraphicum Graecum* LXV (Leiden

ing Emotions III. Arousal, Display, and Perception of Emotions in the Greek World, which he edited, will be published by Steiner Verlag. Chaniotis resumed his research on ancient Crete, preparing together with Antonis Kotsonas (Institute for the Study of the Ancient World, New York University) the systematic excavation of the city of Lyktos, for which they have received a five-year permit from the Greek Ministry of Culture. Because of the pandemic, the beginning of the excavation was postponed to June 2021.

The digitization of squeezes of Greek inscriptions at the IAS, a project generously funded by the Fowler Merle-Smith Family Trust and the Charles Simonyi Fund for Arts and Sciences, made significant progress and received a grant from the National Endowment for the Humanities. The “Epigraphic Friday” workshop, which Chaniotis has organized since 2013, attracted in March 2020 more than

30 scholars and graduate students from American and European universities. Subjects related to epigraphy, the history and culture of Late Antiquity, and archaeology were treated by Members and Visitors in the Ancient Studies Seminar (October 2018–May 2020), which continued online after the lockdown in March. Chaniotis gave ten lectures in Germany, Greece, Switzerland, Turkey, and the United States. His lectures focused on his research on theatricality in public life, the history of emotions, and his new research project on the transformations of night life from the fourth century B.C.E. to the fourth century C.E.

In April 2020 Chaniotis was appointed member of the Council of Higher Education in Greece, a board of five members responsible for the strategic planning and evaluation of Greek universities.

The work of **Nicola Di Cosmo**, Luce Foundation Professor in East Asian Studies, this year was divided between research and administrative duties, having served as Acting Co-Executive Officer of the School from October 2019 to March 2020. Four areas of research were especially active: ethnic and cultural aspects of the northern frontier in ancient China, urbanism and imperial capitals in nomadic empires, Manchu political culture, and the ongoing study of connections between climatic and historical events, in collaboration with climatologists.

The first area of research involves the study of a broader range of material and cultural exchanges between China and foreign peoples in the period of the construction of the early Great Wall. Archaeological discoveries raised the issue, investigated by Di Cosmo, of social and political changes within the non-Chinese communities, and of an early commercialization of the northern frontier as an early instantiation of the Silk Road. One essay was completed in March and is forthcoming. Another, entitled “The Birth of the Silk Road between Ecological Frontiers and Military Innovation,” was published in 2020.

The second area, which combines environmental, political, and economic history with archaeological and material analysis, concerns the evolution of urban centers and imperial cities in medieval Mongolia. In the study “Turko-Mongol Capitals in Medieval Eurasia: Itinerancy, Fixity, and Polycentrism” (forthcoming), the dualism between fixed and itinerant imperial capitals is examined primarily by comparing two empires (Uyghur and Mongol), both of which had a fixed capital as well as itinerant imperial courts. Several questions are raised by examining this particular model of imperial governance, which potentially leads to a re-interpretation of imperial relations in the greater Eurasian world.

The third area of research addresses East Asian political cultures in the early modern period, and their understanding

and reception in Europe. Di Cosmo began a new study on the concept of the “just war” in the Manchu conquest, a topic he had formerly examined in a limited way. Expanding the comparative perspective of the theory or doctrine of “just war” in pre- and early modern extra-European civilizations, the analysis of documentation in Manchu and Mongol reveals the existence of a rich trove of traditions, practices, concepts, and ideas related not just to the justification of war but also to the correct behavior of combatants. Such a collection of documentary evidence is further enriched by contemporary commentaries by European observers of the Manchu conquest and their justification of the war according to seventeenth-century European notions.

The fourth area continues the study of climatic factors in the Mongol empire, with a special emphasis on the Mongol invasion of regions that were environmentally unsuited to the requirements of the Mongol army and therefore present important case studies for investigating the relationship between war and environment in medieval Eurasia.

Because of service in the School, and the cancellation of several events in the spring due to Covid-19, speaking engagements were limited to the Oriental Institute in Prague (September 2019), the European University Institute, Florence (November 2019), All Souls, Oxford (December 2019), and Middlebury College (March 2020).

Within the IAS, activities also included serving on the Ad Hoc Committee and the Title IX Committee. Finally, he organized the East Asian seminar series, which included both Social Science and Historical Studies Members, and consisted of ten seminars. A few seminars that had to be cancelled in the spring are going to be rescheduled.

Jonathan Haslam, George F. Kennan Professor, has reached the stage of copy-editing the manuscript for *The Spectre of War: International Communism and the Origins of World War II*, due to be published by Princeton University Press in May 2021.

The book is grounded in Comintern



In February 2020, Visitor KARINA URBACH (far right) hosted a panel discussion on “Anti-Semitism—Past and Present.” The panel, which also included (left to right) Daniel Finkelstein, Julie Gottlieb, and Deborah Lipstadt, examined the recent surge of anti-Semitism in Europe and the United States.

and Russian archives and takes in the diplomatic archives of the other leading European powers and the United States. It should present a challenge to scholars on both sides of the aisle: those who think Communism never presented a real threat to bourgeois Europe, and those who think Neville Chamberlain had no anti-Communist motives in pursuing the appeasement of Nazi Germany.

Haslam continues to study modern Greek for a major project on the civil war and the emerging cold war that promises to keep him busy for many years to come.

He is also researching and writing a new book on *Culture and Power: The Literary Left in Latin America and the Revolution in Cuba, 1959–1972*, in particular making use of the rich archival holdings at the Firestone Library at Princeton University. The book focuses on the degree to which the writers in the sixties “boom” identified with the revolution and eventually (not all) fell out with it. Gabriel García Márquez is a major touchstone in this process.

Professor **Myles W. Jackson** is continuing his research on three book-length projects. The first is a study on the collaborations between natural scientists, radio and electrical engineers, and musicians. Specifically, Jackson is looking at the history of the *trautonium*, an electronic musical instrument invented in Berlin in 1930. His second project profiles a general history of the intersections between the natural sciences and music from the late eighteenth century to the present. His third project details the reciprocal relationships between science and society over the past three centuries and is aimed at a popular audience.

In September 2019 Jackson gave two lectures in Canada, one on intellectual property and biological molecules at York University and one on physics, engineering, and music at the University of Toronto. He also spoke at Harvard University on recent historiographic trends in the history of science. At the invitation of IAS Trustee Shirley Tilghman, Jackson spoke in November to the Princeton Class of 1969 on gene patenting. As a result of the pandemic, his other lectures were either postponed



DAN KOMODA

Professor MYLES W. JACKSON organized the History of Science lecture series.

or cancelled. He has been asked to deliver a lecture as part of the University of Heidelberg’s *Ringvorlesungen*, a university-wide lecture series usually attended by about seven hundred people. The lecture takes place November 2020 and is entitled “Eigentum: Genetische Information und biologische Moleküle (“Property: Genetic Information and Biological Molecules”). A number of Jackson’s published essays appeared, including “No Longer the Focal Point: Goethe and Newtonianism,” in *The Reception of Isaac Newton in Europe*; “Automata, Physiology, and Opera in the Nineteenth Century,” in *Nineteenth-century Opera and the Scientific Imagination*; and “Johannes Brahms in the Age of Science,” in *Johannes Brahms in Context*. Jackson’s work will be featured among sixty other leading scholars in the exhibition “The Fascination of Science” by the German photographer Herlinde Koelbl debuting in Berlin in October 2020.

His lecture series on the History of Science during the autumn term was very well attended, averaging an audience of approximately eighty per talk. One talk was cancelled in the spring due to the pandemic. Jackson assisted in running the IAS’s After Hours Conversations program and sits on the IAS Library Committee, the Investment Committee, and the Director’s Search Committee. He serves on the Board of Directors of the American Friends of the Alexander von Humboldt Foundation and on the Prizes and Awards Committee of the History of Science Society. Finally, Jackson co-taught a graduate student seminar, “The Law and

Science,” with Angela Creager (Princeton University) during the spring.

In 2019–20 Professor **Sabine Schmidtke** focused on the Zaydi tradition of Yemen and Northern Iran, Twelver Shi’i legal and doctrinal thought, the history of Islamic studies and the “Science of Judaism” at the turn of the century, and Islamic and Jewish doctrinal thought.

The partnership with Hill Museum & Manuscript Library (HMML) at St. John’s University, Collegeville, in Minnesota to build up a repository to host digital surrogates of manuscripts pertaining to the Zaydi literary tradition continued to flourish. Besides the funding provided for the continuation of the project by the National Endowment for the Humanities (2018–2021), additional grants by the Ruth Stanton Foundation and the Lambert Foundation supported the project, allowing for the digitization of additional collections of Yemeni manuscripts in Italy (Rome, Naples), which has been concluded during the summer of 2020. In the framework of the NEH project, the collections of Yemeni manuscripts in Leiden and Berlin have been digitized, as well as the Stookey collection (owned by the University of Texas at Austin). Due to Covid-19, the digitization process was interrupted during March through May 2020. In the meantime, the data have been dispatched. As soon as the IAS reopens, the data will be processed by the information technology personnel (Digital Scholarship@IAS) and thereafter uploaded onto vHMML’s virtual reading room. Through additional funding



Professor SABINE SCHMIDTKE (left) with Professor Emeritus GLEN W. BOWERSOCK (right)

provided by the Carnegie Corporation in New York, digital surrogates of four private manuscript collections in Yemen have been cleaned up and will be prepared for upload unto HMML once the IAS reopens. The Carnegie Corporation in New York also supported the preparation of an edited volume, “Yemeni manuscript cultures in peril” (co-edited with Hassan Ansari), which is close to completion and will be published by Gorgias Press.

In early March, shortly before the lockdown, Schmidtke spent a week in St. Petersburg, Russia, to finalize critical editions of selected Jewish and Muslim dogmatic works by Jewish and Muslim authors, fragments of which are preserved in the Firkovitch collections held by the National Library of Russia. The resulting volume, *Jewish-Muslim Intellectual History Entangled: Textual Materials from the Firkovitch Collection, Saint Petersburg* (Cambridge: Open Publishers, 2020), brings a large-scale collaborative project of some twenty years to conclusion. The publication, by Camilla Adang, Bruno Chiesa, Omar Hamdan, Wilferd Madelung, Sabine Schmidtke, and Jan Thiele, is freely accessible on the publisher’s website www.openbookpublishers.com/product/1193, this according with and in support of the IAS’s recently launched open access policy.

Analyzing the crossroads of Islamic Studies and the “Science of Judaism” at the turn of the century, Schmidtke also continued to work on a monograph on Martin Schreiner (1863–1926), a former

student of Ignaz Goldziher who played a pioneering role in the scholarly exploration of the Mu’tazila (to be published by Mohr Siebeck). In parallel, an edition of his correspondence (in Arabic, Hebrew, Hungarian, and German) is being prepared (with Dora Zsom). In addition, an (open access) article was published on aspects of Schreiner’s work and methodology, “Scribal Practices among European Scholars during the Second Half of the Nineteenth Century: The Cases of Auguste Steinschneider (Auerbach), Moritz Steinschneider, and Martin Schreiner,” *Comparative Oriental Manuscript Studies (COMSt) Bulletin* 6/1 (2020), pp. 51–71. Of related interest, Schmidtke also began working on the letters by Schreiner’s contemporary with whom he collaborated on a number of projects related to Islamic philosophy, Friedrich Kern. Both correspondences have been accepted for publication by Brill, Leiden.

Schmidtke further completed a theme issue for the journal *Intellectual History of the Islamicate World* entitled “The Arabic Literary Genizot beyond Denominational Borders” (co-edited with Geoffrey Khan and Sarah Stroumsa, to be published in two fascicles in September 2020 and April 2021). In addition, Schmidtke finalized an edited volume (co-edited with George A. Kiraz) entitled “Scribal Habits in Near Eastern Manuscript Traditions” (currently in press with Gorgias Press), a collection of papers based on two IAS conferences (in 2018 and 2019) on Near Eastern manuscript traditions.

In the field of Twelver Shi’i thought,

she completed, with Long-term Member Hassan Ansari, volume one of a three-volume study, “Imami Thought in Transition: An Archeological Inquiry into Texts and their Transmissions” (currently in press with UCO Press, Cordoba). Semi-final drafts of volumes two and three have been completed and are currently under revision. In the field of Shii Studies, Schmidtke completed (with H. Ansari) the fourth volume of the peer-reviewed journal *Shii Studies Review*, published by Brill, Leiden (www.brill.com/ssr).

Over the course of the year, Schmidtke organized a number of major events. These included a summer school, co-convened by Robert Gleave and Hassan Ansari, “Shi’i Legal Theory Summer School” (IAS, August 2020), a collaboration between the IAS-based Shii Studies Research Program (SSRP) funded by the Carnegie Corporation of New York, and the Law, Authority and Learning in Imami Shiite Islam project (LAWALISI) at the University of Exeter funded by the European Research Council. Additionally, Schmidtke convened two public events, both well-attended by the Princeton community: “Iran at the Crossroads of Civilizations: Scholars and Lawyers Speaking about Iranian History and Cultural Heritage” (IAS, January 2020) [<https://albert.ias.edu/handle/20.500.12111/7882> and <https://video.ias.edu/icc/2020/0127>], and “Why Yemen Matters: The Heritage of a Land in Crisis” (IAS, February 2020) [<https://albert.ias.edu/handle/20.500.12111/7883>]. Two scholarly meetings that had been planned for April and June 2020 had to be cancelled in view of the lockdown since mid-March.

Schmidtke also spent much of her time at the Institute with a large and diverse group of Members studying subjects related to the Near and Middle East, though not necessarily to Islam. The group was highly international, with Members from Belgium, France, Iran, United Arab Emirates, and the United States. Over the course of the year, the Members regularly met in a biweekly lively seminar (in addition to a great deal of socializing, which was also

frequented by Members from the School of Social Science of the IAS, Princeton University graduate students and faculty, and former Members of the IAS, as well as occasional visitors.

Schmidtke further began to donate significant portions of her personal library to the Historical Studies–Social Science Library of the Institute for Advanced Study, in an effort to strengthen the library’s profile in Near Eastern and Islamic Studies, and she will continue to do so over the coming years [<https://albert.ias.edu/handle/20.500.12111/7903>].

On March 9, 2020, at the last *After Hours Conversation* of the academic year before the coronavirus crisis closed IAS, Andrew W. Mellon Professor **Francesca Trivellato** and Julia Ott (The New School and Member of the School of Social Science, 2019–20) presented *Capitalism: A Journal of History and Economics*, which they co-founded and edit together with Marc Flandreau (University of Pennsylvania) and Carolyn Biltot (Graduate Institute, Geneva).

Shortly thereafter, the Early Modern Europe seminar moved online for the last few sessions of rich discussions of Members’ works in progress. Trivellato is grateful for the feedback she received in the course of the seminar on a paper on the legal and cultural history of shipwrecks that she is writing with Guillaume Calafat (Université Paris 1–Panthéon-Sorbonne and Member of the School of Historical Studies, 2017–18). In February 2020, together with her colleagues Nicola Di Cosmo and Suzanne Conklin Akbari, Trivellato hosted Sebastian Conrad (Freie Universität Berlin and visitor in the Global History Lab at Princeton University) for a roundtable entitled *What is Global History?* [www.ias.edu/video/what-is-global-history].

Trivellato published a number of articles pertaining to areas of her current research on the economic history of pre-industrial Europe and the scholarly traditions associated with the subject: “Economic and Business History as Cultural History: Pitfalls and Possibilities,” *I Tatti Studies in the Italian Renaissance* (2019); “Beyond Production vs. Consumption and Structure vs. Identity:

The Case for a Renewed Jewish Economic History,” *American Jewish History* (2019); “Gino Luzzatto e l’archivio storico della comunità ebraica di Livorno,” co-authored with Tommaso Munari, *Archivio storico italiano* (2020); “Renaissance Florence and the Origins of Capitalism: A Business History Perspective,” *Business History Review* (2020); and “The Moral Economies of Early Modern Europe,” *Humanity: An International Journal of Human Rights, Humanitarianism, and Development* (2020).

A Japanese translation of her book *Familiarity of Strangers* (2009) appeared in

academic year 2019–20 in the Covid lockdown. Before this crisis he had been glad to welcome several scholars in fields very close to his own: Thibaut Boulay, who works on Hellenistic epigraphy in Asia Minor; Anne-Valérie Pont, whose admirable book on the end of the Greek city in Asia Minor he had read before publication (it has now appeared); Zbigniew Fiema, an experienced archaeologist who has worked at Petra in Jordan and at Mada’in Salih in Saudi Arabia; and Christian Robin, who is the leading scholar today of the south Arabian peninsula in the centuries immediately



Andrew W. Mellon Professor **FRANCESCA TRIVELLATO**, Professor **SUZANNE AKBARI**, and Luce Foundation Professor in East Asian Studies **NICOLA DI COSMO** (left to right) joined Sebastian Conrad (far right) for a roundtable discussion of the latter’s *What Is Global History?*

print. That book is also the topic of an interview she gave for a forum on “Trust and Distrust in Exploring the Human Past” published in the *Journal of Modern European History* (2020).

Before all travel and in-person gatherings came to a halt, she gave numerous lectures, including the opening keynote of the thirteenth conference of the European Historical Economics Society in Paris, the fifty-fifth Erasmus Lecture at the Centre for Reformation and Renaissance Studies of the University of Toronto, and the 2020 Carolyn L. Drucker ’80 Memorial Lecture in the Program in Judaic Studies at Princeton University.

Professor Emeritus **Glen W. Bowersock**, like his colleagues and many School Members, spent the second half of the

before Islam. All four of these eminent scholars, who have long been in close touch with Professor Bowersock, shared their learning generously with the School of Historical Studies to its immense profit. Their departures brought an unexpected and sad end to their fruitful presence at the Institute.

During the academic year Professor Bowersock published articles on Palestine and on Seleucid history in the *New York Review of Books*. A German translation of his book *The Crucible of Islam* appeared with Beck Verlag as well as a Hebrew translation, from the Israel Historical Society, of his *Empires in Collision*. He contributed a paper on an inscription from Zafar to the *Festschrift* for Mikhail Piotrovsky, director of the Hermitage in



AMIAS Member GABRIELA SOTO LAVEAGA's research weaves together two microhistories—one in Mexico and one in India—to examine the impact of twentieth-century hybrid seed technology in a pair of farming communities. She gave a Friends Dinner with a Member talk titled “Global Hunger/Scientific Solutions? A ‘Universal’ Solution to End World Hunger” at the beginning of March.

St. Petersburg. He has tried during the lockdown to complete a final draft of his paper for a forthcoming publication from the Getty Museum on cultural heritage and atrocities in the light of late antique examples that might illuminate the recent horrors at Bamyam and Palmyra.

During the academic year 2019–20, Professor Emerita **Caroline W. Bynum** continued to work on her book *Dissimilar Similitudes: Devotional Objects in Late Medieval Europe*, which will appear from Zone Books in late 2020. By exploring the concept of “similitude,” Bynum treats two closely connected themes: the nature of comparison across cultures and across time (that is, how do we choose things that are “like” each other in different contexts?) and the paradoxical ways in which medieval objects impel viewers to see (that is, how does a devotional object mirror an unseen, un-seeable, and dissimilar heaven through the ordinary things of earth?). She has carried these themes further in a more theoretical piece, “Interrogating ‘Likeness’: Fake Friends, *Similia similibus*, and Heavenly Crowns,” published in *Historische Anthropologie* 28.1 (2020). She published an epilogue to the volume *Religious Materiality in the Early Modern World* that appeared from the University of Amsterdam Press in the fall of 2019, and in January 2020 participated in a conversation with artist Heide Hatry on “Images and Icons” for the “Religion

in Public Life” series at Columbia University. She is currently working on a different sort of object: Confederate monuments in the American South where she grew up. Putting Civil War memorials in the context of southern racism and anti-Semitism, she argues that it is not enough to remove such objects. They need to be used for instruction about American failure over the past 150 years to come to terms with the legacies of slavery. Other sites, such as places of lynching and slave auctions, need to be similarly memorialized and discussed. Drawing on her earlier study of medieval anti-Semitic objects in Germany, she considers lessons Americans might learn from recent German efforts to come to terms with their past. Although she has lived in New York City since retirement, she stays in contact with IAS Faculty members, especially Yve-Alain Bois, Francesca Trivellato, and Suzanne Akbari, as well as with Emeriti Glen Bowersock and Giles Constable, and is in lively email conversation with a number of former School Members in the United States and abroad, especially in Israel and the UK. She also continues to advise several graduate students in the history and art history departments at Columbia University.

Patrick J. Geary spent his first year as Professor Emeritus working on his recently-awarded European Research

Council Synergy Grant, HistoGenes. This 10-million-euro award, which he received as co-Principal Investigator along with historian Walter Pohl (Austrian Academy of Sciences), archaeologist Tivadar Vida (Eötvös Loránd University, Budapest), and geneticist Johannes Krause (Max-Planck Institute for Evolutionary Anthropology in Leipzig), is studying population structures and mobility in the Carpathian basin between 400 and 900 C.E. through the genomic, isotopic, and anthropological analysis of approximately six thousand burials in the region. HistoGenes unites historians, archaeologists, geneticists, anthropologists, and specialists in bio-informatics, isotope analysis, and other scientific methods to address a wide range of historical questions from an interdisciplinary perspective. The unique interdisciplinary nature of the project and its scope (the largest of its kind ever attempted) will also allow the team to explore fundamental theoretical and methodological issues. The hope is that HistoGenes will not only advance our knowledge about a key period in European history, but also establish new standards for the historical interpretation of genetic data.

In September, Geary participated in a conference on “Retirement from Court in Avignon,” presenting a paper on the Frankish Prince-Monk Carloman (ca. 706–754), son of Charles Martel, who denounced his worldly power to become a monk in Italy, paving the way for his brother Pepin to become the first Carolingian king.

In October and November, in conjunction with HistoGenes, Geary spoke at a variety of institutions about various aspects of the integration of genomics into historical research. Having relocated post retirement to Portland, Oregon, he spoke first at Portland State University on “Integrating Genomic Data into Historical Research: Mobility and Social Structure in Late Antiquity.” Subsequently he spoke at the Université de Montréal on “L’analyse génomique au service de l’histoire des migrations barbares: résultats préliminaires,” and at the University of Colorado on “The Challenge of Genetic History: Rewriting

the Barbarian Migrations through Genetics and Archaeology.”

In October Geary was inducted as a member of the American Academy of Arts and Sciences at the Academy’s annual meeting in Cambridge, Massachusetts.

At the American Historical Association’s annual meeting in New York, Geary participated in two panels, one on “Writing History with Scientific Data” and another on “Rethinking Materiality with Medieval Britain.” In February, he attended the first plenary meeting of the HistoGenes team in Vienna, Austria, then flew to Berlin where he delivered the annual Berlin Brandenburg Academy of Sciences lecture in the series “The Medieval Millennium” on the challenges and dangers of integrating genomic data into early medieval historical research.

The onset of the Covid-19 pandemic in March required him to cancel a series of engagements at Vanderbilt University, the Israeli Institute for Advanced Study, the University of Vienna, and elsewhere. However, he continued to meet weekly via Zoom with his colleagues in HistoGenes in order to develop deeper mutual understandings of genetic, archaeological, and historical research while advancing this ambitious project. Also via Zoom, he has been able to chair yet again the M.A. defenses at the Central European University, and in June he spoke on the dangers of genomic history to a group of Institute patrons and Board members.

Geary published several papers in

English and Italian on genomic history and, along with colleagues, published an article on Longobard-era migrations in the *European Journal of Human Genetics*.

In November 2019, the Oxford University Press published the fourth and last volume in the series Professor Emeritus **Jonathan Israel** has published since arriving at IAS in 2001 on the role of the Radical Enlightenment in the rise of modern Western democracies, gender and race equality, freedom of conscience, and freedom of speech. This last volume, entitled *The Enlightenment that Failed. Ideas, Revolution and Democratic Defeat, 1748–1830*, focuses on the period from shortly before the American and French Revolutions down to the 1848 revolutions and adopts a broad trans-Atlantic perspective focusing on North and South America as well as Europe and the European colonial empires.

Prior to the onset of the pandemic, during the closing months of 2019 and opening weeks of 2020, Israel discussed his recent research and gave research papers at Blois, in France, at the Academic Sinica in Taipei, and at Johns Hopkins University, Baltimore. The talk at Blois was in connection with the publication of the French translation of his 2014 book on the role of ideas in the French Revolution, published by Alma in Paris in the autumn of 2019 under the title *Idées révolutionnaires. Une histoire intellectuelle de la Révolution française*, which has led to some lively debate in France. The lecture in Taiwan was about American reactions to

rival and conflicting European Enlightenment interpretations of the significance of the American Revolution. The paper in Baltimore was on the role of Spinoza in late Enlightenment German philosophy and political thought.

Most of Israel’s activity during this academic year was in connection with the new full-length biography of Spinoza that he has begun working on systematically since 2018. During February, just before the libraries and archives in Britain and Europe were closed, Israel managed to complete some of the research on rare books and pamphlets at the British Library needed for his research on Spinoza’s life and legacy, but the shutdown prevented him from proceeding with the extensive research that needs to be done in Dutch archives and libraries.

During the autumn of 2019 Israel also completed the last stages and revisions of his new book on *Revolutionary Jews from Spinoza to Marx*, which is now scheduled to be published by University of Washington Press early in 2021. Israel has also been revising the paper on d’Holbach’s political thought given at Göttingen in May 2019 challenging the traditional view in the historiography that d’Holbach was a *royaliste* by presenting evidence that he was in fact a crypto-republican deeply critical not only of absolutist but also of British-style constitutional monarchy. The paper is due to appear in a volume of papers reassessing the significance of d’Holbach to be published by Brill.

2019–20 MEMBERS AND VISITORS

f First Term ♦ *s* Second Term ♦ *m* Long-term Member ♦ *v* Visitor

Hassan Farhang Ansari
Islamic Law and Theology ♦ Institute for Advanced Study ♦ *m*
Funding provided by the National Endowment for the Humanities

Robert James Antony
Chinese History ♦ Guangzhou University ♦ *v, f*

Jan Bemmman
Archaeology and History of Inner Asia ♦ Universität Bonn
Gerda Henkel Stiftung Member

Ruth Ben-Ghiat
Modern European History ♦ New York University ♦ *s*
Funding provided by the Andrew W. Mellon Foundation

Lauren Benton
History ♦ Vanderbilt University
Funding provided by the Andrew W. Mellon Foundation

Thibaut Boulay
Ancient History ♦ Université de Tours

Aaron Michael Butts
Near Eastern Studies ♦ The Catholic University of America
The Andrew W. Mellon Foundation Fellowships for Assistant Professors

Hannah Chazin
Archaeology of the South Caucasus ♦ Columbia University
The Andrew W. Mellon Foundation Fellowships for Assistant Professors

Tamara Chin
Comparative Literature ♦ Brown University
Frederick Burkhardt Fellowship funded by the American Council of Learned Societies

Godefroid De Callatay
Islamic Studies ♦ Université Catholique de Louvain
Willis F. Doney Member

Charlotte Denoël

Medieval Manuscripts ♦ Bibliothèque Nationale de France
George William Cottrell, Jr. Member

Paul Chandler Dilley

Religions of Late Antiquity ♦ The University of Iowa
Frederick Burkhardt Fellowship funded by the American Council of Learned Societies

Mary Kamal Farag

Late Antiquity ♦ Princeton Theological Seminary
Funding provided by the Patricia Crone Fund

Zbigniew Tomasz Fiema

Archaeology, Ancient History ♦ University of Helsinki
Funding provided by the Patrons' Endowment Fund and the Hetty Goldman Membership Fund

Arnaud Fossier

Medieval Italy, Church and Canon Law ♦ Université de Bourgogne
Funding provided by the Herodotus Fund

Heidi Catherine Gearhart

Art History, Medieval Europe ♦ Humboldt-Universität zu Berlin
Elizabeth and J. Richardson Dilworth Fellow; additional funding provided by the Ruth Stanton Foundation

Eva Giloi

Modern Germany ♦ Rutgers, The State University of New Jersey
Martin L. and Sarah F. Leibowitz Member

Marius Hauknes

History of Art ♦ University of Notre Dame
Agnes Gund and Daniel Shapiro Member

Daniel Bernardo Hershenzon

Early Modern History ♦ University of Connecticut
John Elliott Member

Aaron Hershkowitz

Ancient History, Epigraphy ♦ Institute for Advanced Study ♦ *ra*
Funding provided by the Charles and Lisa Simonyi Fund for Arts and Sciences; additional funding provided in memory of Fowler Merle-Smith

Joshua Howard

Modern Chinese History ♦ University of Mississippi
The Starr Foundation East Asian Studies Endowment Fund Member

Rob Iliffe

History of Science ♦ University of Oxford
Ralph E. and Doris M. Hansmann Member

Christopher P. Jones

Classical Philology and History ♦ Harvard University ♦ *ra*

Matt Kadane

Early Modern Europe ♦ Hobart and William Smith Colleges ♦ *s*
Willis F. Doney Member

Juliette Kennedy

Mathematical Logic, Foundations of Mathematics ♦ University of Helsinki ♦ *v, f*

George A. Kiraz

Ottoman History of Religious Minorities, Syriac Studies ♦ Beth Mardutho: The Syriac Institute ♦ *ra*

Hiroaki Kuromiya

Modern Eurasian History ♦ Indiana University
The Starr Foundation East Asian Studies Endowment Fund Member

Fabio Lanza

Modern Chinese History ♦ The University of Arizona ♦ *f*
Roger E. Covey Member in East Asian Studies

Hartmut Leppin

Ancient History ♦ Goethe-Universität Frankfurt ♦ *f*

Deirdre Loughridge

Music ♦ Northeastern University
Edward T. Cone Member in Music Studies

Isabelle Marchesin

Medieval Iconography, Visual Semiotics ♦ Institut National d'Histoire de l'Art, Paris ♦ *v*

Molly Nesbit

Art History ♦ Vassar College ♦ *s*
Funding provided by the Andrew W. Mellon Foundation

Esen Ogus

Classical Archaeology ♦ Austin Peay State University
Funding provided by the Hetty Goldman Membership Fund

Charles Parker

Early Modern Europe, World History ♦ Saint Louis University
Felix Gilbert Member

Anthony Michael Petro

History of Religion and Visual Studies ♦ Boston University
Funding provided by the Fund for Historical Studies

Marjorie Elizabeth Plummer

Early Modern Religion, Gender History ♦ The University of Arizona ♦ *f*
William D. Loughlin Member

Anne-Valérie Pont

Roman History, Epigraphy, Empire, Cities ♦ Université Paris-Sorbonne
Funding provided by the Herodotus Fund

Regine Pruzsinszky

Ancient Near Eastern Studies ♦ Albert-Ludwigs-Universität Freiburg ♦ *s*
Funding provided by the Fund for Historical Studies

Lisa Regazzoni

Early Modern France, Material Culture ♦ Goethe-Universität Frankfurt ♦ *f*
Funding provided by the Fund for Historical Studies

Christian (Xian) Robin

Ancient History ♦ Centre National de la Recherche Scientifique, Paris
Funding provided by the Patricia Crone Fund

Andrew Sartori

Intellectual History ♦ New York University ♦ *f*
Willis F. Doney Member

Gideon Shelach-Lavi

Archaeology ♦ The Hebrew University of Jerusalem ♦ *s*

Andrew Sloan

Soviet, European, and Jewish History ♦ Baruch College, The City University of New York
Hans Kohn Member

Gabriela Soto Laveaga

History of Science in Latin America and India ♦ Harvard University
AMIAS Member

Justin Stearns

History of the Middle East ♦ New York University Abu Dhabi
Patricia Crone Member

Daniel Strum

Early Modern Atlantic History ♦ University of São Paulo ♦ *s*
Funding provided by the Fund for Historical Studies

Hiroshi Takayama

Medieval History ♦ The University of Tokyo ♦ *f*
Willis F. Doney Member

Marion Thomas

History of Life Sciences and Primatology ♦ Université de Strasbourg
Founders' Circle Member; funding provided by Deborah Lunder and Alan Ezekowitz

Kira Thurman

German History, Musicology, and Black Studies ♦ University of Michigan
The Andrew W. Mellon Foundation Fellowships for Assistant Professors

Stephen V. Tracy

Greek History and Epigraphy ♦ American School of Classical Studies in Athens ♦ *ra*

Karina Urbach

Modern International Relations and Jewish Family History ♦ University of London ♦ *v*

Glen Van Brummelen

History of Astronomy ♦ Quest University Canada
Funding provided by the Fund for Historical Studies

Daniel Martin Varisco

History ♦ American Institute for Yemeni Studies
Funding provided by the Patricia Crone Fund

Alla Vronskaya

History of Modern Architecture ♦ Illinois Institute of Technology
Funding provided by the Herodotus Fund

Ao Wang

Literature, Poetry ♦ Wesleyan University
Funding provided by the Gladys Krieble Delmas Foundation

Laura Weigert

Art History ♦ Rutgers, The State University of New Jersey
Funding provided by the Patrons' Endowment Fund

Cord Whitaker

Medieval Literature and the History of Race ♦ Wellesley College
Friends of the Institute for Advanced Study Member

Judith Cinema Zeitlin

Chinese Literature and the Arts ♦ The University of Chicago ♦ *s*
The Starr Foundation East Asian Studies Endowment Fund Member

School of Mathematics

The School of Mathematics, established in 1933, was the first School at the Institute for Advanced Study. Several central themes in mathematics of the twentieth and twenty-first centuries owe their major impetus to discoveries that have taken place in the School, which today is an international center for research on mathematics and theoretical computer science.

FACULTY

Camillo De Lellis

IBM von Neumann Professor

Helmut Hofer

Hermann Weyl Professor

Jacob Lurie

Peter Sarnak

Akshay Venkatesh

Robert and Luisa Fernholz Professor

Avi Wigderson

Herbert H. Maass Professor

PROFESSORS EMERITI

Enrico Bombieri

Pierre Deligne

Phillip A. Griffiths

Robert P. Langlands

Robert D. MacPherson

Thomas Spencer

Visiting Professor IRIT DINUR specializes in theoretical computer science, particularly error-correcting codes and probabilistically checkable proofs. She spoke on “Unique and 2:2 Games, Grassmannians, and Expansion” as part of the annual Hermann Weyl lecture series.

IN ACADEMIC YEAR 2019–20 the School of Mathematics held a special year on “Optimization, Statistics, and Machine Learning,” headed by Distinguished Visiting Professor **Sanjeev Arora**. Activities in that special year explored how these traditional disciplines are changing as they respond to modern challenges, especially deep learning. The program hosted eighteen Members in each term.

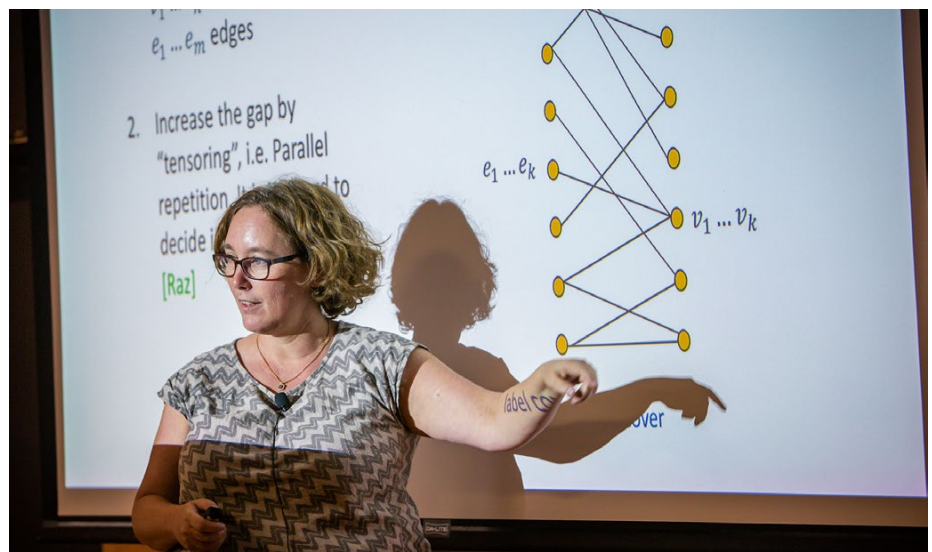
As for Arora’s personal projects, two running themes emerged.

First, opening the black box of deep learning. What happens during training? Why does the deep net end up fitting the training data? Why does the trained net generalize to new unseen data?

One salient insight is that perhaps the traditional optimization view of deep learning is missing some key aspects that make it a poor fit for today’s deep nets. In a paper in *ICLR’20* with student Zhiyuan Li, Arora highlighted this by showing that the usual notion of learning rate/step size from optimization does not make much sense in modern deep nets. Arora and Li showed that it is possible to do state-of-the-art training in state-of-the-art nets while

increasing the learning rate exponentially: multiply the lr by $(1+c)$ for some $c>0$ at each iteration, causing lr to increase to gigantic levels by the end. They demonstrated both experimentally and also via mathematical proof that an exponential lr schedule can be used to train at least as well as current schedules. A follow-up paper (in review) with Li and another student, Kaifeng Lyu, shows a theoretical framework for thinking about such phenomena, which adapts the usual stochastic differential equation framework.

A second running theme, motivated by data privacy issues, asks the question: Can my data be used to train a deep net (say at a remote server) without making me reveal the data? Classical cryptography does allow for handling such seemingly oxymoronic requirements, albeit at a huge computational cost that essentially rules it out of deep learning scenarios. Arora and collaborators presented a simple way, InstaHide, to hide/encrypt information in the training data, which allows the encrypted instances to be used in existing deep learning frameworks as-is with essentially no impact on training speed and only a small impact on



ANDREA KANE

final accuracy. Follow-up manuscripts with the same coauthors apply this idea to other types of data, and also to improving adversarial robustness.

Richard Feynman famously called turbulence “the most important unsolved problem of classical physics.” Nowadays, science can actually say a lot about turbulent flows: continuum mechanics gives a widely accepted description of the motion of fluids through mathematical objects called systems of partial differential equations, which describe the relations between the rates of change of a fluid’s

throughout their motion and, depending on the degree of idealization, they are described by two of the most famous (and most studied) systems of partial differential equations: the Euler equations and the Navier-Stokes equations.

It is everyone’s everyday experience that viscosity slows down fluids: without the action of an external force, the motion tends to die out, and the rate at which this happens seemingly depends on how viscous the fluid is. In the (very idealized) situation of the Euler equations, the motion should not experience any slow-down, because viscosity is absent.

surprising mathematical hypothesis: due to the existence of anomalous dissipation, he postulated the existence of solutions to the Euler equations which indeed dissipate kinetic energy, contrary to what classical mathematics predicts. Onsager’s hypothesis could be summarized as follows: “If the rate of dissipation of the kinetic energy is really independent of the viscosity, then I could set the viscosity to 0 and still see dissipation.”

There is actually nothing wrong in the theorems of classical mathematics: Onsager’s conjectural solutions would be so irregular that the usual hypotheses under which those theorems are derived would no longer be valid. The first rigorous indication that Onsager could be right came through pioneering works of Vladimir Scheffer and Alexander Shnirelman in the nineties. The Onsager conjecture was finally verified by Phil Isett in 2016, building upon an unusual discovery of De Lellis and collaborator László Székelyhidi Jr. Between 2007 and 2015, in a series of works, De Lellis and Székelyhidi uncovered a subtle link with a completely unrelated famous theorem of Nash from the fifties. They started a theory on how to produce rather irregular solutions of several classes of partial differential equations, a theory successfully implemented in many different situations by several other researchers.

While the solution of Onsager’s conjecture is certainly a striking, completely rigorous, mathematical proof of a very nontrivial prediction of the theory of turbulent fluid motions, a much more compelling result should account for the presence of viscosity, albeit small, and show anomalous dissipation in solutions to the Navier-Stokes equations. De Lellis and Members in the School of Mathematics have been working at the problem in 2019–20.

De Lellis and Member Hyunju Kwon have made substantial progress on a conjecture of Isett, who observed that anomalous dissipation in solutions of the Navier-Stokes equations would lead to a much stronger statement than Onsager put forward in his original 1949 paper. Using the tools developed by De Lellis and Székelyhidi (and refined by

various macroscopic physical quantities, like its density, velocity, etc. However, from the point of view of pure mathematics, it is very interesting to understand whether, if we base ourselves only on the equations which are supposed to describe fluid flows, we can predict the phenomenology observed by applied mathematicians and engineers. This poses several challenges to pure mathematicians, which IBM von Neumann Professor **Camillo De Lellis** spent the year investigating. One well-known example is the so-called “anomalous dissipation,” a widely accepted phenomenon in the theory of turbulence of incompressible fluids. Incompressible fluids are those whose density remains constant

This is, at least, what nineteenth century mathematics predicts. However, scientists have long observed that in many fluids which undergo turbulent motion, much more force is needed to sustain the motion than what could be predicted by their relatively modest viscosity. How much force is actually needed seems to be independent of how much friction there is, as was first pointed out in the early forties by Kolmogorov. This has been dubbed “anomalous dissipation” because the rate of decay of the fluid motion is related to how quickly its kinetic energy is “dissipated.”

In 1949, Lars Onsager, a Nobel prize winner in chemistry and a prominent theoretical physicist, put forward a very



ANDREA KANE

As part of the special year on “Optimization, Statistics, and Machine Learning” headed by Distinguished Visiting Professor SANJEEV ARORA (center), the School hosted a four-day October workshop titled “Theory of Deep Learning: Where Next?”

Székelyhidi and Modena), Member Maria Colombo and De Lellis, in a joint work with Elia Bruè, settled another open problem related to the motion of individual fluid particles. Their work shows that, contrary to what many mathematicians believed previously, when the velocity of a fluid is highly irregular, even if one knows the instantaneous velocity of the fluid at any point of the space, it is not possible to meaningfully consider the trajectory of a single ideal particle without taking into account the trajectories of all the other particles surrounding it. Again, this is strikingly different to what was proved by mathematicians in the early twentieth century when the velocity is instead regular.

The research activities in symplectic geometry at IAS, led by **Helmut Hofer**, Hermann Weyl Professor, cover a wide range of topics. Among these are questions in dynamical systems, foundational work in pseudoholomorphic curve theory, low-dimensional topology and geometry, theories of symplectic invariants, and the ramifications of such theories for problems in other mathematical fields.

Due to Covid-19, the IAS/Princeton University Joint Symplectic Seminar had to switch in March 2020 to an online mode. The new Symplectic Zoominar expanded beyond IAS and Princeton University and now includes universities in Montreal, Paris, and Tel Aviv. The Zoominar has been very successful; it



Member **SILVIA GHINASSI**, co-organizer of the MC@HOME series, gives an After Hours Conversation.

has many participants, and the organizers decided to continue this even after the pandemic is over.

Von Neumann Fellow Emmy Murphy was awarded the prestigious 2020 New Horizons Prize for the introduction of notions of loose Legendrian submanifolds. This work has been very fruitful for the recent developments of higher dimensional symplectic geometry, particularly understanding symplectic flexibility in dimension at least six. The question about symplectic rigidity and flexibility is very interesting in dimension four and is far from well-understood. Von Neumann Fellow Yaron Ostrover continued his work to understand the fine line between rigidity and flexibility.

One of the highlights during the academic year was the proof of the long-standing Simplicity conjecture from the seventies by von Neumann Fellow Daniel Cristofaro-Gardiner in a joint work with former Member Sobhan Seyfaddini and Vincent Humiliere. This conjecture was the remaining open problem about the structure of certain transformation groups. The proof showcases the power of the recent developments in so-called continuous symplectic geometry.

Member Daniel Alvarez-Gavela continued his joint work with former Distinguished Visiting Professor Yasha Eliashberg (Stanford University) and former Member David Nadler (University of California, Berkeley) on the arborealization program, which will ultimately lead to a better understanding of an important class of symplectic manifolds.

Member Sara Tukachinsky continued her work, in part jointly with former Member Jake Solomon, on open Gromov-Witten theory and related questions. This work was motivated in part by mirror-symmetry, a mathematical phenomenon first exhibited in string theory. Member Nancy Hingston, with former von Neumann Fellow Alexandru Oancea and Kai Cieliebak, collaborated on a large joint project on various aspects of string topology, particularly Poincaré duality of loop spaces. This project, which started with a 2017 presentation by



Von Neumann Fellow **EMMY MURPHY** was awarded the prestigious 2020 New Horizons Prize for the introduction of notions of loose Legendrian submanifolds.

ANDREA KANE

ANDREA KANE

Hingston in the informal “Mathematical Conversations” IAS seminar, has produced several important recent papers.

Member Zhiyuan Zhang continued his work with former von Neumann Fellow Barney Bramham, leading to a generalization of the Herman-Yoccoz result on the circle diffeomorphisms. Zhang also started joint work with Member Alex Eskin and von Neumann Fellow Rafael Potrie.

Professor Hofer and Member Zhengyi Zhou had numerous discussions on polyfold and Fredholm theory, a theory introduced by Hofer and former Members Kris Wysocki and Edi Zehnder and carried out in large parts at IAS. The discussions with Zhou were very important in finishing the final version of the (meanwhile) 1020-page manuscript, which gives a comprehensive view of the theory. Zhou obtained a number of new results concerning the existence of exact

mathematical fields together to discuss and popularize important ideas from one area to the whole community. This aspect has been very successful over the years, and not unexpectedly, the Mathematical Conversations have been a venue for starting new developments in mathematics and theoretical computer science. Due to the quite unique format of the series, it was challenging to move it online. Jointly with Member Silvia Ghinassi, Hofer created MC@Home (Mathematical Conversations at Home) with a modified format to take advantage of Zoom features and maintain an informal atmosphere. Ghinassi implemented a very successful format and it became a great success. MC@Home is open to Members of the School, and by invitation only to former members of IAS and a selected group of international mathematicians, depending on the topic. Right from the start, MC@Home had an international

and machine learning”; “Musings about a 10-year collaboration with biological morphologists, or How to make biologists comfortable with fiber bundles”; “The reversibility paradox: 130 years after Loschmidt and Zermelo”; “Weyl laws and dense periodic orbits”; and “Mathematics formalization for mathematicians.” Daniel Cristofaro-Gardiner gave a presentation on the “Simplicity conjecture” and Lisa Piccirillo (MIT) gave a presentation on “Knot concordance and 4-manifolds.”

Many interesting and important functions in mathematics arise as the solutions to *algebraic* differential equations. For example, the square-root function $f(z) = \sqrt{z}$ satisfies the differential equation

$$\frac{df(z)}{dz} = \frac{2}{z} f(z).$$

Note that this equation has a *singularity* at the point $z = 0$. This is related to the fact that the function $f(z)$ is ambiguously defined: every nonzero complex number z has exactly two square roots (which are negatives of one another). In general, the obstruction to finding a *global* solution to a differential equation that can be locally solved is measured by an object called the *monodromy representation* of the equation. In his famous address to the Second International Congress of Mathematicians, David Hilbert asked if *every* representation can appear as the monodromy representation of a suitably chosen algebraic differential equation (this was the twenty-first of Hilbert’s celebrated “twenty-three problems” for the mathematics of the twentieth century). Many mathematicians contributed important work on this question and its generalizations (including Professor Emeritus Pierre Deligne), ultimately culminating in the construction of the *Riemann-Hilbert correspondence* of Masaki Kashiwara and Zoghman Mebkhout in the early 1980s (working independently of one another), which articulates a close connection between the study of algebraic differential equations and the topology of algebraic varieties defined over the field of complex numbers. Over the past year, Professor **Jacob Lurie** and his collaborator, Visitor



Visitor MARK GORESKY (left) with Professor PETER SARNAK (right)

fillings for a variety of spaces, a currently very active area of research. He will need some of the polyfold theory for some of his current projects on localization.

Mathematical Conversations, a long-running informal series Hofer started about ten years ago, with presentations aimed towards the general audience of Members at the School of Mathematics, had to move online. The goal of the Mathematical Conversations series has been two-fold: socializing and bringing researchers in different

audience, the former von Neumann Fellow, Fields Medal winner, and French parliamentarian Cédric Villani being one frequent participant. MC@Home started with a timely presentation by the Distinguished Visiting Professor (Mathematics and Systems Biology) Lai-Sang Young on “Consequences of delays and imperfect isolation in epidemic control,” April 9. The following sessions covered many topics in mathematics and theoretical computer science, among them talks entitled “Vignettes about pure mathematics



ANDREA KANE

In January 2020, Professor Emeritus ENRICO BOMBIERI (center) was awarded the 2020 Crafoord Prize in mathematics for outstanding and influential contributions in all major areas of mathematics, particularly number theory, analysis, and algebraic geometry. The Institute hosted a celebration in his honor.

Bhargav Bhatt, have developed an analogue of this Riemann-Hilbert correspondence for algebraic varieties which are defined over p -adic fields. This too builds on the work of many other mathematicians, but a novel feature of the present work is that the context allows algebraic varieties and differential equations with arbitrarily prescribed singularities.

Another ongoing project of Lurie's aims to clarify and extend the *calculus of functors*. The classical differential calculus (dating back to the work of Newton and Leibniz in the seventeenth century) is based on a simple idea: to understand a general function $f(x)$ of one variable x , one should attempt to *approximate* $f(x)$ by simpler functions which are already well-understood (such as linear functions). In the early 1990s, Tom Goodwillie proposed to apply the same idea in a different context. Rather than considering *functions* (operations which take as input a number x and produce as output another number $f(x)$), he was interested in studying *homotopy functors* (operations which take as input a space X and produce as output another space $F(X)$; algebraic topology provides an endless supply of examples of such operations). Where traditional calculus approximates general functions $f(x)$ by linear functions, Goodwillie explained how to approximate homotopy functors $F(X)$ by functors of a relatively simple type, known as *excisive*

functors. This idea was the starting point for what is now known as the *calculus of functors*, which is an essential tool in modern algebraic topology. It is in many respects analogous to the classical differential calculus, but there is an important point where the analogy breaks down: while the identity function $f(x) = x$ is already linear, the identity functor $F(X) = X$ is not excisive. In fact, the higher derivatives of the functor $F(X) = X$ have a rich and interesting structure, which is intimately connected with the theory of Lie algebras (originally introduced by Sophus Lie in the 1870s, for a completely different purpose). A primary goal of Lurie's recent work is to provide a conceptual explanation for the appearance of Lie algebras in this context, and to understand what replaces them in more exotic settings.

In his delightful AMS Einstein lecture (see www.ams.org/notices/200902/rtx090200212p.pdf) "Birds and Frogs," Freeman Dyson speculates as to how a classification of 1-dimensional (Fourier) quasicrystals might lead to a proof of the Riemann hypothesis. Such a quasicrystal is an arrangement of a discrete set of weighted point masses on the line whose frequency decomposition (Fourier transform) is again of this form. The basic example is a periodic arrangement of points with unit weights placed on an arithmetic progression, or finite unions

thereof. He adds that such a classification might be difficult, and even the basic question of whether there are such quasicrystals with positive weights and which are not periodic had been an open problem for some time.

In their recent work on spectra of metric graphs, Pavel Kurasov and Professor **Peter Sarnak** answer this question by constructing many such quasicrystals. A metric graph is an arrangement of finitely many rods of possibly different lengths which are suitably joined at their endpoints (allowing for three or more rods per join). The additive structure of the vibrational frequencies of this structure can be studied using advanced tools from Diophantine analysis. The analogue of the Selberg (School of Mathematics Faculty, 1951–2007) Trace formula in this simple setting yields a positive quasicrystal, and if the lengths are chosen carefully, it is not periodic. This confirms Dyson's guess that 1-dimensional quasicrystals are very rich and complex, and their complete classification is no doubt very difficult.

The theory of automorphic forms, which is the study of periodic structures in higher dimensional homogeneous spaces, continues to be a very active and central theme in the School of Mathematics. Many of the weekly number theory seminars concern recent advances in the theory. Member Shai Evra established the "density hypothesis" for many of these (nonabelian) periodic spaces. The holy

grail concerning the location of the frequency spectra of these general spaces goes by the name “the general Ramanujan conjectures,” and the density hypothesis serves as a substitute for the former in certain problems. Evra is the 2020 recipient of the Sastra Ramanujan prize for his work on the closely related topic of higher dimensional expanders.

Robert and Luisa Fernholz Professor **Akshay Venkatesh** continued to develop a project on duality of automorphic periods with recent von Neumann Fellow Yiannis Sakellaridis and recent Member David Ben-Zvi. This duality gives a unifying principle for what is sometimes called the *relative* Langlands program, and Venkatesh hopes that it will shed light on certain unexplained oddities of number theory, such as the existence of identities between different infinite sums of L -functions. It is closely related to

ideas in the physics literature studied by past School of Natural Sciences Member Davide Gaiotto and Charles Simonyi Professor Edward Witten.

Venkatesh and Professor Jacob Lurie organized a year-long learning seminar on nonabelian Hodge theory. This attracted an audience both of IAS Members and mathematicians from Princeton University; the group studied a remarkable sequence of papers from the 1980s that give a Hodge-theoretic picture of local systems on a complex algebraic variety.

Research continued apace in the Computer Science and Discrete Mathematics group, led by Herbert H. Maass Professor **Avi Wigderson**. In work on analysis of Boolean functions, Member Dor Minzer and collaborators developed a strong form of the hypercontractive inequality, enabling the understanding of threshold phenomena

in low probability regimes across statistical physics and combinatorics. In work on circuit complexity, Visiting Professor Toniann Pitassi and Member Robert Robere gave new lifting theorems enabling the best hardness results in a variety of monotone computational models. In approximation algorithms, Member Fotis Iliopoulos used fine analysis of certain Markov chains for efficiently coloring graphs at the so-called “algorithmic barrier.” In coding theory, Visiting Professor Irit Dinur and collaborators used high dimensional expanders to make progress on the problem of locally testable codes. And in optimization, Wigderson and collaborators used tools from invariant and representation theory to develop a framework and algorithms extending convex optimization from the classical setting of Euclidean geometry to the geodesic setting of Riemannian manifolds.

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School of Natural Sciences

The School of Natural Sciences, established in 1966, supports research in broad areas of astrophysics, systems biology, and theoretical physics. Areas of current interest include investigating the origin and composition of the universe; conducting research at the interface of molecular biology and the physical sciences; and elementary particle physics, string theory, quantum theory, and quantum gravity.

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Nima Arkani-Hamed

Stanislas Leibler

Juan Maldacena

Carl P. Feinberg Professor

Nathan Seiberg

James Stone

Scott Tremaine

Richard Black Professor

Michail Tsodyks

C.V. Starr Professor

Edward Witten

Charles Simonyi Professor

Matias Zaldarriaga

PROFESSORS EMERITI

Stephen L. Adler

Freeman J. Dyson

deceased February 28, 2020

Peter Goddard

Peter Goldreich

Arnold J. Levine

EACH YEAR THE SCHOOL OF Natural Sciences appoints about fifty Members, the majority of them post-doctoral fellows, who are typically at the Institute for three years, some for up to five years. Collaboration is encouraged among Members who work in the School's many scientific areas—from molecular biology to mathematical physics.

From its earliest days, the Institute has been a leading center for fundamental physics, contributing substantially to many of its central themes, which now interrelate with astrophysics and biology. Areas of current interest in theoretical physics include elementary particle physics, string theory, quantum theory, and quantum gravity, and their relationship to geometry, theoretical and observational astrophysics, and cosmology.

Research in the School's astrophysics group encompasses astronomical systems from nearby planets to distant galaxies, from black holes to the dark matter and dark energy that dominate the evolution of the universe. There is a growing cross-fertilization between astrophysics and

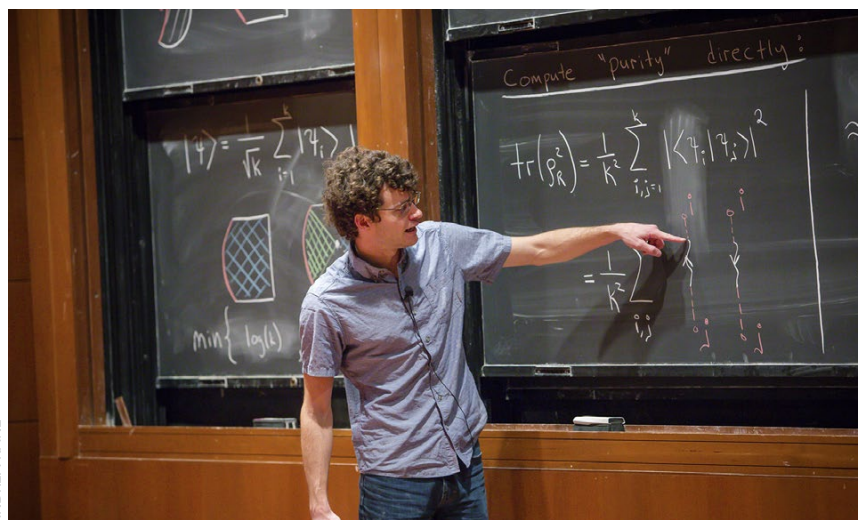
elementary particle physics, and the work of many Members and Faculty crosses the boundary between these two disciplines. Members in the astrophysics research group employ an array of tools from theoretical physics, large-scale computer simulations, and ground- and space-based observational studies to investigate the origin and composition of the universe, and to use the universe as a laboratory to study fundamental physics. At the Simons Center for Systems Biology, the tools of modern physics and mathematics are being applied to biological investigation on varying scales, from molecular to organismic, and in some cases focusing on understanding disease processes.

The School's collaborative and pioneering approach to the sciences, which extends to the Institute's School of Mathematics, Princeton University, and the larger scientific community, continues to transform research in these fields and to open opportunities for powerful and important discoveries.

Astrophysics

Professor **James Stone** was pleased to join the Astrophysics group in the School this year. Stone's research focuses on the use of computational methods to study astrophysical plasma dynamics in a wide range of settings, from the formation of planets around newborn stars to the accretion of gas onto supermassive black holes at the centers of galaxies. The group was fortunate to receive funding from the Schmidt Futures foundation to support activities in

Long-term Member (2014–19) DOUGLAS STANFORD joined Stanford University as an assistant professor in 2019. He returned to IAS in December for the "Qubits and Spacetime" workshop, speaking on "Replica Wormholes and the Black Hole Interior."



ANDREA KANE

computational astrophysics at IAS. The funding has supported Member Jeffrey Fung, who has been working with Stone and Princeton University graduate student Avery Bailey to model how gas giant planets grow through the accretion of gas from remnant disks of material surrounding a newly-formed star. In particular, they are studying how a small eccentricity in the planet's orbit can change the rate and properties of gas accretion, and what this implies for astronomical observations of planet formation. Stone has also been working with Member Matthew Coleman to extend computational methods used to model plasma dynamics so that they can be applied to systems with more complicated equations of state. In the future these new extensions will be used to model mergers of compact objects (such as neutron stars) to investigate how the plasma dynamics modifies the gravitational wave signal observed by LIGO for such events, in comparison to the case of merging black holes. Additionally, Stone has been extending these same computational methods to enable them to run on a more diverse range of high-performance computing systems, such as graphical processing unit (GPU) accelerated clusters available at national supercomputing centers. The goal is to leverage the resources available at these centers in order to enable much larger and more accurate computations of astrophysical systems than has been possible before.

For over a century, astrophysicists have attempted to apply the powerful tools of statistical mechanics to understand the structure and evolution of stellar systems such as star clusters and galaxies. We now recognize that the most promising arenas for these applications are the dense stellar systems (so-called “galactic nuclei”) found surrounding black holes in the centers of galaxies, such as the system surrounding the black hole in our Milky Way galaxy that was recently imaged by the Event Horizon Telescope. Richard Black Professor **Scott Tremaine**, working with former Member Jihad Touma (American University of Beirut) and Mher Kazandjian (Leiden University)



Friends of the Institute for Advanced Study Member LENA MURCHIKOVA presents “Feeding a Black Hole” as part of the Friends Lunch with a Member series.

has shown that the orbital shapes and orientations of stars surrounding a black hole should be found in a kind of thermal equilibrium, and that this equilibrium can undergo a robust phase transition from a spherical to a lopsided shape, in which most stars are on high-eccentricity orbits with aligned orientations. The rate of transient events, such as flares from tidally disrupted stars and gravitational-wave signals from stars spiraling into the black hole, is expected to be much higher in the lopsided phase. Better models of cluster formation and evolution are needed to determine whether clusters should be found in this phase.

Our understanding of planets around other stars has expanded dramatically in the past two decades. One of the simplest unresolved questions is whether and how the properties of planets are influenced by their neighbors. Is the planet-formation process universal? Or does it depend on the properties of the host system? Or does it depend in some more complex way on the properties of the planets' neighbors? Tremaine and IAS Member Lena Murchikova have provided a precise statistical formulation of these questions and have applied it to measurements of planetary radii in the largest available uniform sample of almost 1000 planets from over 350 systems. They conclude

that the distribution of radii does depend on the host system—most likely through the size and mass of the gas disk that initially surrounded the host star and from which the planets formed—but that there is no evidence that the radii of planets depend on the properties of their neighbors.

Professor **Matias Zaldarriaga** continues to be interested in topics related to cosmology. Together with Marko Simonović, Mikhail Ivanov, and Oliver Philcox, Zaldarriaga used data from the BOSS galaxy survey to obtain an independent one-percent measurement of the expansion rate of the universe. In the last few years discrepant measurements of this quantity have been reported in the literature, which might signal an inconsistency in the standard model of cosmology. The group, together with former Member Colin Hill, used this data to constrain some of the models that have been proposed to explain the discrepancy. Looking into the future, Professor Zaldarriaga and the group developed a new technique to compress galaxy survey data that has the benefit of simplifying the analysis, making it more robust and potentially enabling certain studies of higher order statistics. Such studies could shed light on

several outstanding questions in observational cosmology, such as the origin of the initial density fluctuations.

During the past year Professor Zaldarriaga continued his involvement in gravitational wave research. Together with members Barack Zackay, Liang Dai, and Tejaswi Venumadhav and Princeton University graduate students Javier Roulet and Seth Olsen, Professor Zaldarriaga applied novel analysis techniques to the public data from the LIGO/Virgo observatory.

A new technique to search for gravitationally lensed events the group developed resulted in an intriguing potential candidate. Furthermore, a joint analysis of all existing gravitational wave events resulted in interesting constraints on the mechanisms that create the LIGO/Virgo sources. The formation channels of these systems are still poorly understood.

Systems Biology

Using theoretical approaches originating in physics, Professor **Stanislas Leibler** and Members working at the Simons Center for Systems Biology are looking for general mechanisms that could operate across different length and time scales and across different organizational levels of biological systems.

In 2019–20, research continued to focus on studies of nonequilibrium aspects of biological phenomena. In particular, together with Member Riccardo Rao, Leibler worked on simple mathematical models to explore quantitatively the dynamical and nonequilibrium aspects of evolution through natural selection. He also continued a collaboration with recent Member Pablo Sartori on nonlinear elastic theory of proteins. Together with BingKan Xue, recent Member at the Center, and Archishman Rajum, a fellow at the Center for Studies in Physics and Biology at Rockefeller University, Leibler has been also developing a general control theory for dynamic memories in biological systems.

Though memory plays a crucial role in many aspects of human cognition, its neuronal underpinnings and computational mechanisms are still

very poorly understood.

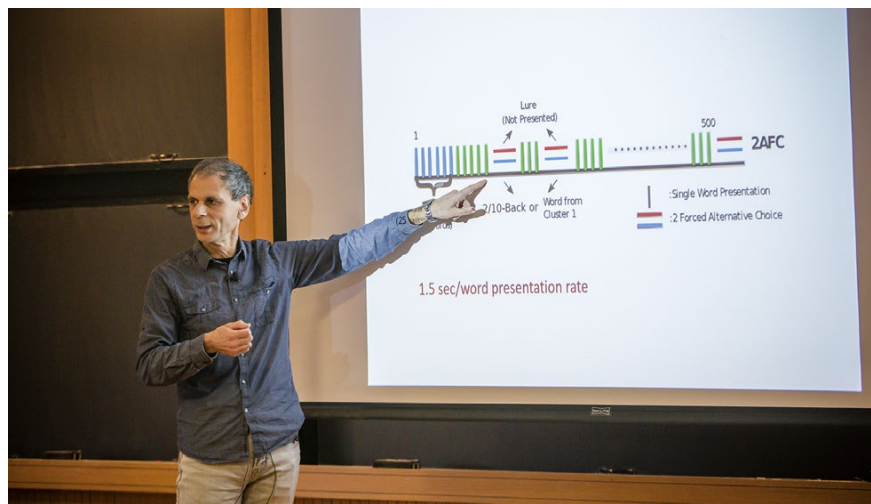
During 2019–20, C.V. Starr Professor **Michail “Misha” Tsodyks** pursued his project on developing mathematical models of memory.

Psychologists developed classical experimental paradigms for studying human memory and use complex phenomenological models to account for results emerging from these experiments. These models are characterized by a large number of free parameters that cannot be independently estimated and have to be tuned to reproduce experimental results. Tsodyks developed a novel approach motivated by neural network models of memory. In this approach, the models are based on hypothesized “first principles” and hence have many fewer free parameters.

In one project, Tsodyks and Visitor Michelangelo Naim developed a simple mathematical model of memory recall based on the principle that memory items

matched the analytical prediction derived mathematically from the model. These observations indicate that some aspects of human memory are governed by universal theoretical principles that are common to all people.

In a second project, pursued with Antoine Georgiou, Tsodyks considered a process of memorization and forgetting during the presentation of a list of items. They assumed that subsequent items can erase previously acquired ones from memory if they are characterized by higher multidimensional “value” that are drawn from a random distribution. This theory can be used to calculate the so-called “retention curve,” i.e., the average probability to maintain the memory for different times after its inception; and “forgetting curve,” i.e., the average probability that the memory will be erased at a certain time after inception. Both of these curves can be measured experimentally by presenting lists of



C.V. Starr Professor Michail Tsodyks joined the Natural Sciences Faculty in 2019. A leading theoretical neuroscientist, Tsodyks spoke on “Mathematical Models of Human Memory” in December.

are recalled in a process that is controlled by an associativity matrix between the items. This model has an exact analytical solution. In particular, it predicts the number of words from a random list that can be recalled, provided that the number of words that remain in memory after the presentation is independently estimated. Naim and Tsodyks then conducted human memory experiments over the internet. Surprisingly, the experimental results that they collected closely

words of increasing length to human subjects and asking them to perform recognition tests at various times during and after the presentation. Experimental results obtained with this paradigm also matched theoretical predictions quite closely.

The hallmarks of Darwinian evolution are random variation (mutation) and natural selection for reproductive fitness. The p53/p63 genes and proteins have

been conserved for 800 million years of evolution in the animal kingdom, validating their importance. The p53/63 proteins form a central hub in this conserved pathway, ensuring the fidelity of information transfer in the germ lines of animals (p63) and somatic tissues of vertebrates (p53). Employing Shannon information theory, it has become possible to calculate the amount of information that each adjacent node in the pathway receives and transmits, indicating the probabilities that the outcome at the receiving node accurately reflects the input from the sending node. The chemical language providing this information resides in protein modifications (epigenetic marks) that sense cellular stresses and respond by either repair from a stress damage and a return to homeostasis, or cell death, depending upon the intensity and types of stress. The conserved geometry of these pathways demonstrates extensive connectivity to many cellular functions, redundancy, feed-back and feed-forward loops, all conferring a robustness that makes it very rare for a single mutational event to cause pathology. The structure of this pathway and the chemical nature of information acquisition about the environment helps to explain why mutations in the p53 gene are the single most common mutations observed in all cancers. (A. J. Levine, *Nature Reviews Cancer*, 2020).

T-cells are an important component of our immune systems. They fight pathogens and cancer and help to

regulate the immune response. Every clone of T-cells has its own unique version of the receptor (TCR) that recognizes a subset of the universe of possible antigens. Learning the rules that relate TCRs with their cognate antigens is an important open problem in immunology. Professor Emeritus **Arnold J. Levine** has been exploring this question together with Research Associate Victor Mikhaylov, in a project to construct an algorithm that could learn these rules from a limited set of training data, by collecting publicly available data, creating tools for managing and cleaning the data, for working with TCR and antigen sequences as well as crystal structures of receptor-antigen complexes. The idea of the approach is to use modeled protein three-dimensional structures as an input into a neural net algorithm, by developing and using tools that process a protein model into a form that can be fed to a neural net.

Theoretical Physics

Professor **Nima Arkani-Hamed**'s work in 2019–20 revolved around extending the surprising connection between new mathematical structures in positive geometries and the amplituhedron, and the basic physics of elementary particle scattering in the real world, together with explorations in a few new directions.

In 2019, he introduced a number of new mathematical objects relating “binary” and “positive” geometries to

the physics of particle and string scattering amplitudes in fascinating new ways, and in early 2020, in joint work with mathematicians and physicists, he put these ideas on a more solid mathematical foundation, introducing the notions of “Positive Configuration Spaces” and “Cluster Configuration Spaces” as the natural playground in which a surprising array of seemingly very different mathematical and physical objects of interest come together.

Arkani-Hamed also embarked on a new direction of exploration, thinking about scattering processes as being observed infinitely far away, on the “celestial sphere.” These “celestial amplitudes” can be thought of as the scattering of particles in a uniform superposition of all energies, from zero to infinity, and are thus uniquely sensitive to both the ultra-violet and infrared aspects of physics. Together with collaborators, Arkani-Hamed showed that known UV and IR properties of quantum gravity translate into powerful constraints on the analytic structure of celestial amplitudes, in particular providing a new “anti-Wilsonian” lens in which to think of UV completion in quantum gravity, as well as a new line of attack on the general question of finding the principles determining the S-matrix, or what is the same, formulating the general notion of “holography” in the flat spacetime, an excellent approximation to the real world ignoring the important questions of cosmology.

An old fundamental mystery in particle physics, made even more pressing by the absence of hints for new particles at the Large Hadron Collider, is the “hierarchy problem”: what explains the origin of the Higgs mass—why is it not dragged to gargantuan values by violent quantum fluctuations in the vacuum? Arkani-Hamed returned to this vexing question from a new perspective, beginning with the simple question: does the value of the Higgs mass parameter affect the expectation value of “local operators” in the Standard Model of particle physics? For essentially all local operators the answer to this question is no, and this is one of the avatars of the hierarchy



Long-term Member SHU-HENG SHAO (right) and Member NIMA LASHKARI (left) researched questions on gravity and quantum field theory.



ANDREA KANE

Long-term Member AHMED ALMHEIRI (left) and Carl P. Feinberg Professor JUAN MALDACENA (right) collaborated on the question of whether information is destroyed by black holes.

problem: nothing is “triggered” as the Higgs mass parameter crosses zero. Arkani-Hamed and collaborators proposed a simple extension of the Standard Model, with two sets of Higgs particles, where the Higgs masses *do* act as a “trigger.” This turns out to demand the existence of new Higgs states necessarily comparable to or lighter than the mass of observed Higgs particles, with no wiggle room to hide them whatsoever. But surprisingly, this model is not yet entirely excluded by collider searches, and will be incisively probed by the high-luminosity run of the LHC, as well as possible future Higgs factories.

The story of the amplituhedron gives an *ab initio* description of the scattering gluons. A long-standing goal has been to connect this physics at “weak coupling” to results at “strong coupling,” where the physics should have a holographic description in terms of string theory in Anti-de-Sitter space. Arkani-Hamed and collaborators found a new line of attack on this problem suggested naturally from the geometry of the amplituhedron, which provides a new expansion of the amplitude with no conventional field-theoretic interpretation. This expansion suggests a natural deformation of the amplitude by a parameter γ , with the amplitude obtained for $\gamma=1$. The geometry provides an extremely simple way of solving for this deformed amplitude as γ approaches zero, but for all values of the coupling between gluons. Remarkably, the answer shares many

features in common with the known exact answer, interpolating between weak gluon coupling to the strong coupling results in AdS space, opening a new avenue of exploration, connecting positive geometries to non-perturbative physics.

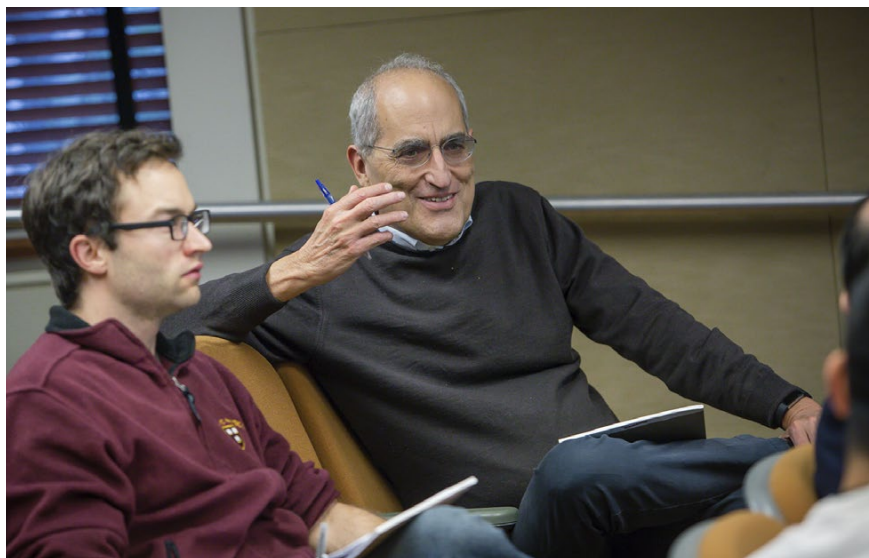
Finally, Arkani-Hamed’s most vigorous efforts in 2020 have revolved around a line of work going back to 2017, finding new “amplituhedra” to describe scattering processes in even more realistic theories, in the lowest order of approximation, without the special properties of supersymmetry and “planarity.” His work of 2019 related these to the mathematics of cluster algebras. But a number of physical and mathematical conceptual issues had to be overcome to extend this to the complete theory at all orders of approximation. In a collaboration with a number of physicists and mathematicians, Arkani-Hamed has been making progress on overcoming these challenges, arriving at a conjectural definition of all-loop, non-supersymmetric, non-planar amplituhedra, which involves a new sort of positive geometry associated with two-dimensional surfaces.

The question of whether information is destroyed by black holes has guided many developments in quantum gravity.

A significant advance was made in two papers, one involving Long-term Member Ahmed Almheiri. These papers showed that a generalization of the Bekenstein-Hawking area formula can

be used to analyze the problem and gives a result for the entropy of a black hole consistent with the preservation of information.

This proposal was further investigated by Almheiri, Members Raghu Mahajan and Ying Zhao, J. Santos, and **Juan Maldacena**, Carl P. Feinberg Professor, who extended the initial proposal. The quantum information contained in the radiation is quantified by computing its von Neumann entropy. Using gravity, this entropy can be computed in terms of the entropy of quantum fields plus the areas of the boundary of the region under consideration. Surprisingly, when computing the entropy of the Hawking radiation, which is outside the black hole, we need to include a portion of the black hole interior. At first sight, this seems strange, since the black hole interior is behind the horizon. Nevertheless, this is what a first principles derivation of the gravitational entropy formula tells us. This derivation shows that non-trivial spacetime topologies, called wormholes, are relevant and provide the necessary bridge for putting these results on a firm footing. These results give a resolution of one important aspect of the black hole information problem by providing a concrete formula using gravitational language that tells us the amount of quantum information that is contained in the radiation coming out of a black hole. The answer obtained in this way is consistent with the preservation of information.



Charles Simonyi Professor EDWARD WITTEN extended the understanding of the relation between random matrices and certain simple models of gravity to include fermions, supersymmetry, and time-reversal symmetry.

It is surprising to see how the classical geometric equations developed by Einstein can be interpreted as quantifying quantum information and entanglement.

Professor **Nathan Seiberg** continued his explorations of quantum field theory. Quantum field theory is important in many branches of physics including particle physics, string theory, condensed matter physics, and cosmology, and it leads to many insights in mathematics.

There is no doubt that we are still very far from a clear and complete understanding of it. In the context of condensed matter physics, it has been widely believed that the long-distance, low-energy behavior of every microscopic (local) system is captured by a quantum field theory. However, recently discovered systems, known as *fractons*, seem to violate this lore. This fact motivated Seiberg to explore whether the standard framework of quantum field theory can be extended such that it can accommodate these systems.

As a preliminary to this investigation, Seiberg studied nonrelativistic field theories with a continuous global symmetry, whose charge is a spatial vector. He presented several such distinct symmetries and demonstrated them in concrete examples. The different

symmetries differ by the equations their Noether currents satisfy. Simple cases, other than the translation symmetry, are an ordinary (relativistic) one-form global symmetry and its nonrelativistic generalization. The coupling of these systems to gauge fields was also explored.

In a series of papers, Seiberg and Long-term Member Shu-Heng Shao followed up on these ideas in a systematic analysis of many known and new systems. They started by studying certain nonstandard continuum quantum field theories in two spatial dimensions. These theories exhibit exotic global symmetries, a subtle spectrum of charged excitations, defects with restricted mobility, and surprising dualities. These continuum models represent the low-energy limits of certain known lattice systems. One key aspect of these continuum field theories is the universal and important role played by discontinuous field configurations.

Seiberg and Shao extended their discussion of these nonstandard continuum quantum field theories from two spatial dimensions to three spatial dimensions. These theories exhibit surprising phenomena similar to their lower dimensional versions. Seiberg and Shao studied various gapless exotic systems with a global $U(1)$ symmetry and gapped variants of them with a

cyclic symmetry. Many of the systems have a known lattice construction. In particular, one of them is a known gapless fracton model and another one is the low-energy limit of the celebrated X-cube model.

Seiberg, Shao, and two students Pranay Gorantla and Ho Tat Lam continued this study of nonstandard continuum field theories in three spatial dimensions. They presented many more examples exhibiting similar peculiar behavior.

With recent IAS Member Douglas Stanford, Charles Simonyi Professor **Edward Witten** extended the understanding of the relation between random matrices and certain simple models of gravity to include fermions, supersymmetry, and time-reversal symmetry. All ten standard random matrix ensembles played a role in the process—the three classical ones of Dyson and Wigner, and others that were introduced more recently. Witten and Stanford extended the work of Maryam Mirzakhani on the volumes of moduli space of Riemann surfaces to the case of super Riemann surfaces. A short introduction to this work is available in Witten's article "Volumes and Random Matrices."

With another recent IAS Member, Kazuya Yonekura, Witten developed a non-perturbative understanding of "anomaly inflow," which is an approach to the Adler-Bell-Jackiw anomaly of gauge theory that sheds light on modern developments involving topological phases of matter. In the process, Witten and Yonekura also obtained a new and more general derivation of a formula for global anomalies Witten had first obtained in 1985.

With Atish Dabholkar and yet another recent IAS Member, Pavel Putrov, Witten resolved a longstanding puzzle about why, in certain gauge theory computations in four dimensional space-time, one encounters "mock modular" functions, rather than true modular functions. The key was something known as the Dine-Seiberg interaction. Mock modular functions have their roots in the work of the Indian mathematician Srinivasa Ramunajan a century ago. They

first appeared in quantum field theory computations in the 1990s, and this recently solved puzzle dates to that time.

With Alex Maloney, another former IAS Member, Witten showed that a certain averaging procedure, applied to a certain family of two-dimensional conformal field theories, gives a striking result that is possibly suggestive of the existence of an exotic new theory of

gravity in three dimensions. Time will tell if that interpretation is correct.

Most of Witten's other papers in the

last year were concerned with specific computations in some simple models of gravity in two dimensions.

FREEMAN J. DYSON, Professor in the School of Natural Sciences since 1953, passed away February 28, 2020, in a hospital near Princeton, NJ. Dyson generated revolutionary scientific insights, including calculations bridging the quantum and human worlds. His contributions stem from his work in numerous areas, including nuclear engineering, solid state physics, ferromagnetism, astrophysics, biology, and applied mathematics.



BENOIT CORTET

2019–20 MEMBERS AND VISITORS

f First Term ♦ *s* Second Term ♦ *m* Long-term Member ♦ *v* Visitor ♦ *dvp* Distinguished Visiting Professor ♦ *jvp* Junior Visiting Professor ♦ *ra* Research Associate

Ahmed Almheiri

Quantum Field Theory ♦ Institute for Advanced Study ♦ *m*

Ravindra Bhatt

Condensed Matter Physics ♦ Princeton University

Christopher Logan Chariker

Computational Neuroscience ♦ Institute for Advanced Study

Susan E. Clark

Astrophysics ♦ Institute for Advanced Study
NASA Hubble Fellow

Matthew Coleman

Astrophysics ♦ Institute for Advanced Study
Funding provided by the National Science Foundation and NASA

Liang Dai

Strong Lensing; Astrophysical Gravitational Waves; Cosmology ♦ Institute for Advanced Study
John N. Bahcall Fellow

Lorenz Eberhardt

String Theory ♦ Institute for Advanced Study
Funding provided by the Della Pietra Family

Jeffrey Fung

Astrophysics ♦ Institute for Advanced Study
IBM Einstein Fellow

Victor Gorbenko

Theoretical Physics ♦ Institute for Advanced Study and Stanford University
Marvin L. Goldberger Member

Felix Haehl

Theoretical Physics ♦ Institute for Advanced Study
Funding provided by the U.S. Department of Energy

Keisuke Harigaya

Particle Physics ♦ Institute for Advanced Study
Funding provided by the Raymond and Beverly Sackler Foundation Fund and the U.S. Department of Energy

Matthew T. E. Heydeman

Theoretical Physics ♦ Institute for Advanced Study and Princeton University

David A. Huse

Statistical Physics ♦ Princeton University

Nafiz Ishtiaque

Quantum Field Theory ♦ Institute for Advanced Study
Funding provided by the National Science Foundation

Daniel Steven Kapec

Theoretical Physics ♦ Institute for Advanced Study
Founders' Circle Member; funding provided by the Chooljian Family and the U.S. Department of Energy

Anna Karlsson

Theoretical Physics ♦ Institute for Advanced Study
Funding provided by the Swedish Research Council

Alexander A. Kaurov

Astrophysics, Cosmology ♦ Institute for Advanced Study
IBM Einstein Fellow

Joonho Kim

Theoretical Physics ♦ Institute for Advanced Study
Funding provided by the National Science Foundation

Alexei Kitaev

Theoretical Physics ♦ California Institute of Technology ♦ *dvp, f*

Simon Knapen

Particle Physics ♦ Lawrence Berkeley National Laboratory
Funding provided by the U.S. Department of Energy and the Paul Dirac Fund

Shota Komatsu

Quantum Field Theory ♦ Institute for Advanced Study
Funding provided by the U.S. Department of Energy

Petr Kravchuk

Particle Physics ♦ Institute for Advanced Study
Funding provided by the Corning Glass Works Foundation Fellowship Fund and the U.S. Department of Energy

Nima Lashkari

Quantum Gravity, Quantum Field Theory, Quantum Information Theory ♦ Purdue University ♦ *v, s*
Funding provided by the National Science Foundation

Adam Levine

Quantum Gravity, Quantum Information Theory ♦ Institute for Advanced Study
Funding provided by the National Science Foundation

Si Li

Mathematical Physics ♦ Tsinghua University ♦ *f*

Elliott H. Lieb

Mathematical Physics ♦ Princeton University ♦ *v*

Hai Lin

Mathematical Physics ♦ Tsinghua University ♦ *s*

Jing Luan

Theoretical Astrophysics and Planetary Science ♦ Institute for Advanced Study
AMIAS Member

Raghu Mahajan

Quantum Field Theory ♦ Princeton University ♦ *v/f, s*

Kento Masuda

Exoplanets ♦ Institute for Advanced Study
Funding provided by the W. M. Keck Foundation Fund

Lia Medeiros

Astrophysics ♦ Institute for Advanced Study

Victor Mikhaylov

Biology ♦ Institute for Advanced Study ♦ *ra*

Ryan Miranda

Astrophysics ♦ Institute for Advanced Study
Funding provided by the National Science Foundation and NASA

Prahar Mitra

Quantum Field Theory ♦ Institute for Advanced Study
Infosys Member; additional funding provided by the U.S. Department of Energy

Sebastian Mizera

Theoretical Physics ♦ Institute for Advanced Study
Founders' Circle Member; funding provided by Carl P. Feinberg

Baurzhan Mukhametzhano

Theoretical Physics ♦ Institute for Advanced Study
Funding provided by the National Science Foundation and the Adler Family Fund

Elena Murchikova

Astrophysics ♦ Institute for Advanced Study
Friends of the Institute for Advanced Study Member

Sridip Pal

Quantum Field Theory ♦ Institute for Advanced Study
Funding provided by The Ambrose Monell Foundation and the U.S. Department of Energy

Robert Penna

Theoretical Physics ♦ Institute for Advanced Study
The Peter Svennilson Membership

Roman Rafikov

Astrophysics ♦ University of Cambridge

Riccardo Rao

Systems Biology ♦ Institute for Advanced Study
Martin A. and Helen Chooljian Member in Biology

Vladimir Rosenhaus

Theoretical Physics ♦ Institute for Advanced Study
William D. Loughlin Member; additional funding provided by the National Science Foundation

Thomas Rudelius

Theoretical Physics ♦ Institute for Advanced Study
Roger Dashen Member; additional funding provided by the National Science Foundation

Jorge Eduardo Santos

Quantum Gravity, General Relativity, Gauge-Gravity Dualities ♦ University of Cambridge ♦ *jvp*
J. Robert Oppenheimer Visiting Professor

Marcel Manfred Schmittfull

Cosmology ♦ Institute for Advanced Study
Funding provided by the National Science Foundation

Shu-Heng Shao

Theoretical Physics ♦ Institute for Advanced Study ♦ *m*
Funding provided by the Simons Foundation

Charlotte Sleight

Theoretical Physics ♦ Institute for Advanced Study
European Commission Marie Curie Fellowship

Wei Song

Theoretical Physics ♦ Tsinghua University

Alexandre Streicher

High Energy Theory ♦ Institute for Advanced Study and Perimeter Institute for Theoretical Physics
Funding provided by the Fund for Memberships in Natural Sciences

Rashid Sunyaev

Astrophysics ♦ Max-Planck-Institute für Astrophysik ♦ *dvp*
Maureen and John Hendricks Distinguished Visiting Professor

Yuan-Sen Ting

Astrophysics ♦ Institute for Advanced Study
NASA Hubble Fellow

Robert J. Vanderbei

Astrophysics ♦ Princeton University

Tejaswi Venumadhav Nerella

Cosmology, Astrophysics ♦ Institute for Advanced Study
John N. Bahcall Fellow

Michael Vogeley

Astrophysics ♦ Drexel University
Funding provided by The Ambrose Monell Foundation

Benjamin Wallisch

Cosmology ♦ Institute for Advanced Study and University of California, San Diego
Bezos Member; additional funding provided by the National Science Foundation

Lai-Sang Young

Dynamical Systems with Applications to the Biological Sciences ♦ New York University ♦ *dvp, s*

Barak Zackay

Astrophysics ♦ Institute for Advanced Study
Frank and Peggy Taplin Member

Ying Zhao

Theoretical Physics ♦ Institute for Advanced Study
Funding provided by the Simons Foundation

School of Social Science

Founded in 1973, the School of Social Science is devoted to a multidisciplinary and international approach to the analysis of societies, social change, and social problems. Every year, a theme is chosen to provide coherence to the collective work undertaken, although other areas of research are also welcome. For 2019–20, the theme was “Economy and Society.” In total, twenty-nine Members and nine Visitors participated in the activities of the School.

FACULTY

Didier Fassin

James D. Wolfensohn Professor

Alondra Nelson

Harold F. Linder Professor

PROFESSORS EMERITI

Joan Wallach Scott

Michael Walzer

HOW TO STUDY and conceptualize the relationships between economy and society has been a central problem for the social sciences from Adam Smith to Karl Marx, from Max Weber to Karl Polanyi. Over the last few decades, profound transformations in the functioning and regulation of the global economic order, the distribution of income and wealth, and the world of labor have generated new empirical and intellectual challenges. The social sciences have undergone a startling evolution, too, with economists turning to experimental methods and the study of various aspects of social life, including inequality and social mobility, while sociologists, anthropologists, historians, legal scholars, and political scientists have developed new empirical and theoretical approaches to the study of markets, finance, risk, and value. It was at the intersection of these two movements—in the world and in the academy—that the theme “Economy and Society” was led by **Didier Fassin**, James D. Wolfensohn Professor, and Visiting Professor **Marion Fourcade**, Professor of Sociology at the University of California, Berkeley.

Topics included market structure and economic action, financial cultures and

technologies, the rise of automation and algorithms, the moral regulation of nations and individuals, old and new forms of labor and labor organization, the economic and political impact of immigration, the transformation of life-styles and subjectivities, the valuation of persons and goods, and the place of economics and economists in social and governmental practices. Because these phenomena and the way people experience them vary across countries, the projects presented and the scholars who proposed them reflected this diversity. A bimonthly seminar was conducted in the School of Social Science and two workshops on “Artificial Intelligence, Machine Learning and the Social Sciences” were held in collaboration with the School of Mathematics. The yearly program was dramatically interrupted by the coronavirus epidemic and the subsequent closure of the Institute mid-March, but all seminars continued online and a collective project on “Economy and Society in the Time of the Pandemic” was undertaken.

The work conducted by **Didier Fassin** during the year has been primarily connected to the nine original lectures he had to prepare for his Chair in public health at the Collège de France. The inaugural lecture, “On the Inequality of Lives,” was delivered in January 2020 and published in September. The other eight lectures, which deal with the birth of public health, the truth of numbers, epistemic frontiers, conspiracy theories, ethical crises, carceral ordeals, precarious exiles, and life in the time of the pandemic, were postponed to the spring of 2021. The occurrence of the health crisis was the matter of research in France on the impact of the coronavirus infection on vulnerable populations—more specifically prisoners, exiles, and homeless—and on the response of public authorities to prevent their exposure to the risk.

Harold F. Linder Professor **ALONDRA NELSON** joined the Faculty of the School of Social Science in July 2019. An acclaimed sociologist, Nelson explores questions in science, technology, and social inequality.



ANDREA KANE



ANDREA KANE



ANDREA KANE

The School's theme year, "Economy and Society" was led by Visiting Professor MARION FOURCADE (left) and James D. Wolfensohn Professor DIDIER FASSIN (right).

Based on the tragic story of a young man belonging to the travelling community, who was shot dead by a special unit of the French police, and on the review of the case by two examination judges, who ended up dismissing it as legitimate defense, Fassin carried out a counter-investigation published under the title *Death of a Traveller* at Le Seuil, with the English version forthcoming at Polity Press. After having presented in subjective third person the various versions of the protagonists, the officers and the parents as well as the prosecutor and the coroner, the book proposes a counter-investigation based on testimonies, autopsy, ballistics, and various other forensic reports, which leads to a version of the facts distinct from the official one. This work is both a theoretical inquiry into truth and lying in the justice system and an experimental research endeavor in anthropological writing.

As part of the Nomis project on crises, fieldwork was continued with Visitor Anne-Claire Defossez on the border between Italy and France in the Alps, which thousands of migrants and refugees cross each year. The focus is on the exiles' experience during their perilous multi-year journey, the solidarity networks rescuing them in the mountain and providing shelter in the valley, and the repressive action of the police and the justice system. The edited volume *Deepening Divides*, the outcome of previous research on borders and boundaries, was published by Pluto Press, as was *A Time for Critique* at Columbia University Press, the result of a

collective endeavor conducted with former Visiting Professor Bernard Harcourt.

The book *Enforcing Order*, based on an ethnography of French police in poor neighborhoods around Paris, was entirely rewritten with a cartoonist as what can be called an "ethno-graphic" to explore innovative forms of writing and transmitting social science. Several earlier books were translated this year into Chinese, Italian, and Portuguese. Finally, Fassin was invited to give the Eric Wolf Lecture at the University of Vienna on the heuristics of conspiracy theories and the Harald Grimen Memorial Lecture in Oslo on forms of life.

Harold F. Linder Professor **Alondra Nelson** joined the School of Social Science in July 2019. A sociologist of science, technology, and social inequality, her research during 2019–20 spanned these areas. Professor Nelson published the results of a list experiment on public attitudes about genetics, race, and inequality in *Du Bois Review* with Ann Morning (New York University) and Hannah Bruckner (New York University Abu Dhabi). She continued the research and writing of her book-length project exploring the ways in which federal science and technology initiatives are utilized as modalities of governance and politics, through a case study of the Obama administration. Nelson also began a project to develop a new field, the "sociology of bioethics"; she is building a team of research collaborators who will examine bioethics as an object of empirical and theoretical inquiry. She is also at work

on "Society after Pandemic," a book of essays exploring how the social conditions exposed, exacerbated, and created by the novel coronavirus compel reconsideration of prevailing ideas of society, institutions, technology, and politics.

Professor Nelson lectured on these and related topics at the Centennial Lecture at Emory University, the Bellwether Lecture at the University of Oxford, and a keynote lecture at the annual meeting of the American Association for the Advancement of Science. She also delivered presentations to the Hastings Center, the Harvard Kennedy School, Cornell Tech, and several other institutions.

She was to receive the 2020 MIT Morison Prize recognizing individuals who combine humanistic values with effectiveness in the world of practical affairs, particularly in science and technology, in March, but the event was delayed until fall 2020. Professor Nelson was inducted into the American Academy of Political and Social Science and was elected as a member of the American Academy of Arts and Sciences and the American Philosophical Society. She was also appointed co-chair of a new National Academy of Medicine Committee of Emerging Science, Technology and Innovation (CESTI) in Health and Medicine. Over the next three years, CESTI will assess the landscape of emerging scientific and technological developments in health and medicine and will develop a multi-sectoral governance framework

to address the potential societal, ethical, legal, and workforce implications of such new technologies and science.

During fall 2019, Professor Emerita **Joan Scott** worked on the revisions for *On the Judgment of History*, which was published in September 2020. In it she examines the idea that history will somehow judge our actions and that moral good will prevail in the end (whenever that is). This is the concept articulated by abolitionists and cited by Martin Luther King: “the arc of the moral universe is long, but it bends towards justice.” The book critically explores the implicit politics of the notion of a linear, ever-improving direction of history by considering three cases: the Nuremberg Tribunal

(1946); the South African Truth and Reconciliation Commission (1996); and the ongoing movements for reparations for slavery in the United States. Before Covid-19 struck, she lectured at Franklin and Marshall College and at the University of Virginia, participated (long-distance) in a dissertation defense in Paris, and was part of a panel celebrating the one-hundredth anniversary of the American Council of Learned Societies. In the spring, she gave a Zoom seminar at Brown University. She continues to serve on the Committee on Academic Freedom and Tenure of the American Association of University Professors and as the lead editor of *History of the Present: A Journal of Critical History*.

Professor Emeritus **Michael Walzer**

spent the second half of academic year 2019–20 attending conferences, giving lectures, and visiting classes around the country—all via Zoom. Walzer’s writing and research focused mostly on the meaning of the word “liberal” in contemporary political discourse—especially on its use as an adjective in phrases like “liberal democracy.” A book on this subject is in progress. Walzer also wrote about immigration, civic republicanism, and social movements, some of this work intersecting with the School’s theme for 2021–22.

A volume of conversations with the French political theorist Astrid von Busekist was published in France in late 2019 and in English under the title *Justice is Steady Work* in mid-2020.

2019–20 MEMBERS AND VISITORS

f First Term ♦ *s* Second Term ♦ *v* Visitor ♦ *vp* Visiting Professor

Najwa Adra

Sociology ♦ Austrian Academy of Sciences ♦ *v*, *s*

Jeremiah O. Arowosegbe

Political Science ♦ University of Ibadan

Naor H. Ben-Yehoyada

Anthropology ♦ Columbia University

Benjamin Braun

Political Economy ♦ Max-Planck-Institut für Gesellschaftsforschung

Ergin Bulut

Media Studies ♦ Koç Üniversitesi, Istanbul ♦ *v*

Başak Can

Anthropology ♦ Koç Üniversitesi, Istanbul

Julia Chuang

Sociology ♦ Boston College ♦ *v*, *s*

Ed Cohen

Modern Thought ♦ Rutgers, The State University of New Jersey

Anne-Claire Defossez

Sociology ♦ Institute for Advanced Study ♦ *v*

Herbert Docena

Sociology ♦ University of the Philippines, Diliman

Marion Fourcade

Sociology ♦ University of California, Berkeley ♦ *vp*

Alexander R. Galloway

Media Studies ♦ New York University

Isabelle Guérin

Socioeconomics ♦ Institut de Recherche pour le Développement, Paris
Roger W. Ferguson, Jr., and Annette L. Nazareth Member

Fleur Johns

Law ♦ University of New South Wales, Sydney

Ravi Kanbur

Economics ♦ Cornell University ♦ *v*, *s*

Robert Karl

History ♦ Institute for Advanced Study

Webb Keane

Anthropology ♦ University of Michigan, Ann Arbor

Eben Kirksey

Cultural Anthropology ♦ Deakin University
Friends of the Institute for Advanced Study Member

Greta LaFleur

Early American Studies ♦ Yale University

Lena Lavinas

Economics ♦ Universidade Federal do Rio de Janeiro

Benjamin Lemoine

Sociology, Political Science, Science and Technology Studies ♦ Université Paris-Dauphine
Richard B. Fisher Member

Pascal Michailat

Economics ♦ Brown University

Virag Molnar

Sociology ♦ The New School

Mitali Nagrecha

Law, Criminal Justice ♦ Harvard Law School ♦ *v*, *s*

Susana Narotzky

Social Anthropology ♦ Universitat de Barcelona

Federico Neiburg

Social Anthropology ♦ Universidade Federal do Rio de Janeiro

Horacio Ortiz

Anthropology of Money ♦ East China Normal University
Funding provided by the Florence Gould Foundation Fund

Julia Ott

History ♦ The New School

Z. Fareen Parvez

Sociology ♦ University of Massachusetts, Amherst

Nathalie M. Peutz

Cultural Anthropology ♦ New York University Abu Dhabi
Wolfensohn Family Member

Adela Pinch

English Literature ♦ University of Michigan, Ann Arbor ♦ *v*

Sarah Quinn

Sociology ♦ University of Washington

Latif Tas

Political Science ♦ SOAS University of London

Anisha Thomas

Gender Studies ♦ SOAS University of London ♦ *v*, *s*

Chloe Thurston

Political Science ♦ Northwestern University

Joëlle Vailly

Sociology, Anthropology ♦ Centre National de la Recherche Scientifique, Paris

Wendy Warren

History ♦ Princeton University
Frederick Burkhardt Fellowship funded by the American Council of Learned Societies

Frederick F. Wherry

Sociology ♦ Princeton University ♦ *v*

Alden H. Young

History, African Studies and Africana Studies ♦ University of California, Los Angeles
AMLAS Member

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Program for Women and
Mathematics*

Prospects in Theoretical
Physics*

IAS/Park City
Mathematics Institute*

Summer Program in
Social Science*

* During the 2019–20
academic year, annual
programs were postponed
due to Covid-19.

BEYOND THE WORK that takes place in the four Schools, the Institute's scope is broadened and enhanced by its special programs, which contribute much to the vitality of the Institute.

The Program in Interdisciplinary Studies, directed by Professor Piet Hut, explores ways of viewing the world that span a range of disciplines from computational astrophysics, geology, and paleontology to artificial intelligence, cognitive psychology, and philosophy.

The Artist-in-Residence Program was established in 1994 to create a musical presence within the Institute community, and to have in residence a person whose work could be experienced and appreciated by scholars from all disciplines. Artists-in-Residence have included Robert Taub, Jon Magnussen, Paul Moravec, Derek Bermel, and Sebastian Currier. Pulitzer Prize-winning composer David Lang has been in residence since 2016, curating the Edward T. Cone Concert Series and artist salons, along with pursuing his creative and intellectual work.

A Distinguished Journalism Fellowship was created to bring a renowned journalist to campus to participate in the life of the community and continue their journalistic work at the Institute.

The Director's Visitors program enables the Director to invite scholars from a variety of fields, including areas not represented within the four Schools, to participate in the range of intellectual and social activities at the Institute.

The Institute's robust digital resources allow scholars opportunities for knowledge-sharing and discovery within a virtual setting. A Digital Scholarship@IAS initiative was formed in 2016 to accelerate the pace of research across disciplines and geographic locations by offering Faculty and Members new tools and technologies to gather and process large amounts of data, visualize the results, and make the data and results openly available.

The Women and Mathematics Program is an annual program with the mission to recruit and retain more women in mathematics. It was cofounded in 1993 by 2019 Abel Prize laureate Karen Uhlenbeck, IAS Distinguished Visiting Professor in the School of Mathematics, and former IAS Member Chuu-Lian Terng.

First held at IAS in 2002, Prospects in Theoretical Physics is a two-week residential summer program that provides lectures and informal sessions on the latest advances and open questions in theoretical physics for exceptionally promising graduate students and postdoctoral scholars. It encourages the participation of women, minorities, and students from smaller institutions that do not have extensive programs in theoretical physics or astrophysics.

The Institute also engages in outreach beyond its local community. Since 1994, the IAS/Park City Mathematics Institute annual summer session brings together educators, researchers, and students for a three-week residential program in Park City, Utah.

Through lectures, seminars, activities, and events, the program is designed to focus on particular topics each year.

The Summer Program in Social Science, led by Didier Fassin, James D. Wolfensohn Professor in the School of Social Science, is an interdisciplinary initiative for early-career scholars from Africa, the Middle East, and Latin America, which aims to enrich and expand the realm of social sciences through the confrontation of different intellectual traditions and perspectives.

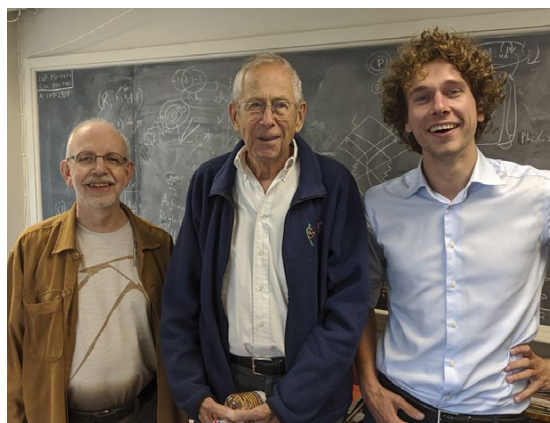
In 2019, DAVID LANG began his second three-year term as Artist-in-Residence.



ANDREA KANE

PROGRAM IN INTERDISCIPLINARY STUDIES

CENTER: ANDREA KANE; RIGHT: DAN KOMODA



Left: Professor PIET HUT (left) and Program Visitor JACO DE SWART (right) with JAMES PEEBLES (center), 2019 Nobel Prize Laureate and former Member (1977–78) and Visitor (1990–91, 1998–99) in the School of Natural Sciences Center: Professor Hut (speaking) leads the After Hours Conversations series, a program of informal talks and discussions designed to spark cross-disciplinary communication. Right: Program Visitor EIKO IKEGAMI's recent research focuses on the experiences and worldviews of autistic adults in virtual worlds and on the various forms of diverse intelligence generally.

The research of Professor **Piet Hut**, head of the Institute's Program in Interdisciplinary Studies, spans a broad range of topics within the general theme of "the Nature of Reality, as seen through the lenses of Math, Matter, and Mind." Some subthemes are: for Math, "Algorithms and Foundations"; for Matter, "Physics and Biology"; and for Mind, "Phenomenology and Contemplation."

Together with colleagues in mathematics, physics, biology, and philosophy, he is currently writing a series of relatively short books, with a typical length in between that of a journal article and a textbook, aimed at an interdisciplinary audience. Each book will combine significant original research with an overview of the interdisciplinary context.

With Harald Wiltsche, philosopher of science at Linköping University, Sweden, he is writing a book titled "Rekindling Natural Philosophy: Toward a Fully Empirical Science and Technology." While following in the footsteps of pragmatists like Peirce and James, and phenomenologists like Husserl and Fink, they develop a more mathematical and scientific methodology, taking up the challenge posed by Husserl to work toward a science of science, akin to James's notion of radical empiricism.

Hut is writing another book, "The Innovation Circle: Emergent Order in Cognition and in the World," with Eric Smith, a physicist working on chemistry and biology at the Earth-Life Science Institute in Tokyo, a research center that Hut and colleagues founded eight years ago within the Tokyo Institute of Technology. The aim is to develop a typology of novelty, with the notion of phase transitions as a broad paradigm for innovation in nature, culture, and technology.

With Mark van Atten, a philosopher at CNRS in Paris, Hut is working on a book that analyzes Brouwer's motivation for the development of Intuitionism, the philosophy of mathematics, based on his interpretation of time and conceptual thinking. Hut envisions establishing a book collection, not as a linear series, but more like Lego bricks that can be put together to be read in different configurations depending on the background and the interests of each reader.

As the head of the Program in Interdisciplinary Studies, Hut has led the After Hours Conversations series of regular "bar talks," in which speakers from each of the four Schools give ten-minute talks, followed by informal discussions, a popular program that he started twelve years ago with Professor Emerita Caroline Walker Bynum.

2019–20 VISITORS

f First Term

Stephen Burlingham
Art and Science

Will Cavendish
Science Communication

Luis Campos
History of Science ♦
The University of New Mexico ♦ *f*

Jaco de Swart
History and Philosophy of Science ♦
University of Amsterdam ♦ *f*

Eiko Ikegami
Historical Sociology ♦ The New School

Michael Th. Rassias
Mathematical Analysis, Analytic Number Theory ♦ Universität Zürich

Michael Solomon
Bioethics ♦ Institute for Advanced Study

Susan L. Sugarman
Psychology and Humanistic Studies ♦ Princeton University

Edwin L. Turner
Astrophysics ♦ Princeton University

ARTIST-IN-RESIDENCE PROGRAM

Academic year 2019–20 marked the beginning of Pulitzer Prize–winning composer **David Lang**’s second three-year term as IAS Artist-in-Residence.

Lang presented the 2019–20 Edward T. Cone Concert Series under the heading of VIRTUOSITY, with the season’s performances examining the relationships between composer, performer, and listener as revealed through the performance of virtuosic music. The season began with Meredith Monk and her vocal ensemble, who gave an intimate performance showcasing awe-inspiring vocal mastery. In November, pianist Conrad Tao played Robert Schumann’s *Kreisleriana*, a quintessential piece of virtuosic romantic piano music. Pianist Vicki Ray joined the FLUX Quartet at the beginning of 2020 for a performance of Stravinsky’s *Three Pieces* followed by Morton Feldman’s *Piano and String Quartet*. The last performance of the series, featuring Benjamin Bagby, was unfortunately cancelled due to Covid-19.

To learn more about the Artist-in-Residence program, visit www.ias.edu/air.



DAN KOMODA

At the end of February, Lang presented *Farmhouse/Whorehouse: An Artist Lecture* by Suzanne Bocanegra Starring Lili Taylor. Part artist lecture, part memoir, and part cultural essay, the performance considered the lives of Bocanegra’s grandparents on their small Texas farm, examining the idyllic place the rural world occupies in our urban imagination.

DISTINGUISHED JOURNALISM FELLOWSHIP



GABI PORTER

Joanne Lipman

With support from the Scully Peretsman Foundation, IAS welcomed **Joanne Lipman**, one of the nation’s leading journalists and a bestselling author, as its first Distinguished Journalism Fellow. While at IAS, Lipman investigated the impact of machine learning and artificial intelligence on the media and on journalism specifically. She also continued her work on gender in the workplace, and engaged with scholars in the School of Social Science for its theme year on “Economy and Society.”

Lipman conducted interviews with numerous Faculty and Members for the Teatime at Home series on subjects ranging from the coronavirus pandemic to the George Floyd protests to deep learning and creativity. Read more at www.ias.edu/teatime-at-home.

2019–20 DIRECTOR’S VISITORS

Curtis Callan
Theoretical Physics and Biology

Carmela Vircillo Franklin
Medieval Latin Literature

Anna Laqua
Institute Visitor

Nora Okka
Spolia

Sarah Paden
Institute Visitor

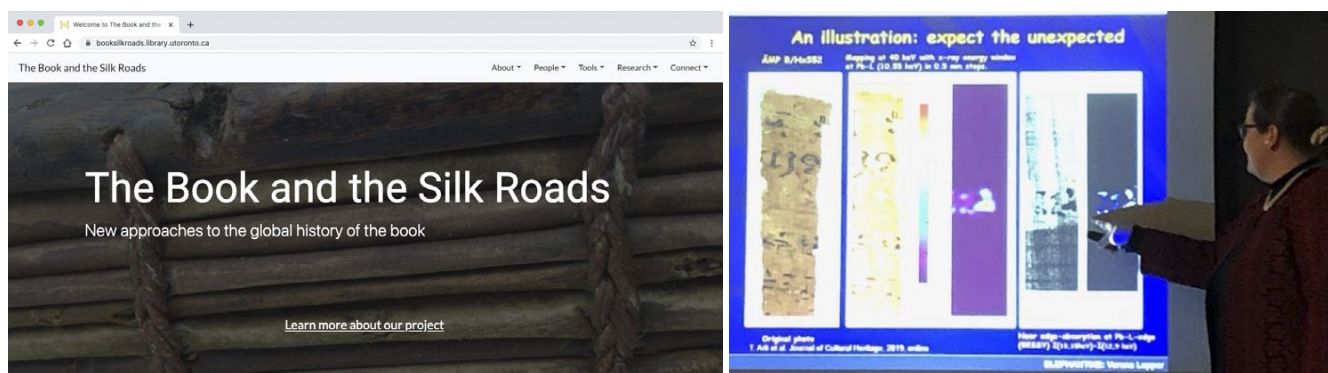
Lorenza Pescia De Lellis
Institute Visitor

Nafeesa Syeed
South Asian History

NORA OKKA prepares a paper impression of the Maxwell Portico at Princeton Battlefield. Her research of spolia (recycled building elements) in the city of Venice blends art and architecture with space and time, framing the city’s antique and Byzantine heritage.



DAN KOMODA



Left: The Book and the Silk Roads project maps connections between parts of the premodern world by describing the technology of the book.
Right: Verena Lepper of Princeton University speaks on “Egyptology in the Digital Age” for the Digital Scholarship Conversations series.

In 2019–20, IAS Faculty and staff continued to support ongoing digital scholarship projects as well as planning for future projects and collaborations. Projects currently underway include:

- **The Zaydi Manuscript Tradition.** In partnership with the Hill Museum and Manuscript Library, Professor Sabine Schmidtke’s Zaydi Manuscript Tradition: A Digital Portal continued to grow. The project has digitized collections of manuscripts from institutions around the world, including Rome Istituto Centrale per il Restauro e la Conservazione del Patrimonio Archivistico e Librario, Istituto per l’Oriente Carlo Alfonso Nallino and Università degli studi “La Sapienza,” Biblioteca di Storia della medicina, and Munich Bayerische Staatsbibliothek. See www.ias.edu/digital-scholarship/zaydi_manuscript_tradition.
- **Krateros: Squeezes of Greek Inscriptions at the IAS.** The Krateros Project, led by Professor Angelos Chaniotis, this year received a significant grant from the National Endowment for the Humanities, which will enable a further three years of work digitizing the Institute’s unique collection of squeezes of ancient Greek inscriptions. Work has almost been completed on 2d digitization of the collection, and preparations are now underway to begin 3d digitization. See www.ias.edu/krateros.
- **The Book and the Silk Roads: New approaches to the global history of the book.** This project, for which Professor Suzanne Akbari is Co-PI, maps connections between parts of the premodern world by describing the technology of the book. Using historical research alongside new, non-destructive scientific methods, the project traces the way that books were made, through local experiment and the transnational exchange of ideas, goods, and craft practices. The project supports new connections between humanists and scientists; librarians, conservators, curators, and academic researchers; universities, museums, and galleries; and scholars working in different parts of the world on various linguistic, religious, and national histories. See <https://booksilkroads.library.utoronto.ca>.
- **Practices of Commentary:** With a five-year SSHRC Insight Grant and supported by Professor Suzanne Akbari among others, this project seeks to develop a global perspective on practices of commentary, de-siloing regionally focused work while simultaneously offering fine-grained and nuanced accounts of the function of commentary in cultures and communities of the premodern world. See <https://globalcommentary.utoronto.ca>.

Albert: The Institute’s Digital Repository.

Intended to preserve and publish research by the Institute’s current and former scholars, as well as to provide modern publishing resources for born-digital projects, datasets, and collaborative efforts, Albert continues to grow (see <https://albert.ias.edu>). At this time it also serves as the platform hosting the Shelby White and Leon Levy Archives Digital Collections (see <https://library.ias.edu/archives>), as well as Krateros, the digital collections of epigraphic squeezes at IAS. Plans for the future include a major software upgrade and improvements to the user interface and analytical engine.

In 2020 the Institute adopted a campus-wide policy outlining its commitment to open access. The policy, originally authored by the Digital Scholarship Working Group, aims to ensure that scholarship from the Institute’s permanent scholars is available to all who wish to benefit from it. The full policy is available online at www.ias.edu/open-access-policy.

About DS@IAS

The strategic direction for the Institute’s support of digital scholarship continues to be provided by the Digital Scholarship Working Group, currently comprised of Jeff Berliner, Emma Moore, Marcia Tucker, María Mercedes Tuyá, and Professor Sabine Schmidtke. This past year, the group again curated the Digital Scholarship Conversations series (see page 55).

RECORD OF EVENTS

School of Historical Studies

ANCIENT STUDIES ACTIVITIES

October 1

Ancient Studies Seminar ♦ *New Epigraphic Evidence for the Cults of Aphrodisias* ♦ **Angelos Chaniotis**, Professor, School of Historical Studies

October 15

Ancient Studies Seminar ♦ *The Poem of Hyssaldomos of Mylasa* ♦ **Christopher Jones**, Harvard University; Institute for Advanced Study

November 12

Ancient Studies Seminar ♦ *Understanding Late Antique Petra* ♦ **Zbigniew Fiema**, University of Helsinki; Member, School of Historical Studies

November 19

Ancient Studies Seminar ♦ *Paradoxes of parrhesia* ♦ **Hartmut Leppin**, Goethe Universitaet; Member, School of Historical Studies

December 10

Ancient Studies Seminar ♦ *Historical Determinants of Statue Production, Use and Re-use in Late Antiquity* ♦ **Esen Ogüs**, Austin Peay State University; Member, School of Historical Studies

January 28

Ancient Studies Seminar ♦ *The 'Koinon of the 13 Cities' in the Light of New Inscriptions from Sardis* ♦ **Martin Hallmannsecker**, University of Oxford

February 11

Ancient Studies Seminar ♦ *The Polis as a Stage: Theatricality and Illusion in the Long Hellenistic Age* ♦ **Angelos Chaniotis**, Professor, School of Historical Studies

February 25

Ancient Studies Seminar ♦ *The Aksumite Ruler Ezana and Accounts of the Conversion of Ethiopia to Christianity* ♦ **Aaron Butts**, The Catholic University of America; Member, School of Historical Studies

March 6

Epigraphic Friday ♦ *Petrified Wit: Humor in Greek Inscriptions* ♦ **Angelos Chaniotis**, Professor, School of Historical Studies ♦ *The Honorific Decree for Neikeratos of Olbia and Hellenistic Oratory* ♦ **Emyr Dakin**, City University of New York ♦ *The 'Pride of Halikarnassos' and its Audience* ♦ **Jeremy McInerney**, University of Pennsylvania ♦ *The Menogeneion at Sardis* ♦ **Christopher Jones**, Harvard University;

Institute for Advanced Study ♦ *Eunoia and eunous: Interstate Relations and Personal Politics* ♦ **Maria Xanthou**, Princeton University ♦ *New inscriptions from Lyttos (Crete)* ♦ **Georgios Tsolakis**, Institute for the Study of the Ancient World; New York University ♦ *Le décret de Mylasa pour Xénodamos* ♦ **Thibaut Boulay**, University of Tours; Member, School of Historical Studies ♦ *The Worship of Cybele on the Thracian Coast of the Black Sea in the light of two inscriptions from Iasos and Priene* ♦ **Dobrinka Chiejkova**, The College of New Jersey ♦ *A List of Priests from Scythopolis/Beth Shean (SEG VIII 33)* ♦ **Kyle Mahoney**, Swarthmore College ♦ *New Inscriptions from Hegra* ♦ **Zbigniew Fiema**, University of Helsinki; Member, School of Historical Studies ♦ *Maryamat, a Qatabanian Trade City Recently Rediscovered* ♦ **Christian Robin**, Centre National de la Recherche Scientifique; Member, School of Historical Studies

March 24

Ancient Studies Seminar ♦ *The Monastic Transformation of Graeco-Roman Popular Theater: A Corpus and Theory of Ancient Christian Comedy* ♦ **Paul Dilley**, University of Iowa; Member, School of Historical Studies

March 31

Ancient Studies Seminar ♦ *The Christians in the Cities of the Roman Empire at the End of the 3rd Century* ♦ **Anne-Valéry Pont**, Sorbonne Université; Member, School of Historical Studies

April 7

Ancient Studies Seminar ♦ *(Re)Constructing the Past in Roman Corinth and Sparta* ♦ **Wolfgang Havener**, Heidelberg University; Princeton University

April 14

Ancient Studies Seminar ♦ *Spying and Waterboarding. The Role of the Laity in Controlling Clerical Misconduct in Late Antique North Africa* ♦ **Michael Hahn**, University of Munich

ART HISTORY ACTIVITIES

October 3

Art History Seminar ♦ *First term introductions + short presentations by the participants* ♦ **Yve-Alain Bois**, Professor, School of Historical Studies

October 10

Art History Seminar ♦ *First term introductions + short presentations by the participants (suite)* ♦ **Yve-Alain Bois**, Professor, School of Historical Studies

October 17

Art History Seminar ♦ *Coming and Going, or, On Being (and Not Being) Attached: Artists on the Move in the Middle Ages* ♦ **Heidi Gearhart**, George Mason University; Member, School of Historical Studies

October 31

Art History Seminar (evening) ♦ *Provoking Religion: Visual Art and the U.S. Culture Wars* ♦ **Anthony Petro**, Boston University; Member, School of Historical Studies

November 13

Art History Seminar ♦ *Painting Against Time: Medicine and Astrology in a Thirteenth-Century Mural* ♦ **Marius Hauknes**, University of Notre Dame; Member, School of Historical Studies

November 20

S.T. Lee Lecture ♦ *Architecture in Two Dimensions: The Case for and Against Drawing* ♦ **Alina Payne**, Harvard University

December 5

Art History Seminar ♦ *Orientation: El Lissitzky's Evolutionary Urbanism* ♦ **Alla Vronskaya**, Illinois Institute of Technology; Member, School of Historical Studies

January 23

Art History Seminar ♦ *Second term introductions + wrap up of fall term and short presentations by new participants* ♦ **Yve-Alain Bois**, Professor, School of Historical Studies

January 30

Art History Seminar ♦ *The Bronze Door of Hildesheim (1015): Decoding Monumental Iconic Works* ♦ **Charlotte Denoël**, Bibliothèque Nationale de France; Member, School of Historical Studies; **Isabelle Marchesin**, Institut National d'Histoire de l'Art, Paris; Visitor, School of Historical Studies

February 20

Art History Seminar ♦ *Chasing Fouquet's Agnes Sorel* ♦ **Laura Weigert**, Rutgers, the State University of New Jersey; Member, School of Historical Studies

February 27

Art History Seminar ♦ *Foucault at Work* ♦ **Molly Nesbit**, Vassar College; Member, School of Historical Studies

March 6

Art History Seminar ♦ *Temporal Painting: The Calendar Cycle at Santi Quattro Coronati* ♦ **Marius Hauknes**, University of Notre Dame; Member, School of Historical Studies

April 8

Art History Zoom Seminar ♦ *The Talent-Meter: Designing Divided Labor* ♦ **Alla Vronskaya**, Illinois Institute of Technology; Member, School of Historical Studies

April 22

Art History Zoom Seminar ♦ *The “Palestrina Pietà”: Gatherings on the History of a Statue Starred by Michelangelo* ♦ **Marilyn Aronberg Lavin**

April 27

Art History Zoom Seminar ♦ *The Christian Concept of Light and its Implication in Medieval Iconography* ♦ **Isabelle Marchesin**, Institut National d’Histoire de l’Art, Paris; Visitor, School of Historical Studies

May 6

Art History Zoom Seminar ♦ *El Lissitzky and the Modern Space of Axonometry* ♦ **Yve-Alain Bois**, Professor, School of Historical Studies

May 13

Art History Zoom Seminar ♦ *The feather and the lead. The weight of words on text-only jackets and covers, in France and the US around WW2* ♦ **Clémence Imbert**

May 27

Art History Zoom Seminar ♦ *The Early Work of Vija Celmins* ♦ **Frances Jacobus-Parker**

EARLY MODERN EUROPE ACTIVITIES

October 10

Early Modern Europe Seminar ♦ *Indigenizing Calvinism in the Dutch Empire* ♦ **Charles Parker**, Saint Louis University; Member, School of Historical Studies

October 28

Early Modern Europe Seminar ♦ *No Better than a Brothel* ♦ **Beth Plummer**, University of Arizona; Member, School of Historical Studies

November 4

Early Modern Europe Seminar ♦ *Metallism and the Social Theory of Money in Seventeenth-Century England* ♦ **Andrew Sartori**, New York University; Member, School of Historical Studies

November 25

Early Modern Europe Seminar ♦ *Religious Artifacts and Slaves in the Early Modern Mediterranean* ♦ **Daniel Hershenzon**, University of Connecticut; Member, School of Historical Studies

December 2

Early Modern Europe Seminar ♦ *Signs of History: A Historical Inquiry into the Monument as an Object of Knowledge* ♦ **Lisa Regazzoni**, Member, School of Historical Studies

January 16

Early Modern Europe Seminar ♦ *Man Alone Sings* ♦ **Deirdre Loughridge**, Northeastern University; Member, School of Historical Studies

January 27

Early Modern Europe Seminar ♦ *The Place of Sorcery in the Thought of a Seventeenth Century Moroccan Astronomer and Alchemist* ♦ **Justin Stearns**, New York University Abu Dhabi; Member, School of Historical Studies

February 3

Early Modern Europe Seminar ♦ *The Globalization of Calvinism and Dutch Society* ♦ **Charles Parker**, Saint Louis University; Member, School of Historical Studies

February 13

Early Modern Europe Seminar ♦ *“The Shipwreck of the Turks”: Law of Nations, Sovereignty, and the Boundaries of Hospitality in the Eighteenth-Century Mediterranean* ♦ **Francesca Trivellato**, Andrew W. Mellon Professor, School of Historical Studies, with **Guillaume Calafat**, Paris 1–Panthéon Sorbonne

February 20

What is Global History? A Roundtable ♦ **Sebastian Conrad**, Professor of History, Free University of Berlin in conversation with **Suzanne Conklin Akbari**, Professor, School of Historical Studies; **Nicola Di Cosmo**, Luce Foundation Professor in East Asian Studies, School of Historical Studies; **Francesca Trivellato**, Andrew W. Mellon Professor, School of Historical Studies

March 5

Early Modern Europe Seminar ♦ *The Maghreb in Spain: Slave and Muslims in Eighteenth-Century Cartagena* ♦ **Daniel Hershenzon**, University of Connecticut; Member, School of Historical Studies

March 27

Early Modern Europe Seminar ♦ *The Enlightenment and Original Sin* ♦ **Matt Kadane**, Hobart and William Smith Colleges; Member, School of Historical Studies

April 13

Early Modern Europe Seminar ♦ *The Blood of Households: Private Violence and Legalities of Raiding in Early European Empires* ♦ **Lauren Benton**, Vanderbilt University; Member, School of Historical Studies

May 15

Early Modern Europe Seminar ♦ *Coevolution of Judicial and Reputational Institutions in Contract Enforcement across the Early Atlantic Sugar Route* ♦ **Daniel Strum**, University of Sao Paulo; Member, School of Historical Studies

EAST ASIAN STUDIES ACTIVITIES

October 7

East Asian Seminar ♦ *China’s Afro-Asian Philology (ca. 1955–65)* ♦ **Tamara Chin**, Brown University; Member, School of Historical Studies

October 14

East Asian Seminar ♦ *Rats, Cats, and Bandits in the Early Modern Canton Delta* ♦ **Robert Antony**, Guangzhou University; Member, School of Historical Studies

October 28

East Asian Seminar ♦ *The Climate of the Manchu Conquest* ♦ **Nicola Di Cosmo**, Luce Foundation Professor in East Asian Studies, School of Historical Studies, Institute for Advanced Study

November 4

East Asian Seminar ♦ *The Barbers of Beijing* ♦ **Fabio Lanza**, University of Arizona; Member, School of Historical Studies

November 25

East Asian Seminar ♦ *From the Ground Up: Refining Views of Japanese History (850–1550) Through Mining* ♦ **Tom Conlan**, Princeton University

December 16

East Asian Seminar ♦ *New China Daily: Social Change and the Class Project in Wartime Nationalist China* ♦ **Joshua Howard**, University of Mississippi; Member, School of Historical Studies

January 20

East Asian Seminar ♦ *Is it finished? Problems in the history of Chinese buildings, with some thoughts on xiu 修* ♦ **Susan Naquin**, Princeton University

February 3

East Asian Seminar ♦ *New insights on the transition to agriculture and sedentary way of life in North China* ♦ **Gideon Shelach-Lavi**, Hebrew University; Member, School of Historical Studies

February 17

East Asian Seminar ♦ *Instability, crises and disintegration of the Turkic empires on the Mongolian plateau* ♦ **Jan Bemmman**, University of Bonn; Member, School of Historical Studies

March 2

East Asian Seminar ♦ *Beneath the China Boom: Labor, Citizenship, and the Making of a Rural Land Market* ♦ **Julia Chuang**, Boston College; Member, School of Historical Studies

MEDIEVAL STUDIES ACTIVITIES

October 31

Medieval Studies Seminar ♦ *First Term Introductions and Disciplinary Methodologies* (Nirenberg, Whitaker) ♦ **Suzanne Conklin Akbari**, Professor, School of Historical Studies ♦ 2019–20 series on “Race, Racialization, and Periodization” co-convened with **Cord Whitaker**, Wellesley College; Member, School of Historical Studies

November 7

Medieval Studies Seminar ♦ *The Politics of the History of Race and Racialization: Jewish Studies and Art History* (Lipton, Mittman) ♦ **Suzanne Conklin Akbari**, Professor, School of Historical Studies, and **Cord Whitaker**, Wellesley College; Member, School of Historical Studies

November 14

Medieval Studies Seminar ♦ *The Intersection of Religion and Race: Muslim Bodies* (Akbari, Heng) ♦ **Suzanne Conklin Akbari**, Professor, School of Historical Studies, and **Cord Whitaker**, Wellesley College; Member, School of Historical Studies

November 19

Book History Workshop ♦ *Formats of the Book in East Asia and Environs* ♦ **Suzanne Conklin Akbari**, Professor, School of Historical Studies; **Nicola Di Cosmo**, Luce Foundation Professor in East Asian Studies, School of Historical Studies; **Paul Chandler Dilley**, University of Iowa; Member, School of Historical Studies; **Martin Heijdra**, Princeton University; **Stephen Teiser**, Princeton University ♦ co-sponsored by the Andrew W. Mellon Foundation and Princeton's Buddhist Studies Workshop

December 5

Medieval Studies Seminar ♦ *Ethnicity, Race, and Racialization* (Reimitz, Rouighi) ♦ **Suzanne Conklin Akbari**, Professor, School of Historical Studies, and **Cord Whitaker**, Wellesley College; Member, School of Historical Studies

January 23

Medieval Studies Seminar ♦ *Critical Race and the Middle Ages* (Kim, Lopez-Jantzen) ♦ **Suzanne Conklin Akbari**, Professor, School of Historical Studies, and **Cord Whitaker**, Wellesley College; Member, School of Historical Studies

February 13

Medieval Studies Seminar ♦ *Political and Racial Identities of the English and the Welsh* (Lavezzo, Lumbley) ♦ **Celia Chazelle**, The College of New Jersey

March 5

Medieval Studies Seminar ♦ *Legalizing Ethnicity and Ethnogenesis* (Reimitz, Haney López) ♦ **Helmut Reimitz**, Princeton University

April 16

Medieval Studies Seminar ♦ *Medieval Indigeneity* (Miyashiro, Rouighi) ♦ **Suzanne Conklin Akbari**, Professor, School of Historical Studies

May 14

Medieval Studies Seminar ♦ *Usury in Pistoia and the Role of Anti-Judaism* (Fossier, Todeschini) ♦ **Arnaud Fossier**, Université de Bourgogne; Member, School of Historical Studies

May 7

Medieval Studies Seminar ♦ *Slavery, the Slave Trade, and Venetian Notarial Documents* (Amitai and Cluse; Stello) ♦ **Nicola Di Cosmo**, Luce Foundation Professor in East Asian Studies, School of Historical Studies

May 21

Medieval Studies Seminar ♦ *Racialization, Enslavement, and Religious Identity* (Epstein, Silleras-Fernández) ♦ **Ariana Myers**, Princeton University

June 4

Medieval Studies Seminar ♦ *Ethnicity and Race in Early Medieval Book Illumination* (Denoël, Michaud) ♦ **Charlotte Denoël**, Bibliothèque Nationale de France; Member, School of Historical Studies

June 11

Medieval Studies Seminar ♦ *Race, Racialization, and Periodization* (Davis, Whitaker) ♦ **Cord Whitaker**, Wellesley College; Member, School of Historical Studies

NEAR/MIDDLE EASTERN AND ISLAMIC STUDIES ACTIVITIES

October 2

Near Eastern Studies Seminar ♦ *Intersections between Arabic and Aramaic: The Case of Syriac Christians* ♦ **Aaron Michael Butts**, The Catholic University of America; Member, School of Historical Studies

October 17

The Historical Studies–Social Science Library Conversations ♦ *The Syriac Orthodox in North America (1895–1995): A Short History* ♦ **George A. Kiraz**, Beth Mardutho: The Syriac Institute; Research Associate, School of Historical Studies

October 23

Near Eastern Studies Seminar ♦ *The Political Subtexts of Coptic-Arabic Pseudepigraphy: Stories of the First Church of Mary as Responses to Territorial Dispossession* ♦ **Mary Kamal Farag**, Princeton Theological Seminary; Member, School of Historical Studies

December 4

Near Eastern Studies Seminar ♦ *The Arabia of Abraha* ♦ **Christian Robin**, Centre National de la Recherche Scientifique, Paris; Member, School of Historical Studies

December 11

Near Eastern Studies Seminar ♦ *The Kidnapping of a 14th Century Rasulid Sultan: The Case of al-Malik al-Mujāhid ‘Alī* ♦ **Daniel Martin Varisco**, American Institute for Yemeni Studies; Member, School of Historical Studies

January 21, 23, 28, 30 and February 13

Near Eastern Studies Workshop ♦ *Documents/Inscriptions from pre-Islamic Southern Arabia* ♦ Led by **Christian Robin**, Centre National de la Recherche Scientifique, Paris; Member, School of Historical Studies. Sponsored by **Sabine Schmidtke**, Professor, School of Historical Studies

January 27

Iran at the Crossroads of Civilization: Scholars and Lawyers Speaking about Iranian History and Cultural Heritage. A Panel Discussion ♦ **Irina Bokova**, former Director-General of UNESCO; **Touraj Daryaei**, University of California, Irvine; **Ani Honarchiansaky**, Princeton University; **Rudi Matthee**, University of Delaware; **Matthew T. Miller**, University of Maryland, College Park; **Alexander Nagel**, State University of New York and Smithsonian Institution, Washington, DC; **Thomas G. Weiss**, The Graduate Center, City University of New York. Sponsored by **Sabine Schmidtke**, Professor, School of Historical Studies

January 29

Near Eastern Studies Seminar ♦ *Medicine, God, and the Occult in 17th Century Morocco* ♦ **Justin Stearns**, New York University Abu Dhabi; Member, School of Historical Studies

February 5

Near Eastern Studies Seminar ♦ *Tribal Dynamics and Nation Building in Yemen* ♦ **Najwa Adra**, Austrian Academy of Sciences; Visitor, School of Social Science

February 12

Near Eastern Studies Seminar ♦ *Mathematical Methods in the Soviet Historiography of Medieval Islamic Architecture* ♦ **Igor Demchenko**, Columbia University; Visitor, School of Historical Studies

February 19

Near Eastern Studies Seminar ♦ *Why Yemen Matters: The Heritage of a Land in Crisis, A Panel Discussion with current IAS Scholars* ♦ **Najwa Adra**, Austrian Academy of Sciences; Visitor, School of Social Science; **Hassan Ansari**, Long-term Member, School of Historical Studies; **Glen W. Bowersock**, Professor Emeritus, School of Historical Studies; **Nathalie Peutz**, New York University Abu Dhabi; Member, School of Social Science; **Christian Robin**, Centre National de la

Recherche Scientifique, Paris; Member, School of Historical Studies; **Sabine Schmidtk**, Professor, School of Historical Studies; **Daniel Martin Varisco**, American Institute for Yemeni Studies; Member, School of Historical Studies

School of Mathematics

September 10

PCTS Seminar Series: Deep Learning for Physics + *Toward Theoretical Understanding of Deep Learning* + **Sanjeev Arora**, Princeton University; Distinguished Visiting Professor, School of Mathematics

September 11

Seminar on Theoretical Machine Learning

September 12

Joint IAS/Princeton University Number Theory Seminar + *Taking the Hecke Algebra to Its Limits* + **Raphael Steiner**, Member, School of Mathematics

September 19

Number Theory Working Group + *Singular Moduli for Real Quadratic Fields (Organizational Meeting)* + **Jan Vonk**, Member, School of Mathematics

Joint IAS/Princeton University Number Theory Seminar + *On the Arithmetic of Elliptic Curves over Quintic Fields* + **Michele Fornea**, Princeton University

September 24

Short talks by postdoctoral members + *A Program for Classifying Transitive Anosov Diffeomorphisms* + **Clark Butler**, Princeton University; Veblen Research Instructor, School of Mathematics + *Flatness, Smoothness, and the Analyst's Traveling Salesman Theorem* + **Silvia Ghinassi**, Member, School of Mathematics + *Geometric Applications of Derived Categories* + **Alexander Perry**, Member, School of Mathematics + *Golden Gates in $PU(n)$ and the Density Hypothesis* + **Shai Evra**, Member, School of Mathematics + *Growth of Topological Invariants of Locally Symmetric Spaces* + **Mikolaj Fraczyk**, Member, School of Mathematics + *Interfaces in Inhomogeneous Media: Pinning, Hysteresis, and Facets* + **William Feldman**, Member, School of Mathematics + *Robustness and Strategic Concerns in Machine Learning* + **Yu Cheng**, Member, School of Mathematics

September 25

Short talks by postdoctoral members + *Counting Curves on Quintic Threefolds* + **Felix Janda**, Member, School of Mathematics + *Exploration in Reinforcement Learning* + **Chi Jin**, Member, School of Mathematics + *Fourier Coefficients of Automorphic Forms* + **Henrik Gustafsson**, Member, School of Mathematics + *Spectral Statistics of Sparse Random Graphs* + **Jiaoyang Huang**, Member, School of Mathematics + *Stochastic Local Search and the Lovasz Local*

Lemma + **Fotios Iliopoulos**, Member, School of Mathematics + *The Thin Obstacle Problem* + **Yash Jhaveri**, Member, School of Mathematics

September 26

Joint IAS/Princeton University Number Theory Seminar + *Golden Gates in $PU(n)$ and the Density Hypothesis* + **Shai Evra**, Member, School of Mathematics

September 27

Short talks by postdoctoral members + *Degeneration of Calabi-Yau Metrics* + **Yang Li**, Member, School of Mathematics + *Ill-Posedness of Incompressible Fluid Models* + **Hyunju Kwon**, Member, School of Mathematics + *New Forms of Hypercontractivity* + **Dor Minzer**, Member, School of Mathematics + *Pointwise Inequalities for Certain Nonlocal Operators* + **Ángel Martínez Martínez**, Member, School of Mathematics + *Systems of Points with Logarithmic Interactions* + **Thomas Leblé**, Member, School of Mathematics + *The Asymptotic Spectrum of Graphs* + **Jeroen Zuiddam**, Member, School of Mathematics + *The Homology Cobordism Group* + **Linh Truong**, Member, School of Mathematics

October 1

IAS-PNI Seminar on ML and Neuroscience + *A Geometric Data Structure from Neuroscience* + **Sanjoy Dasgupta**, University of California, San Diego; Special Year Member, School of Mathematics

Short talks by postdoctoral members + *On the Connection between Neural Networks and Kernels: A Modern Perspective* + **Simon Du**, Member, School of Mathematics + *p -adic Hodge Theory for Local Systems* + **Koji Shimizu**, Member, School of Mathematics + *Primes in High-Dimensional Equivariant Settings* + **Rohit Nagpal**, Member, School of Mathematics + *Proof and Circuit Complexity* + **Robert Robere**, Member, School of Mathematics + *Relative Smoothness: Progress, Mysteries, and Hamiltonians* + **Christopher Maddison**, Member, School of Mathematics

October 2

Seminar on Theoretical Machine Learning + *Rethinking Control* + **Elad Hazan**, Princeton University, Google AI Princeton

Short talks by postdoctoral members + *Discrete Optimization under Uncertainty* + **Sahil Singla**, Member, School of Mathematics + *Distributional Aspects of Hecke Eigenforms* + **Raphael Steiner**, Member, School of Mathematics + *Incidence Estimates with Application to Fourier Analysis* + **Hong Wang**, Member, School of Mathematics + *Interactive Learning with Comparison Queries* + **Shay Moran**, Google Brain; Visitor, School of Mathematics + *Life in Characteristic p (And How to Escape It)* + **Remy van Dobben de Bruyn**, Princeton University; Veblen Research Instructor, School of Mathematics + *Matrix Theory : Optimization,*

Concentration and Algorithms + **Zhao Song**, Member, School of Mathematics + *Singular Moduli for Real Quadratic Fields and p -adic Families of Modular Forms* + **Jan Vonk**, Member, School of Mathematics + *Towards Building a Foundation of Deep Learning* + **Jason Lee**, Member, School of Mathematics

October 3

Joint IAS/Princeton University Number Theory Seminar + *A Stacky Approach to Crystalline (and Prismatic) Cohomology* + **Vladimir Drinfeld**, The University of Chicago; Visiting Professor, School of Mathematics

Working Seminar in Algebraic Number Theory

October 4

Short talks by postdoctoral members + *A Short Talk around the Harish-Chandra Transform* + **Alexander Yom Din**, Member, School of Mathematics + *Decay of Correlations for Anosov Flows* + **Zhiyuan Zhang**, Member, School of Mathematics + *Dynamics of Deep Neural Networks—A Fourier Analysis Perspective* + **Yaoyu Zhang**, Member, School of Mathematics + *Estimating the Wasserstein Metric* + **Jonathan Niles-Weed**, Member, School of Mathematics + *Robustness of Graph Properties—Property Testing and Removal Lemma* + **Fan Wei**, Member, School of Mathematics + *Uniqueness Aspects of Symplectic Fillings* + **Zhengyi Zhou**, Member, School of Mathematics

October 7

Members' Seminar + *Logarithmic Concavity of Schur Polynomials* + **June Huh**, Visiting Professor, School of Mathematics

Analysis Seminar + *Weak Solutions of the Navier-Stokes Equations May Be Smooth for A.E. Time* + **Maria Colombo**, École Polytechnique Fédérale de Lausanne; von Neumann Fellow, School of Mathematics

Symplectic Dynamics/Geometry Seminar + *Bourgeois Contact Structures: Tightness, Fillability and Applications* + **Agustin Moreno**, University of Augsburg

October 8

Seminar on Theoretical Machine Learning + *Unsupervised Ensemble Learning* + **Boaz Nadler**, Weizmann Institute of Science; Member, School of Mathematics

October 9

Seminar on Theoretical Machine Learning + *Designing Fast and Robust Learning Algorithms* + **Yu Cheng**, University of Illinois at Chicago

Mathematical Conversations + *Finite Fields and the Ax-Grothendieck Theorem* + **Remy van Dobben de Bruyn**, Princeton University; Veblen Research Instructor, School of Mathematics

October 10

Joint IAS/Princeton University Number Theory Seminar ♦ *Extremal Cases of Rapoport-Zink Spaces* ♦ **Michael Rapoport**, Universität Bonn, University of Maryland

Working Seminar on Nonabelian Hodge Theory

Working Seminar in Algebraic Number Theory

October 11

Analysis – Mathematical Physics ♦ *Nodal Domains of Equivariant Eigenfunctions on Kaluza-Klein 3-Folds* ♦ **Junehyuk Jung**, Texas A&M University ♦ *On a Universal Limit Conjecture for the Nodal Count Statistics of Quantum Graphs* ♦ **Lior Alon**, Technion

Special Dynamics Seminar ♦ *On Radon Measures Invariant under Horospherical Flows on Geometrically Infinite Manifolds* ♦ **Or Landesberg**, The Hebrew University of Jerusalem

October 14

Members' Seminar ♦ *Finding Structure in High Dimensional Data, Methods and Fundamental Limitations* ♦ **Boaz Nadler**, Weizmann Institute of Science; Member, School of Mathematics

Analysis Seminar ♦ *On the (In)Stability of the Identity Map in Optimal Transportation* ♦ **Yash Jhaveri**, Member, School of Mathematics

Symplectic Dynamics/Geometry Seminar ♦ *Inscribing Rectangles in Jordan Loops* ♦ **Richard Schwartz**, Brown University

October 15

Workshop on Theory of Deep Learning: Where next? ♦ *Are All Features Created Equal?* ♦ **Aleksander Madry**, Google ♦ *Emergent Linguistic Structure in Deep Contextual Neural Word Representations* ♦ **Chris Manning**, Stanford University ♦ *Fixing GAN Optimization through Competitive Gradient Descent* ♦ **Anima Anandkumar**, California Institute of Technology ♦ *Is Optimization the Right Language to Understand Deep Learning?* ♦ **Sanjeev Arora**, Princeton University; Distinguished Visiting Professor, School of Mathematics ♦ *Overcoming the Curse of Dimensionality and Mode Collapse* ♦ **Ke Li**, University of California, Berkeley ♦ *PAC-Bayesian Approaches to Understanding Generalization in Deep Learning* ♦ **Karolina Dziugaite Roy**, Simons Institute for the Theory of Computing ♦ *Spotlight Talks* ♦ Various ♦ *Spotlight Talks* ♦ Various ♦ *Tightening Information-Theoretic Generalization Bounds with Data-Dependent Estimates with an Application to SGLD* ♦ **Daniel M. Roy**, University of Toronto ♦ *What 2-Layer Neural Nets Can We Optimize?* ♦ **Rong Ge**, Duke University; Member, School of Mathematics

October 16

Mathematical Conversations ♦ *What Is Percolation?* ♦ **Stanislav Smirnov**, University of Geneva; Visitor, School of Mathematics

Workshop on Theory of Deep Learning: Where next? ♦ *Energy-Based Approaches to Representation Learning* ♦ **Yann LeCun**, New York University and Facebook AI ♦ *From Classical Statistics to Modern ML: The Lessons of Deep Learning* ♦ **Mikhail Belkin**, Ohio State University ♦ *Neural Models for Speech and Language: Successes, Challenges, and the Relationship to Computational Models of the Brain* ♦ **Michael Collins**, Columbia University ♦ *On Large Deviation Principles for Large Neural Networks* ♦ **Joan Bruna**, New York University ♦ *On the Connection between Neural Networks and Kernels: A Modern Perspective* ♦ **Simon Du**, Member, School of Mathematics ♦ *Panel Session* ♦ Various ♦ *Spotlight Talks* ♦ Various ♦ *Towards a Theoretical Foundation of Neural Networks* ♦ **Jason Lee**, Princeton University; Member, School of Mathematics

October 17

Joint IAS/Princeton University Number Theory Seminar ♦ *Geometric Lifts of Odd Galois Representations* ♦ **Stefan Patrikis**, University of Utah

Working Seminar on Nonabelian Hodge Theory

Working Seminar in Algebraic Number Theory

Workshop on Theory of Deep Learning: Where next? ♦ *Designing Explicit Regularizers for Deep Models* ♦ **Tengyu Ma**, Stanford University ♦ *Interpreting Deep Neural Networks* ♦ **Bin Yu**, University of California, Berkeley ♦ *Kernel and Rich Regimes in Deep Learning* ♦ **Nati Srebro**, Toyota Technological Institute at Chicago ♦ *Learning Representations Using Causal Invariance* ♦ **Leon Bottou**, Facebook AI Research ♦ *Poster Session* ♦ Various ♦ *Provably Efficient Reinforcement Learning with Linear Function Approximation* ♦ **Chi Jin**, Member, School of Mathematics ♦ *Spotlight Talks* ♦ Various ♦ *Spotlight Talks* ♦ Various ♦ *Understanding the Inductive Bias Due to Dropout* ♦ **Raman Arora**, Johns Hopkins University; Member, School of Mathematics

October 18

Workshop on Theory of Deep Learning: Where next? ♦ *Are All Features Created Equal* ♦ **Behnam Neyshabur**, Google ♦ *Concentration Inequalities for Random Matrix Products* ♦ **Rachel Ward**, The University of Texas at Austin; von Neumann Fellow, School of Mathematics ♦ *Informal Discussion Sessions* ♦ *Machine Learning* ♦ **Surya Ganguli**, Stanford University ♦ *Reinforcement Learning, Deep Learning, and the Role of Policy Gradient Methods* ♦ **Sham Kakade**, University of Washington ♦ *Representational Power of Graph Neural Networks* ♦ *Stefanie Jegelka*, Massachusetts Institute of Technology ♦ *Spotlight Talks* ♦ Various ♦ *Spotlight Talks* ♦ **Zhiyuan Li**, **John Zarka**, **Stanislav Fort**, Princeton University, l'Ecole normale supérieure, Stanford University

October 21

Members' Seminar ♦ *Length and Volume in Symplectic Geometry* ♦ **Daniel Cristofaro-Gardiner**, University of California, Santa Cruz; von Neumann Fellow, School of Mathematics

Analysis Seminar ♦ *Strong Ill-Posedness of the Logarithmically Regularized 2d Euler Equations in the Borderline Sobolev Space* ♦ **Hyunju Kwon**, Member, School of Mathematics

Symplectic Dynamics/Geometry Seminar ♦ *Koszul Duality and Knot Floer Homology* ♦ **Thomas Hockenhull**, University of Glasgow

October 22

PCTS Seminar Series: Deep Learning for Physics ♦ *Autoregressive Simulation of Many-Body Quantum Systems* ♦ **Or Sharir**, Hebrew University of Jerusalem ♦ *Machine Learning Techniques for Many-Body Quantum Systems* ♦ **Giuseppe Carleo**, Simons Foundation

October 23

Seminar on Theoretical Machine Learning ♦ *Optimization Landscape and Two-Layer Neural Networks* ♦ **Rong Ge**, Duke University; Member, School of Mathematics

Mathematical Conversations ♦ *Khovanov Homology* ♦ **Linh Truong**, Member, School of Mathematics

October 24

Joint IAS/Princeton University Number Theory Seminar ♦ *A Slice or Two of a Diagonal Cubic: Arithmetic Stratification via the Circle Method* ♦ **Trevor Wooley**, Purdue University

Working Seminar on Nonabelian Hodge Theory ♦ *Epsilon Regularity and Removable Singularities* ♦ **Karen Uhlenbeck**, The University of Texas at Austin; Distinguished Visiting Professor, School of Mathematics

Working Seminar in Algebraic Number Theory

October 28

Members' Seminar ♦ *Sparse Matrices in Sparse Analysis* ♦ **Anna Gilbert**, University of Michigan; Member, School of Mathematics

Analysis Seminar ♦ *The Surface Quasigeostrophic Equation on the Sphere* ♦ **Angel Martinez Martinez**, Member, School of Mathematics

Symplectic Dynamics/Geometry Seminar ♦ *Spectrum and Abnormals in Sub-Riemannian Geometry: The 4D Quasi-Contact Case* ♦ **Nikhil Savale**, University of Cologne

October 30

Mathematical Conversations ♦ *Optimal Transport and Its Unexpected Appearances* ♦ **Maria Colombo**, École Polytechnique Fédérale de Lausanne; von Neumann Fellow, School of Mathematics

October 31

Working Seminar on Nonabelian Hodge Theory

Working Seminar in Algebraic Number Theory

Joint IAS/Princeton University Number Theory Seminar

November 1

Analysis – Mathematical Physics ♦ *Epsilon-Regularity for Minimal Surfaces near Quadratic Cones* ♦ **Luca Spolaor**, University of California, San Diego ♦ *Local Bound on the Number of Nodal Domains* ♦ **Aleksandr Logunov**, Princeton University

November 4

Members' Seminar ♦ *Pseudoholomorphic Curves with Boundary: Can You Count Them? Can You Really?* ♦ **Sara Tukachinsky**, Member, School of Mathematics

Analysis Seminar ♦ *The Forced Mean Curvature Flow in Random Media* ♦ **William Feldman**, Member, School of Mathematics

Symplectic Dynamics/Geometry Seminar ♦ *Homological Mirror Symmetry for a Complex Genus 2 Curve* ♦ **Catherine Cannizzo**, Simons Center for Geometry and Physics, Stony Brook

November 5

Seminar on Theoretical Machine Learning ♦ *On Implicit Regularization and Autotuning of Normalization in Deep Learning* ♦ **Rachel Ward**, The University of Texas at Austin; von Neumann Fellow, School of Mathematics

November 7

Workshop on New Directions in Reinforcement Learning and Control ♦ *Curiosity, Unobserved Rewards and Neural Networks: On Recent Progress in Building Solid Foundations for RL* ♦ **Csaba Szepesvari**, DeepMind, University of Alberta ♦ *Lightning Talks* ♦ **Galen Cho**, Microsoft Research; **Christina Yu**, Cornell University; **Cyril Zhang**, Princeton University; **Laura Balzano**, University of Michigan, Ann Arbor; Member, School of Mathematics; **Max Simchovitz**, University of California, Berkeley ♦ *Robust Control with Perception in the Loop: Towards Open-World Manipulation* ♦ **Russ Tedrake**, Massachusetts Institute of Technology, Toyota Research Institute ♦ *The Non-Stochastic Control Problem* ♦ **Elad Hazan**, Princeton University, Google AI ♦ *Towards Structural Risk Minimization for RL* ♦ **Emma Brunskill**, Stanford University ♦ *Understanding Deep Networks and Its Role Played in Prioritized Search* ♦ **Yuandong Tian**, Facebook AI ♦ *Unsupervised State Embedding and Aggregation towards Scalable Reinforcement Learning* ♦ **Mengdi Wang**, Princeton University

Working Seminar on Nonabelian Hodge Theory

Working Seminar in Algebraic Number Theory

Joint IAS/Princeton University Number Theory Seminar ♦ *The Weyl Bound for Dirichlet L-Functions* ♦ **Matthew Young**, Texas A&M; von Neumann Fellow, School of Mathematics

November 8

Workshop on New Directions in Reinforcement Learning and Control ♦ *Deep Reinforcement Learning in the Real World* ♦ **Sergey Levine**, University of Berkeley ♦ *Is a Good Representation Sufficient for Sample Efficient Reinforcement Learning* ♦ **Sham Kakade**, University of Washington ♦ *Lightning Talks* ♦ **Chi Jin**, Member, School of Mathematics; **Lin Yang**, University of California, Los Angeles; **Alec Koppel**, U.S. Army Research Laboratory in the Computational and Information Sciences Directorate; **Karan Singh**, Princeton University; **Nataly Brukhim**, Princeton University ♦ *Risk and Robustness in RL: Nothing Ventured, Nothing Gained* ♦ **Shie Mannor**, Technion ♦ *Strategic Exploration via State Abstraction from Rich Observations* ♦ **John Langford**, Microsoft

November 11

Members' Seminar ♦ *Lie Algebras and Homotopy Theory* ♦ **Jacob Lurie**, Professor, School of Mathematics

Analysis Seminar ♦ *An Application of Displacement Convexity at the Level of Point Processes* ♦ **Thomas Leblé**, Member, School of Mathematics

Symplectic Dynamics/Geometry Seminar ♦ *Local Rigidity and C^0 Symplectic and Contact Topology* ♦ **Mike Usher**, University of Georgia

November 12

Seminar on Theoretical Machine Learning ♦ *Fast IRLS Algorithms for p -Norm Regression* ♦ **Sushant Sachdeva**, University of Toronto; Member, School of Mathematics

November 13

Seminar on Theoretical Machine Learning ♦ *Some Statistical Results on Deep Learning: Interpolation, Optimality and Sparsity* ♦ **Guang Cheng**, Purdue University; Member, School of Mathematics

Mathematical Conversations ♦ *Erdős Distinct Distances Problem on the Plane* ♦ **Hong Wang**, Member, School of Mathematics

November 14

Working Seminar on Nonabelian Hodge Theory

Working Seminar in Algebraic Number Theory

Joint IAS/Princeton University Number Theory Seminar ♦ *Local Systems over Shimura Varieties: A Comparison of Two Constructions* ♦ **Kai-Wen Lan**, University of Minnesota

November 15

Joint IAS/Princeton University Theoretical Machine Learning Seminar ♦ *Can Learning Theory Resist Deep Learning?* ♦ **Francis Bach**, Institut national de recherche en informatique et en automatique

Analysis – Mathematical Physics ♦ *Extreme Eigenvalue Distributions of Sparse Random Graphs* ♦ **Jiaoyang Huang**, Member, School of Mathematics ♦ *Unitary, Symplectic, and Orthogonal Moments of Moments* ♦ **Emma Bailey**, University of Bristol

Special Dynamics Seminar ♦ *Effective Bounds for the Least Solutions of Homogeneous Quadratic Diophantine Inequalities* ♦ **Thomas Hille**, Yale University

November 18

Analysis Seminar ♦ *The Singular Set in the Fully Nonlinear Obstacle Problem* ♦ **Ovidiu Savin**, Columbia University

Symplectic Dynamics/Geometry Seminar ♦ *Twisted Generating Functions and the Nearby Lagrangian Conjecture* ♦ **Sylvain Courte**, Grenoble Alpes University

Hermann Weyl Lectures ♦ *The PCP Theorem* ♦ **Irit Dinur**, Weizmann Institute of Science; Visiting Professor, School of Mathematics

November 19

Hermann Weyl Lectures ♦ *High Dimensional Expansion and Error Correcting Codes* ♦ **Irit Dinur**, Weizmann Institute of Science; Visiting Professor, School of Mathematics

PCTS Seminar Series: Deep Learning for Physics ♦ *Deep Learning and String Theory* ♦ **James Halverson**, Northeastern University ♦ *Flows three ways* ♦ **Kyle Cranmer**, New York University

November 20

Seminar on Theoretical Machine Learning ♦ *Nonconvex Minimax Optimization* ♦ **Chi Jin**, Princeton University; Member, School of Mathematics

Mathematical Conversations ♦ *Some Challenging Graph Inequality* ♦ **Fan Wei**, Member, School of Mathematics

Hermann Weyl Lectures ♦ *Unique and 2:2 Games, Grassmannians, and Expansion* ♦ **Irit Dinur**, Weizmann Institute of Science; Visiting Professor, School of Mathematics

November 21

Joint IAS/Princeton University Number Theory Seminar ♦ *Canonical Integral Models of Shimura Varieties* ♦ **George Pappas**, Member, School of Mathematics

Working Seminar on Nonabelian Hodge Theory

Working Seminar in Algebraic Number Theory

November 22

Special Dynamics Seminar ♦ *On Some Consequences of Exponential Mixing* ♦ **Federico Rodriguez-Hertz**, Penn State University

November 25

Joint IAS/Princeton University Number Theory Seminar ♦ *On Singularity Properties of Word Maps and Applications to Probabilistic Waring Type Problems* ♦ **Itay Glazer**, Weizmann Institute of Science

Special Seminar ♦ *Topological Quantum Phases* ♦ **Alexei Kitaev**, California Institute of Technology; Distinguished Visiting Professor, School of Natural Sciences

Members' Seminar ♦ *Convergence of nearest Neighbor Classification* ♦ **Sanjoy Dasgupta**, University of California, San Diego; Member, School of Mathematics

Symplectic Dynamics/Geometry Seminar ♦ *Homological Mirror Symmetry for Elliptic Hopf Surfaces* ♦ **Abigail Ward**, Harvard University

November 26

Seminar on Theoretical Machine Learning ♦ *A Fourier Analysis Perspective of Training Dynamics of Deep Neural Networks* ♦ **Yaoyu Zhang**, Member, School of Mathematics

December 2

Members' Seminar ♦ *Mathematical Models of Human Memory* ♦ **Michail Tsodyks**, C.V. Starr Professor, School of Natural Sciences

Analysis Seminar ♦ *Distance Estimate on Kähler Manifolds* ♦ **Yang Li**, Member, School of Mathematics

Symplectic Dynamics/Geometry Seminar ♦ *Disjoint Lagrangian Spheres and Cyclic Dilations* ♦ **Yin Li**, King's College London

December 3

IAS-PNI Seminar on ML and Neuroscience ♦ *A Distributional Code for Value in Dopamine-Based Reinforcement Learning* ♦ **Matthew Botvinick**, DeepMind

Joint IAS/Princeton University Number Theory Seminar ♦ *Thin Groups and the Arithmetic of Imaginary Quadratic Fields* ♦ **Katherine Stange**, University of Colorado, Boulder

December 4

Seminar on Theoretical Machine Learning ♦ *Uncoupled Isotonic Regression* ♦ **Jonathan Niles-Weed**, New York University; Member, School of Mathematics

Mathematical Conversations ♦ *Episodic Memory from First Principles* ♦ **Michelangelo Naim**, Weizmann Institute of Science; Visitor, School of Natural Sciences

December 5

Joint IAS/Princeton University Number Theory Seminar ♦ *Higher Order Uniformity of the Möbius Function* ♦ **Joni Teräväinen**, University of Oxford

Special Seminar on Hilbert's 13th Problem I ♦ *The Geometry of Hilbert's 13th Problem* ♦ **Jesse Wolfson**, University of California, Irvine

Working Seminar on Nonabelian Hodge Theory

Working Seminar in Algebraic Number Theory

December 6

Analysis - Mathematical Physics ♦ *Cardy Embedding of Random Planar Maps* ♦ **Nina Holden**, ETH Zürich ♦ *The Nonlinear Stability of the Schwarzschild Metric without Symmetry* ♦ **Mihalis Dafermos**, Princeton University

Special Seminar on Hilbert's 13th Problem II ♦ *Topology of Resolvent Problems* ♦ **Benson Farb**, University of Chicago

December 9

Members' Seminar ♦ *The h-Principle in Symplectic Geometry* ♦ **Emmy Murphy**, Northwestern University; von Neumann Fellow, School of Mathematics

Analysis Seminar ♦ *On the Gradient-Flow Structure of Multiphase Mean Curvature Flow* ♦ **Tim Laux**, University of California, Berkeley

Symplectic Dynamics/Geometry Seminar ♦ *Convex Hypersurface Theory in Higher-Dimensional Contact Topology* ♦ **Ko Honda**, University of California, Los Angeles

December 11

Mathematical Conversations ♦ *Cohomology Theories and Formal Groups* ♦ **Jacob Lurie**, Professor, School of Mathematics

December 12

Joint IAS/Princeton University Number Theory Seminar ♦ *The Arithmetic Fundamental Lemma for Unitary Groups: An Update* ♦ **Wei Zhang**, Massachusetts Institute of Technology

Working Seminar on Nonabelian Hodge Theory

Working Seminar in Algebraic Number Theory

December 13

Analysis - Mathematical Physics ♦ *A Rigorous Derivation of the Kinetic Wave Equation* ♦ **Tristan Buckmaster**, Princeton University ♦ *Localization and Unique Continuation on the Integer Lattice* ♦ **Charles Smart**, University of Chicago

December 17

Seminar on Theoretical Machine Learning ♦ *How Will We Do Mathematics in 2030?* ♦ **Michael R. Douglas**, Simons Center for Geometry and Physics, Stony Brook

December 18

Seminar on Theoretical Machine Learning ♦ *Online Learning in Reactive Environments* ♦ **Raman Arora**, Johns Hopkins University; Member, School of Mathematics

Mathematical Conversations ♦ *Faster and Simpler Algorithms for Robust Statistics* ♦ **Yu Cheng**, University of Illinois at Chicago; Visitor, School of Mathematics

December 19

Working Seminar on Nonabelian Hodge Theory

January 13

Analysis Seminar ♦ *Weak Solutions to the Navier—Stokes Inequality with Arbitrary Energy Profiles* ♦ **Wojciech Ożański**, University of Southern California; Member, School of Mathematics

January 14

IAS-PNI Seminar on ML and Neuroscience ♦ *Compositional Inductive Biases in Human Function Learning* ♦ **Samuel J. Gershman**, Harvard University

January 15

Mathematical Conversations ♦ *Hypoocoercivity* ♦ **George Deligiannidis**, University of Oxford

January 16

Seminar on Theoretical Machine Learning ♦ *Foundations of Intelligent Systems with (Deep) Function Approximators* ♦ **Simon Du**, Member, School of Mathematics

Working Seminar on Nonabelian Hodge Theory

January 17

Analysis - Mathematical Physics ♦ *Inverse Problems for Quantum Graphs* ♦ **Pavel Kurasov**, Stockholm University

January 21

Seminar on Theoretical Machine Learning ♦ *The Blessings of Multiple Causes* ♦ **David M. Blei**, Columbia University

Computer Science/Discrete Mathematics Seminar II ♦ *Approximating CSPs on Expanding Structures, and Applications to Codes* ♦ **Madhur Tulsiani**, Toyota Technological Institute at Chicago

January 22

Mathematical Conversations ♦ *What Is a Motive?* ♦ **Pierre Deligne**, Professor Emeritus, School of Mathematics

January 23

Joint IAS/Princeton University Number Theory Seminar ♦ *Motivic Euler Products in Motivic Statistics* ♦ **Margaret Bilu**, New York University

Seminar on Theoretical Machine Learning ♦ *In Defense of Uniform Convergence: Generalization via Derandomization* ♦ **Daniel M. Roy**, University of Toronto; Member, School of Mathematics

Working Seminar on Nonabelian Hodge Theory

January 27

Computer Science/Discrete Mathematics Seminar I ♦ *Equality Alone Does Not Simulate Randomness* ♦ **Marc Vinyals**, Technion

Members' Seminar ♦ *Knotted 3-Balls in the 4-Sphere* ♦ **David Gabai**, Princeton University

Symplectic Dynamics/Geometry Seminar ♦ *Symplectic Embeddings, Integrable Systems and Billiards* ♦ **Vinicius Ramos**, Instituto Nacional de Matemática Pura e Aplicada

January 28

Seminar on Theoretical Machine Learning ♦ *What Noisy Convex Quadratics Tell Us about Neural Net Training* ♦ **Roger Grosse**, University of Toronto; Member, School of Mathematics

Computer Science/Discrete Mathematics Seminar II ♦ *Pseudo-Deterministic Algorithms* ♦ **Toniann Pitassi**, University of Toronto; Visiting Professor, School of Mathematics

January 30

Joint IAS/Princeton University Number Theory Seminar ♦ *Eisenstein Series and the Cubic Moment for $PGL(2)$* ♦ **Paul Nelson**, ETH Zürich

Working Seminar on Nonabelian Hodge Theory

February 3

Computer Science/Discrete Mathematics Seminar I ♦ *$MIP^* = RE$* ♦ **Henry Yuen**, University of Toronto

Members' Seminar ♦ *Coarse Dynamics and Partially Hyperbolic Diffeomorphisms in 3-Manifolds* ♦ **Rafael Potrie**, Universidad de la República, Uruguay; von Neumann Fellow, School of Mathematics

Analysis Seminar ♦ *When Do Interacting Organisms Gravitate to the Vertices of a Regular Simplex?* ♦ **Robert McCann**, University of Toronto

Symplectic Dynamics/Geometry Seminar ♦ *Counting Embedded Curves in Symplectic 6-Manifolds* ♦ **Aleksander Doan**, Columbia University

February 4

Seminar on Theoretical Machine Learning ♦ *Algorithm and Hardness for Kernel Matrices in Numerical Linear Algebra and Machine Learning* ♦ **Zhao Song**, Member, School of Mathematics

Computer Science/Discrete Mathematics Seminar II ♦ *Proofs, Circuits, Communication, and Lower Bounds in Complexity Theory* ♦ **Robert Robere**, Member, School of Mathematics

February 5

Mathematical Conversations ♦ *Anosov Flows in 3-Manifolds and the Fundamental Group* ♦ **Rafael Potrie**, Universidad de la República, Uruguay; von Neumann Fellow, School of Mathematics

February 6

Seminar on Theoretical Machine Learning - PCTS Seminar Series: Deep Learning for Physics ♦ *Dynamics of Generalization in Overparameterized Neural Networks* ♦ **Andrew Saxe**, University of Oxford ♦ *Understanding Machine Learning via Exactly Solvable Statistical Physics Models* ♦ **Lenka Zdeborova**, Centre national de la recherche scientifique

Computer Science/Discrete Mathematics - Special Seminar ♦ *Explicit Rigid Matrices in P^{NP} via Rectangular PCPs* ♦ **Prahladh Harsha**, Tata Institute of Fundamental Research

Joint IAS/Princeton University Number Theory Seminar ♦ *Supersingular Main Conjectures, Sylvester's Conjecture and Goldfeld's Conjecture* ♦ **Daniel Kriz**, Massachusetts Institute of Technology

Working Seminar on Nonabelian Hodge Theory

February 10

Computer Science/Discrete Mathematics Seminar I ♦ *Paths and Cycles in Expanders* ♦ **Michael Krivelevich**, Tel Aviv University

Members' Seminar ♦ *Spectra of Metric Graphs and Crystalline Measures* ♦ **Peter Sarnak**, Professor, School of Mathematics

Analysis Seminar ♦ *On Dynamical Spectral Rigidity and Determination* ♦ **Jacopo De Simoi**, University of Toronto

Symplectic Dynamics/Geometry Seminar ♦ *Floer Homotopy without Spectra* ♦ **Mohammed Abouzaid**, Columbia University

February 11

Seminar on Theoretical Machine Learning ♦ *Geometric Insights into the Convergence of Non-Linear TD Learning* ♦ **Joan Bruna**, New York University; Member, School of Mathematics

Computer Science/Discrete Mathematics Seminar II ♦ *Proofs, Circuits, Communication, and Lower Bounds in Complexity Theory* ♦ **Robert Robere**, Member, School of Mathematics

February 12

Mathematical Conversations ♦ *p -adic Numbers in Cryptography and Rocky Horror* ♦ **Mark Goresky**, Visitor, School of Mathematics

February 13

Joint IAS/Princeton University Number Theory Seminar ♦ *Moduli Spaces of Shtukas over Function Fields* ♦ **Jared Weinstein**, Boston University

Seminar on Theoretical Machine Learning ♦ *The Lottery Ticket Hypothesis: On Sparse, Trainable Neural Networks* ♦ **Jonathan Frankle**, Massachusetts Institute of Technology

Working Seminar on Nonabelian Hodge Theory

February 14

Analysis - Mathematical Physics ♦ *Regularity of the Free Boundary for the Two-Phase Bernoulli Problem* ♦ **Guido De Philippis**, New York University ♦ *Stable Shock Formation for the Compressible Euler Equations* ♦ **Vlad Vicol**, New York University

February 18

IAS-PNI Seminar on ML and Neuroscience ♦ *Compositional Generalization in Minds and Machines* ♦ **Brenden Lake**, New York University

Computer Science/Discrete Mathematics Seminar II ♦ *An Invitation to Invariant Theory* ♦ **Viswambhara Makam**, Member, School of Mathematics

February 19

Mathematical Conversations ♦ *Regularization Effect of Gradient Flow Dynamics* ♦ **Yaoyu Zhang**, Member, Institute for Advanced Study

February 20

Joint IAS/Princeton University Number Theory Seminar ♦ *Isolation of L^2 Spectrum and Application to Gan-Gross-Prasad Conjecture* ♦ **Yifeng Liu**, Yale University

Seminar on Theoretical Machine Learning ♦ *Geometric Deep Learning for Functional Protein Design* ♦ **Michael Bronstein**, Imperial College London

Working Seminar on Nonabelian Hodge Theory

February 24

Computer Science/Discrete Mathematics Seminar I ♦ *Strong Average-Case Circuit Lower Bounds from Non-Trivial Derandomization* ♦ **Lijie Chen**, Massachusetts Institute of Technology

Members' Seminar ♦ *Direct and Dual Information Bottleneck Frameworks for Deep Learning* ♦ **Naftali Tishby**, The Hebrew University of Jerusalem

Analysis Seminar ♦ “Observable Events” and “Typical Trajectories” in Finite and Infinite Dimensional Dynamical Systems ♦ **Lai-Sang Young**, New York University; Distinguished Visiting Professor, School of Mathematics and Natural Sciences

Symplectic Dynamics/Geometry Seminar ♦ *Classification of N -Component Links with Khovanov Homology of Rank 2^N* ♦ **Boyu Zhang**, Princeton University

February 25

Seminar on Theoretical Machine Learning ♦ *Learning from Multiple Biased Sources* ♦ **Clayton Scott**, University of Michigan

Computer Science/Discrete Mathematics Seminar II ♦ *Is the Variety of Singular Tuples of Matrices a Null Cone?* ♦ **Viswambhara Makam**, Member, School of Mathematics

February 26

Mathematical Conversations ♦ *Euler Flow with Odd Symmetry* ♦ **Hyunju Kwon**, Member, School of Mathematics

February 27

Joint IAS/Princeton University Number Theory Seminar ♦ *A p -adic Monodromy Theorem for De Rham Local Systems* ♦ **Koji Shimizu**, Member, School of Mathematics

Seminar on Theoretical Machine Learning ♦ *Preference Modeling with Context-Dependent Salient Features* ♦ **Laura Balzano**, University of Michigan; Member, School of Mathematics

Working Seminar on Nonabelian Hodge Theory

Computer Science/Discrete Mathematics Seminar II ♦ *Spectral Independence in High-Dimensional Expanders and Applications to the Hardcore Model* ♦ **Kuikui Liu**, University of Washington

February 28

Analysis - Mathematical Physics ♦ *Dimerization and Néel Order in Different Quantum Spin Chains through a Shared (Classical) Loop Representation* ♦ **Michael Aizenman**, Princeton University ♦ *Rectifiability Is Necessary and Sufficient* ♦ **Svitlana Mayboroda**, University of Minnesota

March 2

Computer Science/Discrete Mathematics Seminar I ♦ *An Improved Cutting Plane Method for Convex Optimization, Convex-Concave Games and Its Applications* ♦ **Zhao Song**, Member, School of Mathematics

Members' Seminar ♦ *Lower Bounds in Complexity Theory, Communication Complexity, and Sunflowers* ♦ **Toniann Pitassi**, University of Toronto; Visiting Professor, School of Mathematics

Analysis Seminar ♦ *Constancy of the Dimension for Non-Smooth Spaces with Ricci Curvature Bounded below via Regularity of Lagrangian Flows* ♦ **Elia Bruè**, Scuola Normale Superiore di Pisa

Symplectic Dynamics/Geometry Seminar ♦ *Twisted Calabi-Yau Algebras and Categories* ♦ **Inbar Klang**, Columbia University

March 3

Seminar on Theoretical Machine Learning ♦ *What Noisy Convex Quadratics Tell Us about Neural Net Training* ♦ **Roger Grosse**, University of Toronto; Member, School of Mathematics

Computer Science/Discrete Mathematics Seminar II ♦ *An Introduction to Boolean Function Analysis* ♦ **Dor Minzer**, Member, School of Mathematics

March 4

Mathematical Conversations ♦ *Rationality of Algebraic Varieties* ♦ **Alexander Perry**, Member, School of Mathematics

Workshop on Machine Learning, Theory and Method in the Social Sciences

March 5

Joint IAS/Princeton University Number Theory Seminar ♦ *Euler System, Eisenstein Congruences and the p -adic Langlands Correspondence* ♦ **Eric Urban**, Columbia University

Seminar on Theoretical Machine Learning ♦ *Understanding Deep Neural Networks: From Generalization to Interpretability* ♦ **Gitta Kutyniok**, Technische Universität Berlin

Working Seminar on Nonabelian Hodge Theory

Workshop on Machine Learning, Theory and Method in the Social Sciences

Workshop on Machine Learning, Theory and Method in the Social Sciences/Alternate

March 9

Computer Science/Discrete Mathematics Seminar I ♦ *Learning from Censored and Dependent Data* ♦ **Constantinos Daskalakis**, Massachusetts Institute of Technology; Member, School of Mathematics

Members' Seminar ♦ *Towards a Mathematical Model of the Brain* ♦ **Lai-Sang Young**, New York University; Distinguished Visiting Professor, School of Mathematics and Natural Sciences

Analysis Seminar ♦ *Higher Order Rectifiability and Reifenberg Parametrizations* ♦ **Silvia Ghinassi**, Member, School of Mathematics

Symplectic Dynamics/Geometry Seminar ♦ *Packing and Squeezing Lagrangian Tori* ♦ **Richard Hind**, University of Notre Dame

March 10

Seminar on Theoretical Machine Learning ♦ *Your Brain on Energy-Based Models: Applying and Scaling EBMs to Problems of Interest to the Machine Learning Community Today* ♦ **Will Grathwohl**, University of Toronto

Computer Science/Discrete Mathematics Seminar II ♦ *Introduction to High Dimensional Expanders* ♦ **Irit Dinur**, Weizmann Institute of Science; Visiting Professor, School of Mathematics

March 11

Seminar on Theoretical Machine Learning ♦ *Improved Bounds on Minimax Regret under Logarithmic Loss via Self-Concordance* ♦ **Blair Bilodaeu**, University of Toronto

March 12

Joint IAS/Princeton University Number Theory Seminar ♦ *An Explicit Realization of Stable L -Packets on (Split) Classical Groups* ♦ **David Soudry**, Tel Aviv University

Working Seminar on Nonabelian Hodge Theory

March 16

Computer Science/Discrete Mathematics Seminar I ♦ *Feature Purification: How Adversarial Training Can Perform Robust Deep Learning* ♦ **Yuanzhi Li**, Carnegie Mellon University

March 17

Computer Science/Discrete Mathematics Seminar II ♦ *Sharp Thresholds and Extremal Combinatorics* ♦ **Dor Minzer**, Member, Institute for Advanced Study

March 19

Working Seminar on Nonabelian Hodge Theory

March 23

Computer Science/Discrete Mathematics Seminar I ♦ *Optimal Tiling the Euclidean Space Using Symmetric Bodies* ♦ **Mark Braverman**, Princeton University

March 24

Computer Science/Discrete Mathematics Seminar II ♦ *High Dimensional Expansion and Agreement Testing* ♦ **Irit Dinur**, Weizmann Institute of Science; Visiting Professor, School of Mathematics

March 26

Joint IAS/Princeton University Number Theory Seminar ♦ *Wiles Defect for Hecke Algebras That Are Not Complete Intersections* ♦ **Chandrashekhhar Khare**, University of California

Seminar on Theoretical Machine Learning ♦ *Margins, Perceptrons, and Deep Networks* ♦ **Matus Telgarsky**, University of Illinois

March 27

Symplectic Seminar ♦ *Fragmentation Pseudo-Metrics and Lagrangian Submanifolds* ♦ **Octav Cornea**, Université de Montréal

March 30

Computer Science/Discrete Mathematics Seminar I ♦ *CSPs with Global Modular Constraints: Algorithms and Hardness via Polynomial Representations* ♦ **Sivakanth Gopi**, Microsoft Research

March 31

Seminar on Theoretical Machine Learning ♦ *Some Recent Insights on Transfer Learning* ♦ **Samory Kpotufe**, Columbia University; Member, School of Mathematics

Computer Science/Discrete Mathematics Seminar II ♦ *High Dimensional Expansion and Agreement Testing* ♦ **Irit Dinur**, Weizmann Institute of Science; Visiting Professor, School of Mathematics

Number Theory Working Group ♦ *p-adic Modular Forms* ♦ **Koji Shimizu**, Member, School of Mathematics

April 2

Joint IAS/Princeton University Number Theory Seminar ♦ *Density Conjecture for Horizontal Families of Lattices in $SL(2)$* ♦ **Mikolaj Fraczyk**, Member, School of Mathematics

Seminar on Theoretical Machine Learning ♦ *Learning Controllable Representations* ♦ **Richard Zemel**, University of Toronto; Member, School of Mathematics

April 3

Symplectic Seminar ♦ *The Simplicity Conjecture* ♦ **Daniel Cristofaro-Gardiner**, Member, School of Mathematics

April 6

Computer Science/Discrete Mathematics Seminar I ♦ *Borrowing Memory That's Being Used: Catalytic Approaches to the Tree Evaluation Problem* ♦ **James Cook**, University of Toronto

Members' Seminar ♦ *The Palais-Smale Theorem and the Solution of Hilbert's 23 Problem* ♦ **Karen Uhlenbeck**, The University of Texas at Austin; Distinguished Visiting Professor, School of Mathematics

April 7

Seminar on Theoretical Machine Learning ♦ *Interpolation in Learning: Steps towards Understanding When Overparameterization Is Harmless, When It Helps, and When It Causes Harm* ♦ **Anant Sahai**, University of California, Berkeley

Computer Science/Discrete Mathematics Seminar II ♦ *Primality Testing* ♦ **Andrey Kupavskii**, Member, School of Mathematics

Number Theory Working Group ♦ *Some Spectral Questions over \mathbb{R} and \mathbb{Q}^p* ♦ **Jan Vonk**, Member, School of Mathematics

April 9

Joint IAS/Princeton University Number Theory Seminar ♦ *On the Kudla-Rapoport Conjecture* ♦ **Chao Li**, Columbia University

Seminar on Theoretical Machine Learning ♦ *Meta-Learning: Why It's Hard and What We Can Do* ♦ **Ke Li**, Member, School of Mathematics

Mathematical Conversations ♦ *Consequences of Delays and Imperfect Isolation in Epidemic Control* ♦ **Lai-Sang Young**, New York University; Distinguished Visiting Professor, School of Mathematics and Natural Sciences

April 10

Symplectic Seminar ♦ *Geometry of Quantum Uncertainty* ♦ **Leonid Polterovich**, Tel Aviv University

April 13

Computer Science/Discrete Mathematics Seminar I ♦ *Legal Theorems of Privacy* ♦ **Kobbi Nissim**, Georgetown University

Analysis Seminar ♦ *Flows of Vector Fields: Classical and Modern* ♦ **Camillo De Lellis**, IBM von Neumann Professor, School of Mathematics

April 14

Number Theory Working Group ♦ *Dedekind Sums, Lattice Point Counting and K^2* ♦ **Akshay Venkatesh**, Robert and Luisa Fernholz Professor, School of Mathematics

April 15

Workshop on New Directions in Optimization, Statistics and Machine Learning ♦ *Evaluating Lossy Compression Rates of Deep Generative Models* ♦ **Roger Grosse**, Member, School of Mathematics ♦ *Generative Modeling by Estimating Gradients of the Data Distribution* ♦ **Stefano Ermon**, Stanford University ♦ *Interpretability for Everyone* ♦ **Been Kim**, Google Brain ♦ *Iterative Random Forests (IRF) with Applications to Genomics and Precision Medicine* ♦ **Bin Yu**, University of California, Berkeley ♦ *Towards Robust Artificial Intelligence* ♦ **Pushmeet Kohli**, Google ♦ *A Snapshot of Few-Shot Classification* ♦ **Richard Zemel**, University of Toronto; Visitor, School of Mathematics

Mathematical Conversations ♦ *Vignettes about Pure Mathematics and Machine Learning* ♦ **Jordan Ellenberg**, University of Wisconsin-Madison

April 16

Joint IAS/Princeton University Number Theory Seminar ♦ *Local-Global Compatibility in the Crystalline Case* ♦ **Ana Caraiani**, Imperial College

Workshop on New Directions in Optimization, Statistics and Machine Learning ♦ *Deep Equilibrium Models via Monotone Operators* ♦ **Zico Kolter**, Carnegie Mellon University ♦ *Do Simpler Models Exist and How Can We Find Them?* ♦ **Cynthia Rudin**, Duke University ♦ *Modularity, Attention and Credit Assignment: Efficient Information Dispatching in Neural Computations* ♦ **Anirudh Goyal**, University of Montreal ♦ *Steps towards More Human-Like Learning in Machines* ♦ **Josh Tenenbaum**, Massachusetts Institute of Technology ♦ *The Peculiar Optimization and Regularization Challenges in Multi-Task Learning and Meta-Learning* ♦ **Chelsea Finn**, Stanford University and Google AI ♦ *Tradeoffs between Robustness and Accuracy* ♦ **Percy Liang**, Stanford University

April 17

IAS/PU-Montreal-Tel-Aviv Symplectic Geometry Seminar ♦ *Equivariant Quantum Operations and Relations between Them* ♦ **Nicholas Wilkins**, University of Bristol

April 20

Computer Science/Discrete Mathematics Seminar I ♦ *Structure vs Randomness in Complexity Theory* ♦ **Rahul Santhanam**, University of Oxford

Analysis Seminar ♦ *A Variational Approach to the Regularity Theory for the Monge-Ampère Equation* ♦ **Felix Otto**, Max Planck Institute Leipzig

April 21

Seminar on Theoretical Machine Learning ♦ *Assumption-Free Prediction Intervals for Black-Box Regression Algorithms* ♦ **Aaditya Ramdas**, Carnegie Mellon University

Computer Science/Discrete Mathematics Seminar II ♦ *Non-Commutative Optimization: Theory, Algorithms and Applications (Or, Can We Prove $P \neq NP$ Using Gradient Descent)* ♦ **Avi Wigderson**, Herbert H. Maass Professor, School of Mathematics

Number Theory Working Group ♦ *Discrete Series Representations and L^2 -Cohomology* ♦ **Mikolaj Fraczyk**, Member, School of Mathematics

April 22

Mathematical Conversations ♦ *Sullivan's Clock: Dennis Sullivan's Counter-Example to the Periodic Orbit Conjecture* ♦ **Richard Schwartz**, Brown University

April 23

Joint IAS/Princeton University Number Theory Seminar + *Symmetric Power Functoriality for Holomorphic Modular Forms* + **Jack Thorne**, University of Cambridge

Seminar on Theoretical Machine Learning + *Deep Generative Models and Inverse Problems* + **Alexandros Dimakis**, University of Texas at Austin

April 24

IAS/PU-Montreal-Tel-Aviv Symplectic Geometry Seminar + *The Geography of Immersed Lagrangian Fillings of Legendrian Submanifolds* + **Lisa Traynor**, Bryn Mawr College

April 27

Computer Science/Discrete Mathematics Seminar I + *Graph and Hypergraph Sparsification* + **Luca Trevisan**, Bocconi University

April 28

Analysis Seminar + *Ellipses of Small Eccentricity Are Determined by Their Dirichlet (Or, Neumann) Spectra* + **Steven Morris Zelditch**, Northwestern University

Computer Science/Discrete Mathematics Seminar II + *A Framework for Quadratic Form Maximization over Convex Sets* + **Vijay Bhattiprolu**, Member, School of Mathematics

Number Theory Working Group + *Runge's Method for Finding Solutions to Certain Diophantine Equations* + **Raphael Steiner**, Member, School of Mathematics

April 29

Mathematical Conversations + *Musings about a 10-Year Collaboration with Biological Morphologists, or How to Make Biologists Comfortable with Fiber Bundles* + **Ingrid Daubechies**, Duke University

April 30

Joint IAS/Princeton University Number Theory Seminar + *Eulerianity of Fourier Coefficients of Automorphic Forms* + **Henrik Gustafsson**, Member, School of Mathematics

Seminar on Theoretical Machine Learning + *Latent Stochastic Differential Equations for Irregularly-Sampled Time Series* + **David Duvenaud**, University of Toronto

May 1

IAS/PU-Montreal-Tel-Aviv Symplectic Geometry Seminar + *Zoll Contact Forms Are Local Maximisers of the Systolic Ratio* + **Alberto Abbondandolo**, Ruhr-Universität Bochum

May 4

Computer Science/Discrete Mathematics Seminar I + *Local Statistics, Semidefinite Programming, and Community Detection* + **Prasad Raghavendra**, University of California, Berkeley

Analysis Seminar + *Exponential Mixing of 3d Anosov Flows* + **Zhiyuan Zhang**, Université Paris 13

May 5

Seminar on Theoretical Machine Learning + *Boosting Simple Learners* + **Shay Moran**, Google Brain; Visitor, School of Mathematics

Computer Science/Discrete Mathematics Seminar II + *Recent Progress on Cutting Planes Proofs* + **Noah Fleming**, University of Toronto

Number Theory Working Group + *Local Langlands Correspondence for $GL(2)$* + **Anna Szumowicz**, Scuola Normale Superiore di Pisa

May 6

Mathematical Conversations + *Discrepancy Theory and Randomized Controlled Trials* + **Daniel Spielman**, Yale University

May 7

Joint IAS/Princeton University Number Theory Seminar + *On Triple Product L Functions* + **Jayce Robert Getz**, Duke University

Seminar on Theoretical Machine Learning + *Learning Probability Distributions; What Can, What Can't Be Done* + **Shai Ben-David**, University of Waterloo

May 8

IAS/PU-Montreal-Tel-Aviv Symplectic Geometry Seminar + *Spectral Characterizations of Besse and Zoll Reeb Flows* + **Marco Mazzucchelli**, École normale supérieure de Lyon

May 11

Computer Science/Discrete Mathematics Seminar I + *Using Discrepancy Theory to Improve the Design of Randomized Controlled Trials* + **Daniel Spielman**, Yale University

May 12

Number Theory Working Group + *Homology Stability for Unitary Groups over S-Arithmetic Rings* + **Rohit Nagpal**, Member, School of Mathematics

Seminar on Theoretical Machine Learning + *Generative Modeling by Estimating Gradients of the Data Distribution* + **Stefano Ermon**, Stanford University

Analysis Seminar + *Quantitative Decompositions of Lipschitz Mappings* + **Guy C. David**, Ball State University

Computer Science/Discrete Mathematics Seminar II + *Convex Set Disjointness, Distributed Learning of Halfspaces, and Linear Programming* + **Shay Moran**, Google Brain; Visitor, School of Mathematics

May 13

Mathematical Conversations + *The Simplicity Conjecture* + **Daniel Cristofaro-Gardiner**, University of California, Santa Cruz; von Neumann Fellow, School of Mathematics

May 14

Joint IAS/Princeton University Number Theory Seminar + *A Geometric View on Iwasawa Theory* + **Mladen Dimitrov**, Université de Lille

Seminar on Theoretical Machine Learning + *Mathzero, the Classification Problem, and Set-Theoretic Type Theory* + **David McAllester**, Toyota Technological Institute at Chicago

May 15

IAS/PU-Montreal-Tel-Aviv Symplectic Geometry Seminar + *Reflections on Cylindrical Contact Homology* + **Jo Nelson**, Rice University

May 18

Computer Science/Discrete Mathematics Seminar I + *The Non-Stochastic Control Problem* + **Elad Hazan**, Princeton University

Analysis Seminar + *Square Function Estimate for the Cone in \mathbb{R}^3* + **Hong Wang**, Member, School of Mathematics

May 19

Number Theory Working Group + *Density of Arithmetic Representations of Function Fields* + **Hélène Esnault**, Freie Universität Berlin, Visiting Professor, School of Mathematics

Seminar on Theoretical Machine Learning + *Neural SDEs: Deep Generative Models in the Diffusion Limit* + **Maxim Raginsky**, University of Illinois Urbana-Champaign

May 20

Mathematical Conversations + *Conley's Fundamental Theorem of Dynamical Systems* + **Amie Wilkinson**, University of Chicago

May 21

Joint IAS/Princeton University Number Theory Seminar + *Iwasawa Theory and Bloch-Kato Conjecture for Unitary Groups* + **Xin Wan**, Chinese Academy of Sciences

Seminar on Theoretical Machine Learning + *Forecasting Epidemics and Pandemics* + **Roni Rosenfeld**, Carnegie Mellon University

May 22

IAS/PU-Montreal-Paris-Tel-Aviv Symplectic Geometry Zoominar + *Mirrors of Curves and Their Fukaya Categories* + **Denis Auroux**, Harvard University

May 25

Analysis Seminar + *An Application of Integers of the 12th Cyclotomic Field in the Theory of Phase Transitions* + **Alik Mazel**, AMC Health

May 26

Number Theory Working Group ♦ *Efficient Primality Tests* ♦ **Avi Wigderson**, Herbert H. Maass Professor, School of Mathematics

May 27

Mathematical Conversations ♦ *Emerging Symmetries in Statistical Physics Systems* ♦ **Hugo Duminil-Copin**, Université de Genève, Institut des Hautes Études Scientifiques

May 28

Joint IAS/Princeton University Number Theory Seminar ♦ *Joint Equidistribution of Adelic Torus Orbits and Families of Twisted L-Functions* ♦ **Farrell Brumley**, Université Sorbonne Paris Nord

May 29

IAS/PU-Montreal-Paris-Tel-Aviv Symplectic Geometry Zoominar ♦ *Duality for Rabinowitz-Floer Homology* ♦ **Alex Oancea**, Institut de Mathématiques de Jussieu-Paris Rive Gauche

June 1

Analysis Seminar ♦ *Winding for Wave Maps* ♦ **Max Engelstein**, University of Minnesota

June 2

Number Theory Working Group ♦ *The Kottwitz Counting Formula for Abelian Varieties* ♦ **Mark Goresky**, Visitor, School of Mathematics

June 3

Mathematical Conversations ♦ *Mathematics Formalization for Mathematicians* ♦ **Patrick Massot**, Université Paris-Sud

June 4

Joint IAS/Princeton University Number Theory Seminar ♦ *Dynamical Generalizations of the Prime Number Theorem and Disjointness of Additive and Multiplicative Actions* ♦ **Florian Richter**, Northwestern University

June 5

IAS/PU-Montreal-Paris-Tel-Aviv Symplectic Geometry Zoominar ♦ *Three Short Research Talks* ♦ **Morgan Weiler**, **Joé Brendel**, **Abror Pirnapasov**, University of California, Berkeley; University of Neuchâtel; Ruhr University Bochum

June 9

Number Theory Working Group ♦ *Motives* ♦ **Pierre Deligne**, Professor Emeritus, School of Mathematics

Seminar on Theoretical Machine Learning ♦ *What Do Our Models Learn?* ♦ **Aleksander Mądry**, Massachusetts Institute of Technology

June 11

Joint IAS/Princeton University Number Theory Seminar ♦ *New Constraints on the Galois Configurations of Algebraic Integers in the Complex Plane* ♦ **Vesselin Dimitrov**, University of Toronto

Seminar on Theoretical Machine Learning ♦ *On Langevin Dynamics in Machine Learning* ♦ **Michael I. Jordan**, University of California, Berkeley

June 12

IAS/PU-Montreal-Paris-Tel-Aviv Symplectic Geometry Zoominar ♦ *Floer Cohomology and Arc Spaces* ♦ **Mark McLean**, Stony Brook University

June 16

Number Theory Working Group ♦ *A Gentle Introduction to Anabelian Geometry* ♦ **Remy van Dobbén de Bruyn**, Princeton University; Veblen Research Instructor, School of Mathematics

Seminar on Theoretical Machine Learning ♦ *On Learning in the Presence of Biased Data and Strategic Behavior* ♦ **Avrim Blum**, Toyota Technological Institute at Chicago

June 17

Mathematical Conversations ♦ *Infinite Dimensional Hamiltonian Systems: When Hard Problems Become Harder* ♦ **Gigliola Staffilani**, Massachusetts Institute of Technology

June 18

Joint IAS/Princeton University Number Theory Seminar ♦ *Independence of l for Frobenius Conjugacy Classes Attached to Abelian Varieties* ♦ **Rong Zhou**, Imperial College London

Seminar on Theoretical Machine Learning ♦ *The Challenges of Model-Based Reinforcement Learning and How to Overcome Them* ♦ **Csaba Szepesvári**, University of Alberta

June 19

IAS/PU-Montreal-Paris-Tel-Aviv Symplectic Geometry Zoominar ♦ *Exotic Symplectomorphisms and Contact Circle Action* ♦ **Igor Uljarevic**, University of Belgrade

June 23

Seminar on Theoretical Machine Learning ♦ *Generalizable Adversarial Robustness to Unforeseen Attacks* ♦ **Soheil Feizi**, University of Maryland

June 24

Mathematical Conversations ♦ *Knot Concordance and 4-Manifolds* ♦ **Lisa Piccirillo**, Brandeis University, Massachusetts Institute of Technology

June 25

Seminar on Theoretical Machine Learning ♦ *Instance-Hiding Schemes for Private Distributed Learning* ♦ **Sanjeev Arora**, Princeton University; Distinguished Visiting Professor, School of Mathematics

June 26

IAS/PU-Montreal-Paris-Tel-Aviv Symplectic Geometry Zoominar ♦ *Distinguishing Monotone Lagrangians via Holomorphic Annuli* ♦ **Ailsa Keating**, University of Cambridge

School of Natural Sciences

ASTROPHYSICS ACTIVITIES

September 9

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch Discussion Colloquium ♦ *Reconstruction of Cosmological Fields in Forward Model Framework - Intensity Mapping & Galaxy Clustering* ♦ **Chirag Modi**, University of California, Berkeley

September 10

Institute for Advanced Study/Princeton University Joint Astrophysics Colloquium ♦ *Teasing Out the True Milky Way* ♦ **Alyssa Goodman**, Harvard-Smithsonian Center for Astrophysics

September 12

Astrophysics Informal Seminar ♦ *Electromagnetic Jets and the Black Hole Shadow* ♦ **Roger Blandford**, Kavli Institute for Particle Astrophysics and Cosmology, Stanford University

September 17

Institute for Advanced Study/Princeton University Joint Astrophysics Colloquium ♦ *The Galactic Center: A Laboratory for the Study of the Physics and Astrophysics of Supermassive Black Holes* ♦ **Tuan Do**, University of California, Los Angeles

September 19

Astrophysics Informal Seminar ♦ *Circumplanetary Disk Dynamics in the Isothermal and Adiabatic Limits* ♦ **Jeffrey Fung**, Member, School of Natural Sciences

September 24

Institute for Advanced Study/Princeton University Joint Astrophysics Colloquium ♦ *Breaking Through to the Other Side of Gravitational Waves* ♦ **Rana Adhikari**, California Institute of Technology

September 26

Astrophysics Informal Seminar ♦ *Optimization Ideas, Algorithms, Tools, and Some Astro-Related Examples* ♦ **Robert Vanderbei**, Princeton University; Member, School of Natural Sciences

October 1

Institute for Advanced Study/Princeton University Joint Astrophysics Colloquium ♦ *Finding Gravitational Waves from the Early Universe* ♦ **Eiichi Komatsu**, Max Planck Institute for Astrophysics

October 3

Astrophysics Informal Seminar + *Long-Period Eclipsing Systems from Kepler Data* + **Kento Masuda**, Member, School of Natural Sciences

October 8

Institute for Advanced Study/Princeton University Joint Astrophysics Colloquium + *Cosmic Collisions – Progress in Gravitational-Wave Astronomy* + **Patrick Brady**, University of Wisconsin-Milwaukee

October 10

Astrophysics Informal Seminar + *Universal Interferometric Signatures of a Black Hole's Photon Ring* + **Alex Lupsasca**, Harvard University

October 15

Institute for Advanced Study/Princeton University Joint Astrophysics Colloquium + *The Continuing Search for Planet Nine* + **Matthew Holman**, Harvard-Smithsonian Center for Astrophysics

October 17

Astrophysics Informal Seminar + *Mid-band Atomic Gravitational wave Interferometric Sensor (MAGIS)* + **Peter Graham**, Stanford University

October 21

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *Extreme Emission Line Galaxies (EELs) as a Platinum Redshift Sample for Galaxy Clustering Measurements with LSST* + **Adam Broussard**, Rutgers, The State University of New Jersey

October 22

Institute for Advanced Study/Princeton University Joint Astrophysics Colloquium + *Red Supergiants: New Perspectives on Dying Stars* + **Emily Levesque**, University of Washington

October 24

Astrophysics Informal Seminar + *Characterizing Star-Planet Systems with Precision Spectroscopy* + **Megan Bedell**, Flatiron Institute, Center for Computation Astrophysics

October 28

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *Mapping the Magnetic Interstellar Medium in Three Dimensions Over the Full Sky with Neutral Hydrogen* + **Susan Clark**, Member, School of Natural Sciences + *Decorrelation from the 3D ISM* + **Brandon Hensley**, Princeton University

October 31

Astrophysics Informal Seminar + *Solar Interiors, Helioseismology and Neutrinos* + **Aldo Serenelli**, Institute of Space Sciences, Spain

November 4

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *Neutrino Mass and Cosmic Flows* + **Hongming Zhu**, University of California, Berkeley + *Low- z BAO Cosmology with HIRAX* + **Benjamin Saliwanchik**, Yale University

November 5

Institute for Advanced Study/Princeton University Joint Astrophysics Colloquium + *Discovery Frontiers in the New Era of Time-Domain Multi-Messenger Astrophysics* + **Raffaella Margutti**, Northwestern University

November 7

Astrophysics Informal Seminar + *Addressing the Initial Patch Problem of Inflation* + **Leonardo Senatore**, Stanford University

November 12

Institute for Advanced Study/Princeton University Joint Astrophysics Colloquium + *CHIME: The Canadian Hydrogen Intensity Mapping Experiment* + **Kendrick Smith**, Perimeter Institute

November 14

Astrophysics Informal Seminar + *Star Cluster Populations: The Link Between Star Formation and Galaxy Formation* + **Michael Fall**, Space Telescope Science Institute

November 18

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *The Likelihood for Large-Scale Structure* + **Giovanni Cabass**, MPA + *Attractors, Bifurcations and Curvature in Multi-Field Inflation* + **Evangelos Sfakianakis**, Nikhef Amsterdam

November 19

Institute for Advanced Study/Princeton University Joint Astrophysics Colloquium + *Generation I Planets* + **Yanqin Wu**, University of Toronto

November 21

Astrophysics Informal Seminar + *Non-Gaussianity & the Spectral Tilt* + **Daniel Green**, University of California, San Diego

November 26

Institute for Advanced Study/Princeton University Joint Astrophysics Colloquium + *How Do You Solve a Problem Like (Photometric) Supernovae?* + **Renée Hložek**, University of Toronto

December 2

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *Analytic Covariance of the Redshift-Space Galaxy Power Spectrum* + **Digvijay Wadekar**, New York University + *Interpolating the Cosmological Structure Formation with Machine Learning* + **Yin Li**, Flatiron Institute, Center for Computational Astrophysics

December 3

Institute for Advanced Study/Princeton University Joint Astrophysics Colloquium + *Dynamics of Black Holes and Gravitational Waves* + **Hyung Mok Lee**, Korea Astronomy and Space Science Institute

December 5

Astrophysics Informal Seminar + *Studying the Magnetic Field of the Diffuse ISM in 3D* + **Gina Panopoulou**, California Institute of Technology

December 10

Institute for Advanced Study/Princeton University Joint Astrophysics Colloquium + *Surprising Impacts of Gravity Waves* + **Jim Fuller**, California Institute of Technology

December 12

Astrophysics Informal Seminar + *Probing Microphysics of the Hot Intracluster Medium* + **Irina Zhuravleva**, University of Chicago

December 16

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *CMB Lensing Tomography to $Z \sim 2$ with Galaxies from the unWISE Catalog* + **Alex Krolewski**, University of California, Berkeley + *New Statistical Descriptions for Non-Gaussian Cosmology* + **Erwan Allys**, École Normale Supérieure

January 30

Astrophysics Informal Seminar + *Quadruply Lensed Quasars, Extreme Deblending and LIGO-mass Primordial Black Holes* + **Paul Schechter**, Massachusetts Institute of Technology

February 6

Astrophysics Informal Seminar + *Imaging Black Holes: Beyond the Shadow* + **Jason Dexter**, University of Colorado Boulder

February 13

Astrophysics Informal Seminar + *Extracting Information from AGN Variability* + **Michael Vogeley**, Drexel University; Member, School of Natural Sciences

February 20

Astrophysics Informal Seminar + *When Stars Attack! Near-Earth Supernova Explosions Revealed by Deep-Ocean and Lunar Radioactivity* + **Brian Fields**, University of Illinois

February 27

Astrophysics Informal Seminar + *Exploring our Heliosphere from Inside-Out: Voyagers' Journey through the Solar Wind and Beyond* + **Jamie Rankin**, Princeton University; Princeton Plasma Physics Laboratory

March 2

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *Galaxy Correlation Function Estimators*

and Probabilistic Redshifts + **Humna Awan**, Rutgers, The State University of New Jersey + *Constraining Cosmology from Galaxy Surveys: Combining Full-Shape and BAO Analyses* + **Oliver Philcox**, Princeton University

March 5

Astrophysics Informal Seminar + *The Origin of Multiphase Galaxy Outflow* + **Evan Schneider**, Princeton University

March 12

Astrophysics Informal Seminar + *Black Hole Entropy and Quantum Information* + **Juan Maldacena**, Carl P. Feinberg Professor, School of Natural Sciences

March 16

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *Effects of Overlapping Sources in Cosmic Shear Statistical Noise* + **Javier Sánchez**, Fermilab

March 17

Astrophysics Informal Seminar + *Study of White Dwarfs and Black Holes Through Astrometric Microlensing* + **Kailash Sahu**, Space Telescope Science Institute

March 23

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *Early Dark Energy Does Not Restore Cosmological Concordance* + **Colin Hill**, Columbia University

March 30

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *Blinded Challenge for Precision Cosmology with Galaxy Surveys* + **Mikhail Ivanov**, New York University; **Marko Simonović**, CERN

April 6

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *Perfectly Parallel Cosmological Simulations Using Spatial Comoving Lagrangian Acceleration* + **Florent Leclercq**, Imperial College

April 13

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *Description of Galaxy Distribution on Large Scales Utilizing the Equivalence Principle* + **Zvonimir Vlah**, CERN

April 20

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *Dark Matter Waves* + **Lam Hui**, Columbia University

April 27

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *Intensity Mapping with CO and CII as Probes of Primordial Non-Gaussianity* + **Azadeh Moradinezhad**, University of Geneva

May 4

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *A New Halo Model Formalism for the Cosmic Infrared Background (CIB) and its Correlation with the thermal Sunyaev-Zel'dovich Effect (tSZ)* + **Abhishek Maniyar**, New York University

May 11

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *What Can the Frontiers of Clusters Teach Us About the Dark Sector?* + **Omar Contigiani**, Leiden University

May 18

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *Probing the Tensor Consistency Relation with the CMB Bispectrum* + **Adri Duivenvoorden**, Princeton University + *Predicting Electron Gas into Dark Matter-only Simulations* + **Leander Thiele**, Princeton University

June 1

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch + *FlowPM: Distributed TensorFlow Implementation of the Cosmological N-body Solver* + **Chirag Modi**, University of California, Berkeley

June 8

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch

June 15

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch

June 22

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch

June 29

Institute for Advanced Study/Princeton University Early Universe/Cosmology Lunch

HIGH ENERGY THEORY ACTIVITIES

September 11

Physics Group Meeting + *Introductory Group Meeting* + **Juan Maldacena**, Carl P. Feinberg Professor, School of Natural Sciences

September 16

High Energy Theory Seminar + *The Holographic Dual of Strongly-deformed $N=4$ SYM Theory* + **Amit Sever**, CERN

September 18

Physics Group Meeting + *A Brief Review of some work on BPS States, Wall-Crossing, Hyperkahler Geometry, Hitchin Systems, etc.* + **Greg Moore**, Rutgers University

September 25

Physics Group Meeting + *Cardy Formula and AdS Black Holes* + **Joonho Kim**, Member, School of Natural Sciences

September 27

High Energy Theory Seminar + *Aspects of Scattering Amplitudes and Moduli Space Localization* + **Sebastian Mizera**, Member, School of Natural Sciences

September 30

High Energy Theory Seminar + *General F-theory Models with $SU(3) \times SU(2) \times U(1) / Z_6$ Symmetry* + **Andrew Turner**, Massachusetts Institute of Technology

October 2

Physics Group Meeting + *Hawking Radiation at Strong Coupling: A Case for Braneworld Black Holes* + **Jorge Santos**, Junior Visiting Professor, School of Natural Sciences; University of Cambridge

October 9

Physics Group Meeting + *Black Hole Images and the Photon Ring* + **Daniel Kapeec**, Member, School of Natural Sciences

October 14

High Energy Theory Seminar + *Entanglement Wedge Reconstruction and the Information Paradox* + **Geoff Penington**, Stanford University

October 16

Physics Group Meeting + *Matrix Models and Minimal Liouville Gravity* + **Baurzhan Mukhametzhannov**, Member, School of Natural Sciences

October 23

Physics Group Meeting + *The Geroch Group* + **Robert Penna**, Member, School of Natural Sciences

October 25

High Energy Theory Seminar + *Correlation Functions in AdS3/CFT2* + **Lorenz Eberhardt**, Member, School of Natural Sciences

October 28

High Energy Theory Seminar + *Dynamical Constraints on RG Flows and Cosmology* + **Tom Hartman**, Cornell University

October 30

Physics Group Meeting + *Topological Holography* + **Nafiz Ishtiaque**, Member, School of Natural Sciences

November 1

High Energy Theory Seminar + *High-Energy Conformal Bootstrap and Tauberian Theory* + **Baurzhan Mukhametzhannov**, Member, School of Natural Sciences

November 6

Physics Group Meeting + *Disordered Electronic Systems: Some Illustrative Vignettes* + **Ravindra Bhatt**, Member, School of Natural Sciences; Princeton University

November 15

High Energy Theory Seminar + *Deforming Holomorphic Chern-Simons at Large N* + **Si Li**, Member, School of Natural Sciences; Tsinghua University

November 18

High Energy Theory Seminar + *TMF and SQFT* + **Theo Johnson-Freyd**, Perimeter Institute

November 20

Physics Group Meeting + *On a Quantum Penrose Inequality* + **Adam Levine**, Member, School of Natural Sciences

November 25

High Energy Theory Seminar + *Perspectives on the Generally-Relativistic Two-Body Problem from Double Copy & EFT* + **Radu Roiban**, Pennsylvania State University

December 2

High Energy Theory Seminar + *Lorentz Symmetry Fractionalizations and Dualities in $(2+1)d$* + **Po-Shen Hsin**, Caltech

December 3–4

Workshop on Qubits and Spacetime + *Complex SYK Model* + **Alexei Kitaev**, California Institute of Technology + *Hypergraphs as Applied to Quantum Information* + **Ning Bao**, Brookhaven National Lab/University of California, Berkeley + *A Canonical Purification for the Entanglement Wedge Cross-Section* + **Thomas Faulkner**, University of Illinois, Urbana-Champaign + *Black Hole Coarse Graining, Connes-Cocycle Flow and its Bulk Dual* + **Raphael Bousso**, University of California, Berkeley + *Replica Wormholes and the Black Hole Interior (Part I)* + **Douglas Stanford**, Stanford University + *Replica Wormholes and the Black Hole Interior (Part II)* + **Geoffrey Penington**, Stanford University + *Toy Models for Evaporating Black Hole* + **Xiaoliang Qi**, Stanford University + *Replica Wormholes and the Entropy of Hawking Radiation* + **Ahmed Almheiri**, Long-term Member, School of Natural Sciences + *Holographic Negativity* + **Xi Dong**, University of California, Santa Barbara + *The First Law of Complexity* + **Alice Bernamonti**, University of Florence + *Random Quantum Circuits, Phase Transitions and Complexity* + **Aram Harrow**, Massachusetts Institute of Technology + *Treelike Geometries and Fast Scrambling from Nonlocal Spin Models* + **Gregory Bentsen**, Princeton University + *Entanglement Wedge Reconstruction in Infinite-Dimensional Hilbert Spaces* + **Monica Jinwoo Kang**, California Institute of Technology + *Beyond the Ensemble: Return of the Baby Universes* + **Henry Maxfield**, University of California, Santa Barbara

December 11

Physics Group Meeting + *Towards Optimal Asymptotic Spectral Gap in 2D Unitary CFT* + **Sridip Pal**, Member, School of Natural Sciences

December 13

High Energy Theory Seminar + *Topological Quantum Phases* + **Alexei Kitaev**, Distinguished Visiting Professor, School of Natural Sciences; Caltech

February 3

High Energy Theory Seminar + *X-ray Search for Axions from Nearby Isolated Neutron Stars* + **Ben Safdi**, University of Michigan

February 10

High Energy Theory Seminar + *An Effective Field Theory of Quantum Black Hole Horizons* + **Walter Goldberger**, Yale University

February 14

High Energy Theory Seminar + *Reparametrization Modes in CFTs & Applications* + **Felix Haehl**, Member, School of Natural Sciences

February 24

High Energy Theory Seminar + *Conformal Fishnet Theory* + **Vladimir Kazakov**, Ecole Normale Supérieure

February 28

High Energy Theory Seminar + $\lambda\phi^4$ in dS + **Victor Gorbenko**, Member, School of Natural Sciences

March 16

High Energy Theory Seminar + *Covariant Phase Space with Boundaries* + **Daniel Harlow**, Massachusetts Institute of Technology

March 25

Physics Group Meeting + *Euclidean Wormholes* + **Juan Maldacena**, Carl P. Feinberg Professor, School of Natural Sciences

March 27

High Energy Theory Seminar + *Solving Random Matrix Models with Positivity* + **Henry Lin**, Princeton University

March 30

High Energy Theory Seminar + *Geometry and $5d N=1$ QFTs* + **Lakshya Bhardwaj**, Harvard University

April 1

Physics Group Meeting + *3d Ising Model and String Theory* + **Shota Komatsu**, Member, School of Natural Sciences

April 8

Physics Group Meeting + *A Nilpotency Index of Conformal Manifolds* + **Petr Kravchuk**, Member, School of Natural Sciences

April 15

Physics Group Meeting + *Pseudorandomness in Black Hole Evaporation* + **Edward Witten**, Charles Simonyi Professor, School of Natural Sciences

April 17

High Energy Theory Seminar + *A Tutorial on Entanglement Island Computations* + **Raghu Mahajan**, Member, School of Natural Sciences

April 22

Physics Group Meeting + *Continuum Quantum Field Theories for Fractons* + **Nathan Seiberg**, Professor, School of Natural Sciences

April 27

High Energy Theory Seminar + *Twisted M-theory and Holography* + **Davide Gaiotto**, Perimeter Institute

May 1

High Energy Theory Seminar + *A Quantum Circuit Interpretation of Evaporating Black Hole Geometry* + **Ying Zhao**, Member, School of Natural Sciences

May 6

Physics Group Meeting + *JT Gravity at Finite Cutoff* + **Luca Iliesiu**, Princeton University

May 13

Physics Group Meeting + *Divergences in String Perturbation Theory* + **Lorenz Eberhardt**, Member, School of Natural Sciences

May 15

High Energy Theory Seminar + *Entanglement Entropy in Flat Holography* + **Wei Song**, Member, School of Natural Sciences; Tsinghua University

May 20

Physics Group Meeting + *Matrix Ensembles with Global Symmetries and 't Hooft Anomalies from 2d Gauge Theory* + **Daniel Kapec**, Member, School of Natural Sciences

May 27

Physics Group Meeting + *Effective Field Theory of Dissipation in Hydrodynamics* + **Felix Haehl**, Member, School of Natural Sciences

June 3

Physics Group Meeting + *Asymptotic Symmetries in $(d+2)$ -dimensional Gauge Theories* + **Prahar Mitra**, Member, School of Natural Sciences

June 10

Physics Group Meeting + *Scrambling-Assisted Wormhole Teleportation Microscopies* + **Alexandre Streicher**, Member, School of Natural Sciences; Perimeter Institute for Theoretical Physics

June 24

Physics Group Meeting ♦ *Generalized Global Symmetries, the Weak Gravity Conjecture, and the Completeness Hypothesis* ♦ **Tom Rudelius**, Member, School of Natural Sciences

July 15

Physics Group Meeting ♦ *Rotations of an Axion Field in the Early Universe* ♦ **Keisuke Harigaya**, Member, School of Natural Sciences

July 20

High Energy Theory Seminar ♦ *Non-perturbative Studies of JT Gravity and Supergravity using Minimal Strings* ♦ **Clifford V. Johnson**, University of Southern California

July 22

Physics Group Meeting ♦ *Reconstructing the Black Hole Interior with Modular Flow* ♦ **Yiming Chen**, Princeton University

July 24

High Energy Theory Seminar ♦ *Many Body Scars as a Group Invariant Sector of Hilbert Space* ♦ **Kiryl Pakrouski**, Princeton University

August 10

High Energy Theory Seminar ♦ *Stellar Basins of Gravitationally Bound Particles* ♦ **Ken Van Tilburg**, KITP, University of California, Santa Barbara

August 17

High Energy Theory Seminar ♦ *Enhanced Corrections to the Page Curve near Holographic Entanglement Transitions* ♦ **Xi Dong**, University of California, Santa Barbara

August 24

High Energy Theory Seminar ♦ *An Update on Exact WKB and Supersymmetric Field Theory* ♦ **Andy Neitzke**, Yale University

August 28

High Energy Theory Seminar ♦ *Partition Functions of the Tensionless String* ♦ **Lorenz Eberhardt**, Member, School of Natural Sciences

THE SIMONS CENTER FOR SYSTEMS BIOLOGY ACTIVITIES

September 12–13

Arnie at 80! Birthday Celebration. Session I: Highlights from a Career at Four Institutions ♦ *Epigenetic Regulation in Development and Disease* ♦ **Rudolf Jaenisch**, Whitehead Institute ♦ *Human Satellite II RNA Supports the Replication of Human Cytomegalovirus* ♦ **Thomas Shenk**, Princeton University ♦ *Telomeres and Cancer* ♦ **Titia de Lange**, The Rockefeller University ♦ *Biology at the IAS – the Arnie Era* ♦ **Harlan Robins**, Adaptive Biotechnologies ♦ Session II: p53 ♦ *Functional States of p53: You Lose Some, You Gain Some* ♦ **Moshe Oren**, Weizmann Institute

of Science ♦ *Therapeutic Ablation of Gain-of-Function (GOF) Missense Mutant p53 Identifies it as Critical Anti-Tumor Target* ♦ **Ute Moll**, Renaissance School of Medicine ♦ *Regulating p53 activity: the Ups and Downs* ♦ **Guillermo Lozano**, MD Anderson Cancer Center ♦ Session III: Systems Biology at IAS ♦ *Li-Fraumeni Syndrome Tumorigenesis* ♦ **Chang Chan**, Rutgers Cancer Institute of New Jersey ♦ *Harnessing Immune Interactions to Predict Cancer Evolution* ♦ **Marta Luksza**, Mount Sinai ♦ *Stemness Genes in Prostate Cancer, a Systems Approach* ♦ **Elke Markert** ♦ Institute of Cancer Sciences, Glasgow University ♦ Session IV: Convergence Research ♦ *What is Not Self?* ♦ **Benjamin Greenbaum**, Mount Sinai ♦ *The Pandemic Arnie* ♦ **Raul Rabadan**, Columbia University ♦ *Duality of the T Cell Receptors* ♦ **Mickey Atwal**, Cold Spring Harbor Laboratory ♦ Session V: Cancer Research and the Future ♦ *The Effects of the EMT Program on Carcinoma Biology* ♦ **Robert Weinberg**, Whitehead Institute, MIT ♦ *Cancer Stem Cell Types and the Order of Mutations Impact the Age of Onset of Cancers* ♦ **Arnold J. Levine**, Professor Emeritus, School of Natural Sciences

November 19

Joshua Lederberg – John von Neumann Symposium: Towards Quantitative Biology (at The Rockefeller University) ♦ *Primary Productivity of the Planet* ♦ **Paul Falkowski**, Rutgers Energy Institute, Rutgers University ♦ *The Biomass Distribution on Earth* ♦ **Ron Milo**, Weizmann Institute of Science ♦ *Structure and Dynamics of Microbial Ecosystems in Sediment* ♦ **Alexander Petroff**, Clark University ♦ *Tigers in the 21st Century: Survival or Extinction?* ♦ **Uma Ramakrishnan**, National Centre for Biological Sciences; Wellcome Trust/DBT India Alliance ♦ *Biodiversity Change During the Anthropocene* ♦ **Mark Vellend**, Université de Sherbrooke

December 6

The Simons Center for Systems Biology Informal Talks on Abstract/Conceptual/Quantitative Aspects of Biology (Virtual Seminar) ♦ *Land, irrigation water, greenhouse gas, and reactive nitrogen burdens of meat, eggs, and dairy production in the United States* ♦ **Gidon Eshel**, Bard College

February 5

The Simons Center for Systems Biology Informal Talks on Abstract/Conceptual/Quantitative Aspects of Biology (Virtual Seminar) ♦ *Associative Memory of Structured Knowledge* ♦ **Julia Steinberg**, Harvard University

February 10

The Simons Center for Systems Biology Informal Talks on Abstract/Conceptual/Quantitative Aspects of Biology (Virtual Seminar) ♦ *Kinetic Uncertainty Relations for the Control of Stochastic Reaction Networks* ♦ **Jiawei Yan**, Harvard University

February 26

The Simons Center for Systems Biology Informal Talks on Abstract/Conceptual/Quantitative Aspects of Biology (Virtual Seminar) ♦ *Stochastic Dynamics Applied to Biological Systems* ♦ **Nicolas Lenner**, Max-Planck Institute for Dynamics and Self-Organization, Göttingen, Germany

March 4

The Simons Center for Systems Biology Informal Talks on Abstract/Conceptual/Quantitative Aspects of Biology (Virtual Seminar) ♦ *Mathematics of Small Neural Networks* ♦ **Carina Curto**, The Pennsylvania State University

March 23

The Simons Center for Systems Biology Informal Talks on Abstract/Conceptual/Quantitative Aspects of Biology (Virtual Seminar) ♦ *A Bottleneck Method of Extracting Relevant Information from Redundant Signals* ♦ **Naftali Tishby**, Hebrew University of Jerusalem

March 24

The Simons Center for Systems Biology Informal Talks on Abstract/Conceptual/Quantitative Aspects of Biology (Virtual Seminar) ♦ *A Bottleneck Method of Extracting Relevant Information from Redundant Signals* ♦ **Naftali Tishby**, Hebrew University of Jerusalem

March 25

The Simons Center for Systems Biology Informal Talks on Abstract/Conceptual/Quantitative Aspects of Biology (Virtual Seminar) ♦ *Collective Behavior of Bacteria and Robots in Complex and Dynamical Environments* ♦ **Trung Phan**, Princeton University

April 1

The Simons Center for Systems Biology Informal Talks on Abstract/Conceptual/Quantitative Aspects of Biology (Virtual Seminar) ♦ *Collective Behavior of Bacteria and Robots in Complex and Dynamical Environments* ♦ **Trung Phan**, Princeton University

April 8

The Simons Center for Systems Biology Informal Talks on Abstract/Conceptual/Quantitative Aspects of Biology (Virtual Seminar) ♦ *Detecting stimulus dimension, sequences, and topology of neural activity* ♦ **Vladimir Itskov**, The Pennsylvania State University

May 7

The Simons Center for Systems Biology Informal Talks on Abstract/Conceptual/Quantitative Aspects of Biology (Virtual Seminar) ♦ *Mathematical modeling of ageing and depression* ♦ **Omer Karin**, Weizmann Institute

June 18

Cancer Convergence Education Network (Virtual Conference). Progress in Immunotherapy + *A role and rationale for neoadjuvant immune checkpoint blockade in cancer therapy* + **Suzanne Topalian**, Johns Hopkins Medicine + *How does checkpoint blockade change the repertoire and genetic programming of neoantigen-specific T cells?* + **Drew Pardoll**, Johns Hopkins Medicine + *Immune Checkpoint Blockade in Cancer Therapy: New insights into therapeutic mechanisms* + **James Allison**, University of Texas, MD Anderson Cancer Center + *From the Clinic to the Lab: Investigating Mechanisms of Response and Resistance to Immune Checkpoint Therapy* + **Padmanee Sharma**, University of Texas, MD Anderson Cancer Center + *Decoding the cellular adaptive immune response to cancer* + **Harlan Robins**, Adaptive Biotechnologies

August 12

CCEN Virtual Meeting + *Using evolutionary theory to gain insights into clonal haematopoiesis and blood cancer risk* + **Jamie Blundell** + *Synonymous mutations reveal genome-wide driver mutation rates in healthy tissues* + **Gladys Poon** + *Pregnancy Specific Glycoproteins talk* + **Arnold J. Levine**, Professor Emeritus, School of Natural Sciences + *Description of New Convergence Teams Project* + **Arnold J. Levine**, Professor Emeritus, School of Natural Sciences

School of Social Science

September 20

Social Science Orientation Session

Social Science Welcome Party

September 23

Social Science Seminar + *Invoking Healing, or How to Think Therapeutically* + **Ed Cohen**, Rutgers, The State University of New Jersey; Member, School of Social Science

September 30

Social Science Seminar + *Hope for a Cure: AIDS Activists, Beautiful Lies, and the World's First "Edited" Children* + **Eben Kirksey**, Deakin University; Member, School of Social Science

October 2

Economy and Society Seminar + *Boom, Doom, Gloom* + Readings curated by **Benjamin Braun**, Max-Planck-Institut für Gesellschaftsforschung, and **Sarah Quinn**, University of Washington; Members, School of Social Science

Economy and Society Film Series + *The Big Short*, directed by Adam McKay; post-screening discussion led by **Benjamin Braun**, Max-Planck-Institut für Gesellschaftsforschung, and **Sarah Quinn**, University of Washington; Members, School of Social Science

October 7

Social Science Seminar + *Unpayable Debts, Emancipatory Debts. The Political and Moral Economies of Women's Debt and Women's Bodies* + **Isabelle Guérin**, Institut de Recherche pour le Développement, Paris; Member, School of Social Science

October 8

Credit and Finance Working Group

October 14

Social Science Seminar + *Of Other Brotherhoods: Mafia, Freemasons, and the Changing Criminalization of Ritual Relationships in Sicily* + **Naor H. Ben-Yehoyada**, Columbia University; Member, School of Social Science

October 16

Economy and Society Seminar + *From the Welfare State to the Debtfare State* + Readings curated by **Lena Lavinias**, Universidade Federal do Rio de Janeiro, and **Chloe Thurston**, Northwestern University; Members, School of Social Science

October 18

Guest Seminar United Nations Workshop + *Private Debt and Human Rights* + **Juan Pablo Bohoslavsky**, Office of the UN's High Commission on Human Rights

October 21

Social Science Seminar + *In the Margins of Medical Evidence: Expert Witnessing and State Violence in Turkey* + **Başak Can**, Koç Üniversitesi; Member, School of Social Science

October 28

Social Science Seminar + *Credit from the State, Credit to the State* + **Sarah Quinn**, University of Washington; Member, School of Social Science

Guest Seminar + *Rights, Reform, and Contestation: Land Dispossession, Gender, and Alternative Models for Justice* + **Souad Eddouada**, Ibn Toufail University, Morocco

October 30

Current Issues Seminar + **Başak Can**, Koç Üniversitesi, and **Latif Tas**, SOAS University of London; Members, School of Social Science

Economy and Society Seminar + *Resistance and Redemption: On Debt, Finance, and Mobilization* + Readings curated by **Benjamin Lemoine**, Université Paris-Dauphine, and **Z. Fareen Parvez**, University of Massachusetts, Amherst; Members, School of Social Science; screening of scenes from documentary film *Bricks*, directed by **Quentin Ravelli**; post-screening discussion led by **Quentin Ravelli**

November 2

Joint Workshop + *Gene Editing and Hope for an HIV Cure* + Organized by **Eben Kirksey**, Deakin University; Member, School of Social Science, and **Myles W. Jackson**, Professor, School of Historical Studies

November 4

Social Science Seminar + *Autochthony, Line Systems and State Building in Nigeria* + **Jeremiah O. Arowosegbe**, University of Ibadan; Member, School of Social Science

November 6–7

Workshop on Social and Ethical Challenges in Machine Learning + Organized by **Sanjeev Arora**, Princeton University; Distinguished Visiting Professor, School of Mathematics, **Didier Fassin**, James D. Wolfensohn Professor, School of Social Science, **Jacob Gates Foster**, University of California, Los Angeles, and **Marion Fourcade**, University of California, Berkeley; Visiting Professor, School of Social Science

November 6

Public Lecture + *Artificial Intelligence, Ethics, and Society: A Cross-Disciplinary Conversation* + **Pedro Domingos**, University of Washington, and **Mary Gray**, Microsoft and Harvard University; moderated by **Alondra Nelson**, Harold F. Linder Professor, School of Social Science

November 11

Social Science Seminar + *The Ethical Stance and the Possibility of Critique* + **Webb Keane**, University of Michigan, Ann Arbor; Member, School of Social Science

Credit and Finance Working Group + *A Political Anthropology of Finance: Studying the Distribution of Money in the Financial Industry as a Political Process* + **Horacio Ortiz**, East China Normal University; Member, School of Social Science

November 13

Economy and Society Seminar + *Reparative Justice as Historical Redress* + Readings curated by **Naor H. Ben-Yehoyada**, Columbia University, **Robert Karl**, Institute for Advanced Study, and **Latif Tas**, SOAS University of London; Members, School of Social Science

Economy and Society Film Series + *Valley of Saints*, directed by Musa Syeed; post-screening discussion led by **Z. Fareen Parvez**, University of Massachusetts, Amherst; Member, School of Social Science, and **Nafeesa Syeed**, Director's Visitor, Institute for Advanced Study

November 15–16

Crisis and Critique Workshop + Organized by **Axel Honneth**, Goethe-Universität Frankfurt and Columbia University, and **Didier Fassin**, James D. Wolfensohn Professor, School of Social Science

November 18

Social Science Seminar + *Reinventing Oneself during the Crisis. Autonomy and Dependencies between Conflict and Solidarity* + **Susana Narotzky**, Universitat de Barcelona; Member, School of Social Science

November 25

Social Science Seminar ♦ *Wealth Regimes: The Political Economy of Asset Management* ♦ **Benjamin Braun**, Max-Planck-Institut für Gesellschaftsforschung; Member, School of Social Science

November 26

Economy and Society Seminar ♦ *Framing Economic Lives* ♦ Readings curated by **Isabelle Guérin**, Institut de Recherche pour le Développement, Paris, **Susana Narotzky**, Universitat de Barcelona; and **Federico Neiburg**, Universidade Federal do Rio de Janeiro; Members, School of Social Science

December 2

Social Science Seminar ♦ *Market Logics, Minority Rights, and American Political Development* ♦ **Chloe Thurston**, Northwestern University; Member, School of Social Science

December 9

Social Science Seminar ♦ *The Crystalline Medium: Computation and Its Consequences* ♦ **Alexander R. Galloway**, New York University; Member, School of Social Science

December 10

Credit and Finance Working Group ♦ *The Missing Movement: Credit, Debt Relief, and the Limits of Anti-Discrimination Politics* ♦ **Chloe Thurston**, Northwestern University; Member, School of Social Science, **Emily Zackin**, Johns Hopkins University, and **Marion Fourcade**, University of California, Berkeley; Visiting Professor, School of Social Science

December 11

Economy and Society Seminar ♦ *Power of the Digital, Digital Powers* ♦ Readings curated by **Horacio Ortiz**, East China Normal University; Member, School of Social Science, and **Marion Fourcade**, University of California, Berkeley; Visiting Professor, School of Social Science

Economy and Society Film Series ♦ *Graduation*, directed by **Cristian Mungiu**; post-screening discussion led by **Naor H. Ben-Yehoyada**, Columbia University and **Virag Molnar**, The New School; Members, School of Social Science

December 16

Social Science Seminar ♦ *Class Trips Beyond Borders: State-Sponsored Heritage Tourism and Ethnic Nationalism* ♦ **Virag Molnar**, The New School; Member, School of Social Science

January 21

Social Science Seminar ♦ *What is Sudanese Political Economy?: Reflections on the Crises of the 1970s* ♦ **Alden H. Young**, University of California, Los Angeles; Member, School of Social Science

Credit and Finance Working Group ♦ *Searching Life in Economy and Ethnography* ♦ **Isabelle Guérin**, Institut de Recherche pour le

Développement, Paris, and **Federico Neiburg**, Universidade Federal do Rio de Janeiro; Members, School of Social Science

January 27

Social Science Seminar ♦ *The Carceral Colony: Prison before the Penitentiary in North America* ♦ **Wendy Warren**, Princeton University; Member, School of Social Science

January 29

Current Issues Seminar ♦ *Focus on Brazil* ♦ **Lena Lavinas** and **Federico Neiburg**, Universidade Federal do Rio de Janeiro; Members, School of Social Science

Economy and Society Seminar ♦ *Global Monetary Hierarchies* ♦ **Pierre-Olivier Gourinchas**, University of California, Berkeley; readings curated by **Benjamin Braun**, Max-Planck-Institut für Gesellschaftsforschung, **Horacio Ortiz**, East China Normal University, and **Alden H. Young**, University of California, Los Angeles; Members, School of Social Science

February 3

Social Science Seminar ♦ *Suspects' Appearance, Origin, and DNA in France. Elements for a Political Conception of Privacy* ♦ **Joëlle Vailly**, Centre National de la Recherche Scientifique, Paris; Member, School of Social Science

February 10

Social Science Seminar ♦ *#Help: The Digital Transformation of Humanitarianism and the Governance of Populations* ♦ **Fleur Johns**, University of New South Wales, Sydney; Member, School of Social Science

February 11

Credit and Finance Working Group ♦ *Sex Debt: Coerced Bodies, Desiring Bodies in Rural South India* ♦ **Isabelle Guérin**, Institut de Recherche pour le Développement, Paris; Member, School of Social Science

February 12

Economy and Society Seminar ♦ *Temporalities of Economy and Society* ♦ readings curated by **Herbert Docena**, University of the Philippines Diliman, **Fleur Johns**, University of New South Wales, Sydney, and **Virag Molnar**, The New School; Members, School of Social Science

Economy and Society Film Series ♦ *People's Republic of Desire*, directed by **Hao Wu**; post-screening discussion led by **Horacio Ortiz**, East China Normal University; Member, School of Social Science, and **Julia Chuang**, Boston College; Visitor, School of Social Science

February 18

Social Science Seminar ♦ *The Rise of Venture Capital, the Return of Inequality, and the Demise of Innovation in the United States, 1936–1982* ♦ **Julia Ott**, The New School; Member, School of Social Science

February 24

Social Science Seminar ♦ *Gate of Tears: Migration and Impasse in Yemen and the Horn of Africa* ♦ **Nathalie M. Peutz**, New York University Abu Dhabi; Member, School of Social Science

February 26

Current Issues Seminar ♦ *Focus on Sudan* ♦ **Alden H. Young**, University of California, Los Angeles; Member, School of Social Science

Economy and Society Seminar ♦ *Money, Circuits, and Social Relations* ♦ **Viviana Zelizer**, Princeton University; readings curated by **Marion Fourcade**, University of California, Berkeley; Visiting Professor, School of Social Science, **Federico Neiburg**, Universidade Federal do Rio de Janeiro; Member, School of Social Science, and **Frederick F. Wherry**, Princeton University; Visitor, School of Social Science

March 2

Social Science Seminar ♦ *Ordinal Citizenship* ♦ **Marion Fourcade**, University of California, Berkeley; Visiting Professor, School of Social Science

March 4–5

Workshop on Machine Learning, Theory, and Method in the Social Sciences ♦ Organized by **Sanjeev Arora**, Princeton University; Distinguished Visiting Professor, School of Mathematics, **Didier Fassin**, James D. Wolfensohn Professor, School of Social Science, **Jacob Gates Foster**, University of California, Los Angeles, and **Marion Fourcade**, University of California, Berkeley; Visiting Professor, School of Social Science

March 4

Public Lecture ♦ *Re-Imagining the Social Sciences in the Age of AI: A Cross-Disciplinary Conversation* ♦ **Elizabeth Bruch**, University of Michigan, and **Thomas Griffiths**, Princeton University; moderated by **Jacob Gates Foster**, University of California, Los Angeles

March 9

Social Science Seminar ♦ *The Debt Economy in Urban India* ♦ **Z. Fareen Parvez**, University of Massachusetts, Amherst; Member, School of Social Science

March 11

Economy and Society Seminar ♦ *International Migrations, Gender and Economy* ♦ **Anne-Claire Defosse**, Institute for Advanced Study and **Ravi Kanbur**, Cornell University; Visitors, School of Social Science, and **Didier Fassin**, James D. Wolfensohn Professor, School of Social Science

From this point on, the seminars took place online with virtual participation via Zoom.

March 25

Economy and Society Seminar ♦ *Religion and Moral Economy* ♦ Readings curated by **Webb Keane**, University of Michigan, Ann Arbor and **Nathalie M. Peutz**, New York University Abu Dhabi; Members, School of Social Science, and **Justin Stearns**, New York University Abu Dhabi; Member, School of Historical Studies

March 30

Social Science Seminar ♦ *Parallel State and Governmentality: Kurdish Response to Authoritarianism* ♦ **Latif Tas**, SOAS University of London; Member, School of Social Science

March 31

Credit and Finance Working Group ♦ Discussion of readings by **Benjamin Lemoine**, Université Paris-Dauphine; Member, School of Social Science

April 6

Social Science Seminar ♦ *The Digitalization of Money in China* ♦ **Horacio Ortiz**, East China Normal University; Member, School of Social Science

April 13

Social Science Seminar ♦ *From Rights to Entitlements to Assets: The Warring of Welfare Regimes* ♦ **Lena Lavinas**, Universidade Federal do Rio de Janeiro; Member, School of Social Science

April 7

Credit and Finance Working Group

April 20

Social Science Seminar ♦ *Embedded (and dis-embedded) Sovereignty. Government Debt, New York Law and Financial Order* ♦ **Benjamin Lemoine**, Université Paris-Dauphine; Member, School of Social Science

April 22

Social Science Seminar ♦ *Writing History from Colombia's Alcatraz* ♦ **Robert Karl**, Institute for Advanced Study; Member, School of Social Science

April 22

Economy, Society and Covid-19: Collective Project around the Pandemic ♦ Planning Meeting

April 27

Social Science Seminar ♦ *Life, Economy and Economic Emergencies* ♦ **Federico Neiburg**, Universidade Federal do Rio de Janeiro; Member, School of Social Science

May 4

Social Science Seminar ♦ *Sexual Violence and the State: A Racial History of Legal Castration in North America* ♦ **Greta LaFleur**, Yale University; Member, School of Social Science

May 5

Credit and Finance Working Group

May 11

Social Science Seminar ♦ *'We are not beggars': Recognition, Resentment, and the Rise of 'Market-based' Global Environmental Regulation* ♦ **Herbert Docena**, University of the Philippines Diliman; Member, School of Social Science

Economy and Society Seminar ♦ *Race and Capitalism* ♦ **Michael C. Dawson**, University of Chicago, and **Megan Ming Francis**, University of Washington

May 12

Credit and Finance Working Group

May 13

Social Science Seminar ♦ *The New Technocrats: Science and Ethics in the Obama Administration* ♦ **Alondra Nelson**, Harold F. Linder Professor, School of Social Science

May 18

Social Science Seminar ♦ *Beveridgean Unemployment Gap* ♦ **Pascal Michailat**, Brown University; Member, School of Social Science

May 19

Credit and Finance Working Group

June 2

Credit and Finance Working Group

Director's Office Events

September 23

Member Welcome Reception

September 28

Member Family Barbeque

October 4

Edward T. Cone Concert Series ♦ **Meredith Monk and Company**

October 5

Edward T. Cone Concert Series and Talk ♦ **Meredith Monk and Company**

October 11

Friends Dinner with a Member ♦ *The Story of Trigonometry: Revolutions in the Heavens, and on Earth* ♦ **Glen Van Brummelen**, Quest University Canada; Member, School of Historical Studies

October 19

Family Science Talk ♦ *Einstein's Dream* ♦ **Robbert Dijkgraaf**, IAS Director and Leon Levy Professor

October 20

Princeton Symphony Orchestra Chamber Series ♦ *Music for Oboe and Strings*

October 25

Public Lecture ♦ *Primes and Knots* ♦ **Akshay Venkatesh**, Robert and Luisa Fernholz Professor, School of Mathematics

October 31

Institute Community Halloween Party

November 1

Friends Talk ♦ *Black Metaphors: How Modern Racism Emerged from Medieval Race-Thinking—and Why It Matters* ♦ **Cord Whitaker**, Wellesley College; Member, School of Historical Studies

November 15

Edward T. Cone Concert Series ♦ **Conrad Tao**

November 16

Edward T. Cone Concert Series and Talk ♦ **Conrad Tao**

November 20

S.T. Lee Public Lecture ♦ *Architecture in Two Dimensions: The Case for and Against Drawing* ♦ **Alina Payne**, Harvard University

November 21

Friends Circle Dinner ♦ *Spolia* ♦ **Nora Okka**, Director's Visitor

November 22

Friends Lunch with a Member ♦ *The Road to Gödel's Incompleteness Theorems* ♦ **Juliette Kennedy**, University of Helsinki; Visitor, School of Historical Studies

November 24

Princeton Symphony Orchestra Chamber Series ♦ *Marc Uys and Friends*

December 4

Friends Public Lecture ♦ *What Is the Value of the Humanities? How We Read (and Write) Today* ♦ **Suzanne Conklin Akbari**, Professor, School of Historical Studies

December 13

Institute Community Reception Celebrating Freeman J. Dyson's 96th Birthday

December 19

Institute Community Holiday Party

January 17

Friends Lunch with a Member ♦ *Credit from the State, Credit to the State* ♦ **Sarah Quinn**, University of Washington; Member, School of Social Science

January 29

Friends Talk ♦ *Eliot and Women* ♦ **Lyndall Gordon**

January 31

Edward T. Cone Concert Series ♦ **Vicki Ray and Flux Quartet**

February 1

Edward T. Cone Concert Series and Talk ♦ **Vicki Ray and Flux Quartet**

February 5

Impact of the Past Lecture ♦ *Anti-Semitism—Past and Present* ♦ **Karina Urbach**, Visitor, School of Historical Studies; **Daniel Finkelstein**; **Julie Gottlieb**, University of Sheffield; **Deborah Lipstadt**, Emory University

February 19

Institute Community Reception Celebrating Enrico Bombieri's Crafoord Prize

February 21

Friends Lunch with a Member ♦ *A Tale of Two Camps: Yemeni Refugees and Ethiopian Migrants in the Horn of Africa* ♦ **Nathalie Peutz**, New York University Abu Dhabi; Member, School of Social Science

February 22

Midwinter Party for Faculty, Members, and Staff

February 28

Artist-in-Residence Special Presentation ♦ *Farmhouse/Whorehouse: an Artist Lecture* by **Suzanne Bocanegra** Starring **Lili Taylor** ♦ **Suzanne Bocanegra**; **Lili Taylor**

March 6

Friends Dinner with a Member ♦ *Global Hunger/Scientific Solutions? A "Universal" Solution to End World Hunger* ♦ **Gabriela Soto Laveaga**, Member, School of Historical Studies

Events after March 6 were conducted remotely.

May 8

Friends Lunch with a Member ♦ *Math, Shadows, and Digital Sundials* ♦ **Silvia Ghinassi**, Member, School of Mathematics

May 15

Friends Lunch with a Member ♦ *Will I Have to Mortgage My House? Reflections on Gene Therapy, Innovation, and Inequality* ♦ **Eben Kirksey**, Deakin University; Member, School of Social Science

May 22

Friends Lunch with a Member ♦ *Victorian Fiction and the Location of Experience* ♦ **Adela Pinch**, University of Michigan; Visitor, School of Social Science

May 29

Friends Lunch with a Member ♦ *Sudan in a Time of Revolution* ♦ **Alden H. Young**, University of California, Los Angeles; Member, School of Social Science

July 16

Friends Talk ♦ *Atomic Spy: The Dark Lives of Klaus Fuchs* ♦ **Nancy Greenspan**

Digital Scholarship@IAS

November 21

Digital Scholarship Conversations ♦ *A Digital Information System for the History of Astral Sciences (DISHAS): Why, and How?* ♦ **Matthieu Husson**, Observatoire de Paris, Université PSL

December 18

Digital Scholarship Conversations ♦ *Egyptology in the Digital Age* ♦ **Verena Lepper**, Princeton University

February 27

Digital Scholarship Conversations ♦ *The Aramaic Online Project—methods and challenges in creating a Neo-Aramaic literary language* ♦ **Shabo Talay**, Freie Universität Berlin

ACKNOWLEDGMENTS

(for the year ended June 30, 2020)

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Left: Professor SUZANNE AKBARI's first IAS public lecture, titled "What Is the Value of the Humanities? How We Read (and Write) Today," was sponsored by the Friends of the Institute for Advanced Study. Center: The Anti-Matters, captained by Professor MYLES W. JACKSON, squared off against Winning is Relative for the second annual Thanksgiving flag football game. Right: While the coronavirus pandemic forestalled in-person events programming, current and former scholars presented virtual talks on topics ranging from computation and black holes, to the evolution of viruses, to racism and democracy.

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Institute for Advanced Study—
Louis Bamberger and Mrs. Felix Fuld Foundation

Financial Statements
June 30, 2020 and 2019

(With Independent Auditors' Report Thereon)

Independent Auditors' Report

The Board of Trustees

Institute for Advanced Study—Louis Bamberger and Mrs. Felix Fuld Foundation:

We have audited the accompanying financial statements of the Institute for Advanced Study—Louis Bamberger and Mrs. Felix Fuld Foundation, which comprise the statements of financial position as of June 30, 2020 and 2019, and the related statements of activities and cash flows for the years then ended, and the related notes to the financial statements.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation and fair presentation of these financial statements in accordance with U.S. generally accepted accounting principles; this includes the design, implementation, and maintenance of internal control relevant to the preparation and fair presentation of financial statements that are free from material misstatement, whether due to fraud or error.

Auditors' Responsibility

Our responsibility is to express an opinion on these financial statements based on our audits. We conducted our audits in accordance with auditing standards generally accepted in the United States of America. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditors' judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the entity's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. Accordingly, we express no such opinion. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of significant accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion, the financial statements referred to above present fairly, in all material respects, the financial position of the Institute for Advanced Study—Louis Bamberger and Mrs. Felix Fuld Foundation as of June 30, 2020 and 2019, and the changes in its net assets and its cash flows for the years then ended, in accordance with U.S. generally accepted accounting principles.

KPMG LLP

October 30, 2020

STATEMENTS OF FINANCIAL POSITION
JUNE 30, 2020 AND 2019

Assets	2020	2019
Cash and cash equivalents	\$ 3,814,747	5,129,094
Accounts receivable and other assets	3,933,664	2,958,222
Grants receivable	2,050,628	2,406,574
Contributions receivable, net	7,612,551	15,951,133
Mortgages receivable	5,244,841	5,806,101
Funds held by bond trustee	886,567	872,355
Beneficial interest in remainder trust	—	1,968
Land, buildings and improvements, equipment, and rare book collection, net	134,365,491	130,257,646
Investments	806,966,477	790,125,348
Total assets	\$ 964,874,966	953,508,441
Liabilities and Net Assets		
Liabilities:		
Accounts payable and accrued expenses	\$ 10,880,698	9,433,853
Deferred revenue	10,330,177	7,353,781
Liabilities under split-interest agreements	1,333,720	1,516,049
Postretirement benefit obligation	24,618,666	19,584,782
Asset retirement obligation	1,198,947	1,172,363
Bond swap liability	3,323,339	2,788,944
Long-term debt, net	83,825,749	88,020,789
Total liabilities	135,511,296	129,870,561
Net assets:		
Net assets without donor restrictions:		
Undesignated	210,745,901	223,454,839
Designated for specific purposes	133,883,663	132,573,325
Total net assets without donor restrictions	344,629,564	356,028,164
Net assets with donor restrictions:		
Purpose restricted	225,473,040	208,663,563
Endowment fund corpus	259,261,066	258,946,153
Total net assets with donor restrictions	484,734,106	467,609,716
Total net assets	829,363,670	823,637,880
Total liabilities and net assets	\$ 964,874,966	953,508,441

See accompanying notes to financial statements.

STATEMENT OF ACTIVITIES
YEAR ENDED JUNE 30, 2020

	Without donor restrictions	With donor restrictions	Total
Operating revenues, gains, and other support:			
Private contributions and grants	\$ 52,000	25,804,143	25,856,143
Government grants	—	5,237,232	5,237,232
Investment income, net	19,932,768	24,119,369	44,052,137
Auxiliary activity	3,986,852	—	3,986,852
Net assets released from restrictions— satisfaction of program restrictions	38,036,354	(38,036,354)	—
Total operating revenues, gains, and other support	62,007,974	17,124,390	79,132,364
Operating expenses:			
School of Mathematics	11,411,097	—	11,411,097
School of Natural Sciences	12,672,231	—	12,672,231
School of Historical Studies	9,432,277	—	9,432,277
School of Social Science	3,975,617	—	3,975,617
Libraries and other academic	4,550,307	—	4,550,307
Administration and general	16,993,017	—	16,993,017
Auxiliary activity	10,082,297	—	10,082,297
Total operating expenses	69,116,843	—	69,116,843
Change in net assets from operating activities	(7,108,869)	17,124,390	10,015,521
Nonoperating activities:			
Change in fair value of bond swap liability	(534,395)	—	(534,395)
Gain on sale of plant assets	326,989	—	326,989
Other components of net periodic pension cost	(4,082,325)	—	(4,082,325)
Total nonoperating activities	(4,289,731)	—	(4,289,731)
Change in net assets	(11,398,600)	17,124,390	5,725,790
Net assets—beginning of year	356,028,164	467,609,716	823,637,880
Net assets—end of year	\$ 344,629,564	484,734,106	829,363,670

See accompanying notes to financial statements.

STATEMENT OF ACTIVITIES
YEAR ENDED JUNE 30, 2019

	Without donor restrictions	With donor restrictions	Total
Operating revenues, gains, and other support:			
Private contributions and grants	\$ 52,000	19,897,538	19,949,538
Government grants	—	6,563,183	6,563,183
Investment income, net	14,644,933	17,452,485	32,097,418
Auxiliary activity	4,402,459	—	4,402,459
Net assets released from restrictions— satisfaction of program restrictions	43,213,445	(43,213,445)	—
Total operating revenues, gains, and other support	62,312,837	699,761	63,012,598
Operating expenses:			
School of Mathematics	11,266,618	—	11,266,618
School of Natural Sciences	12,163,326	—	12,163,326
School of Historical Studies	9,787,655	—	9,787,655
School of Social Science	3,703,414	—	3,703,414
Libraries and other academic	6,241,792	—	6,241,792
Administration and general	18,591,030	—	18,591,030
Auxiliary activity	10,696,058	—	10,696,058
Total operating expenses	72,449,893	—	72,449,893
Change in net assets from operating activities	(10,137,056)	699,761	(9,437,295)
Nonoperating activities:			
Change in fair value of bond swap liability	(472,494)	—	(472,494)
Gain on sale of plant assets	(259,957)	—	(259,957)
Other components of net periodic pension cost	(475,595)	—	(475,595)
Total nonoperating activities	(1,208,046)	—	(1,208,046)
Change in net assets	(11,345,102)	699,761	(10,645,341)
Net assets—beginning of year	367,373,266	466,909,955	834,283,221
Net assets—end of year	\$ 356,028,164	467,609,716	823,637,880

See accompanying notes to financial statements.

STATEMENTS OF CASH FLOWS
YEARS ENDED JUNE 30, 2020 AND 2019

	2020	2019
Cash flows from operating activities:		
Change in net assets	\$ 5,725,790	(10,645,341)
Adjustments to reconcile change in net assets to net cash used in operating activities:		
Depreciation	6,955,181	6,528,737
Contributions restricted for endowment and plant	(6,458,360)	(11,281,481)
Net appreciation on investments	(46,980,004)	(34,259,323)
Change in fair value of bond swap liability	534,395	472,494
Gain on sale of plant assets	(326,989)	(259,957)
Amortization of debt issuance costs	58,034	62,253
Amortization of bond discount	21,926	23,861
Changes in assets/liabilities:		
Receivables and other assets	(58,236)	(213,704)
Contributions receivable	8,338,582	8,155,060
Beneficial interest in remainder trust	1,968	1,064,498
Accounts payable and accrued expenses	1,446,845	(1,515,336)
Deferred revenue	2,976,396	(2,169,207)
Postretirement benefit obligation	5,033,884	1,275,830
Asset retirement obligation	26,584	30,327
Net cash used in operating activities	(22,704,004)	(42,731,289)
Cash flows from investing activities:		
Proceeds from sale of plant assets	1,489,392	973,386
Purchase of plant assets	(12,225,429)	(15,329,104)
Proceeds from sale of investments	292,127,469	258,562,949
Purchase of investments	(261,988,594)	(205,246,160)
Net cash provided by investing activities	19,402,838	38,961,071
Cash flows from financing activities:		
Contributions restricted for endowment and plant	6,458,360	11,281,481
Decrease in liabilities under split-interest agreements	(182,329)	(303,893)
Principal payments on long-term debt	(4,275,000)	(4,105,000)
Net cash provided by financing activities	2,001,031	6,872,588
Net (decrease) increase in cash, cash equivalents and restricted cash	(1,300,135)	3,102,370
Cash, cash equivalents and restricted cash—beginning of year	6,001,449	2,899,079
Cash, cash equivalents and restricted cash—end of year	\$ 4,701,314	6,001,449
Supplemental data:		
Interest paid	\$ 3,073,691	3,271,097
Reconciliation of total cash, cash equivalents and restricted cash reported within the statements of financial position that sum to the total of the same such amounts shown above:		
Cash and cash equivalents	\$ 3,814,747	5,129,094
Funds held by bond trustee	886,567	872,355
Total cash, cash equivalents and restricted cash shown above	\$ 4,701,314	6,001,449

See accompanying notes to financial statements.

NOTES TO FINANCIAL STATEMENTS
JUNE 30, 2020 AND 2019

(1) **Organization and Summary of Significant Accounting Policies**

(a) ***Organization***

The Institute for Advanced Study—Louis Bamberger and Mrs. Felix Fuld Foundation (the Institute), an independent, private institution devoted to the encouragement, support, and patronage of learning, was founded in 1930 as a community of scholars where intellectual inquiry could be carried out in the most favorable circumstances.

Focused on mathematics and classical studies at the outset, the Institute today consists of the School of Historical Studies, the School of Mathematics, the School of Natural Sciences, and the School of Social Science. Each school has a small permanent faculty, and some 190 fellowships are awarded annually to members visiting the Institute from other research institutions and universities throughout the world.

The Founders' original letter to the first trustees described the objectives of the Institute as follows: "The primary purpose is the pursuit of advanced learning and exploration in fields of pure science and high scholarship to the utmost degree that the facilities of the institution and the ability of the faculty and students will permit."

(b) ***Summary of Significant Accounting Policies***

Basis of Presentation

The accompanying financial statements, which are presented on the accrual basis of accounting, have been prepared to focus on the Institute as a whole and to present net assets and revenues, expenses, gains, and losses based on the existence or absence of donor-imposed restrictions. Accordingly, net assets and changes therein are classified as follows:

- **Without Donor Restrictions**—Net assets not subject to donor-imposed stipulations. Net assets without donor restrictions may be designated for specific purposes by action of the Board of Trustees.
- **With Donor Restrictions**—Net assets subject to donor-imposed restrictions that will be met either by actions of the Institute or the passage of time. Also included in this category are net assets subject to donor-imposed restrictions to be maintained permanently by the Institute, including gifts and pledges wherein donors stipulate that the corpus of the gift be held in perpetuity and that only the income be made available for specific purposes. Other restricted items in this net asset category include annuity and life income gifts for which the ultimate purpose of the proceeds is subject to donor-imposed restrictions.

Revenues are reported as increases in net assets without donor restrictions unless use of the related asset is limited by donor-imposed restrictions. Expenses are reported as decreases in net assets without donor restrictions. Expiration of donor-imposed restrictions that simultaneously increase net assets without donor restrictions and decrease net assets with donor restrictions are reported as net assets released from restrictions.

In the statements of activities, the Institute includes in operations all revenue and expenses that are an integral part of its program and supporting activities. Change in the fair value of bond swap liability, gain on sale of plant assets and other components of net periodic pension cost are recognized as nonoperating activities.

(i) ***Cash and Cash Equivalents***

Cash and cash equivalents consist of cash on hand and all highly liquid investments with an original maturity of three months or less, except for those managed as a component of the Institute's investment portfolio.

(ii) ***Mortgages Receivable***

The Institute regularly offers first mortgages on primary residences to full-time faculty and senior administrative employees who have met certain requirements stipulated by the Board of Trustees.

(iii) ***Investments***

Investments in marketable securities are reported in the financial statements at fair value based on published market quotations. Investments in limited partnerships and hedge funds are reported in the financial statements at estimated fair value using net asset value (NAV) or its equivalent as a practical expedient, based upon values provided by external investment managers or general partners, unless it is probable that all or a portion of the investment will be sold for an amount different from NAV. The Institute reviews and evaluates the

values provided by external investment managers and general partners and agrees with the valuation methods and assumptions used in determining the fair value of funds. These estimated fair values may differ significantly from the values that would have been used had a ready market for these securities existed. As of June 30, 2020 and 2019, the Institute had no plans or intentions to sell investments at amounts different from NAV.

The statements of activities recognize unrealized gains and losses on investments as increases and decreases, respectively, in net assets without donor restrictions unless their use restricted by explicit donor stipulation or law. Gains and losses on the sale of investment securities are calculated using the specific-identification method.

(iv) Fair Value Measurements

Fair value is defined as the exchange price that would be received for an asset or paid to transfer a liability (an exit price) in the principal or most advantageous market for the asset or liability in an orderly transaction between market participants on the measurement date. The fair value hierarchy requires an entity to maximize the use of observable inputs and minimize the use of unobservable inputs when measuring fair value. A financial instrument's level within the fair value hierarchy is based on the lowest level of any input that is significant to the fair value measurement. The three levels of inputs used to measure fair value are as follows:

- Level 1: Quoted prices in active markets for identical assets or liabilities
- Level 2: Observable inputs other than Level 1 prices, such as quoted prices for similar assets or liabilities, quoted prices in markets that are not active, or other inputs that are observable or can be corroborated by observable market data for substantially the full term of the assets or liabilities
- Level 3: Unobservable inputs that are supported by little or no market activity and that are significant to the fair value of the asset or liabilities.

Fair value estimates are made at a specific point in time based on available market information and judgments about the financial asset, including estimates of timing, amount of expected future cash flows, and the credit standing of the issuer. In some cases, the fair value estimates cannot be substantiated by comparison to independent markets. In addition, the disclosed fair value may not be realized in the immediate settlement of the financial asset and does not reflect any premium or discount that could result from offering for sale at one time an entire holding of a particular financial asset. Potential taxes and other expenses that would be incurred in an actual sale or settlement are not reflected in amounts disclosed.

NAV is used as a practical expedient for certain commingled funds, privately held investments, and securities held in partnership format for which a readily determinable fair value is not available, unless the Institute believes such NAV calculation is not measured in accordance with fair value.

These values may differ significantly from values that would have been used had a readily available market existed for such investments, and that difference could be material to the change in net assets of the Institute.

(v) Plant Assets and Depreciation

Proceeds from the sale of plant assets, if there are no donor-imposed restrictions, are transferred to operating funds or, if subject to donor-imposed restrictions, to amounts with donor restrictions for plant acquisitions. Depreciation is provided over the estimated useful lives of the respective assets on a straight-line basis (buildings and capital improvements 20–40 years, equipment 3–6 years).

(vi) Split-Interest Agreements

The Institute is the beneficiary of various unitrusts, a pooled income fund, and a gift annuity fund. The Institute's interest in these split-interest agreements is reported as a contribution in the year received and is calculated as the difference between the fair value of the assets contributed to the Institute and the estimated liability to the beneficiary. This liability is computed using actuarially determined rates and is adjusted annually to reflect changes in the life expectancy of the donor or annuitant, amortization of the discount, and other changes in the estimates of future payments. The assets held by the Institute under these arrangements are recorded at fair value as determined by quoted market prices and are included as a component of investments.

(vii) Unamortized Debt Issuance Costs

Debt issuance costs represent costs incurred in connection with debt financing. Amortization of these costs is provided on the effective interest method extending over the remaining term of the applicable indebtedness.

(viii) *Asset Retirement Obligation*

The Institute recognizes the fair value of a liability for legal obligations associated with asset retirements in the period in which the obligation is incurred if a reasonable estimate of the fair value of the obligation can be made. When the liability is initially recorded, the Institute capitalizes the cost of the asset retirement obligation by increasing the carrying amount of the related long-lived asset. The liability is accreted to its present value each period and the capitalized cost associated with the retirement obligation is depreciated over the useful life of the related asset. Upon settlement of the obligation, any difference between the cost to settle the asset retirement obligation and the liability recorded is recognized as a gain or loss in the statements of activities.

(ix) *Contributions*

Contributions, including unconditional promises to give, are recognized initially at fair value as revenues in the period received. Conditional promises to give are not recognized until they become unconditional, that is when the conditions on which they depend are met. Contributions of assets other than cash are recorded at their estimated fair value. Pledges of contributions to be received after one year are discounted at a risk-adjusted discount rate. The discount rates range from 0.16% to 1.94%. Amortization of discount is recorded as additional contribution revenue in accordance with donor-imposed restrictions, if any, on the contributions. The inputs to the fair value estimate are considered Level 3 in the fair value hierarchy.

Contributions of long-lived assets are reported as unconditional contribution revenue. Contributions restricted for the acquisition of grounds, buildings, and equipment are reported as revenue with donor restrictions. These contributions are reclassified to net assets without donor restrictions when the associated long-lived asset is placed in service.

Included in contributions are gifts from members of the Board of Trustees which are received in the normal course of business.

(x) *Grants*

The Institute receives grants from a number of sources including corporations, foundations and governmental agencies. Grants are evaluated as to whether they qualify as contributions or exchange transactions as defined by U.S. GAAP and to determine if there are any donor restrictions.

Based on the Institute's review of grants received, the granting agency does not receive commensurate value for the grant and therefore grant income is considered a voluntary, nonreciprocal transaction that meets the definition of a contribution. Each grant also has one or more barriers, which must be overcome which therefore categorize them as conditional contributions for the Institute. Grant revenue with donor imposed conditions is recorded initially as deferred revenue (if the funds are received in advance) and is reported as revenue as the conditions are satisfied. At the same time, the Institute records net assets released from restrictions to match the expenses incurred in satisfying the donor restrictions.

(xi) *Auxiliary Activity*

The Institute receives income and incurs expenses relating to the operations of a dining services facility and a housing complex on campus for the use by our community of scholars. The income and expenses are displayed on the statement of activities as Auxiliary Activity.

The revenue streams include income from the sale of food and beverages, rental income, laundry income and pet registration fees. These revenue streams, except for rental income, are recognized at the point in time in which the service is provided. Rental income is recognized over a period of time since the tenants are simultaneously receiving and consuming the benefit of the service provided. Auxiliary income is recognized in the fiscal year in which the service is delivered.

(xii) *Functional Allocation of Expenses*

The costs of providing program services and support services of the Institute have been summarized on a functional basis in the statements of activities. These costs include direct and indirect costs that have been allocated, on a consistent basis, among the programs and administrative expenses. Natural expenses are accounted for on a direct cost basis to the school or department upon which the expenses are incurred.

There are certain indirect costs that cannot be charged on a direct basis. The Institute allocates these costs (academic building expenses including costs to maintain the academic buildings, interest and depreciation) to the schools and supporting departments reported in the accompanying statement of activities on a square footage basis. Note 10 shows the relationship between the functional and natural classifications of expenses.

Fundraising expenses incurred by the Institute amounted to \$2,265,661 and \$3,131,077 for the years ended June 30, 2020 and 2019, respectively. This amount is included in administration and general expenses in the accompanying statements of activities.

(xiii) Tax Status

The Institute is exempt from federal income taxes pursuant to Section 501(c)(3) of the Internal Revenue Code (the Code) and is listed in the Internal Revenue Service Publication 78. The Institute has been classified as a public charity under Section 509(a) of the Code.

There are certain transactions that could be deemed unrelated business income and would result in a tax liability. Management reviews transactions to estimate potential tax liabilities using a threshold of more likely than not. It is management's estimation that there are no material tax liabilities that need to be recorded.

(xiv) Use of Estimates

The preparation of financial statements in conformity with U.S. generally accepted accounting principles requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the financial statements. Estimates also affect the reported amounts of revenues and expenses during the reported period. Actual results could differ from those estimates.

(xv) New Accounting Standards Adopted

In fiscal year 2020, the Institute adopted the provisions of the applicable Accounting Standards Updates (ASU), as follows:

ASU 2016-15, *Statement of Cash Flows (Topic 230): Classification of Certain Cash Receipts and Cash Payments*, which changes how not-for-profit entities report specific cash flow issues. The significant requirements of the ASU relate to (1) debt prepayment or extinguishment costs, (2) proceeds from the settlement of insurance claims, and (3) distributions received from equity method investees. The Institute performed an analysis of the provisions of the ASU and concluded that the adoption of this ASU did not significantly impact the Institute's financial statements.

ASU 2016-18, *Statement of Cash Flows: Restricted Cash*, which requires that the statement of cash flows explains the change in the total of cash, cash equivalents and amounts generally described as restricted cash or restricted cash equivalents for the fiscal year. The Institute applied these changes to the cash flow retrospectively.

(xvi) Reclassifications

Certain reclassifications have been made to prior year amounts to conform with the current year presentation and as a result of the adoption of the new accounting standards.

(xvii) Future Accounting Standards

The Financial Accounting Standards Board (FASB) issued ASU 2016-02, *Leases (Topic 842)*, which requires all lessees to recognize all leases, including operating leases, on-balance sheet via a right of use asset and lease liability, unless the lease is a short term lease. The Institute is currently evaluating the impact of this ASU and plans to adopt ASU 2016-02 for the year ending June 30, 2021.

The FASB issued ASU 2018-13, *Fair Value Measurement Disclosure Framework—Changes to the Disclosure Requirements for Fair Value Measurement (Topic 820)*, which eliminate, modify and add additional disclosure requirements on fair value measurements. The two main amendments of future ASU include (1) removal of the requirement to report the amount and reason for transfer between Level 1 and Level 2 investments, and (2) remove the requirement to disclose the valuation process for Level 3 fair value measurements. The Institute is currently evaluating the impact of this ASU and plans to adopt ASU 2018-13 for the year ending June 30, 2021.

The FASB issued ASU 2018-14, *Compensation—Retirement Benefits—Defined Benefit Plans—General, Disclosure Framework—Changes to the Disclosure Requirements for Defined Benefit Plans (Subtopic 715-20)*, which modifies the disclosure requirements for employers that sponsor defined benefit pension and/or other postretirement benefit plans. The ASU eliminates requirements for certain disclosures that are no longer considered cost beneficial, requires new disclosures that the FASB considers pertinent and clarifies certain disclosure requirements. The Institute is currently evaluating the impact of this ASU and plans to adopt ASU 2018-14 for the year ending June 30, 2021.

(2) Contributions Receivable

Contributions receivable at June 30, 2020 and 2019 were as follows:

	2020	2019
Amounts expected to be collected:		
Less than one year	\$ 3,050,000	5,450,000
One to five years	4,650,000	11,719,901
	7,700,000	17,169,901
Discount for present value (0.16%–1.94%)	(87,449)	(1,218,768)
Total	\$ 7,612,551	15,951,133

At June 30, 2020, 97% of gross contributions receivable and 7% of contributions revenue are from one donor. At June 30, 2019, 97% of gross contributions receivable and 21% of contributions revenue are from four donors.

During fiscal year 2011, the Institute received two conditional pledges totaling \$100 million to enhance the Institute's endowment fund. The pledges were conditioned on the Institute raising an additional \$100 million in cash or pledges from third-party donors in the period January 1, 2011 through June 30, 2015, which have been met. The conditional pledge payments began in June 2011 and the last payment was received in the fiscal year ended June 30, 2020. As of June 30, 2020 and 2019, the Institute has recorded revenue totaling approximately \$100.5 million relating to these conditional pledges.

(3) Liquidity and Availability of Resources

Resources available to the Institute to fund general expenditures have seasonal variations during the year attributable to a concentration of contributions received at calendar and fiscal year-end and transfers from the endowment. The Institute actively manages its resources to align its cash inflows with anticipated outflows, including approving the endowment draw rate in accordance with policies approved by its Board of Trustees. As further described in note 8, the Institute has lines of credit which may be drawn on, if needed, to manage cash flows.

Financial assets and liquidity resources available within one year for general expenditures, such as operating expenses, scheduled principal and interest payments on debt, and capital constructions costs not financed with debt, at June 30, 2020 and 2019 were as follows:

	2020	2019
Financial assets:		
Cash and cash equivalents	\$ 3,814,747	5,129,094
Accounts receivable due less than 1 year	311,883	69,949
Mortgage receivable due less than 1 year	280,982	561,260
Contributions receivable due less than 1 year, net	3,050,000	5,450,000
Endowment appropriated for expenditure—operations	44,643,800	47,557,100
Total financial assets available within one year	52,101,412	58,767,403
Liquidity resources:		
Lines of credit	50,000,000	50,000,000
Total financial assets and liquidity resources available within one year	\$ 102,101,412	108,767,403

(4) Investments, Funds Held by Bond Trustee, and Beneficial Interest in Remainder Trust

(a) Overall Investment Objective

The overall investment objective of the Institute is to invest its assets in a prudent manner that will achieve a long-term rate of return sufficient to fund a portion of its annual operating activities and capital preservation. The Institute diversifies its investments among various managers and investment opportunities. Substantially all of the investments are pooled with each individual fund subscribing to or disposing of units on the basis of the market value per unit,

determined on a quarterly basis. Major investment decisions are authorized by the Board's Investment Committee, which oversees the Institute's investment program in accordance with established guidelines.

(b) Allocation of Investment Strategies

The Institute may hold shares or units in traditional institutional funds, traditional stocks and fixed-income securities, as well as in alternative investment funds involving hedged strategies, private equity, and real asset strategies. Hedged strategies involve funds whose managers have the authority to invest in various asset classes at their discretion, including the ability to invest long and short. Funds with hedged strategies generally hold securities or other financial instruments for which a ready market exists and may include stocks, bonds, put or call options, swaps, currency hedges, and other instruments and are valued accordingly. Private equity funds employ buyout and venture capital strategies and focus on investments in turn-around situations. Real asset funds generally hold interests in public real estate investment trusts or commercial real estate through sole-member entities. Private equity and real asset strategies therefore often require the estimation of fair values by the fund managers in the absence of readily determinable market values. Because of the inherent uncertainties of valuation, these estimated fair values may differ significantly from values that would have been used had a ready market existed, and the differences could be material. Such valuations are determined by fund managers and generally consider variables such as operating results, comparable earnings multiples, projected cash flows, recent sales prices, and other pertinent information and may reflect discounts for the illiquid nature of certain investments held.

The following tables summarize the Institute's investments and other assets at fair value by major category in the fair value hierarchy as of June 30, 2020 and 2019, as well as related strategy, liquidity, and funding commitments:

		2020				
		Total	Level 1	Level 2	Level 3	Investment at NAV
Investments:						
Hedge funds—onshore:						
Emerging markets	\$	469,055	—	—	—	469,055
Multiple strategies		45,665,352	—	—	—	45,665,352
Hedge funds—offshore:						
Structured credit		12,497,447	—	—	—	12,497,447
Distressed/high-yield		881,523	—	—	—	881,523
Emerging markets		4,392	—	—	—	4,392
Equities—long bias		46,341,332	—	—	—	46,341,332
Equities—long/short		29,101,146	—	—	—	29,101,146
Fixed income arbitrage		15,981,337	—	—	—	15,981,337
Multiple strategies		158,723,859	—	—	—	158,723,859
Quantitative/CTA		66,419,641	—	—	—	66,419,641
Insurance		38,516,308	—	—	—	38,516,308
Bio tech/healthcare		18,938,505	—	—	—	18,938,505
Discretionary macro		12,835,007	—	—	—	12,835,007
Energy trading		43,988	—	—	—	43,988
Total		446,418,892	—	—	—	446,418,892
Limited partnerships		252,517,353	—	—	—	252,517,353
Exchange-traded funds		6,168,474	6,168,474	—	—	—
Cash equivalents		98,473,417	98,473,417	—	—	—
Other investments:						
Assets held under split-interest agreements:						
Cash equivalents		118,700	118,700	—	—	—
Fixed income securities		3,269,641	—	—	3,269,641	—
Total investments	\$	806,966,477	104,760,591	—	3,269,641	698,936,245
Other assets:						
Funds held by bond trustee:						
Cash equivalents	\$	886,567	—	886,567	—	—
Total other assets	\$	886,567	—	886,567	—	—

2019					
	Total	Level 1	Level 2	Level 3	Investment at NAV
Investments:					
Hedge funds—onshore:					
Emerging markets	\$ 494,770	—	—	—	494,770
Multiple strategies	45,728,879	—	—	—	45,728,879
Hedge funds—offshore:					
Structured credit	16,218,967	—	—	—	16,218,967
Distressed/high-yield	990,139	—	—	—	990,139
Emerging markets	10,934	—	—	—	10,934
Equities—long bias	17,934,730	—	—	—	17,934,730
Equities—long/short	31,279,081	—	—	—	31,279,081
Fixed income arbitrage	25,040,305	—	—	—	25,040,305
Multiple strategies	194,744,214	—	—	—	194,744,214
Quantitative/CTA	70,983,674	—	—	—	70,983,674
Insurance	35,780,986	—	—	—	35,780,986
Bio tech/healthcare	32,841,186	—	—	—	32,841,186
Discretionary macro	16,280,036	—	—	—	16,280,036
Energy trading	152,313	—	—	—	152,313
Total	488,480,214	—	—	—	488,480,214
Limited partnerships	216,388,962	—	—	—	216,388,962
Exchange-traded funds	9,882,000	9,882,000	—	—	—
Cash equivalents	71,685,551	71,685,551	—	—	—
Other investments:					
Assets held under					
split-interest agreements:					
Cash equivalents	55,761	55,761	—	—	—
Fixed income securities	3,632,860	—	—	3,632,860	—
Total investments	\$ 790,125,348	81,623,312	—	3,632,860	704,869,176
Other assets:					
Beneficial interest in					
remainder trust	\$ 1,968	1,968	—	—	—
Funds held by bond trustee:					
Cash equivalents	872,355	—	872,355	—	—
Total other assets	\$ 874,323	1,968	872,355	—	—

The following tables present the Institute's activities for the years ended June 30, 2020 and 2019 for investments classified in Level 3:

2020	
Assets held under	
split-interest	
agreement	
Fixed income	
securities	
Level 3 roll forward	
Fair value at June 30, 2019	\$ 3,632,860
Dispositions	(254,046)
Net appreciation (realized and unrealized)	(109,173)
Fair value at June 30, 2020	\$ 3,269,641

2019			
Level 3 roll forward	Assets held under split-interest agreement	Beneficial interest in	Total
	Fixed income securities	remainder trust	
Fair value at June 30, 2018	\$ 3,797,307	1,066,466	4,863,773
Dispositions	(267,729)	(1,025,173)	(1,292,902)
Net appreciation (realized and unrealized)	103,282	(41,293)	61,989
Fair value at June 30, 2019	\$ 3,632,860	—	3,632,860

The Institute's accounting policy is to recognize transfers between levels of the fair value hierarchy on the date of the event or change in circumstances that caused the transfer. There were no transfers between investments classified as Level 1 and Level 2 for the years ended June 30, 2020 or 2019. For the year ended June 30, 2019, the beneficial interest in remainder trust investment transferred out of Level 3 and into Level 1. There were no transfers in or out of investments classified as Level 3 for the years ended June 30, 2020 and 2019.

Private equity and venture capital investments are generally made through limited partnerships. Under the terms of such agreements, the Institute may be required to provide additional funding when capital or liquidity calls are made by fund managers. These partnerships have a limited existence, and they may provide for annual extensions for the purpose of disposing portfolio positions and returning capital to investors. However, depending on market conditions, the inability to execute the fund's strategy or other factors, a manager may extend the terms of a fund beyond its originally anticipated existence or may wind the fund down prematurely. The Institute cannot anticipate such changes because they generally arise from unforeseeable events, but should they occur, they could reduce liquidity or originally anticipated investment returns. Accordingly, the timing and amount of future capital or liquidity calls in any particular future year are uncertain. As of June 30, 2020, the Institute is obligated under certain limited partnership agreements to advance additional funding in the amount of \$111,426,871, which is anticipated to be called over the next 10 years.

Investment liquidity as of June 30, 2020 is aggregated below based on redemption or sale period:

	Investment fair values
Investment redemption or sale period:	
Daily	\$ 104,641,890
Monthly	78,428,577
Quarterly	100,869,322
Semiannually	44,613,763
Annually	64,310,253
Subject to rolling lock ups or other restrictions	147,224,982
Illiquid	266,877,690
Total as of June 30, 2020	\$ 806,966,477

(c) *Funds Held by Bond Trustee*

Funds held by bond trustee represent funds held for debt service payments to be made for the various bond indentures. These funds are being held in trust by U.S. Bank.

(d) *Redemption Restrictions—Hedge Funds*

At June 30, 2020, the Institute had hedge fund investments of approximately \$446,419,000, of which approximately \$95,504,900 was restricted from redemption for lock-up periods. At June 30, 2019, the Institute had hedge fund investments of approximately \$488,480,000, of which approximately \$67,692,000 was restricted from redemption for lock-up periods. Some of the investments with redemption restrictions allow early redemption for specified fees.

The terms and conditions upon which an investor may redeem an investment vary, usually with the majority requiring 30 to 180 days' notice after the initial lock-up period.

The expirations of redemption lock-up periods are summarized in the table below:

	<u>Amount</u>
Fiscal year:	
2021	\$ 19,562,100
2022	26,995,600
2023 and thereafter	<u>48,947,200</u>
Total	<u>\$ 95,504,900</u>

(e) ***Redemption Restrictions—Limited Partnerships***

At June 30, 2020 and 2019, the Institute had limited partnership investments of approximately \$252,517,200 and \$216,389,000, respectively, which were restricted from redemption for lock-up periods. Some of the investments with redemption restrictions allow early redemption for specified fees. The terms and conditions upon which an investor may redeem an investment vary, usually with the majority requiring 30 to 180 days' notice after the initial lock-up period.

The expirations of redemption lock-up periods are summarized in the table below:

	<u>Amount</u>
Fiscal year:	
2021	\$ 26,616,300
2022	32,594,700
2023	8,052,000
2024	15,209,100
2025	38,717,600
2026 and thereafter	<u>131,327,500</u>
Total	<u>\$ 252,517,200</u>

(5) **Investment Return and Endowment Spending Policy**

Investment return consists of interest, dividends, and realized and unrealized gains and losses on investments. Each year, the Institute includes a portion of its endowment return in its operating budget, with the amount of such planned support determined using its spending policy. The policy of the Institute is to distribute for current spending a percentage of the fair value of pooled investments, which is determined by the Board of Trustees annually. The budgeted spending rate for operating and capital purposes was 6.64% and 6.84% for 2020 and 2019, respectively. The actual spending rate for operating and capital purposes was 5.97% and 5.96% for 2020 and 2019, respectively.

The following tables summarize the investment return and its classification in the statements of activities for the years ended June 30, 2020 and 2019:

	<u>2020</u>		
	<u>Without donor restrictions</u>	<u>With donor restrictions</u>	<u>Total</u>
Investment income, net of investment expenses	\$ (901,203)	(2,026,664)	(2,927,867)
Net appreciation (realized and unrealized)	<u>20,833,971</u>	<u>26,146,033</u>	<u>46,980,004</u>
	<u>\$ 19,932,768</u>	<u>24,119,369</u>	<u>44,052,137</u>

2019			
	Without donor restrictions	With donor restrictions	Total
Investment income, net of investment expenses	\$ (791,049)	(1,370,856)	(2,161,905)
Net appreciation (realized and unrealized)	15,435,982	18,823,341	34,259,323
	<u>\$ 14,644,933</u>	<u>17,452,485</u>	<u>32,097,418</u>

(6) Endowment

The Institute's endowment consists of approximately 120 individual funds established for a variety of purposes including both donor-restricted endowment funds and funds designated by the Board of Trustees to function as endowments. Net assets associated with endowments, including funds designated by the Board of Trustees to function as endowments, are classified and reported based on the existence or absence of donor-imposed restrictions.

(a) Interpretation of Relevant Law

The Institute has interpreted the New Jersey-enacted version of the Uniform Prudent Management of Institutional Funds Act (UPMIFA) as allowing the Institute to appropriate for expenditure or accumulate so much of a donor-restricted endowment fund as the Institute determines is prudent for the uses, benefits, purposes, and duration for which the endowment fund is established, subject to the intent of the donor as expressed in the gift instrument. Unless stated otherwise in the gift instrument, the assets in a donor-restricted endowment fund are donor-restricted assets until appropriated for expenditure by the Board of Trustees of the Institute. As a result of applicable accounting guidance, the Institute classifies as net assets with donor restrictions (a) the original value of gifts donated to the permanent endowment, (b) the original value of subsequent gifts to the permanent endowment, and (c) the accumulations to the permanent endowment made in accordance with the direction of the applicable donor gift instrument at the time the accumulation is added to the fund. The remaining portion of the donor-restricted endowment fund that is not classified as endowment fund corpus within the net assets with donor restrictions is classified as net assets with donor purpose restrictions until those amounts are appropriated for expenditure in a manner consistent with the standard of prudence prescribed by UPMIFA.

From time to time, the fair value of assets associated with individual donor-restricted endowments may fall below the original corpus the fund included in net assets with donor restrictions due to unfavorable market fluctuations subsequent to the investment of the gift. Under the provisions of UPMIFA, spending from such endowment funds with deficiencies would be permitted. Deficiencies of this nature, which are reported in net assets with donor restrictions, totaled approximately \$2,127,800 and \$2,086,000 at June 30, 2020 and 2019, respectively. Subsequent gains that restore the fair value of the assets of the donor-purpose restricted endowment fund are classified as an increase in net assets with donor restrictions.

Below is a schedule which represents the composition of the Institute's endowment funds and funds designated by the Board of Trustees to function as endowments by type of fund as of June 30, 2020 and 2019:

2020				
	Without donor restrictions	With donor restrictions		Total
		Original gift	Accumulated gains	
Undesignated	\$ 195,167,670	—	—	195,167,670
Specific purpose designated funds	133,883,663	—	—	133,883,663
Donor—purpose restricted funds	—	28,936,721	167,170,268	196,106,989
Endowment fund corpus	—	259,261,066	—	259,261,066
	<u>\$ 329,051,333</u>	<u>288,197,787</u>	<u>167,170,268</u>	<u>784,419,388</u>

		2019			
		Without donor restrictions	With donor restrictions		
			Original gift	Accumulated gains	Total
Undesignated	\$	207,880,560	—	—	207,880,560
Specific purpose designated funds		132,573,325	—	—	132,573,325
Donor—purpose restricted funds		—	10,836,804	166,145,736	176,982,540
Endowment fund corpus		—	258,946,153	—	258,946,153
	\$	340,453,885	269,782,957	166,145,736	776,382,578

Changes in the Institute's endowment funds and funds designated by the Board of Trustees to function as endowments for the fiscal years ended June 30, 2020 and 2019 were as follows:

		Without	With donor restrictions		Total
		donor restrictions	Original gift	Accumulated gains	
Net assets, June 30, 2018	\$	352,072,272	261,973,214	171,021,471	785,066,957
Investment returns:					
Investment income, net		(1,075,587)	—	(1,343,894)	(2,419,481)
Net appreciation (realized and unrealized)		<u>15,435,982</u>	<u>—</u>	<u>18,842,518</u>	<u>34,278,500</u>
Total investment return		14,360,395	—	17,498,624	31,859,019
Contributions		52,000	7,809,743	—	7,861,743
Appropriation for expenditure— operations		<u>(26,030,782)</u>	<u>—</u>	<u>(22,374,359)</u>	<u>(48,405,141)</u>
Net assets, June 30, 2019		<u>340,453,885</u>	<u>269,782,957</u>	<u>166,145,736</u>	<u>776,382,578</u>
Investment returns:					
Investment income, net		(1,559,997)	—	(2,015,900)	(3,575,897)
Net appreciation (realized and unrealized)		<u>20,833,971</u>	<u>—</u>	<u>26,255,188</u>	<u>47,089,159</u>
Total investment return		19,273,974	—	24,239,288	43,513,262
Contributions		52,000	18,414,830	—	18,466,830
Appropriation for expenditure— operations		<u>(30,728,526)</u>	<u>—</u>	<u>(23,214,756)</u>	<u>(53,943,282)</u>
Net assets, June 30, 2020	\$	<u>329,051,333</u>	<u>288,197,787</u>	<u>167,170,268</u>	<u>784,419,388</u>

(b) Funds with Deficiencies

From time to time, the fair value of assets associated with individual donor restricted “true” endowment funds may fall below the level of the donor or UPMIFA requires to be retained as a fund of perpetual duration. Deficiencies of this nature are reported in net assets with donor restrictions. As of June 30, 2020, eight funds with an original gift of \$3,137,675 were “underwater” by \$2,127,812. As of June 30, 2019, seven funds with an original gift of \$3,087,675 were “underwater” by \$2,086,798.

(c) *Return Objectives and Risk Parameters*

The Institute has adopted investment and spending policies for endowment assets that attempt to provide a predictable stream of funding to programs supported by its endowment while seeking to maintain the purchasing power of the endowment assets.

(d) *Strategies Employed for Achieving Objectives*

The Institute manages its investments in accordance with a total return concept and the goal of maximizing returns within acceptable levels of risk. The Institute relies on a total return strategy in which investment returns are achieved through both capital appreciation (realized and unrealized) and current yield (dividends and interest). The Institute's spending policy is designed to provide a stable level of financial support and to preserve the real value of its endowment.

(7) **Physical Plant**

Physical plant and equipment are stated at cost at date of acquisition, less accumulated depreciation.

A summary of plant assets at June 30, 2020 and 2019 is as follows:

	2020	2019
Land	\$ 373,738	373,738
Land improvements	3,041,804	3,013,115
Buildings and improvements	197,630,912	188,798,187
Equipment	39,804,806	38,261,197
Rare book collection	203,508	203,508
Joint ownership property	5,361,177	5,131,177
	246,415,945	235,780,922
Accumulated depreciation	(112,050,454)	(105,523,276)
Net book value	\$ 134,365,491	130,257,646

(8) **Long-term Debt**

A summary of long-term debt at June 30, 2020 and 2019 is as follows:

	2020	2019
2006 Series B—NJEFA	\$ 17,800,000	19,500,000
2006 Series C—NJEFA	13,700,000	14,300,000
2008 Series C—NJEFA	725,000	1,420,000
2012 Taxable	14,495,000	14,915,000
2015 Taxable	14,030,000	14,355,000
2017 Taxable	23,960,000	24,495,000
Long-term debt	84,710,000	88,985,000
Less:		
Unamortized bond discount	(252,189)	(274,115)
Unamortized debt issuance costs	(632,062)	(690,096)
Total long-term debt	\$ 83,825,749	88,020,789

Interest expense on long-term debt for the years ended June 30, 2020 and 2019 was \$3,011,400 and \$3,207,818, respectively.

(a) *2006 Series B*

In July 2006, the Institute received proceeds of the New Jersey Educational Facilities Authority (the Authority) offering of \$29,600,000 Revenue Bonds, 2006 Series B of the Institute for Advanced Study Issue. The 2006 Series B Bonds were issued to finance the advance refunding of the outstanding 1997 Series G Bonds, the partial advance refunding of the 2001 Series A Bonds, and to pay a portion of certain costs incidental to the sale and issuance of the 2006 Series B Bonds.

(b) 2006 Series C

In March 2007, the Institute received proceeds of the Authority offering of \$20,000,000 Revenue Bonds, 2006 Series C of the Institute for Advanced Study Issue. Proceeds are being used to finance the costs of construction, renovating, and equipping certain educational facilities of the Institute to fund capitalized interest on the 2006 Series C Bonds during the renovation and construction and to pay certain costs incidental to the sale and issuance of the 2006 Series C Bonds.

(c) 2008 Series C

In March 2008, the Institute received proceeds of the Authority offering of \$11,255,000 Revenue Bonds, 2008 Series C of the Institute for Advanced Study Issue. The 2008 Series C Bonds were issued to finance the advance refunding of outstanding 1997 Series F Bonds, the advance refunding of outstanding 1997 Series G, and to pay a portion of certain costs incidental to the sale and issuance of the 2008 Series C Bonds.

(d) 2012 Taxable

In December 2012, the Institute received proceeds of \$17,320,000 Taxable Bonds, 2012 Series of the Institute for Advanced Study Issue, which were issued at a discount of approximately \$92,000. The 2012 Taxable Bonds were used to finance the advance refunding of outstanding 2001 Series A Bonds, to fund renovations to the Members Housing facility and the costs of renovation and equipping certain educational facilities of the Institute and to pay certain costs incidental to the sale and issuance of the 2012 Taxable Bonds.

(e) 2015 Taxable

In November 2015, the Institute received proceeds of \$15,300,000 Taxable Bonds, 2015 Series of the Institute for Advanced Study Issue, which were issued at a discount of approximately \$80,000. The 2015 Taxable Bonds were used to fund capital projects at the Institute and for other corporate purposes of the Institute and to pay certain costs incidental to the sale and issuance of the 2015 Taxable Bonds.

(f) 2017 Taxable

In November 2017, the Institute received proceeds of \$25,000,000 Taxable Bonds, 2017 Series of the Institute for Advanced Study Issue, which were issued at a discount of approximately \$84,000. The 2017 Taxable Bonds were used to fund capital projects at the Institute and for other corporate purposes of the Institute and to pay certain costs incidental to the sale and issuance of the 2017 Taxable Bonds.

(g) Interest Rates

The 2006 Series B and C Bonds bear interest at variable rates. The bonds were issued in the weekly mode with weekly rates determined by Lehman Brothers Inc., as a Remarketing Agent and paid monthly. The maximum interest rate on the 2006 Bonds shall be twelve percent (12%) per annum. The 2006 bonds are subject to redemption at various prices and require principal payments and sinking fund installments through July 1, 2031 (Series B) and July 1, 2036 (Series C). The obligation to pay the Authority on a periodic basis, in the amounts sufficient to cover principal and interest due on the bonds, is a general obligation of the Institute. On September 18, 2008, the Institute entered into a contract with JPMorgan Chase Bank to take over as a remarketing agent, replacing Lehman Brothers Inc.

The 2008 Series C Bonds bear interest at rates ranging from 3% to 5% per annum, payable semiannually, are subject to redemption at various prices and require principal payments and sinking fund installments through July 1, 2021. The obligation to pay the Authority on a periodic basis, in the amounts sufficient to cover principal and interest due on the bonds, is a general obligation of the Institute.

The 2012 Taxable bonds bear interest at rates ranging from 0.388% to 3.892% per annum, payable semiannually, are subject to redemption at various prices and require principal payments and sinking fund installments through December 1, 2042. The obligation to make the interest payments on a periodic basis, in the amounts sufficient to cover principal and interest due on the bonds, is a general obligation to the Institute.

The 2015 Taxable bonds bear interest at rates ranging from 0.906% to 4.394% per annum, payable semiannually, are subject to redemption at various prices and require principal payments and sinking fund installments through December 1, 2045. The obligation to make the interest payments on a periodic basis, in the amounts sufficient to cover principal and interest due on the bonds, is a general obligation to the Institute.

The 2017 Taxable bonds bear interest at rates ranging from 1.713% to 3.732% per annum, payable semiannually, are subject to redemption at various prices and require principal payments and sinking fund installments through November 1, 2047. The obligation to make the interest payments on a periodic basis, in the amounts sufficient to cover principal and interest due on the bonds, is a general obligation to the Institute.

(h) **Bond Swap Agreement**

On December 22, 2008, the Institute entered into a swap agreement with Wells Fargo Bank covering \$28,900,000 of outstanding 2006 Series B Bonds that required the Institute to pay a fixed rate of 3.7702% to Wells Fargo Bank in exchange for Wells Fargo Bank agreeing to pay the Institute a variable rate equal to 67% of the USD-LIBOR-BBA rate with a term of three months, payable monthly, on an identical notional amount. The notional value of the 2006 Series B Bond is \$22,300,000. The effective date of the swap was December 22, 2008, and the termination date of the swap agreement coincides with the maturity of the bonds, which is July 1, 2031.

The Institute entered into this swap agreement with the intention of lowering its effective interest rate. At June 30, 2020 and 2019, the fair value of the interest rate swap was (\$3,323,339) and (\$2,788,944), respectively. The change in fair value recognized during the years ended June 30, 2020 and 2019 in the amount of (\$534,395) and (\$472,494), respectively, is reported in the statements of activities in change in fair value of bond swap liability. The swap agreement utilizes Level 2 inputs to measure fair value. The fair value of the interest rate swap was determined using pricing models developed based on the LIBOR swap rate and other market data. Under the swap agreement, the Institute may be required to post collateral to the counterparty if certain triggering events (rates and dollar thresholds) are met. As of June 30, 2020 and 2019, there was no requirement to post collateral imposed by the swap counterparty.

The bonds are repayable as follows at June 30, 2020:

	<u>Amount</u>
Year ending June 30:	
2021	\$ 4,325,000
2022	3,735,000
2023	3,965,000
2024	4,105,000
2025	4,145,000
2026 through 2048	<u>64,435,000</u>
Total	<u>\$ 84,710,000</u>

The 2006 Series B, 2006 Series C, and 2008 Series C bonds are secured by a pledge of revenues pursuant to the respective Loan Agreements.

(i) **Lines of Credit**

As of June 30, 2020 and 2019, the Institute had unsecured loan agreements representing a line of credit. As of June 30, 2020 and 2019, the agreements provide for borrowings up to \$50,000,000, of which \$30,000,000 is available through June 2021 and \$20,000,000 is available through March 2022. Interest payments are due on demand and interest accrues for the \$30,000,000 line of credit at LIBOR rate plus 50 basis points, which is 0.98% as of June 30, 2020 and for the \$20,000,000 line of credit at the LIBOR rate plus 90 basis points, which was 1.38% as of June 30, 2020. There were no borrowings in fiscal year 2020 or 2019 against the lines of credit. No interest expense was incurred for the years ended June 30, 2020 and 2019.

(j) **Standby Bond Purchase Agreement**

On July 17, 2017, in connection with the substitution of the Standby Bond Purchase Agreements, the 2006 Bonds were subject to mandatory tender for purchase and were remarketed with an alternate liquidity facility on July 17, 2017. The 2006 Bonds continue to be in the Weekly Mode, with J.P. Morgan Securities LLC serving as a Remarketing Agent for the Bonds. Each Series of the 2006 Bonds are secured by a new Standby Bond Purchase Agreement issued by TD Bank, N.A.

(9) **Pension Plans and Other Postretirement Benefits**

Separate voluntary defined-contribution retirement plans are in effect for faculty members and eligible staff personnel, both of which provide for annuities, which are funded, to the Teachers Insurance and Annuity Association and/or the College Retirement Equities Fund. Contributions are based on the individual participant's compensation in accordance with the formula set forth in the plan documents on a nondiscriminatory basis. Contributions for the years ended June 30, 2020 and 2019 totaled approximately \$2,692,000 and \$2,666,000, respectively.

In addition to providing pension benefits, the Institute provides certain health care and life insurance benefits for retired employees and faculty. Substantially, all of the Institute's employees may become eligible for these benefits if they meet minimum age and service requirements. The Institute accrues these benefits over a period in which active employees become eligible under existing benefit plans.

The components of net periodic postretirement benefit cost other than the service cost component are included in a line item in the nonoperating activities section of the statement of activities.

The following table provides a reconciliation of the change in benefit obligation of the plan at June 30, 2020 and 2019. There are no plan assets at June 30, 2020 or 2019.

	2020	2019
Postretirement benefit obligation:		
Retirees	\$ 6,957,427	6,494,495
Fully eligible active plan participants	4,628,169	3,012,837
Other active plan participants	13,033,070	10,077,450
Postretirement benefit obligation	\$ 24,618,666	19,584,782
Change in benefit obligation:		
Benefit obligation at beginning of year	\$ 19,584,782	18,308,952
Service cost	951,559	800,235
Interest cost	676,845	745,173
Benefits paid	(426,711)	(450,870)
Actuarial loss	3,832,191	181,292
Benefit obligation at end of year	\$ 24,618,666	19,584,782
Components of net periodic benefit cost:		
Service cost	\$ 951,559	800,235
Interest cost	676,845	745,173
Amortization of net loss	3,832,191	181,292
Net periodic postretirement benefit cost	\$ 5,460,595	1,726,700

	2020	2019
Benefit obligation weighted average assumptions at June 30, 2020 and 2019:		
Discount rate	2.66 %	3.50 %
Periodic benefit cost weighted average assumptions for the years ended June 30, 2020 and 2019:		
Discount rate	3.50 %	4.13 %

The healthcare trend rate is assumed to be 6.5% in fiscal 2020 and 6.5% in fiscal 2019, trending to an ultimate rate of 5.0% in 2030 and thereafter.

The effects of a 1% increase or decrease in trend rates on total service and interest cost and the postretirement benefit obligation are as follows:

	2020		2019	
	Increase	Decrease	Increase	Decrease
Effect on total service and interest cost	\$ 537,340	(374,994)	465,436	(334,858)
Effect on the postretirement benefit obligation	5,333,882	(4,163,634)	4,924,714	(3,542,289)

Projected payments for each of the next five fiscal years and thereafter through 2029 are as follows:

	Amount
Year ending June 30:	
2021	\$ 506,000
2022	526,000
2023	553,000
2024	583,000
2025	614,000
2026 through 2030	3,849,000

The Institute funds claims as they are incurred. The Institute does not expect to contribute any amounts in fiscal year 2020 or 2019, except as needed to provide for benefit payments.

(10) Natural Allocation of Expenses

The costs of providing program services and support services of the Institute have been summarized on a functional basis in the statement of activities. The following chart shows the relationship between the functional and natural classifications of expenses. Certain operating costs have been allocated among the functional categories as disclosed in note 1(b).

Expenses by natural classification for the year ended June 30, 2020 consist of the following:

		2020							
		Schools of				Library and other academic	Administration and general	Auxiliary Activity	Total
		Mathematics	Natural Sciences	Historical Studies	Social Science				
Salaries	\$	2,886,231	4,505,316	3,630,502	1,098,726	1,528,996	9,663,125	1,783,160	25,096,056
Stipends		5,081,973	3,309,575	2,560,054	1,533,777	109,200	—	—	12,594,579
Employee benefits and taxes		1,069,198	1,590,453	1,312,528	379,580	512,096	3,307,260	549,624	8,720,739
Materials and supplies		30,018	44,610	35,814	40,623	41,961	540,381	277,902	1,011,309
Conferences and travel		438,823	522,008	427,316	177,011	702,050	645,088	396,166	3,308,462
Insurance, legal and professional fees		38,803	140,329	161,115	—	535,122	2,302,334	167,060	3,344,763
Occupancy (inc. utilities and real estate taxes)		—	—	—	—	—	957,715	1,443,666	2,401,381
Interest expense		—	—	—	—	—	1,564,092	1,447,308	3,011,400
Books and periodicals		285	3,863	939	—	720,961	13,192	386	739,626
Other expenses		616,015	805,873	215,604	213,881	247,947	(208,875)	42,903	1,933,348
Depreciation		40,132	201,204	46,774	10,044	151,974	2,530,930	3,974,122	6,955,180
Subtotal		10,201,478	11,123,231	8,390,646	3,453,642	4,550,307	21,315,242	10,082,297	69,116,843
Academic building allocation		1,209,619	1,549,000	1,041,631	521,975	—	(4,322,225)	—	—
	\$	11,411,097	12,672,231	9,432,277	3,975,617	4,550,307	16,993,017	10,082,297	69,116,843

Expenses by natural classification for the year ended June 30, 2019 consist of the following:

		2019							
		Schools of				Library and other academic	Administration and general	Auxiliary Activity	Total
		Mathematics	Natural Sciences	Historical Studies	Social Science				
Salaries	\$	2,663,909	3,597,476	3,576,217	1,052,821	1,614,822	9,660,809	1,947,108	24,113,162
Stipends		5,069,737	3,612,469	2,451,392	1,328,841	138,950	—	—	12,601,389
Employee benefits and taxes		1,057,075	1,389,777	1,355,750	385,194	545,894	3,454,253	588,689	8,776,632
Materials and supplies		39,831	98,981	40,315	44,193	84,766	817,788	455,854	1,581,728
Conferences and travel		506,039	535,660	493,234	152,048	1,809,252	1,112,078	653,273	5,261,584
Insurance, legal and professional fees		34,488	369,590	379,405	8,900	755,894	2,923,323	211,354	4,682,954
Occupancy (inc. utilities and real estate taxes)		—	—	—	—	—	850,000	1,402,842	2,252,842
Interest expense		—	—	—	—	—	1,690,559	1,517,259	3,207,818
Books and periodicals		127	3,533	1,396	333	741,664	10,904	794	758,751
Other expenses		644,251	882,720	388,021	193,394	410,863	129,432	35,615	2,684,296
Depreciation		14,484	89,462	36,990	4,042	139,687	2,360,802	3,883,270	6,528,737
Subtotal		10,029,941	10,579,668	8,722,720	3,169,766	6,241,792	23,009,948	10,696,058	72,449,893
Academic building allocation		1,236,677	1,583,658	1,064,935	533,648	—	(4,418,918)	—	—
	\$	11,266,618	12,163,326	9,787,655	3,703,414	6,241,792	18,591,030	10,696,058	72,449,893

(11) Net Assets

Net assets are comprised of the following at June 30, 2020 and 2019:

	2020	2019
Net assets without donor restrictions:		
Undesignated	\$ 210,745,901	223,454,839
Designated for specific purpose funds:		
School of Mathematics	16,550,293	16,308,145
School of Natural Sciences	21,940,767	21,936,096
School of Historical Studies	17,511,076	17,251,781
School of Social Science	1,592,425	1,505,873
Libraries and other academic	71,394,109	70,895,415
Administration and general	4,894,993	4,676,015
Designated for specific purpose funds	133,883,663	132,573,325
Total net assets without donor restrictions	\$ 344,629,564	356,028,164
Net assets with donor restrictions and appropriation through endowment spending policy:		
Subject to expenditure for specific purpose:		
School of Mathematics	\$ 28,587,218	28,787,317
School of Natural Sciences	22,918,517	21,646,276
School of Historical Studies	36,239,165	36,675,554
School of Social Science	57,761,434	58,140,108
Libraries and other academic	7,227,021	6,624,038
Administration and general	72,739,685	56,790,270
Net assets with donor-purpose restrictions	225,473,040	208,663,563
Net assets held as endowed fund corpus to generate income for specified purposes	259,261,066	258,946,153
Total net assets with donor restrictions	\$ 484,734,106	467,609,716

(12) COVID-19

On March 11, 2020, the World Health Organization declared the COVID-19 outbreak a public health emergency. In response, various governmental agencies mandated stringent regulations and guidelines to help organizations promote the health and safety of their communities. In connection with this event and restrictions by state and local governments, the Institutes members, faculty, and staff were transitioned to remote operations, which in some cases disrupted planned programmatic activity.

The United States Congress passed the Coronavirus Aid, Relief, and Economic Security (CARES) Act on March 27, 2020. The Institute recognized Employee Retention Credits through June 30, 2020 under the CARES Act of approximately \$411,000. Those credits were used to offset a portion of the cost of keeping faculty and staff on payroll during the mandated shutdown. The Institute has been able to continue its academic mission to date but uncertainty around the breadth and duration of other business disruptions related to the pandemic could potentially impact operations in the future.

(13) Subsequent Events

The Institute evaluated events subsequent to June 30, 2020 through October 30, 2020, the date on which the financial statements were issued, and determined there were no subsequent events required to be disclosed.



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