IAS | THE INSTITUTE LETTER

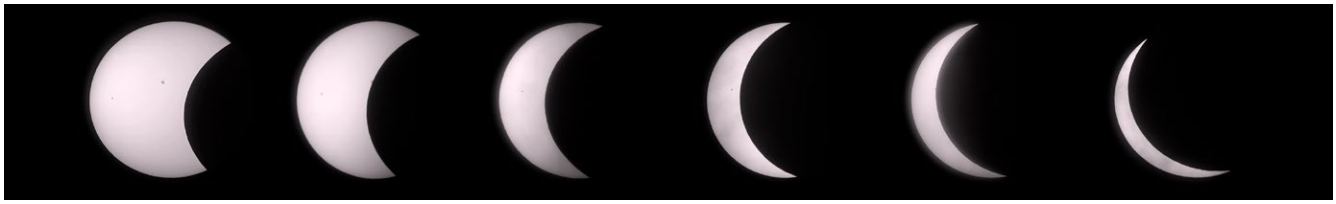
Spring 2024

From Beads to Bubbles: Exploring the Principle of Geometric Minimization

Collaborating on Co-production

Profiling PLATFORM

Labor & Leisure in the Music of the Theremin



GEORGE N. WONG

IAS | THE INSTITUTE LETTER Spring 2024

Contents

MASTHEAD

On April 8, 2024, a total solar eclipse crossed North America. **George N. Wong**, Frank and Peggy Taplin Member in the School of Natural Sciences, captured the phases (approximately 90% of totality) visible from IAS teatime on an 8" Newtonian telescope. Read more about Wong's research on page 6.

COVER IMAGE

An image of soap bubbles in the air. As light waves reflect off the top and bottom surfaces of the spheres, creating a tranquil display of colors, we see the true value of what this simple beauty can offer us. Portions of equations from geometric minimization research can be seen in the sections where the spheres overlap. Afro-Latina artist **Islenia Mil** is an illustrator who specializes in conceptual problem-solving and crafting meaningful narratives through her artistry. She has done work for *NPR*, *Scientific American*, and *The New Yorker*.

IAN KOMODA

Questions and comments regarding *The Institute Letter* should be directed to publications@ias.edu.

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For discovery, everything must be in its proper place.
Chalk, sitting on the sill of a blackboard.
A book, stocked on a shelf in the library.
A colleague, across the way.
A breakthrough, at hand.

Backdropped by the spirit and capacity of our buildings and grounds—from the roaming walking trails in the Woods to the curiosity-inducing geometry of the spaces in Rubenstein Commons—discovery emerges through the Institute's unique *mise en place* of space, people, and ideas. In a 1953 lecture titled *The Sciences and Man's Community*, past Director J. Robert Oppenheimer characterized these conditions as the "uninhibited association of [people]" which makes the "ever more specialized and expert technological world nevertheless a world of human community."

In this issue, this association and the moments of discovery, planned and unplanned, that spring from it, are accentuated. You will see how a refreshed and robust set of artistic programming brings discovery to life. How Einstein's theory of relativity influenced a new approach to a thorny problem in medieval studies. How historians and theologians are thinking together about the co-production of the Islamic, Christian, and Jewish traditions. How collaborative efforts maximized mathematicians' knowledge of minimal surfaces. How real-life experiences of making and performing music inspired ongoing research into a unique electronic instrument.

As the Institute continues to bring about uninhibited association, its Faculty, Members, Staff, and Supporters each have their own place. It is this community, united in the pursuit of discovery, that sustains the continued emergence of knowledge.

A COMMUNITY OF *Discovery*

SAMEER KHAN

Brian Zeger and Jared Werlein demonstrated musical translation from poem to performance using the works of Franz Schubert.

An Eventful Season

MARIA O'LEARY

This spring, the Institute for Advanced Study experienced a renaissance in its artistic programming. The campus hosted performances which stretch far and wide in terms of genre: a hip-hop dance troupe took to the stage of Wolfensohn Hall, chamber musicians have enthralled scholars at teatime, and a retrospective performance from thrice-Grammy-nominated composer and IAS Artist-in-Residence (2009–13) Derek Bermel celebrated three generations of American concert music. This new programming was held in addition to long-standing events, such as regular play reading meetings in Rubenstein Commons, which offer the opportunity for scholars to informally gather and immerse themselves in literature. Through such programming, the arts bring together those from all Schools, often with members of the surrounding Princeton community, to engage in creative dialogue, foster interdisciplinary thinking and build connections, and enrich the cultural tapestry of the Institute campus.

Of course, Institute events are by no means limited to those of the artistic variety. Building on our tradition of bringing together mathematicians and historians with natural and social scientists, we continue to host academic events featuring high-profile speakers who reflect on issues that are relevant not only within the realms of scholarship but also across the wider world. ■

The images overleaf highlight the incredible breadth and depth of events offerings.

ANDREA KANE

On April 9, Margrethe Vestager, the Executive Vice President of the European Commission for A Europe Fit for the Digital Age, delivered the 2024 IAS Public Policy Lecture. The Q&A following the lecture was led by Alondra Nelson, Harold F. Linder Professor in the School of Social Science.

ANDREA KANE

In February, the Institute hosted an in-depth performance about hip-hop's cultural roots with a focus on the dance element known as breaking. Members of the IAS community joined the dancers on stage for an immersive experience.

MARIA O'LEARY

Renowned for his talent for using everyday objects to highlight unique mathematical surprises, Tadashi Tokieda of Stanford University visited the Institute to deliver a pair of math magic shows.

ANDREA KANE

The Institute's annual International Potluck event saw scholars and their families each bring along a dish from their culture as a way of collectively creating a meal of global culinary specialities.

Discovery Knows No Borders

As Christopher Nolan's *Oppenheimer* biopic swept the Academy Awards in March, the Institute for Advanced Study unveiled a film of its own: a 90-second anthem video showcasing IAS and its mission of enabling foundational discovery. The video connects influential figures from the Institute's illustrious history, including founding Faculty member Albert Einstein and Director J. Robert Oppenheimer, with scholars who continue to shape research in both the sciences and humanities today.

Scan the QR code to watch the video on YouTube

SAMEER KHAN

Sierra Lomuto at work alongside a colleague in the Historical Studies - Social Science Library

Using Gravity to Find Grounding in Medieval Studies

When **Sierra Lomuto** arrived at the Institute in the autumn, she was working through a thorny problem in her discipline of medieval studies. Medieval studies has conventionally been a European field, but scholars have been seeking ways to move beyond this scope, in order to think about the global history of that period.

"Many people think of the Middle Ages as being stationary—people were not in contact, everybody was isolated. Every medievalist knows that Europe was not isolated or cut off from Africa and Asia," says Lomuto. "But the way that we have studied that past has severed those connections. In the last twenty years, medievalists have been interested in what is now being termed 'the global Middle Ages,' where we think about Africa, Asia, and Europe together, either comparatively or as an interconnected whole."

This endeavor is complicated by the difficulty of taking a European centered term like "Middle Ages" and applying it to people and places that have created their own periodization and have their own way of thinking about their history. In some ways, medievalists' efforts to disrupt Euro-centrism has brought about its re-entrenchment.

Around the beginning of the academic term, Lomuto, Member in the School of Historical Studies, was invited to write the afterword for a cluster of essays in the Spring 2024 issue of *postmedieval* on how to de-center Europe outside of the rubric of the global Middle Ages, called "Grounds for a trans-regional medieval studies, beyond the global." As she sat by the pond on a gorgeous fall day, she read the four essays featured in the issue and pondered how she wanted to approach the problem.

She found inspiration in Einstein: "In one of the essays I was responding to, the author talks about needing to keep one foot in your own field but widen out like a drafting compass. One foot is you and the other foot circles out to other fields you might not be an expert in to inform your perspective. And I really loved that! But if you're in this Euro-centric field, you're still caught in an epistemological imperializing gaze. And so, I was considering the way Einstein thinks about gravity: what grounds us? As matter, we actually impact the shape of space-time. Where gravity resides is in that space between

matter and spacetime, and it's constantly shifting. It is the relationship between things that grounds us, and where we can find our gravity moves and shifts."

Lomuto seeks to embrace movement, using it as a way to orient the discipline towards a three-dimensional scope that is more about "relationships between" than any central point of origin. She writes, "To be global, the circle must become a sphere, a process that engulfs the center in three-dimensional space. The surface is left center-less, but orientation is paramount.... As Einstein has taught us, gravity exists within the relationship between the curvature of spacetime and the matter that interacts with it. In other words, we can find the force that grounds us within the dynamic and dialogic movement between ourselves and that with which we engage."

Instead of relying on a framework to engage the past, putting the notion of spacetime to use in our historical analysis moves us beyond the global.

Instead of relying on a framework to engage the past, putting the notion of spacetime to use in our historical analysis moves us beyond the global, enabling "stability not in a stationary foot but in the ever-shifting relations *between*."

This constant shifting of perspectives, and finding a sense of grounding in such motion, is undergirded by the willingness to write a piece that is not the be-all and end-all answer to a problem, but simply one perspective that may or may not be useful to us in the future. "My conclusion in the afterword is that we have to have this humility of not knowing, and not coming up with definitive conclusions. We have to move the globe, and we have to move ourselves. Some work might become irrelevant—and that's actually a good thing! Because we are supposed to be constantly moving." It is this that allows us to truly think together. "That is what the Institute *is*. When I'm working on my monograph, I'm thinking in conversation with other people. And that's the way that the most compelling scholarship happens." ■

APPLIED MATHEMATICS

Taking Theory to Traffic

The largest live autonomous vehicle traffic experiment ever conducted began the week of November 18, 2022, in Nashville, Tennessee. It involved 100 cars and a workforce of more than 250. One of its goals was to analyze how level two autonomous vehicles can impact traffic waves. This experiment, run by the CIRCLES Consortium, used 4 miles of highway, 288 cameras, and an impressive command center—but one of its most vital resources was equations on a blackboard.

In front of one of these blackboards was **Benedetto Piccoli**, current Visitor in the School of Mathematics. He thinks of these road networks in terms of graphs, and uses theoretical tools like conservation laws to understand traffic waves.

Traffic analysis using cameras and conservation laws dates back to the 1930s. But in the 1950s, partial differential equations (PDEs) came into play: the Lighthill-Witham-Richards model combined density, speed, flow, and partial derivatives with respect to time and space to formulate conservations related to traffic.

One of the insights you get with a PDE like this is how discontinuities, called "shocks," travel in time. Solving for these shocks becomes especially complicated when they behave "non-classically," appearing to violate the entropic conditions of the physical system. At IAS, Piccoli is working with IBM von Neumann Professor Camillo De Lellis on completing theories related to these problems, including those in fluid dynamics, specifically diffusive-dispersive equations related to the non-classical continuities or "shocks" of the same type you see in the traffic models.

But how can you use theory to influence traffic? By coupling PDEs (describing bulk traffic flow) with ordinary differential equations that position your actuators within the flow, namely the automated cars, you can do just this. This coupled micro-macro model, in addition to control theories such as the Kalman Filter, allows for the creation of algorithms which, when fed into 2–5% of level two autonomous vehicles, can dissipate traffic waves.

Piccoli, an applied mathematician, is a unique addition to the theoretically-minded IAS. "I'm extremely happy to be here among these great minds and see that the Institute has interest in these types of activities," he said.

After all, these "activities" could result in fewer accidents and less fuel consumption and pollution. It is one of the great examples of how equations on a blackboard are sincerely felt by society. ■

Uncovering Sgr A*'s Magnetic Fields

A new image from the Event Horizon Telescope collaboration, which includes **George N. Wong**, Frank and Peggy Taplin Member in the School of Natural Sciences, has uncovered strong and organized magnetic fields spiraling from the edge of Sagittarius A* (Sgr A*), the supermassive black hole at the center of the Milky Way.

This new observation was achieved by recording the polarized properties of the light in the black hole image, effectively measuring the way the electromagnetic waves were vibrating as they reached the telescope. The polarized light allowed the researchers to map the magnetic field lines of the black hole, revealing a magnetic field structure strikingly similar to that of the black hole at the center of the M87 galaxy.

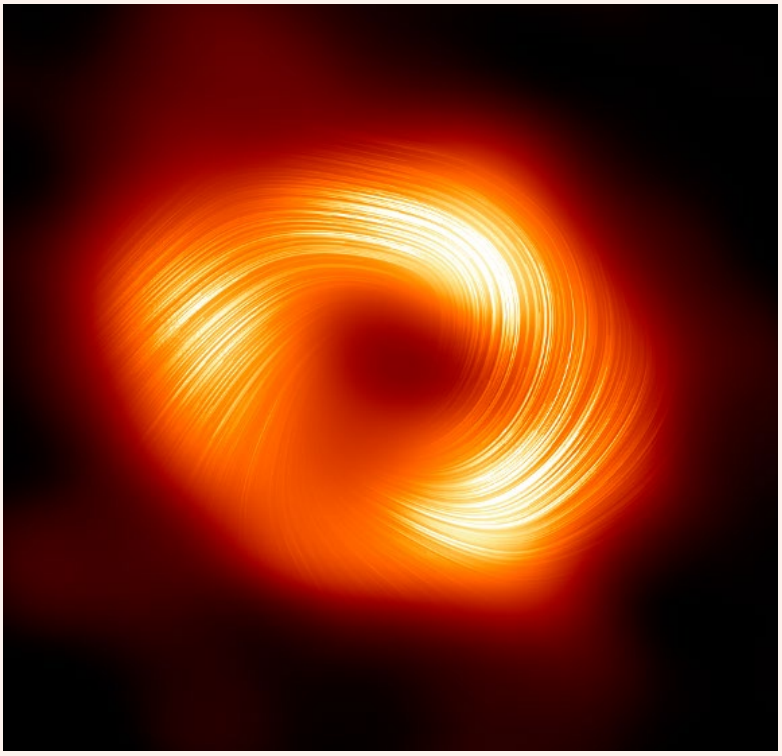
In addition to helping us better understand what's going on at the center of our galaxy, the new data also validate our previous results and offer tantalizing predictions.

The fact that the magnetic field structure of M87's central black hole is so similar to that of Sgr A* is significant because it suggests that the physical processes that govern how a black hole feeds and launches a jet might share significant commonalities across supermassive black holes, despite differences in mass, size, and surrounding environments. This result allows scholars to refine their theoretical models and simulations, enhancing understanding of how matter is influenced near the event horizon of a black hole.

"By imaging polarized light from hot glowing gas near black holes, we are directly inferring the structure and strength of the magnetic fields that thread the flow of gas and matter that the black hole feeds on and ejects," said Angelo Ricarte, Harvard Black Hole Initiative Fellow and project co-lead.

"Exactly how magnetic fields behave as they are dragged toward the event horizon is one of the most important uncertainties in our understanding of supermassive black hole accretion, and with the EHT we're able to directly study that region," added Wong, who co-leads the Theory Working Group within the EHT collaboration. "In addition to helping us better understand what's going on at the center of our galaxy, the new data also validate our previous results and offer tantalizing predictions. I'm very excited about what we'll see in the future with increased resolution and sensitivity…and movies!"

These results were published on March 27 in *The Astrophysical Journal Letters* and further research is ongoing. The EHT observed Sgr A* and M87 again in April 2024. Each year, the images improve as the EHT incorporates new telescopes, larger bandwidth, and new observing frequencies. Planned expansions for the next decade will enable high-fidelity movies of Sgr A*, may reveal a hidden jet, and could allow astronomers to observe similar polarization features in other black holes. Meanwhile, extending the EHT into space will provide sharper images of black holes than ever before. ■



EHT COLLABORATION

This image shows the polarized view of the Milky Way black hole. The lines mark the orientation of polarization, which is related to the magnetic field around the shadow of the black hole.

ASTROPHYSICS

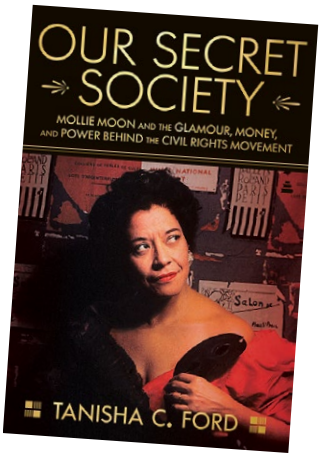
This selection of books provides a peek into the treasure-trove of scholar publications that have been promoted via the Institute's social media channels in the past six months. If you'd like to continue hearing about scholar publications via X or Instagram, flip to the back cover to find out how to follow us.

"A captivating history of NASA's Space Transportation System—the space shuttle—chronicling the inevitable failures of a doomed design."

In *Dark Star,* Matthew Hersch challenges the existing narrative of the most significant human space program of the last 50 years, NASA's space shuttle. He begins with the origins of the space shuttle, which Hersch explains was built the wrong way, at the wrong time, and for all the wrong reasons. Describing the unique circumstances that led to the space shuttle's creation by President Nixon's administration in 1972 and its subsequent flights from 1981–2011, Hersch illustrates how the shuttle was doomed from the start.

Matthew Hersch
Visitor, School of Historical Studies (2021–22)

"An engrossing social history of Mollie Moon, the fundraiser extraordinaire who reigned over the glittering 'Beaux Arts Ball,' the social event of New York and Harlem society, for fifty years."



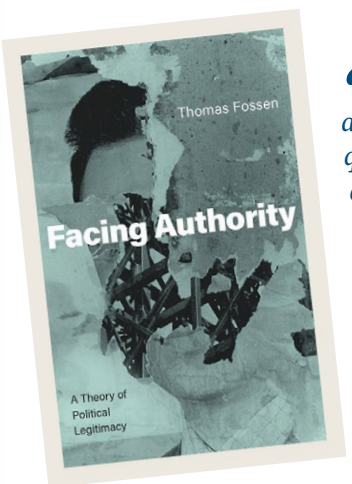
In *Our Secret Society,* Tanisha C. Ford brilliantly illuminates a little-known yet highly significant aspect of the civil rights movement—the power-house fundraising effort that supported it. The book brings into focus Mollie Moon, who, as the president of the National Urban League Guild, raised millions to fund grassroots activists battling for economic justice and racial equality.

Tanisha C. Ford
Roger W. Ferguson, Jr. and Annette L. Nazareth Member, School of Social Science (2021–22)

"An expansive new study that explores the wide breadth of Italian painting in the fifteenth century, introducing ground-breaking approaches and discoveries."

Challenging the traditional focus on Venice, Florence, and Rome, *Painting in Fifteenth-Century Italy* traverses the peninsula from north to south and culminates in the global ports of Naples and Sicily. Diane Cole Ahl reappraises the careers and collaborations of painters, some little-known today. With greater frequency than previously imagined, these masters traveled widely to seek professional opportunities and expand their artistic horizons.

Diane Cole Ahl
Member, School of Historical Studies (2006)



"Political protest is often at least partially about the question of legitimacy. How can we distinguish whether a regime is legitimate, or merely purports to be so?"

In *Facing Authority,* Thomas Fossen develops a new philosophical approach to political legitimacy, interweaving analyses of key concepts (including representation, identity, and temporality) with examples of real-life struggles for legitimacy, from the German Autumn to the Arab Spring. Instead of asking "what makes authorities legitimate?," Fossen investigates how the question of legitimacy manifests itself in practice.

Thomas Fossen
Member, School of Social Science (2020–21)

THEEN MOY/FLICKR

PLAT

"I am not so much interested in platforms, but in those who have to live with them. It is comparatively easy to think of platforms in terms of business models, technologies, markets, public policies, or forms of capitalism. It is much harder to unpack the work that ordinary people have to do to cope with, understand, and challenge platforms on a daily basis. Take a service like Google Search and its ranking of web pages. For scholars, engineers, and politicians, this may be a problem of monopoly and bias. For yoga mat resellers, anti-fracking activists, and local politicians, it is a battleground on which they have to compete for visibility day in and day out. Now, when you do this kind of empirically grounded research, something fascinating happens. The 'platform' tends to disappear and becomes just another aspect of a person's life—yet at the same it is always there. It is this tension that makes the concept both so useful and so problematic."

Malte Ziewitz
Member

"In a well-known 1989 paper, sociologist Susan Leigh Star and philosopher James Griesemer coined the term 'boundary objects.' They defined them as 'objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites.' In my work, I treat the notion of platform as a boundary object: technologies such as social media apps and global messaging systems that are used variously by different actors in divergent contexts, but which have a series of shared traits that facilitate being identified as a distinct conceptual entity."

Pablo Boczkowski
Member

"The new identification infrastructure of Aadhaar (a *de facto* mandatory biometrics identification system for every Indian citizen and resident) displays all characteristics of platforms: scale, ubiquity, dependency. Its adoption has catapulted the Indian state into a new era. India is currently in the process of creating an extant digital public infrastructure that is enabled by Aadhaar, and not yet seen at this scale anywhere else in the world, at least for the moment. The concept of platform has allowed me to become attuned to this next generation of the state-making in altogether new ways and ask a new question: if commercial platforms, such as Amazon and Uber, ushered in a new kind of capitalism, what does the platformization of governance do to state-making and sovereignty?"

Kriti Kapila
Member

Ahoy platforms ahead!
Always hungry, ever-watching
'Til death do us part.

"Uber. TaskRabbit. DoorDash. In less than a decade, digital platforms have made the gig economy a household word and gig work a popular form of employment. In my research, I am interested in the intersection of work and digital platforms. How have they helped create a world of work that is both profoundly enthralling and deeply exploitative? Why does your Uber driver drive? No, it's not (only) because they want to save up money for their next vacation or to pay the water bill. It's because of empowering cultural narratives calling them entrepreneurs and heroes and the alluring features on the platform's app that enable work to become a 'game' in which the odds are always in the platform's favor. Try this: the next time you're in a ride-hailing car, don't ask the driver about their day, instead, ask them if they are winning the game. Hint: you already know the answer."

Lindsey D. Cameron
Member

Scan for more scholar insights into the PLATFORM theme year

FORM

"My current research focuses on one of the most heavily consumed and highly contested forms of media: pornography. I am writing a book on how performers produce pornography through their daily work. My ethnographic research shows that rather than seeking a sterile work environment, performers try to coproduce varying degrees of emotional intimacy–ranging from friendly rapport to sexual chemistry and attraction–throughout the workday. Digital platforms (like Pornhub and OnlyFans) have profound consequences for how performers interact with each other in this process. Understanding how platforms structure performers' interactions helps reveal the ways in which intimacy can both make work meaningful and go dangerously wrong."

Hannah Wohl
AMIAS Member

"In relation to global health, the notion of the platform offers an alternative to the field's commodity fetishism: the idea that contextual problems of disease burden can be addressed, at least temporarily, by the 'delivery,' 'roll out,' or 'scaling up' of singular, standardized objects. The specific political affordances of platforms, their ability to shift the horizon of technological progress toward either public agency or corporate capture remains a matter for empirical investigation, demanding historically grounded, ethnographically informed analysis of the new sets of actors and spatial-technical arrangements that platform technologies catalyze and, with any luck, may ultimately give way to more radically democratic public health projects."

Ann Kelly
Member

THIS IS ENGINEERING/FLICKR

"I am concerned with the process of platformization. Or, how companies and entrepreneurs (e.g., journalists, game developers, or creators) become dependent on platform companies, such as Facebook, Google, ByteDance, and Tencent. Platform companies give way to platform markets and platform infrastructures, arrangements which, in turn, impact platform labor (those working with and for platforms), creativity (content distributed via platforms), and ultimately, democracy. After all, many platform companies have morphed into transnationally operating conglomerates, which have become dominant corporate actors. An endless slew of high-profile lawsuits aimed against the abuse of corporate power attests to the urgency of this research agenda."

David B. Nieborg
Member

FINISHING SCHOOL/FLICKR

During the 2023–24 academic year, the School of Social Science hosted a special theme year titled "**PLATFORM**." To offer a view into their work, some of the theme year participants shared thoughts on what the word "platform" means in their work and how "platform" serves as a useful concept in their research.

From Beads to Bubbles

Exploring the Principle of Geometric Minimization

by Abbey Ellis

Much of the physical world around us operates on the fundamental principle of "minimization." It governs everything from the motion of a ball around a roulette wheel to the trajectories of galaxies through spacetime, and is a source of endless fascination for Paul Minter, Veblen Fellow in the Institute's School of Mathematics. The phenomenon of minimization can be seen throughout nature, where systems seem to "want" to take a path that uses the least amount of energy possible to return to an equilibrium state.

Minter explains this with an example: "Imagine a bead threaded through a circular wire hoop which is held in a vertical orientation. If you were to spin the bead around, it would eventually settle at the very bottom of the hoop. This is its point of minimal energy: it needs to expend no energy to 'keep itself' here. This bead and hoop system can be described as 'stable' because if you slightly perturb the bead, it will always roll back to the same spot.[1]"

But there also exists an "unstable" critical point, which is where the bead balances perfectly on the top of the hoop. This can be considered its point of maximum energy. If you nudge the bead slightly while it is in this position, it will not return to its original location but will instead roll around the hoop. Therefore, despite the top of the hoop being a plausible resting place, this state is described as being "unstable."

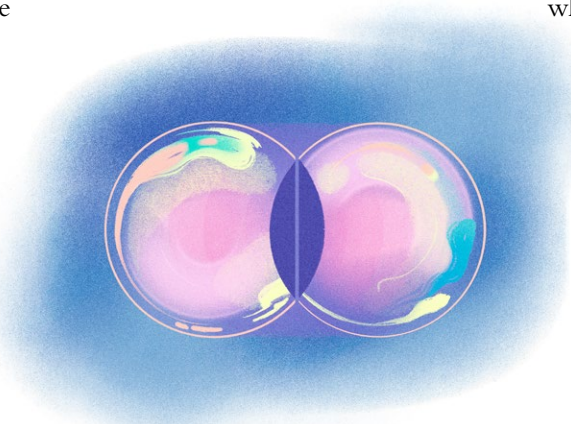
Systems that exhibit a form of stability served as the basis for Minter's Ph.D. research. In order to explain this, take the bead example a step further: instead of a bead on a circular hoop, now imagine a bead maze that you might have played with as a child, with many undulating wires. The point of minimal energy for the beads on this maze would be the horizontal wooden base at the bottom, but there exist other parts of the maze where the bead would sit in a stable state. For example, when moving the bead along the wire, you might find that it comes to rest in a small trough half-way around the maze, where the wire dips slightly. If you gave the bead a little nudge, it would stay in this position (exhibiting stability). But if you

1 Stability is important: in the real world, one would not expect for unstable states to survive for very long. This is because a small influx of energy, which would be commonplace in a real-world setting, will cause an unstable system to be disrupted. Therefore, one expects the majority of systems to be stable.

gave it a big push, it would continue to roll along the wire and find its way to the base.

In this case, the minimal point of the whole system (what's called the "global" minimum) would still be the wooden base. But if you zoomed in and looked at the bead sitting in the trough, considering only its immediate (or "local") surroundings, this trough would be its most minimal stable point. Minter's Ph.D. research concerned geometric objects that exhibit these kinds of stable minima—including in far higher dimensions.

When he arrived at the Institute in August 2022, his expertise in this field became key for a project conducted by a pair of his fellow geometric measure theorists: Camillo De Lellis, IBM von Neumann Professor in the School of Mathematics, and Anna Skorobogatova, an IAS visiting graduate student based at Princeton University. The questions which De Lellis and Skorobogatova were tackling pertained to minimizing area, which is closely related to minimizing certain energies. The trio's collaboration, which forms the subject of this article, has resulted in the publication of a new paper that was highlighted last fall in a report for the National Science Foundation.



A double bubble connected as if in midair

Prior to his arrival at IAS, Minter attended a summer conference on the subject of regularity theory at the University of Pisa in Italy. There, he met Skorobogatova and learned of her ongoing work with De Lellis at the Institute. During their initial conversation, he recalls thinking, "Well, the type of situation they need to understand is very similar to the ones I have been thinking about during my Ph.D.!"

The work in which De Lellis and Skorobogatova were engaged can be introduced by means of another example. Instead of playing with a bead maze, now imagine that you are blowing a soap bubble using a simple wand. Why does the bubble that you create take the form of a sphere? Why not an ovoid? Or a cylindrical shape? Or something totally random?

Again, the answer is minimization. Bubbles form a shape that has the least surface area possible within the system's required constraints. The constraint for the bubble is, of course, the volume of air that has been placed inside. A sphere is the shape that accommodates the required amount of air with the minimal surface area. Thus, bubbles are spherical.

De Lellis and Skorobogatova were investigating what one can say about the geometric structure of more general objects that are governed by minimization principles. To demonstrate the difficulty inherent in providing an answer, imagine that, having admired your first bubble with its minimized surface area, you decide to blow a second. Your two bubbles join in midair, and you notice that they connect in a very specific configuration: the double bubble. This is the shape that minimizes the surface area of the two bubbles combined. But something fundamental has changed about them.

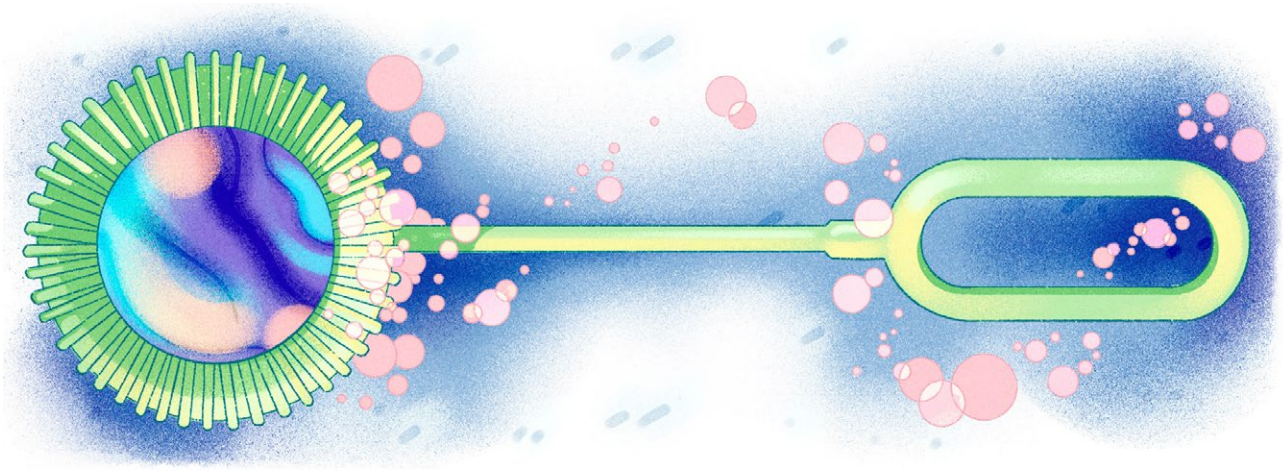
A single bubble is a smooth sphere, but when two bubbles connect, joining points are created, which have "corners." At these points, described by mathematicians as "singularities," the bubble ceases to be smooth. Minter, De Lellis, and Skorobogatova are fascinated by what happens when such singularities arise. Their research asks the following: How complicated can singularities be? Can there be lots of singularities? Do the singularities themselves have some sort of structure?

"In this area of research, the ultimate goal would be to provide a full geometric description of a singularity for a variety of different geometric minimization problems. Progress has been made in certain cases, and the problem has been completely resolved in others, but there are many key situations for which we do not yet know the answer," Minter states. "Full geometric descriptions appear to be very difficult to achieve, but there are softer, related questions that one can ask."

An important player in the development of this field was Frederick J. Almgren Jr., a frequent Member in the Institute's School of Mathematics. Almgren's regularity theorem lays out, in a roughly thousand-page proof, the particular qualities of a singular set of a mass-minimizing surface.[2] Prior to his appointment to the Institute Faculty in 2018, De Lellis was well known for producing, alongside his collaborator Emanuele Spadaro, a more accessible version of Almgren's proof that was more widely understandable to geometric measure theorists. Their work resulted in a concise, up-to-date version of the theory that not only reinforced Almgren's original claims, but also opened new avenues of inquiry for mathematicians to examine.

The precise area of Almgren's work that pertains to Minter, De Lellis, and Skorobogatova's latest endeavor concerned the quantification of singularities. When confronted with geometric objects that have such singularities, Almgren investigated whether he could enumerate how many singularities there were. He was able to show that if one fixes some geometric boundary, and then looks for the surface that spans that boundary with the minimum area (like a soap film stretched

2 Almgren's initial work on the regularity theorem was completed in 1983. This was followed by a posthumous publication in the year 2000.



A soap film within a bubble wand, which behaves in a similar way to a soap film stretched between a piece of circular wire, described below.

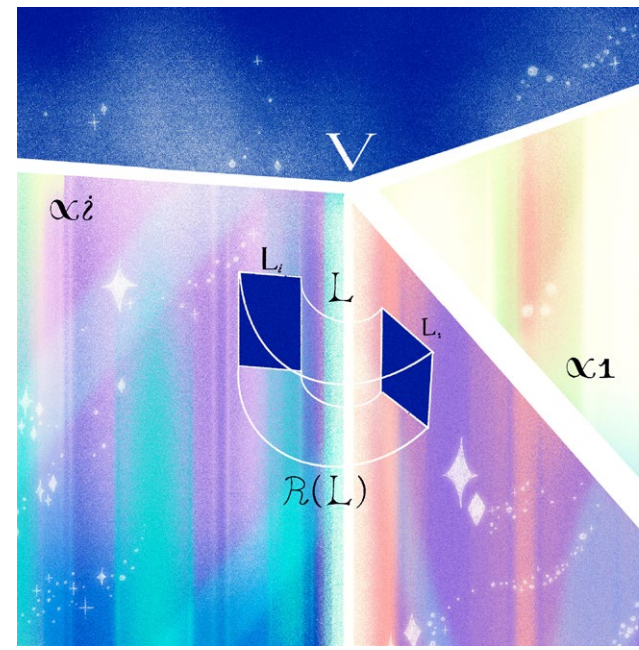
within a piece of circular wire), then singularities of that surface always exist in two dimensions fewer than the surface itself.

What does this mean? Let's first return to the slightly different example of the bubble. In this case, one is not fixing a boundary, but rather fixing the total enclosed volume (i.e., the amount of air inside the bubble), and then finding the minimum surface. That surface is two-dimensional, and, for a double bubble, the singularity which occurs where two bubbles meet takes the form of a one-dimensional line. Thus, the singularity exists in *one* dimension less than the surface. Almgren's work was analogous to this, but his starting point was different, since he was interested in soap films with a given boundary rather than bubbles that enclosed a given volume. As a result, his singularities always existed in *two* dimensions fewer than their associated surface. Unfortunately, this difference means the simplest "surface" that Almgren considered existed in four-dimensions, which is rather hard to visualize!

Almgren's rule also applies to objects in far higher dimensions than just four. For example, in a 400-dimensional object in 1,000-dimensional space, the singularities could be 398-dimensional. "Understanding the number of possible singularities through their dimension is a useful way of starting to describing their structure," Minter continues. "But it remains something of a qualitative statement. It cannot, for example, tell you anything about the local structure of singularities and it does not help to classify them."

To study singularities in a more precise way, Minter, De Lellis, and Skorobogatova investigated their local geometric structure. In simple terms, they put the singularity under a microscope. In the case of the double bubble singularity, zooming in on the connection point between the two bubbles showed that the bubbles met along a connection point in the form of a geometric structure, namely a line. Continuing to zoom in, they observed that the surfaces began to look like three flat planes that ultimately intersect at the singularity, forming a type of Y-shape. The technical name for these intersecting planes is a "tangent cone."

In the case of bubbles, only two different types of singularities are observed: Y-type singularities in double bubbles and another type which looks like a tetrahedron, seen in triple bubble clusters. But in other objects, especially in higher dimensions, singularities can look very different. Minter and his collaborators were able to show that these singularities in high dimensions are not arbitrary. Instead, they have a certain geometric structure. Moreover, they were able to prove that for the vast majority of singularities the tangent cone is unique. In other words, they demonstrated that when you put a typical singularity under a microscope, you see a fixed shape (analogous to the Y-shape in the double bubble)



A zoomed in view of the double bubble singularity, highlighting the Y-shape where the three flat planes intersect.

as you zoom in.[3] To summarize, Minter, De Lellis, and Skorobogatova's work has enhanced our understanding of what kind of structures form minimal surfaces.

Collaboration was key in the success of the project. "Working collaboratively made it much simpler because we had people with expertise on each side of things," Minter outlines. But there was no single *Eureka!* moment where everything came together. Instead, Minter describes the "nervous anticipation" that the trio felt as their work progressed: "In any project, there come points where the math seems to be working, and then there are some horrendous technicalities that you have to sit down and work through. I think at the end, we breathed a sigh and thought, 'Phew, everything *is* going to work out.'"

Minter, De Lellis, and Skorobogatova are continuing their collaborative work with a follow-up project, which is related to objects which minimize area "mod *p*." Mod *p* numbers can be described as remainders which result when natural numbers (i.e., the numbers that you use for counting, e.g., 1, 2, 3, all the way to infinity) are divided by *p* (a prime number). The trio's research into area minimizing objects has provided a machinery which might be applicable to this related problem. "Now," Minter says, "we are trying to adapt our machinery to this new problem. And currently, things are looking promising."

In the words of Swiss mathematician Leonhard Euler over 300 years ago, "Nothing at all takes place in the universe in which some rule of maximum or minimum does not appear," meaning that the principle of minimization will provide scholars with intriguing questions for many more years to come. ■

3 These conclusions were independently reached at the same time by another pair of scholars, Brian Krummel (University of Melbourne) and 2019 Member in the School of Mathematics Neshan Wickramasekera (University of Cambridge), using different methods.

Paul Minter is a Veblen Fellow in the Institute's School of Mathematics. He came to IAS as a Veblen Research Instructor (2022–23), after completing his Ph.D. at the University of Cambridge. He was awarded a Clay Research Fellowship in 2023. To date, his focus has been at the interface between geometry and mathematical analysis, trying to understand special geometric structures which arise and their relation to geometry and topology.

Paul Minter is one of three scholars from the School of Mathematics to appear in the final three installments of the Institute's Paths to Math video series. The series is being released this spring.

Paths to Math chronicles the academic journeys of individuals scholars from IAS, highlighting the moments that ignited their passion for math. With each unique story, the series celebrates the universality of mathematics and the inclusive community of practitioners at IAS.

Alongside Minter, Member Kalyani Kansal (2023–24), and Distinguished Visiting Professor Karen Uhlenbeck (2019–27) are featured. Uhlenbeck's special edition video will close out the series. You can check out Paul's Path to Math by scanning the QR code below. To see the full playlist, visit **ias.edu/paths-to-math**

THE INSTITUTE LETTER 13

BY
Abbey Ellis

LABOR &

In his solo string works, Baroque composer Johann Sebastian Bach was renowned for a powerful paradoxical effect: namely creating the illusion that multiple instruments were playing in harmony when this was not the case. Bach's technique, known as "implied polyphony," often involved rapidly oscillating between two melodies in different octaves, infusing his music with an orchestral effect through the use of only a single violin or cello.

Paradoxes of a musical nature also abound in the work of Clara Latham, Martin L. and Sarah F. Leibowitz Member and Edward T. Cone Member in Music Studies in the School of Historical Studies. The contradictions that inspire her work surround the perceptions of musical labor, with particular reference to music technology. Broadly speaking, Latham is intrigued by the dualities in the perception of music as both a pastime, a source of fun and emotional fulfillment, and an activity that requires intense effort to perfect.

The association of music and leisure often causes the labor involved in acquiring musical skill to be overlooked. To explain this, Latham gives an example from her experiences in musical conservatory. In such settings, students spend up to 10 hours a day in a practice room, and yet, Latham tells us, "Friends and family will still urge them to get out their guitar in social settings, saying something like, 'don't you want to play for us?'" She contrasts this with attitudes to other enterprises such as cooking: "The same people who urge a musician to pick up their instrument would certainly think twice about saying to someone who owns a restaurant, 'Oh, would you like to come and cater my party for free, just because you love cooking?'"

Because music is often perceived as a passion, something that a performer feels driven to do, there is a pervasive assumption that it does not count as work. Latham describes falling into this fallacy herself during her career as a musician: "When I was 20, before I went on my first tour, I had mental images of our band just rolling up on a bus and having all these people at the ready, setting up our stuff. In reality, it was me and 8 guys in 2 small rental cars driving 10 hours a day, sleeping on strangers' couches. It was hard! Those experiences definitely inspire the question of 'why do people always assume that music is not work?'"

While Latham was teaching the history and practice of electronic music at her home institution, The New School's Eugene Lang College of Liberal Arts in New York, she noticed in some of her students a belief or an expectation that technology would make them better musicians. "Some people think if they just have the right tools and the right technology, they will magically be rendered an expert DJ or musician," Latham says with a smile. The sense gained from a conversation with Latham is that musical labor is at once unacknowledged and also something that musicians seek to do away with.

Latham's personal confrontation of this paradox inspired her latest research efforts in the field of musical technology, which form the focus of her IAS Membership. Her project explores the early days of electronic music, the emergence of which coincided with a period when music began to be viewed as a commodity due to new recording technologies such as phonographs and radios. Latham chose to structure her project around the RCA theremin,[1] the first electronic instrument to be commercially marketed in the U.S. For Latham, the theremin serves as a lens through which to examine both the paradox of musical labor and the broader societal implications of the commodification of music.

The RCA theremin is a highly unusual electronic instrument, notable on account of it being played without physical contact from the musician. The instrument consists of a box with two metal antennae that generate an electromagnetic field. The performer interacts with the theremin by moving their

1 The acronym RCA stands for the Radio Corporation of America, who manufactured the theremin.

& LEISURE

IN THE MUSIC OF THE THEREMIN

hands in the vicinity of these antennae, which disrupts the electromagnetic field. This action produces the theremin's unique, almost squealing sound, which *New York Times* music critic Harold C. Schonberg once described as being like that of a cello "lost in a dense fog, crying because it does not know how to get home."

The instrument's pitch is controlled by vertical hand movements and volume is adjusted by horizontal motion. The positioning of the hands and fingers is also consequential for the sound produced. Thus, although the musician does not actually touch the theremin, their body essentially becomes an extension of the instrument while playing. Although the theremin might seem unusual, its distinctive sound may be more familiar than you first think: the instrument was used in the 1950s film *The Day the Earth Stood Still* to create the ominous sound that signified the appearance of the evil alien.[2]

The theremin first arrived in the U.S. alongside its inventor, Leon Theremin, at the end of 1927. Theremin came to the U.S. from his native Leningrad, where he developed the instrument while working as a scientist. His entrance onto American soil was well-timed: prior to the Wall Street Crash, in the years 1928 and 1929, music technologies such as radios and phonographs were immensely popular.

Yet at the time, there was a backlash against so-called mechanical music. Latham explains that much of this stemmed from those who stood to lose money from the technology's development, such as composers. Early copyright laws meant that a record company could buy one copy of sheet music, make a recording, and then replicate it *ad infinitum*, selling as many records as they pleased. It wasn't until the Copyright Act of 1909 that they had to pay composers a flat rate for each mechanical reproduction.

Amidst the controversies surrounding copyright, mechanical music and so-called mechanical music-makers were imbued with the characteristic of soulless regurgitation, and were presented as being harmful to the tradition and practice of music. John Philip Sousa, in 1906, described such machines as a "…substitute for human skill, intelligence, and soul," and in the melodramatic manner of the alarmist (a label to which he fully submits), likens them to the English sparrow "which, introduced and welcomed in all innocence, lost no time in multiplying itself to the dignity of a pest, to the destruction of numberless native songbirds, and the invariable regret of those who did not stop to think in time."[3]

2 Unsurprisingly, given Latham's research questions, the theremin can itself be considered something of a paradox. It does not straightforwardly fit into the classification of a musical media (like a tape and radio) or an instrument (such as a traditional violin or piano). Latham describes theremins as "objects in-between—an example of a media being used as an instrument."

3 Sousa, J. P. (1906) "The Menace of Mechanical Music" in *Appleton's Magazine* Vol. 8, p. 278

Simple and graceful movements of the hands produce and control the tone of the RCA Theremin. The young lady is playing a note of rather high pitch (note position of right hand) and powerful volume (controlled with left hand)

"Men did play the theremin," Latham says, "but a lot of the players happen to be women. The marketing of the theremin embraced a distinct flapper aesthetic, featuring images of women with a roaring twenties look demonstrating how to play the instrument. This marketing targeted a specific audience, namely the modern woman who embodied the traditional role of a Victorian housewife, but with a new and stylish Gatsby-esque vibe."

Wanamaker Concert

Introducing

RCA THEREMIN

An absolutely new, unique musical instrument anyone can learn to play.

TUESDAY AFTERNOON

October 15th

At 2:30

Wanamaker Auditorium
First gallery, new building

The invention of Professor Leon Theremin, distinguished young Russian scientist . . . it is not a radio, not a phonograph, not like anything you have ever heard or seen. . . has no keyboard, strings, reeds or other mechanical aids or sources of sound.

Is the only musical instrument which may be played without being touched. . . anyone who can hum or whistle a tune can learn to play the Theremin. . . playing this incredible instrument resolves itself into nothing more complicated than waving one's hands in the air!

Demonstration by Zinaida Hanenfeldt

In an effort to combat the criticism leveled at mechanical music, much of the repertoire performed on the theremin consisted of popular classics, such as Schubert's "Ave Maria" and "Air of Dalila" by Saint-Saens. "That couldn't be further from so-called 'new' music that you would expect from the likes of Stravinsky," she tells us. The reason for this is to associate the theremin with so-called bonafide music. "They were trying to emphasize that this *is* music," she continues. "This isn't noise. They were trying to legitimize themselves by appealing to traditional tastes. But then the modernists did not like it for that very same reason. So really, the theremin could not win with either crowd!"

Despite the negative perception of the instrument with some audiences, by 1929, the theremin was being intensively marketed to consumers. This marketing is a key ingredient in Latham's research, as it embodies the tension between labor and leisure. The marketing of the theremin suggested that it would offer the joy of music without the hard work needed to become proficient.[4] For example, one advertisement reads:

> "Without keys, or bow, or reed, or string, or wind, without material media of any kind—anyone can make exquisitely beautiful music with nothing but his own two hands!"[5]

In these advertisements, music is implied to be a labor-intensive endeavor from which the hard work can be removed, but other, contemporaneous marketing campaigns for household appliances present music in a very different light. These ads, for products such as vacuum cleaners and washing machines, name music and dancing as entirely pleasurable pursuits to which consumers can escape after automating their household labor. Again, the question remains of the precise position that music occupies within this society. Is it a leisure activity, or a chore?

While the theremin's marketing blurs the lines between music-as-leisure and music-as-labor, Latham describes it as being inherently based on a lie: the theremin is, in fact, very difficult to play! In her discussion of this, Latham reflected on an interview that she conducted with Lydia Kavina, a prominent figure in the world of the theremin: she is famous as both an educator and performer of the instrument. Kavina, who is also the grand-niece of Leon Theremin himself, described to Latham the challenges associated with mastering this unique instrument. She emphasized that any tiny movement made by the player affects the sound of the theremin, stating that this leaves little room for performative gestures of any kind. "So no classic rock style poses!" adds Latham. Kavina had to dedicate significant skill and practice to excel at playing the theremin. Likely as a result of this, the instrument is not commonly used today. It still maintains a niche but dedicated fan base that appreciates its complexity: "they certainly do not perceive it as easy to play," Latham tells us.

Latham's research also touches upon a second lie inherent in the theremin's marketing, which again surrounds hidden labor. Advertisements for the theremin were geared towards a very particular sector of society: white, middle class American women. But other women, often immigrants or those from less affluent socioeconomic backgrounds, were employed in the production of these technologies. This often-overlooked workforce of women labored in factories for very low wages, due to the fact that they could be paid less than their male counterparts. "Many of the workers manufacturing the components that went into radios and theremins were women," says Latham. "People have cultural memory of women, especially immigrant women, working in factories for the textile industry, and this was happening in the realm of music technology too." Yet the marketing brushes over this, presenting the technology as if it operates entirely independently of human labor. "When it seems like music technology, or a technology in general, is doing some kind of work for you, making you a better musician, I always aim to ask 'what's the other side of that? Where is the labor actually happening?'," Latham says.

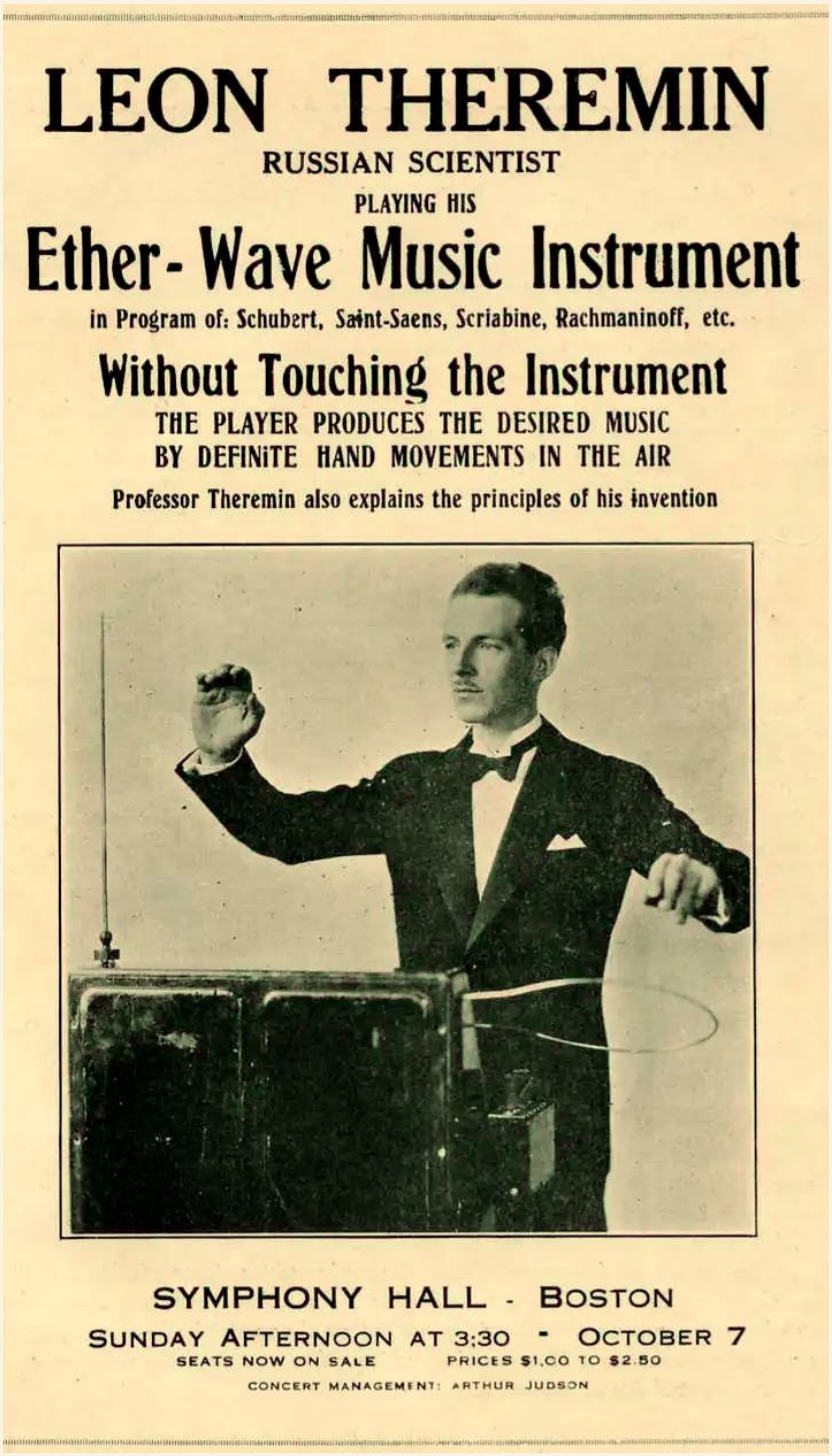
Using music in this way, as a lens through which broader questions about contemporary society can be interrogated, feels natural for Latham. This is due to the strong personal connections that individuals often form with the music that they make and the music that they love. "While people may also feel strongly about other forms of art like paintings or TV shows," she tells us, "the

4 Other new electronic instruments, such as the autoharp, were marketed similarly. Latham describes the autoharp as the Guitar Hero of its day, since it automatically creates chords with the press of a button.

5 RCA Theremin promotional brochure, Radiola Division, Radio-Victor Corporation of America, 1929.

unique intensity of the bond that they have with music creates a potent platform for exploring societal issues. It is this investment that makes music a powerful way to ask wider ethical or political questions."

Moving back to Bach allows us to recognize the harmonies that exist between the ideas exemplified in his music and those that permeate Latham's work. The German composer's implied polyphony technique, which simulates an ensemble of musicians by means of a single instrument, might be considered an early form of music technology and a precursor to the theremin, capable of creating an effect similar to the modern-day mixing desk. For a listener enjoying Bach's music, the technique might seem effortless, but there is, in fact, a great deal of skill involved in its successful execution. Again, juxtapositions between perception and reality proliferate, in the same way that Latham's research reveals both the hidden truth of the complexity of the theremin and the often-overlooked nature of musical labor. A final comparison can be drawn with the help of an experimental research study conducted with real listeners to Bach's music.[6] The study highlighted that the German composer's use of implied polyphony had a significant impact: it enhanced the aural appeal of his melodies even when they were played mechanically, without added expressiveness from a performer. In many cases, passages containing implied polyphony were considered to be more engaging by audiences, especially when the polyphony created simultaneous, linear streams of sound. Similarly, exploring the conflicting concepts entwined in Latham's research, of music-as-labor and music-as-leisure, brings about a richer, and indeed more captivating, understanding of early twentieth century society. ■



Clara Latham is Assistant Professor of Music Technology at Eugene Lang College in New York City. She is currently the Martin L. and Sarah F. Leibowitz Member and Edward T. Cone Member in Music Studies in the School of Historical Studies at the Institute for Advanced Study. Her research focuses on the relationship between music, technology, and labor in the history of electronic music. Her articles have been published in The Journal of Musicology, Sound Studies, Women & Music, *and* The Opera Quarterly.

6 Davis, S. 2006 "Implied Polyphony in the Solo String Works of J. S. Bach: A Case for the Perceptual Relevance of Structural Expression," in *Music Perception: An Interdisciplinary Journal*, Vol. 23.5, pp. 423–446.

Collaborating on Co-production

An interview with Katharina Heyden

In 2017, Katharina Heyden, theologian and current Director's Visitor, founded the Interfaculty Research Cooperation on "Religious Conflicts and Coping Strategies," with the aim of better understanding the role religion plays in social conflicts and exploring religion's potential to both pacify and exacerbate such conflicts. The Cooperation, which she ran as Director through 2022, was a huge collaborative project involving over 40 scholars across a broad variety of fields; in addition to theology, religious studies, and history, scholars worked in areas such as law, psychology, political science, ethnology, and media sciences.

Heyden met Institute Director and Leon Levy Professor, David Nirenberg (then based at The University of Chicago), during a conference titled "Claiming History in Religious Conflicts." At the conference, Heyden, a Full Professor for Ancient History of Christianity and Interreligious Encounters at the University of Bern, Switzerland, listened with great interest to a lecture delivered by Nirenberg on the subject of "The Historian as Theologian." The lecture opened a fruitful interaction between the two, and their shared perspective became the impetus behind the current collaboration between the Institute for Advanced Study and the University of Bern. This collaboration, the Co-produced Religions Project, seeks to think collaboratively about the religions of Islam, Christianity, and Judaism using the concept of co-production as a methodology.

Heyden explains, "The intersections of Islam, Christianity, and Judaism are well-known, but scholars tend to treat each as largely independent from the others, at least after some initial point of origin." The Co-produced Religions Project instead wants to highlight the interdependence of these religions—to see, in fact, that interdependence is a fundamental attribute of the three traditions. Judaism, Islam, and Christianity have formed, re-formed, and transformed over time through interacting with or thinking about one another, such that their pasts, presents, and futures cannot be examined or understood separately. Where intercultural and interreligious studies have been fruitful, they have often also been one-sided, teaching us about a specific group's perception; instead, exploring the three traditions as a co-production captures the dynamic of the three's constant transformation in relation to one another.

The Co-produced Religions Project currently includes 11 postdocs (4 located at IAS and 7 in Bern) and 13 senior scholars of the three religions from around the world. These collaborators work on their own research, as well as collaborate on kindred projects. Some of this work is turned into short studies for the Project's digital archive. Open seminars and in-person conferences and workshops help in the production of co-authored papers.

Heyden dove deeper into the concept of co-production, the details of this collaboration, and what it means to think together in the humanities when she spoke to *The Institute Letter* this spring.

IL: What was your shared perspective with David Nirenberg that grew into this project?

KH: In our conversations, David and I discovered many kindred ways of thinking about not only the entanglement of Judaism, Christianity, and Islam, but also the relationship between critical and constructive work on religions, competing hermeneutics, history, and theology. We both think that the notion of religious co-production can be a productive way of thinking about the entangled histories of the three religions—and that such a notion could help explain the deep ambivalence in the relationship between them, as well as open more potentials for constructive thinking with an historical awareness within these religions. When creating our project, we tried to create a framework which would allow for intense thinking about the notion of religious co-production itself, while also allowing the opportunity to build up a digital archive with sources and case studies that show what kind of work the notion of co-production can actually do.

IL: How might the concept of co-production as a methodology be fruitful in research fields beyond religion?

KH: Co-production can be applied to almost everything that results from any kind of human interaction. Almost every culture, every knowledge, every society, every history is co-produced. So, we do see the notion of co-production as broadly applicable—in fact, co-production has been used recently within political science and sociology as a more normative concept to foster social integration in making laws, creating communities, etc.—but its methodology has to be adjusted and refined for any specific case or context in order to be a useful tool for academic work.

Interestingly, when we first discussed a draft of our conceptual paper in the group and elsewhere, many of our colleagues asked us to sharpen and limit the concept of co-production in order to make it a useful methodology for them to work with. Now, when I present the project and the idea of co-production to even broader interdisciplinary audiences, colleagues from many different fields can immediately see why thinking in terms of co-production can be very inspiring for them too.

> One could say our project on "Co-produced Religions: Judaism, Christianity, and Islam" is an attempt to gather scholars from very different disciplines and academic cultures on a blackboard.

IL: How does the methodology of co-production look when applied to the study of religions, and specifically within your project?

KH: Every human interaction within any dimension of the religious (artifacts, rituals, laws, symbols, stories, images of the divine, etc.) will involve some kind of co-production. In the case of Judaism, Christianity, and Islam, we encounter a more specific type of co-production. These three traditions have a common and competitive history which leads to shared and competing hermeneutics. This is heightened by the fact that they are "historical religions" (i.e., they think about revelation in terms of and connected to past events). Often, to make work on co-production manageable, we choose to focus on one specific object, or ritual, or passage, or story, or theological motif. We call these "moments" of religious co-production. Still, because so many things turn out to be relevant and interrelated in these three traditions, if experts on the three traditions in their various cultural forms look together at one such "moment," it is almost always like opening Pandora's box.

IL: You mention that intercultural and interreligious studies, while fruitful, can be one-sided. Can you think of an example from the Co-produced Religions Project that would highlight the difference?

KH: Here is an example: there has been much work done on the perceptions, images, and imaginations of Muslims and Jews as "religious others" in Christian sources, both texts and images, in the past decades. As a result, we now know much about how "othering" works in religious histories and hermeneutics. What is less examined, and therefore less understood, is what work such representation of "others" did for the self-perception, or self-creation, of those who perceived and presented the "others." Co-production is very much about the back and forth of images and imaginations, narratives and counter-narratives, perceptions and repercussions. And it is not limited to detecting the intentions of authors we can clearly identify as either Muslim, or Jewish, or Christian (which is what both historians and theologians usually try to figure out). It is more about the dynamics and new meanings that emerge from the various interactions of historical agents. And to understand that, you need to include sources and pieces of evidence from many places and times and not limit yourself to the study of one or another clearly identifiable agent or author.

IL: How does using the concept of co-production to capture the dynamic of these three traditions' transformations help you, as a theologian, understand the past with an eye toward the present and the future?

KH: Religious "insiders" and communities tend to think of (and represent) their traditions as traditions of developments, rather than entanglements. (Alas, the English cannot really duplicate the German pun with the words "Entwicklung," which means development, and "Verwicklung," which means entanglement.) This has to do with a certain ideal of "purity" in many religions. But historical research on religions teaches us that there is no such thing as pure tradition, or pure development. This is the critical potential of historical research.

But there is a constructive potential, too. If religious communities can learn to think of themselves as co-produced, they will also learn to acknowledge what they owe to each other, in the good and the bad sense of owing. Such awareness of being deeply co-produced could be cultivated within religious communities in gestures and attitudes which are grateful and responsible to the others at the same time. If we take co-production seriously, we have to admit that neither of the three traditions can understand themselves without the others, that each one was, is, and will be dependent on the others for historical reasons.

When I give sermons in Switzerland, I always try to preach with a kind of awareness that the Christian tradition has always been co-produced. This includes not only showing what Christians owe to Jews and Muslims, but also pointing to the ambivalent potentials almost every theological thought in Christianity has with regard to Judaism and Islam, which is, of course, something that preachers often would rather avoid.

IL: What does "thinking together" look like for the Co-produced Religions Project?

KH: Thinking about historical and hermeneutical co-production in and across Judaism, Christianity, and Islam almost always requires collaboration. I guess this is mainly because we are trained as we are: as experts in only one, or sometimes even two, of the traditions. In a sense, the way we are trained in academia today is still mirroring the tendency of religious traditions to treat themselves independently from each other! One might hope this will change in the future, but even then I don't think that one single scholar can really embrace everything that is necessary to seriously examine the co-production of these three religions. The challenge starts with language skills and mere knowledge of historical archives: for antiquity and the Middle Ages, you must at least cover sources in Hebrew, Aramaic, Syriac, Greek, Arabic, and Latin. And then there is also Coptic, Ethiopic, Armenian, Georgian, Judeo-Arabic, etc. Not to forget material cultures, which are so important if we try to understand "lived religion." For this, we need the expertise covered by archeologists and art historians. Then, in order to be able to understand such a complex phenomenon as religion, you need to combine etic and emic perspectives, i.e., inner-religious (such as theology, philosophy, and law) and outside perspectives (meaning sociology, anthropology, ethnology, and religious studies). Very few academics are trained to combine emic and etic perspectives and methodologies. So I would claim that serious academic research on the co-production of these three traditions in all their variety cannot be anything but a collaborative effort.

Sometimes, when I see scientists standing at the huge blackboards in Rubenstein Commons—where my office is located—vividly discussing equations, formulae, and other scientific problems, I find myself wondering: what would scholars in my own field, history of religions, do if they found themselves together at a blank blackboard? One could say our project on "Co-produced Religions: Judaism, Christianity, and Islam" is an attempt to gather scholars from very different disciplines and academic cultures on a blackboard. Religion is, of course, not a problem one could "resolve" like a scientific problem. But it is no less complex. And given that the three religions have proven their potential to both aggravate and pacify conflicts throughout history to this present day, it is not only a fascinating subject but also an important goal to better understand the ambivalent dynamics and potentials of religions. ■

The case study on the following pages is a recent project by Heyden and Nirenberg, examining the co-production of "Joseph tunics." Scan the QR code to visit the Co-produced Religions website, where you will be able to read the unabridged version of this piece, access the other case studies in their digital archive, and find out more about the project.

The Co-produced Religions project will continue its work with a conference on "the excluded third" in June 2025, along with its open seminars, book series, collaborations and co-authored papers, and additions to the digital archive.

Wearing the "Egyptian Dream"
Joseph Tunics as Multi-layered Objects of Religious Co-production

by Katharina Heyden and David Nirenberg

Shortly after the Muslim conquest of Egypt in 641 C.E., linen and woolen tunics decorated with colorful motifs from the story of Joseph the Dreamer became fashionable among wealthy urbanites. This fashion trend, co-produced between Judaism, Christianity, and Islam, can tell us a great deal about how Egyptians of all three religions shared ideas about many subjects, from hopes for a fortunate life to stereotypes about skin color and the slave trade. These textiles also teach us that even what we do not know about past worlds can stimulate our thinking about religious co-production.

Fig. 1: Central medallion of Joseph-Orbiculus, Egypt, (7./8. cent.) Stadtmuseum Simeonstift Trier Inv. Nr. VII 52

Evidence of a fashion trend emerges from the desert sands of Egypt, whose dry embrace has preserved more than 70 fragments of wool and linen tunics decorated with scenes from the story of Joseph.

As told in chapters 37–40 of Genesis and in Sura 12 in the Qur'an, that story is gripping. It tells of a gifted and dreamy child, preferred by his father above his elder siblings, almost murdered by his jealous brothers, only to be plucked from death and sold into slavery in Egypt. His owner's wife, angered because he resisted her lascivious desires, has him imprisoned on false charges of rape. Released after proving a skilled interpreter of dreams, he is promoted to a position of great power at Pharaoh's court, where his foresight and strategy saves the Egyptian people and reunites his Israelite kin.

Small wonder such a story attracted interest. It was expanded into a Hellenistic novel, *Joseph and Asenath*, probably by a Greek-speaking Jew in Egypt in the first century, though the oldest surviving manuscript is a sixth century version in Old Syriac. In this version, after a long struggle against the desire of the many Egyptian women whose desire is kindled by his beauty, Joseph marries Asenath, mentioned as his wife in Genesis 41:45 but now identified as the daughter of his owner Potiphar, converted to Judaism. Roughly a century later the (Christian? Jewish? Jewish-Christian?) *Testament of the Patriarchs* also dwells on the attempts of the Egyptian women to seduce Joseph. Another few centuries later we find twelve lengthy Syriac Christian sermons *On the most beautiful Joseph*. The Qur'an dedicated its longest continuous narrative to a biblical figure in the eponymous Sura 12, entitled Yūsuf, whose themes include Joseph's overwhelming beauty, patience in adversity, resistance to female seduction, and God's ultimate rewarding of virtue. And across this entire period, the rabbis of the Talmud drew on the Joseph of Genesis to think about love and jealousy, virtue and temptation, migration and homecoming, even the coming Messiah.

These texts, all of them produced before the tunics, constitute a form of co-production. In them we can see diverse communities of Jews, Christians, and Muslims adapting an ancient story, borrowing and translating it from one another, influencing each other's interpretations even as they tailored their own to their needs. Sometimes those needs were common. Joseph provided believers in all three faiths with an example of virtuous beauty, of hope even in deepest despair, and of the highs and lows of life in family, household, and court. Those needs could also be exclusive or competitive. Christian exegetes came to interpret Joseph, raised from the deadly pit, as a figure of Christ. Potiphar's lecherous and falsely accusing wife, on the other hand, they equated with the Jews and their Synagogue. In the Qur'an, Yūsuf criticizes those who associate partners with God, taking aim at both pagans and Christians. And according to Islamic tradition, the entire Sura was revealed in response to Jewish rivals who had induced the people of Mecca to test the Prophet Muhammad by asking him about Joseph.

Regardless of whether their goals are common or distinctive, in most of these texts we can tell what community produced them. It is otherwise with the woven story. All the surviving examples of Joseph tunics come from the first two centuries of Islamic rule, that is from roughly 650–850 C.E., when communities of all three faiths were present in Egypt. [...]

Fig 2: St. Menas Tunic, Egypt, from Akhmim/Panopolis necropolis; 7./8. cent., woven linen with tapestrywoven woolen decoration; 120x 104 cm; Victoria and Albert Museum in London, Inv. Nr. 136-1891

Fig. 3: Joseph-Orbiculus, Egypt, (7./8. cent.), 30x 28 cm, white linen and colored wool, rep binding, flying needle; Stadtmuseum Simeonstift Trier Inv. Nr. VII 52

No tunic has been preserved intact, but we can deduce the arrangement of the ornaments from other tunics (Fig. 2). Most of the 70 extant decorative fragments of Joseph tunics spread around the world show scenes from Joseph's childhood, as in the circular piece, or orbiculum, at the Simeonstift in Trier (Figs. 1 and 3).

Even after deciphering the woven narrative, it is still not easy to know who wove it or who wore it. These were clearly precious objects, their story of redemption from death and the triumph of virtue over adversity making them an attractive choice not only for luxury garb but also for burial. (As is generally the case with Egyptian textiles from this period, our surviving examples all come from funeral contexts.) Muslims, Christians, and Jews alike could have seen the Joseph tunics being worn in markets and other public spaces, or at communal events such as funeral ceremonies or the annual Nile festival, celebrated jointly by adherents of all three religions. We can call the garments "Egyptian," but can we call them Jewish, Christian, or Muslim?

The tunics are generally classified as Coptic, a term used for Egyptian Christians since late antiquity. But these textiles do not have any specifically Christian detail in their pictorial program. Moreover, Joseph tunics only became fashionable under Umayyad Muslim rule (starting in mid seventh century), as material-based dating has recently proven. What might the trend owe to Islam?

Scholars have often assumed that the tunics must have been worn exclusively by Christians because Rabbinic and Islamic law sometimes forbade figurative décor. But written record of these laws post-dates our garments, and, in any case, prohibitions often enough target lived realities. We know that many Islamic (and also Jewish) societies not only tolerated but celebrated figural representation of prophets and kings. The Umayyad caliphs themselves decorated the walls of their palaces and even their coinage with human figures. And long after the Umayyads, the historian al-Maqrizi reports that in tenth century Cairo, people would stop by the house of a Muslim named al-Nu'man to see a painting of Joseph on his wall, because they admired the way in which the painter had made the white body of Yūsuf stand out against the dark background.

The historical archive we possess today does not allow us to name with any certainty the religion of the weavers or the wearers of these tunics. This is only in part because of the paucity of the evidence: it is also because these objects were so thoroughly co-produced by Christians, Muslims, and Jews. We've already touched on one level of this coproduction: the textual story of Joseph had passed through many hands as it made its way from Hebrew to Septuagint Greek to the Aramaic, Coptic, and Syriac Christian translations of the "Old Testament" to the Arabic of the Qur'an, and thence to countless collections of stories. [...]

In fact, the textile Joseph was just as co-produced as the textual. The absence of specifically Christian motifs and the emergence of the woven Joseph story under early Islam is not exceptional, but rather representative of the history of Egyptian clothes. Dionysian-pagan motifs predominated on textiles throughout the Hellenistic, Roman, and Byzantine periods in Egypt, even during centuries of Christian dominance. Biblical motifs emerged only with the arrival of Islam, which seems to have caused a change in pictorial program that we might characterize as anti-pagan, rather than the iconoclasm one might expect. In other words, the mere existence of biblical motifs on Egyptian textiles is

already a religious co-production.

In the specific case of the Joseph motif, some of its particulars might also point to traces of co-production. Much more than the account in Genesis, the Qur'an emphasizes the role of Joseph's owner's wife, making her a protagonist of the story, and even justifying her passionate response to Joseph's overwhelming beauty (12:29-33). Perhaps this explains why, in some examples, the slave owner may be represented as a woman rather than a man (Fig. 4).

There are other hints at deep processes of co-production. The Umayyad period saw the rapid expansion of a vast trade in sub-Saharan peoples, as the new Islamic rulers sought to build an enslaved labor force (called the Zanj) for the marshy lands of southern Iraq. The striking blackness of the slave trader in the orbiculi might reflect Egyptian experience of this contemporary trade. Or it could be the product of a centuries-long process whereby Hellenistic, Christian, and Islamic ethnographers attempted to map biblical designations such as Ishmaelite and Midianite (as Genesis names the groups involved in the discovery and sale of Joseph) onto the peoples of the world they conquered.

Fig. 4: Detail of Joseph Orbiculus, Egypt, 7./8. cent., woven linen with tapestry-woven woolen decoration; Stiftung Phoebus Antwerpen, Inv.-Nr. 625

By the time the story of Joseph emerged onto textile under the Umayyads, it already had a very long history. Every moment in that history produced many different but inter-related meanings within Judaism, Christianity, and Islam. For Jews such as Artapanus, Philo, and Josephus, Joseph was the patriarch who brought Judaism to Egypt and helped establish a flourishing Empire. For Christians, Joseph's triumph over mortal adversity served as a prefiguration of Christ. Theologians such as Origen and Tertullian were captivated by Joseph's youthful dreams, drawing parallels between the conflicts Joseph and Jesus had with their brothers, and between Jacob's bowing to Joseph and Mary's veneration of Jesus under the cross. For Muslims, Yūsuf was akin to the prophet Muhammad in the combination of wisdom, virtue, and beauty, as the passionate attention paid to Joseph in an eleventh-century collection of *Lives of the Prophets* demonstrates.

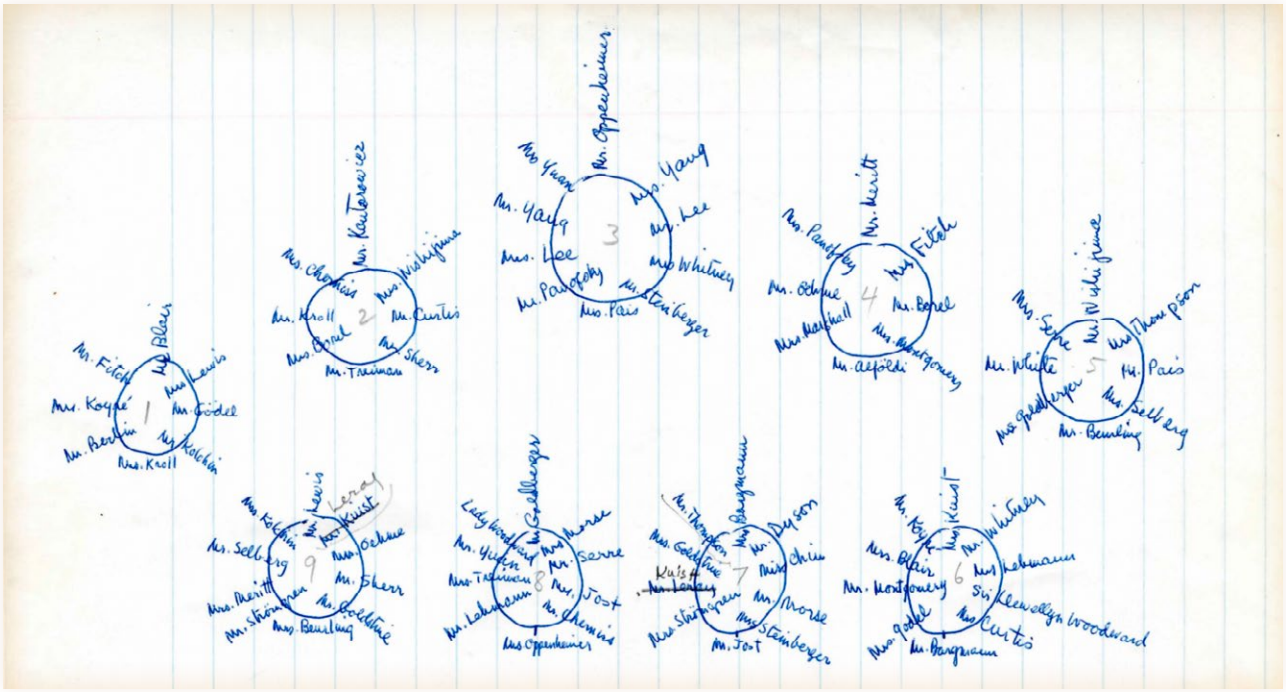
But the Umayyad moment also reminds us that Muslims, Jews, and Christians not only shared many meanings of the Joseph story, but also constantly reshaped their understanding of that story in relation to each other. In the generations after the Arab conquest of Egypt, Joseph came to do new work for believers of all three faiths. Joseph was, after all, the quintessential immigrant to Egypt, an aspect emphasized in the Qur'an, which repeats (at v. 21 and 56) that "This is how We established Joseph in the land, so that We might teach him the interpretation of dreams / so that he settled wherever he pleased."

For Muslims in Umayyad Egypt, "the land" was the one they now ruled as newcomers, much as Joseph had. For Jews and Christians, Joseph could provide an example of how to serve in some of the many, sometimes very powerful, roles they would play in the courts of Egypt's Muslim rulers over the centuries. Severus of Al Ashmuein, for example, drew on Joseph to praise the skills of John IV, the Christian Patriarch of Alexandria under Umayyad rule (r. 775-799): "Now Abba John was beautiful in form, perfect in stature, inspired by God in all his affairs. And everyone desired to behold his welcome form, and it was granted to him to be acceptable to all princes and governors, like Joseph the Truthful, with whom God's hand was, and whom God saved from all his sorrows, and to whom he gave grace and wisdom before the Pharaoh." From such examples we can see how Joseph's relationship to Pharaoh could serve Umayyad Egyptian elites of all faiths as a divinely sanctioned example of politics in a religiously plural society.

We may not be able to say whether the Joseph textiles were Christian, Jewish, or Muslim. But what we can say with certainty is that they were a co-production, one that articulated new possibilities for co-existence of the three religions in Egypt. ■

Intimacy, Illumination, and Understanding ... But First Drinks

by Caitlin Rizzo



SHELBY WHITE AND LEON LEVY ARCHIVES CENTER

Institute records document the table arrangements for an on-campus dinner held to celebrate C. N. Yang and T. D. Lee's 1957 Nobel Prize in Physics. In addition to knowing that Isiah Berlin and Alexandre Koyré sat next to each other, we also know that they enjoyed a meal of turtle soup.

In the Winter 1958 issue of *Daedalus*, J. Robert Oppenheimer, then-IAS Director (1947–66), published "The Growth of Science and the Structure of Culture," an attempt to understand how scientific revolutions bear upon both cultural and disciplinary "conclusions about the nature of reality." In the essay, Oppenheimer creates a lofty framework to understand the influence of science on culture, so readers may be surprised to learn that he concludes the essay quite simply:

> I think that the unity we can seek lies really in two things. One is that the knowledge which comes to us at such a terrifyingly, inhumanly rapid rate has some order in it. We are allowed to forget a great deal, as well as to learn. This order is never adequate. The mass of ununderstood things, which cannot be summarized, or wholly ordered, always grows greater; but a great deal does get understood.
>
> The second is simply this: we can have each other to dinner. We ourselves, and with each other by our converse, can create not an architecture of global scope, but an immense, intricate network of intimacy, illumination, and understanding. Everything cannot be connected with everything in the world we live in. Everything can be connected with anything.

Intimacy, illumination, and understanding are, perhaps, a tall order for a dinner. However, shared meals have become pivotal architecture at the Institute for social and intellectual engagement. From our cherished teatime tradition to celebratory dinners, the Institute fosters

ALFRED EISENSTADT

Institute for Advanced Study Dining Room in Fuld Hall

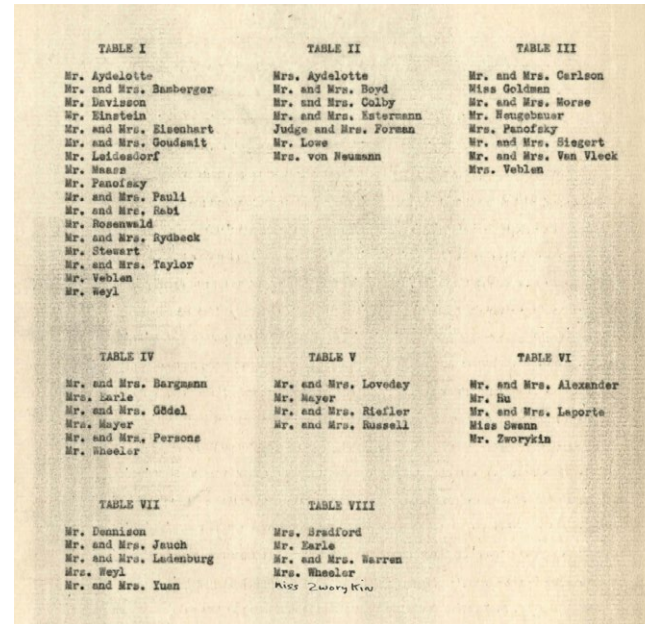


TABLE I
Mr. Aydelotte
Mr. and Mrs. Bamberger
Mr. Davisson
Mr. Einstein
Mr. and Mrs. Eisenhart
Mr. and Mrs. Goudsmit
Mr. Leidesdorf
Mr. Maass
Mr. Panofsky
Mr. and Mrs. Pauli
Mr. and Mrs. Rabi
Mr. Rosenwald
Mr. and Mrs. Rydbeck
Mr. Stewart
Mr. and Mrs. Taylor
Mr. Veblen
Mr. Weyl

TABLE II
Mrs. Aydelotte
Mr. and Mrs. Boyd
Mr. and Mrs. Colby
Mr. and Mrs. Estermann
Judge and Mrs. Foreman
Mr. Lowe
Mrs. von Neumann

TABLE III
Mr. and Mrs. Carlson
Miss Goldman
Mr. and Mrs. Morse
Mr. Neugebauer
Mrs. Panofsky
Mr. and Mrs. Siegert
Mr. and Mrs. Van Vleck
Mrs. Veblen

TABLE IV
Mr. and Mrs. Bargmann
Mrs. Earle
Mr. and Mrs. Gödel
Mrs. Mayer
Mr. and Mrs. Persons
Mr. Wheeler

TABLE V
Mr. and Mrs. Loveday
Mr. Mayer
Mr. and Mrs. Riefler
Mr. and Mrs. Russell

TABLE VI
Mr. and Mrs. Alexander
Mr. Bu
Mr. and Mrs. Leporte
Miss Swann
Mr. Zworykin

TABLE VII
Mr. Dennison
Mr. and Mrs. Jauch
Mr. and Mrs. Ladenburg
Mrs. Weyl
Mr. and Mrs. Yuan

TABLE VIII
Mrs. Bradford
Mr. Earle
Mr. and Mrs. Warren
Mrs. Wheeler
Miss Zworykin

SHELBY WHITE AND LEON LEVY ARCHIVES CENTER

Seating chart for a celebratory dinner held in honor of Wolfgang Pauli's 1945 Nobel Prize in Physics

its unique network of intimacy, illumination, and understanding by gathering its community around the table. The Shelby White and Leon Levy Archives Center is home to a range of documents which speak to dining at the IAS, from dinner menus to seating charts. Though such documentation hardly seems to offer much to scholarship as a singular item, cumulatively these records offer a fascinating glimpse into the history of shared meals at the Institute, a chance to wonder at possible conversations had across the table, and the opportunity to appreciate the intricate network we have built, and continue to build, by "having each other to dinner."

The second is simply this: we can have each other to dinner.

This iteration of "From the Archives" originated with Landon Jones, long-time Friend of the Institute, who, having always found fruitful the relationship between food and thought, reached out to the Archives Center to share his research into the topic. Over the years, he has conducted interviews with IAS community members and amassed folders of historic documentation, showing how meals came to have a central significance from nearly the first academic term to present day.

In his study overlooking Marquand Park, Jones offers insights into the ways that scholars have often relied upon food as a metaphor to communicate complicated ideas in a universal way. We might consider the way that black holes "eat" the matter around them in astrophysics, for example, or the way that we ask for the "raw" data or "raw" numbers as an analogy in mathematics. These metaphors can offer significant insight into the way both scholars and the general public understand both the referent and the culture in which complicated ideas circulate.

As Oppenheimer states in his conclusion, such architectures are not often globally useful; while they can foster connections, these connections are limited in their capacity to illuminate everything. Oppenheimer, though, is clearly not only arguing for "dinner" as metaphor. Anyone who has spent time at the Institute will have experienced first-hand the significant connections that a meal can make. The Archives Center's materials offer us a glimpse at the possible connections made here, through table arrangements and seating charts, which, in turn, offer us a glimpse at the far vaster network of intimacy and illumination of which we are a part.

For instance, our records contain the preparations made by Frank Aydelotte, IAS Director (1939–47), for the dinner to celebrate Wolfgang Pauli's Nobel Prize in Physics on December 10, 1945. The table arrangements preserved by the Institute's Director's Office even reveal the scholars seated among the table of honor. The tables provide a vision of the American pluralistic dream, the "melting pot" (to use another food metaphor) at its best.

The Institute held a similar dinner during the tenure of Oppenheimer to honor C. N. Yang (School of Math/Natural Sciences Faculty 1955–66) and T. D. Lee (Faculty 1960–62 in the same School) for their acceptance of the Nobel Prize for Physics in 1957. Perhaps unsurprisingly, the menus under Oppenheimer reflected a renewed sense of cosmopolitanism (featuring hot French bread and demi tasse), though the pre-dinner cocktails (a staple of mid-century American culture) remained.

Oppenheimer's dinners serve as significant records to document the guests of the Institute that often went otherwise unrecorded. Records from 1961, for example, reveal that Oppenheimer held a dinner in honor of Sir Henry Willink but extended a last-minute invitation to another guest: Vladimir Nabokov. Nabokov's name appears in Oppenheimer's own hand on a list of invitees

and sits next to the Director at the head of the table, only a few months before he would leave the United States for Switzerland for good. The handwritten note is the only record of Nabokov's visit to the Institute that remains in the IAS archives. The addition provides insight into the intimacies of Institute life, and, yet it raises that perpetual question at the center of Oppenheimer's conclusion: What do we make of a universe in which seemingly everything might be connected with anything? Might we strive forever without truly making sense of anything?

Oppenheimer's final answer provides a glimpse of perhaps the most compelling option: we persist. If scholars continue to find ways to anthropomorphize black holes and archivists can still manage to keep up with the "terrifyingly, inhuman rapid rate" that we continue to produce and record new knowledge, there does seem to be hope. And though perhaps food metaphors are not always neatly all-encompassing, here's one that is true: at the Institute, we are constantly nourishing one another. In this place where having each other to dinner means seating next to one another the physicist and the historian, the theologian and the anthropologist, the mathematician and the poet, we offer the opportunity for uninhibited association. And though we face large and complex challenges within a world where we cannot possibly understand everything, every time we come together over a meal and meet a colleague with a new perspective, we can look at such challenges with just a little more illumination and understanding. ■


Dinner Feb. 11

drinks first ? if so, sit down about 7:20-7:25. Felix to ask guests how they like their filet.

turtle soup
small filet with mushrooms — côte roti 55
green beans
rolls
(no salad)
fruit and cheese
coffee, brandy

RO

Sir Henry Willink — Mr. Nabokov
Gen. Greenbaum — Mr. Kennan (?)
Mr. Morse — Mr. Johnson
Sir Hugh Taylor — Mr. Yang
Mr. Lee — Mr. Brown
Dr. Greenbaum — Mr. Cherwin
Mr. Craig — Mr. Dyson

Mr. Taretzki

If Kennan not there, move Taretzki to right

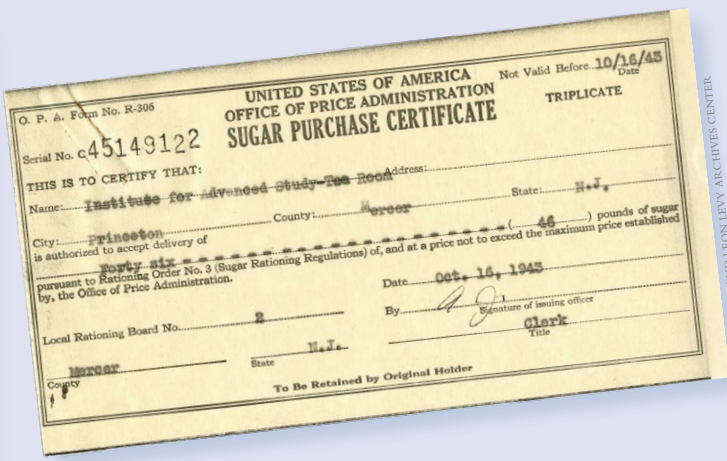
SHELBY WHITE AND LEON LEVY ARCHIVES CENTER

Seating chart for a 1961 dinner held by J. Robert Oppenheimer in honor of Sir Henry Willink, including guest Vladimir Nabokov

Asking Ourselves: Who is at the Table?

Nearly every decade of archival records preserved by the Institute offers insights into the ways that material culture structures and reflects intellectual imagination. Cumulatively, these records of dining menus and seating charts offer an interesting lens by which to understand the way that the material culture of food—with all its attendant hierarchies of production, service, and value—infiltrate the world of scholarship and affect the nature of our understanding. As a microcosm, the records regarding the food required for scholarship reciprocally invite a question about the labor required to cultivate and produce that food, as well as its invisibility both then and now.

In the 1930s and the early 1940s, early dining hall menus and rationing tickets reveal how the austerity of the global depression and the onset of WWII impacted the scarcity of even the most basic food supplies on campus. Correspondence reveals sugar as a coveted commodity, the cause of competition, and, of course, an important fuel for early computers working late into the night. Scholars, including Kara Walker, former guest artist of the Institute, have done much to explore the role that a material commodity as mundane as sugar played in mobilizing a global trade system from its antecedents in the transatlantic slave trade to present day. Walker's famous sculpture *A Subtlety, or the Marvelous Sugar Baby* can help connect the little luxuries of computing scholars in war time to larger hierarchies that normalized the unpaid and overworked labor of black and brown bodies working to sweeten, lighten, and whiten the lives of a more privileged class of individuals.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Serial No. C 45149122

THIS IS TO CERTIFY THAT:

Name: Institute for Advanced Study-Tea Room Address:

City: Princeton County: Mercer State: N.J.

is authorized to accept delivery of (46) pounds of sugar

pursuant to Rationing Order No. 3 (Sugar Rationing Regulations) of, and at a price not to exceed the maximum price established by, the Office of Price Administration.

Forty six

Date Oct. 16, 1943

By (Signature of issuing officer)

Local Rationing Board No. 2

Clerk
Title

Mercer
County

N.J.
State

To Be Retained by Original Holder

SHELBY WHITE AND LEON LEVY ARCHIVES CENTER

A sugar certificate submitted in 1943 on behalf of the Institute's "Tea Room" during World War II. Though many people associated with the Institute were involved in war work, either at home or abroad, and the numbers on campus were somewhat reduced, rituals like tea were maintained for the duration of the war.

News of the Institute Community

Director

DAVID NIRENBERG, Director and Leon Levy Professor, won the Eberhard Karls Universität Tübingen's 2024 Leopold Lucas Prize.

Faculty

BHARGAV BHATT, Fernholz Joint Professor in the School of Mathematics, received the 2023 Infosys Prize in Mathematical Sciences.

DIDIER FASSIN, James D. Wolfensohn Professor in the School of Social Science, was presented with an honorary doctorate from the Université Libre de Bruxelles.

ALONDRA NELSON, Harold F. Linder Professor in the School of Social Science, was honored with the Technical University of Munich School of Social Sciences and Technology's inaugural Friedrich Schiedel Prize for Social Sciences and Technology. She was also named the U.S. representative to the United Nations High-level Advisory Body on Artificial Intelligence, and she received the Public Service Award from the Federation of American Scientists.

JAMES STONE, Professor in the School of Natural Sciences, was awarded the James Craig Watson Medal by the National Academy of Sciences.

MISHA TSODYKS, C.V. Starr Professor in the School of Natural Sciences, was recognized with a Swartz Prize for Theoretical and Computational Neuroscience by the Society for Neuroscience.

Emeriti

EDWARD WITTEN, Professor Emeritus in the School of Natural Sciences, was awarded a Benjamin Lee Professorship by the Asia Pacific Center for Theoretical Physics. The professorship was named for prominent South Korean physicist **BENJAMIN WHISOH LEE**, a frequent IAS Member.

Members

NETA BAHCALL, Member (1982–83) and Visitor (1983–85, 1986–87) in the School of Natural Sciences, was awarded the 2024 Henry Norris Russell Lectureship from the American Astronomical Society.

American Mathematical Society Awards

Six past Members from the School of Mathematics were presented with awards:

JÓZSEF BALOGH (2002)
Leroy P. Steele Prize for Seminal Contribution to Research

JESSICA FINTZEN (2017–18, 2020–21)
Frank Nelson Cole Prize in Algebra

JENNIFER HOM (2015–16)
Levi L. Conant Prize

SVITLANA MAYBORODA (2018, 2021)
Elias M. Stein Prize for New Perspectives

VICTOR OSTRIK (2003–04, 2007)
Chevalley Prize in Lie Theory

GRETA PANOVA (2017–18)
AMS Joan and Joseph Birman Fellowship for Women Scholars

MANDUHAI BUYANDELGER, Member (2014–15) in the School of Social Science, was awarded the E. Gene Smith Inner Asia Book Prize by the Association for Asian Studies.

TAMARA GOLAN, Member in the School of Historical Studies, was awarded the Historians of German, Scandinavian, and Central European Art Emerging Scholars Prize.

DOUGLAS FLOWE, Member in the School of Historical Studies (2021–22), will co-host the upcoming season of the *Ancient China From Above* docuseries on National Geographic.

WANG HUI, Elizabeth and J. Richardson Dilworth Fellow in the School of Historical Studies, was included in *Prospect Magazine*'s 2024 list of Top Thinkers. He has also been elected to the Academy of Europe.

KRITI KAPILA, Member in the School of Social Science, was awarded the Bernard S. Cohn Prize for first books on South Asia by the Association for Asian Studies.

SAMUEL MOYN, Member (2008–09) in the School of Historical Studies, was included in *Prospect Magazine*'s 2024 list of Top Thinkers.

JOANNA OLCHAWA, Agnes Gund and Daniel Shapiro Member in the School of Historical Studies, was awarded the Reginald Taylor and Lord Fletcher Essay Prize from the British Archaeological Association. She also received EU grant funding from the Deutsche Forschungsgemeinschaft as Principal Investigator on the project *Sound Art History*.

KEN ONO, Member (1995–97) in the School of Mathematics, was elected an Honorary Fellow of the Indian Academy of Sciences.

ALISON LOCKE PERCHUK, Friends Member (2018–19) in the School of Historical Studies, received the 2024 Karen Gould Prize for Art History from The Medieval Academy of America.

JULIA TICONA, Member in the School of Social Science, was awarded a grant as part of the NEH's Dangers and Opportunities of Technology: Perspectives from the Humanities program.

ROBERTO TOTTOLI, Member (2016–17) and Visitor (2019) in the School of Historical Studies, was elected President of the Foundation Leone Catenai for Muslim Studies at the Accademia dei Lincei.

Avi Wigderson Receives 2023 ACM A.M. Turing Award

An honor regarded as the "Nobel Prize of Computing"

Avi Wigderson, Herbert H. Maass Professor in the School of Mathematics, was named by the Association for Computing Machinery (ACM) as the recipient of the 2023 ACM A.M. Turing Award. With this honor, Wigderson has become the first person to receive both a Turing Award and the Abel Prize, widely considered to be the highest recognition for lifetime achievement in mathematics.

DAN KOMODA

The Turing award recognizes Wigderson's foundational contributions to the theory of computation, and decades of intellectual leadership in theoretical computer science.

"I am excited that the ACM has again recognized with this award the theory of computation community, which has contributed so much to computing practice and technology," said Wigderson. "I feel lucky to be part of this extremely dynamic community, whose fundamental goals have deep conceptual, intellectual, and scientific meaning, well beyond practical motivations. My four decades in this field have been a continuous joyride, with fun problems, brilliant researchers, and many students, postdocs, and collaborators who have become close friends."

Wigderson's key contributions have enhanced understanding of the role of randomness and pseudorandomness in computation. Computer scientists have discovered a remarkable connection between randomness and computational difficulty (i.e., identifying natural problems that have no efficient algorithms). Working with colleagues, Wigderson authored a highly influential series of works on trading hardness for randomness. Simply put, they proved that randomness is not necessary for efficient computation. This sequence of works revolutionized the ways in which computer scientists think about randomness, ideas which were applicable to many areas of theoretical computer science. ■

Scan to watch a video of Wigderson discussing his Turing Award and research career in a conversation with IAS Director and Leon Levy Professor David Nirenberg

American Academy of Arts and Sciences

The following scholars have been elected to the AAA&S:

School of Mathematics

CAMILLO DE LELLIS
IBM von Neumann Professor
AKSHAY VENKATESH
Robert & Luisa Fernholz Professor
SOURAV CHATTERJEE (2023–24)
HEE OH (2002–03, 2006)
VLADIMÍR SVERÁK (1993, 2021–22)

School of Natural Sciences

KENNETH INTRILIGATOR (1995–97, 1998–99, 2005–06)
XIAO-GANG WEN (1990–91, 2022–23)

School of Social Science

WEBB KEANE (1997–98, 2019–20)
MURIEL NIEDERLE (2005–06)
GARY GERSTLE (1990–91)
GIDEON A. ROSEN (2014–15)

2024 Sloan Research Fellowships

The following scholars have won Sloan Research Fellowships:

School of Mathematics

THEODORE DIMITRIOS DRIVAS (2022)
SIMON SHAOLI DU (2019–20)
JIAOYANG HUANG (2019–20)
CHI JIN (2019)
DANIEL LITT (2018–19)
JINYOUNG PARK (2020–21)
SARAH PELUSE (2020–23)
SAMUEL PUNSHON-SMITH (2021–22)

School of Natural Sciences

SUSAN E. CLARK (2017–21)
GEOFF PENINGTON (2021–22)

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