The Symplectic Piece

BY HELMUT HOфер AND DEREK BERMEl

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—JOHN CAGE

Helmut Hofer, Professor in the School of Mathematics, writes:

Last September, the School of Mathematics launched its yearlong program with my Member seminar talk “First Steps in Symplectic Dynamics.” About two years earlier, it had become clear that certain important problems in dynamical systems could be solved with ideas coming from a different field, the field of symplectic geometry. The goal was then to bring researchers from the fields of dynamical systems and symplectic geometry together in a program aimed at the development of a common core and ideally leading to a new field—symplectic dynamics.

Not long before, in my 2010 inaugural public lecture at IAS, “From Celestial Mechanics to a Geometry Based on the Concept of Area,” I had described the historical background and some of the interesting mathematical problems belonging to this anticipated field of symplectic dynamics. The lecture began with a computer program showing a simple single orbit to a complex multicolored tangle of orbits. This image (produced with a Java applet by Alec Jacobson at http://alecjacobson.com/programs/three-body-chaos) shows colorful markings of the paths of satellites as they evolve from a

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Leon Levy Foundation Permanently Endows the Directorship

The Leon Levy Foundation has donated $20 million to the Institute for Advanced Study. This gift reflects continued support of the Institute by Trustee Shelby White and the Leon Levy Foundation, which was created in honor of White’s late husband, Leon Levy, a leading financier who served on the Institute’s Board of Trustees for fifteen years and as Vice Chairman and President of the Corporation from 1995–2003. “This magnificent gift from the Leon Levy Foundation will help to further strengthen the Institute’s endowment, which is essential to our continued success as a research institution of the highest standard,” said Robbert Dijkgraaf, Director of the Institute and Leon Levy Professor. “Shelby White’s and the Foundation’s stalwart support has sustained important areas of research at the Institute, including the formation of an archives center and program, and this most recent donation moves us closer to our $200 million campaign goal. I am honored to be the first to hold the new endowed Directorship.”

White, founding Trustee of the Leon Levy Foundation, commented, “My husband would have been proud to have the Institute Directorship named in his honor. He was a great believer in the Institute’s mission and work, and he personally devoted many hours to its success. The Foundation is pleased that it can continue to support the Institute’s important initiatives.”

This major gift will be increased by $5 million from the $100 million challenge grant made by the Simons Foundation and the Charles and Lisa Simonyi Fund for Arts and Sciences in 2011 to create a $25 million Leon Levy Endowment Fund. In recognition of the gift, the Director of the Institute will carry a new title and titular professorship, Director and Leon Levy Professor, which will be permanently associated with the position. This donation brings the capital campaign total to more than $48 million, of the $100 million goal to meet the challenge grant (see page 15).

The Leon Levy Foundation, founded in 2004 to support scholarship at the highest level, has continually contributed to the Institute in significant ways. The New Initiatives Fund, established by Levy and White in 1998, helped to promote progress in new and important programs such as systems biology and theoretical computer science, and to support emerging research in mathematics and astrophysics. From 2005–12, the Foundation sponsored a Leon Levy Member in the School of Social Science. Past Leon Levy Members have included economists and political scientists who, through the support of the Foundation, have also delivered an annual Leon Levy Lecture on the nature of their work while in residence at the Institute. The Foundation funded the new land-scaping of the courtyard entrance to Fuld Hall, completed in 2009, as well as other landscape improvements, and it supported a historic landscape study to fully understand the development of the Institute’s campus. A $3.5 million gift from the Foundation in 2009 funded the creation of the Shelby White and Leon Levy Archives Center, which is enabling the conservation and collection of the Institute’s current and future holdings of records and historical documents, Faculty papers, oral histories, photographs, and other significant documentation.
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Questions and comments regarding the Institute Letter should be directed to Kelly Devine Thomas, Senior Publications Officer, via email at kdthomas@ias.edu or by telephone at (609) 734-8091.

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News of the Institute Community

JUAN MALDACENA, Professor in the School of Natural Sciences, has received the 2012 Fomenchuk Prize of the Institute of Theoretical and Experimental Physics in Moscow, awarded for outstanding achievement in theoretical physics. Maldacena and former School of Natural Sciences Members LUIS FERNANDO ALDAY (2007, 2008–10) and AMIT SEVER (2011–12), along with Pedro Vieira, were awarded the Journal of Physics A Best Paper Prize 2012 for their paper “Y-system for Scattering Amplitudes” in Journal of Physics A: Mathematical and Theoretical 43 (2010). Allday is Professor at the Mathematical Institute of the University of Oxford, and Sever is a Senior Postdoctoral Fellow at the Perimeter Institute for Theoretical Physics.

JOAN WALLACH SCOTT, Harold F. Linder Professor in the School of Social Science, and KAREN UHLENBECK, Robert and Luis Fernholz Visiting Professor (2012) in the School of Mathematics, have been awarded honorary degrees by Princeton University.

RICHARD TAYLOR, Professor in the School of Mathematics, and BRUCE KONNER, an Institute Trustee and Chairman of Castron Alternative Management LP, have been elected to the American Academy of Arts and Sciences, along with eight former Institute Members and Visitors.

CAROLINE WALKER BYNUM, Professor Emerita in the School of Historical Studies, has been elected to the Orden Pour le Mérite für Wissenschaften und Künste of the Federal Republic of Germany. Bynum is one of two new members elected by the membership to the Order, which has a total of thirty-seven German and thirty-six foreign members.

Berghahn Books has published Myth and Modernity: Barlach’s Drawings on the Nibelungen by PETER PARET, Professor Emeritus in the School of Historical Studies, and Helga Thiemer. The book addresses Ernst Barlach’s sequence of large drawings on the medieval epic The Song of the Nibelungen, examining the epic’s course through German history and the artist’s biography as well as the place the drawings occupy in the art, culture, and politics of Germany.

Yale University Press has published In God’s Shadow: Politics in the Hebrew Bible by MICHAEL WALZER, Professor Emeritus in the School of Social Science. Drawing on decades of thinking about Biblical politics, Walzer discusses the views of the ancient biblical writers on justice, hierarchy, war, the authority of kings and priests, and the experience of exile.

AVISHAI MARGALIT, former George F. Kennan Professor (2006–11), in the School of Historical Studies, has been awarded the Ernst Bloch Prize by the city of Ludwigshafen by the Rhine, which recognizes works important to a critical examination of the present. Margalit is now an Honorary Fellow at the Van Leer Jerusalem Institute.

ROBBERT DIJKGRAAF, Director of the Institute and Leon Levy Professor, has been made a Knight of the Order of the Netherlands Lion. Dijkgraaf, who is Distinguished University Professor of Mathematical Physics at the University of Amsterdam and past President of the Royal Netherlands Academy of Arts and Sciences (2008–12), also has been appointed as an honorary member of the Netherlands Physical Society and the Royal Netherlands Chemical Society.

GRAHAM FARMELO, a Director’s Visitor, has been awarded the 2012 Kelvin Medal and Prize from the Institute of Physics for his outstanding work in communicating science to a broad audience, in particular for his book The Strangest Man: The Hidden Life of Paul Dirac, Mystic of the Atom (Basic Books, 2009), which he worked on during his stay at the Institute.

RossiLL IMPAGLIAZZO, Visiting Professor (2007–12) and former Member (2003) in the School of Mathematics, is an expert in one mathematicians, theoretical physicists, and theoretical computer scientists selected as Simons Investigators in 2012. The program, which is supported by the Simons Foundation and is in its inaugural year, is intended to enable outstanding scientists to undertake long-term study of fundamental questions. Impagliazzo is Professor at the University of California, San Diego. Eight former Institute Members and Visitors were also selected for the first class of Simons Investigators.

LÁSZLÓ LOVÁSZ, Visiting Professor (2011–12) in the School of Mathematics, and three former Institute Members have been elected to the National Academy of Sciences. Lovász is Professor at Eötvös Loránd University in Budapest.

Four Professors in the School of Natural Sciences—NIMA ARKANI-HAMED, JUAN MALDACENA, NATHAN SEIBERG, and EDWARD WITTEN—have each been awarded $3 million for their significant and path-breaking contributions to the field of fundamental physics from the Milner Foundation. The inaugural Fundamental Physics Prize, created by Internet investor Yuri Milner to recognize transformative advances in the field and inspire interest in fundamental physics, was awarded to five additional recipients—former Members Maxim Kontsevich (1992–93 and 2002), Professor at the Institut des Hautes Études Scientifiques, and Ashoke Sen (1996–98), Professor at the Harish-Chandra Research Institute; Alan Guth of the Massachusetts Institute of Technology; Alexei Kitaev of the California Institute of Technology; and Andrei Linde of Stanford University. The physicists will serve on the selection committee for future recipients of the prize, which will be awarded annually. "These exceptional prizes are well-deserved recognition of the path-breaking contributions of the visionary physicists from the Milner Foundation," said Robbert Dijkgraaf, Director of the Institute and Leon Levy Professor. “The Institute has a remarkable legacy in advancing our understanding of the fundamental laws of nature, and the work of these four current Faculty members illustrates the current strength and excellent future prospects of research in theoretical physics at the IAS. We wish to compliment Yuri Milner for his extraordinary generosity that we hope stimulates new generations of physicists.”

Inscriptions Antica Euclidis anno posteriores. Ed. tenuia. Pars I: Fasc. 5: Lages et decreta annorum 2298–1687/ by STEPHEN TRACY, long-term Visitor in the School of Historical Studies, and Vouda N. Bardi has been published by Walter De Gruyter. The work, which publishes 325 laws and decrees from the first year of independence from Macedonian occupation and the end of the third Macedonian War, was done under the auspices of the Inscriptiones Graecae project of the Berlin-Brandenburg Academy of Sciences.

SUBHANKAR BANERJEE, a former Director’s Visitor (2011), is the recipient of a 2012 Lannan Cultural Freedom Award from the Lannan Foundation. Banerjee is a photographer and writer and the editor of Arctic Voices: Resistance at the Tipping Point (Seven Stories Press, 2012).

MAXIM KONTSEVICH, former Member (1992–93) in the Schools of Natural Sciences and Mathematics and Visitor (2002) in the School of Mathematics, has been awarded the 2012 Shaw Prize in Mathematical Sciences for his work in algebra, geometry, and mathematical physics. Kontsevich is Professor at the Institut des Hautes Études Scientifiques.

JOANNE MANCINI, former Visitor (2009–10) in the School of Social Science, has received the 2011 Patricia and Phillip Frost Essay Award from the editorial board of American Art for her article “Pedro Cambón’s Asian Objects: A Transpacific Approach to 18th-Century California” (Spring 2011). Mancini is Lecturer at the National University of Ireland, Maynooth.

The 2012 Raymond and Beverly Sackler Prize in the Physical Sciences has been awarded to SARA SEAGER, former Member (1999–2002) in the School of Natural Sciences, for her analysis of the atmospheres and internal compositions of extrasolar planets. Seager is Class of 1941 Professor of Physics and Planetary Science at the Massachusetts Institute of Technology.

The Norwegian Academy of Science and Letters has awarded the 2012 Abel Prize to ENDRE SZEMERÉDI, former Member (2007–08, 2009–10) in the School of Mathematics, for his contributions to discrete mathematics and theoretical computer science, and their impact on additive number theory and ergodic theory. Szemerédi is State of New Jersey Professor of Computer Science at Rutgers, the State University of New Jersey, and Research Fellow at the Alfred Renyi Institute of Mathematics, Hungarian Academy of Sciences, Budapest.

STEVEN VANDERPUTTEN, former Member (2005) in the School of Historical Studies, has received the Friedrich Wilhelms Betel Research Award of the Alexander von Humboldt Foundation in recognition of his work on the social and cultural history of the Western Middle Ages. Vanderputten is a Professor at Ghent University.
Major Starr Foundation Grant Supports Simons Center for Systems Biology

Peter Goddard: Thoughts on Stepping Down as Director

The following text is excerpted from remarks given by Peter Goddard, the Institute’s eighth Director (January 2004–June 2012), at a dinner with Trustees, Faculty, and others in May. Peter Goddard first came to the Institute as a Member in the School of Natural Sciences when he was twenty-nine in 1974. He returned to the Institute in 1988 as a Member in the School of Mathematics. A mathematical physicist, he is distinguished for his pioneering contributions in the areas of string theory, quantum field theory, and conformal field theory. Upon stepping down as Director at the end of June, he became a Professor in the School of Natural Sciences.

In some ways it seems like yesterday that the telephone rang in Cambridge and Steve Adler asked me whether I would be interested in being considered in the search for the next Director of the Institute. When I told my wife Helen, she said that it was an enormous honor to be approached in that way. And then a little while later, she said, “But, you are not taking it seriously, are you?”

When Lewis Strauss, who was chairing the search committee in 1946, consulted Albert Einstein about the qualities he should be seeking in the third Director of the Institute, Einstein told him he should look for a quiet man who would not disturb people who are trying to think. I have tried to satisfy the Einstein criterion.

Over the last eight and a half years, as I have welcomed each incoming group of new Members on behalf of the Institute, I have remarked on the warmth of the welcome that is our grantmaking is about: fostering the exploration and development of new opportunities.

In the last decade, the Simons Center has enabled a number of outstanding scientists to move into the forefront of the field and make an indelible impact at leading academic institutions and research laboratories around the world. The center was established in 2005 by Arnold J. Levine, now Professor Emeritus in the School of Natural Sciences, and was named for James H. Simons, a Trustee of the Institute and former Member (1972) in the School of Mathematics, and his wife, Marilyn Haws Simons. Stanislas Leibler, a Professor in the School of Natural Sciences who holds a faculty position jointly at the Institute and the Rockefeller University, is working to extend the interface between physics and biology to create new solutions and approaches to fundamental biological problems. Leibler and his colleagues are developing a theoretical understanding of biological functions—in one set of studies, they are investigating patterns of gene evolution that suggest how different parts of proteins interact.

Also at the Simons Center, Faculty and Members are actively engaged in a number of areas of cancer research, including identifying the role genes play in the origins of cancers and the metabolism of cancer cells, developing strategies to profile specific cancers, and exploring means to improve cancer prevention and treatment strategies.

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That is what our grantmaking is about: fostering the exploration and development of new opportunities.

The last eight years have seen some challenging times because of the global economic crisis, which has affected us all in so many ways. But, I believe, the essentials of the academic life of the Institute have not been damaged. First, this is because of the extremely generous support provided by the Institute’s Trustees. The Institute’s founding Director, Abraham Flexner, told the Trustees, at their first meeting in 1930, “it is not the function of a board of trustees to be merely amiable.” Nobody could accuse our Trustees of being “merely amiable”! Their commitment to the Institute continues to be quite extraordinary: a really great job. And over the last eight and a half years, as I have welcomed each incoming group of new Members on behalf of the Institute, I have remarked on the warmth of the welcome.

Peter Goddard served as the eighth Director of the Institute, from January 1, 2004, through June 30, 2012.
On Wednesday, July 4, shortly after 4 a.m., the Institute’s new Director, Robbert Dijkgraaf, was in Bloomberg Hall, cracking open three bottles of vintage champagne to begin a rather unusual party. He was among the scientists who had been in the Hall’s lecture theater since 3 a.m. to watch a presentation from Geneva on the latest results from the CERN laboratory’s Large Hadron Collider. In the closing moments, after CERN’s Director-General Rolf Heuer cautiously claimed the discovery of a new sub-atomic particle—“I think we have it, yes”—ap- plause broke out in the CERN auditorium and in the Bloomberg Hall lecture theater. Within minutes, the IAS party was underway.

The new particle shows several signs that it is the Higgs boson, the only missing piece of the Standard Model, which gives an excellent account of nature’s electromagnetic, weak, and strong interactions. Although some physicists had come to doubt whether the boson existed, since 3 a.m. to watch a presentation from Geneva on the latest results from the CERN laboratory’s Large Hadron Collider. In the week before the CERN presentation, Arkani-Hamed invited colleagues to the party and organized the catering. Convinced that he had won his bet, he bought three bottles of champagne, including two of Special Cuvée Bollinger.

The latest results from the CERN laboratory’s Large Hadron Collider announced last December that they had found the first signs of a particle consistent with the Higgs boson, with about 125 GeV/c². It remained to be seen whether the particle really did exist, or if the first hint had been a glitch in the data. A few months ago, when the CERN authorities announced that two of their experimental groups would announce their results jointly on July 4, the rumor mill began to grind noisily, especially on the Internet. A week earlier, it was common knowledge among physicists that something dramatic was about to happen. Arkani-Hamed expected between ten and fifteen colleagues to attend the screening of the presentation, but his prediction was not one of his most accurate—he was too low by a factor of three. The physicists watched mostly in silence as the experimenters’ story unfolded—the particle appeared to exist and to decay into others, such as pairs of photons, at the expected rates (though with one tantalizing exception). Unusually for a seminar like this, the IAS audience—as well as the one in CERN—broke into applause several times and there were even a few gasps of delight. The same was happening all over the world, now that the quest for the Higgs boson was apparently coming to fruition.

Arkani-Hamed later said that he “never doubted for a second” that the Higgs particle would be detected and that he would win his bet: “All decent theorists have known for some time that there had to be a Higgs boson more or less where it was found.” After a glass of champagne, he added: “Nature is extremely constrained—there aren’t nymphs around every tree and dryads around every corner. Physics works.”

The party was probably unique in the history of the Institute—no one could remember another occasion when its physicists qualified champagne and speared Italian-style macerated strawberries after a seminar beginning in the middle of the night. Renée Hlozek, an astrophysicist at Princeton University, brought cookies decorated with a symbol denoting the Higgs field. On loan from Marilena LoVerde, a Member in the Institute’s School of Natural Sciences, and Laura Newburgh, a physicist at Princeton University, was a diorama of CERN’s huge ATLAS particle detector, delicately crafted from Peeps (marshmallow candies with hardened sugar shells), as well as paper and items molded from wax, held together with sticky tape.

A few hours after the party broke up, Robbert Dijkgraaf tweeted a photograph of the remnants of the celebration: “Decay products of 3 am #higgs event … Never forget 1st week as Director!” By then, Arkani-Hamed had talked with the New York Times’s science correspondent Dennis Overby and given him the quote that concluded his report on the Higgs-like particle: “It’s a triumphant day for fundamental physics. Now some fun begins.”

Soon afterward, Arkani-Hamed heard that the gentleman who bet against Higgs agreed to pay him his winnings, $225. The check is, apparently, still in the mail.
I believe that we can know that God exists, that the soul is immortal, and that there is the existence of God, the immortality of the soul, the freedom of the will. Leibniz mentally changed the way philosophers think of the big-ticket items of metaphysics—universality and necessity (as in claims of causation) is objectively valid and not otherwise. “This principle had enormous implications for Leibniz, for it allowed him to argue that the world, as a series of contingent things, could not have the reason for its existence with and in it; rather there must be an extraordinary reason—God.

Further, as a response to the mind-body problem, Leibniz advanced the theory of “pre-established harmony,” according to which there is no interaction at all between substances; the mind proceeds and “unfolds” according to its own laws, and the body moves according to its own laws, but they do so in perfect harmony, as is fitting for something designed and dated by God. Speaking, however, Leibniz was not a dualist; he did not believe that there were minds and bodies—at least not in the same sense and at the most fundamental level of reality. Rather, in his mature metaphysical view, there are only simple substances, or monads, mind-like beings endowed with forces that ground all phenomena. Finally, according to Leibniz, since these simple substances are ontologically primary and ground the phenomena of matter and motion, space and time are merely the ordered relations derived from the preexistence of each monad. Leibniz contrasted his view with that of Isaac Newton, according to whom there is a sense in which space and time can be considered absolute and space can be considered something substantial.

In his Critique of Pure Reason (1781; 2nd ed. 1787), Immanuel Kant presented a revolutionary philosophical view, one that challenged rationalist and empiricist orthodoxy and one that, he believed, provided answers to certain questions that had been the subject of perennial conflict. Kant advocated “transcendental idealism,” according to which space and time are forms of sensibility—that is, external conditions of the human mind that, in themselves, presuppose Leibniz’s principle of sufficient reason—therefore making failure impossible. Colleagues in the School of Social Sciences, however, certainly believe that even Albert’s questions themselves presuppose Leibniz’s principle of sufficient reason—that there is a reason for everything. For his part, however, Kant had argued that the principle of sufficient reason is valid only in the realm of experience and that it does not even have meaning when applied to things outside the world of sense (and prior to the origin of the world). In other words, the metaphysics of transcendental science, conceived as an inductive and deductive enterprise based on sense experience, can never give us an answer to the question of whether there is something rather than nothing? But neither can rationalist metaphysics.

In the end, Kant counsels philosophical humility.1

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1 But who wants to be humble? Consider the following concluding argument. Despite its tendency to pretentious nonsense,

(1) Metaphysics is better than nothing.

Colleagues in the School of Natural Sciences, however, certainly believe that

(2) Nothing is better than empirical science.

Colleagues in the School of Mathematics, meanwhile, surely believe in the transitivity relation:

if a > b and b > c, then a > c.

(3) Therefore, metaphysics is better than empirical science.

Despite the apparently rock-solid deductive form of this argument, colleagues in the School of Social Science likely see in it merely disciplinary posturing. As a philosopher, however, I must sadly (and humbly) admit that, even if the conclusion is true, the argument itself commits the fallacy of amphiboly, for it trades on the ambiguous meaning and grammar of “nothing” and expressions involving it. I suspect that any proposed answer to the question “Why is there something rather than nothing?” will flout with other ambiguities attached to nothingness.
Modular Arithmetic: Driven by Inherent Beauty and Human Curiosity

BY RICHARD TAYLOR

Modular arithmetic has been a major concern of mathematicians for at least 250 years, and is still a very active topic of current research. In this article, I will explain what modular arithmetic is, illustrate why it is of importance for mathematicians, and discuss some recent breakthroughs.

For almost all its history, the study of modular arithmetic has been driven purely by its inherent beauty and by human curiosity. But in one of those strange pieces of serendipity which often characterize the advance of human knowledge, in the last half century modular arithmetic has found important applications in the “real world.” Today, the theory of modular arithmetic (e.g., Reed-Solomon error correcting codes) is the basis for the way DVDs store or satellites transmit large amounts of data without corrupting it. Moreover, the cryptographic codes which keep, for example, our banking transactions secure are also closely connected with the theory of modular arithmetic.

You can visualize the usual arithmetic as operating on points strung out along the “number line.”

To add 3 and 5, you start at 0, count 3 to the right, and then a further 5 to the right, ending on 8. To multiply 3 by 5, you start at 0 and count 3 to the right 5 times ending up at 15. These sorts of operations should be familiar from elementary school.

In modular arithmetic, one thinks of the whole numbers arranged around a circle, like the hours on a clock, instead of along an infinite straight line. One needs to decide at the outset how many “hours” our clock is going to have. It can be any number, not necessarily 12. As a first illustration, let’s suppose that we have seven “hours” on our clock—say we are doing arithmetic modulo 7.

\[ \begin{array}{c|c|c|c|c|c|c|c} \hline 
& 0 & 1 & 2 & 3 & 4 & 5 & 6 \\
\hline \hline 
\text{MODULO 7} & \cdots & 1 & 2 & 3 & 4 & 5 & 6 \cdots \\
\hline 
\end{array} \]

To add 3 and 5 modulo 7, you start at 0, count 3 clockwise, and then a further 5 clockwise, this time ending on 1. To multiply 3 by 5 modulo 7, you start at 0 and count 3 clockwise 5 times, again ending up at 1. We would write

\[ 3 \cdot 5 \equiv 1 \mod 7 \]

As we mentioned above, there is nothing special about 7. We can put any number of “hours” around our clock face and do arithmetic modulo any whole number. Our usual clocks can be used to do arithmetic modulo 12.

This may seem a rather trite variant on our usual arithmetic, and the reader could legitimately wonder if it is more than a curiosity. I hope this article will convince her that it is.

An important observation is that any arithmetic equality that is true in normal arithmetic is also true in modular arithmetic modulo any whole number you like. This easily results from the observation that one can wind the usual number line around the modular clock face, turning usual arithmetic into modular arithmetic.

To illustrate a major reason why mathematicians care about modular arithmetic, let me start with one of the oldest questions in mathematics: Find Pythagorean triples, i.e., find whole number solutions, to the equation

\[ X^2 + Y^2 = Z^2. \]

By Pythagoras’s theorem, this is the same as finding right-angled triangles all of whose sides have lengths that are whole numbers (when measured in the same units). For instance

\[ 3^2 + 4^2 = 5^2 \]

and there is a right-angled triangle:

\[ \begin{array}{c}
\text{X} \\
\text{Y} \\
\text{Z}
\end{array} \]

The 3,800-year-old Babylonian tablet Plimpton 322 lists Pythagorean triples. The second column of the tablet lists values for \( X \) and the third column the corresponding value of \( Z \); the value of \( Y \) is not listed.

In modern notation, the solutions listed on Plimpton 322 are as follows:

<table>
<thead>
<tr>
<th>( X )</th>
<th>( Y )</th>
<th>( Z )</th>
</tr>
</thead>
<tbody>
<tr>
<td>119</td>
<td>120</td>
<td>169</td>
</tr>
<tr>
<td>3367</td>
<td>3456</td>
<td>4827</td>
</tr>
<tr>
<td>4601</td>
<td>4800</td>
<td>6649</td>
</tr>
<tr>
<td>12709</td>
<td>13500</td>
<td>18541</td>
</tr>
<tr>
<td>65</td>
<td>72</td>
<td>97</td>
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<td>319</td>
<td>360</td>
<td>481</td>
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<tr>
<td>2291</td>
<td>2700</td>
<td>3541</td>
</tr>
<tr>
<td>799</td>
<td>960</td>
<td>1249</td>
</tr>
</tbody>
</table>

It is noteworthy that some of these solutions are quite complicated, but we don’t know how they were generated. Could it have been trial and error, or did the Babylonians know an algorithm?

What is certain is that 1,500 years later the Greeks knew the algorithm to generate all whole number solutions to this equation. We know this because Euclid explained the method in Book X of his famous Elements. In modern algebraic notation, Euclid proves that every whole number solution to \( X^2 + Y^2 = Z^2 \) has the form

\[ X = (a^2 - b^2) \frac{c}{2} \]

\[ Y = abc \]

\[ Z = (a^2 + b^2) \frac{c}{2} \]

where \( a, b, \) and \( c \) are themselves whole numbers such that \( a, b, \) and \( c \) have the same parity (i.e., are both odd or both even).

But what if we change the problem slightly? What about asking for the solution of

\[ X^2 + Y^2 = 2Z^2 \]

or

\[ X^2 + Y^2 = 3Z^2 \]

in whole numbers? It turns out that as soon as we find one non-zero solution in whole numbers, the method described in Euclid’s Elements applies, and we can describe all solutions in whole numbers explicitly. So for instance the equation

\[ X^2 + Y^2 = 2Z^2 \]

has a solution

\[ X = 1 \quad Y = 1 \quad Z = 1 \]

and one deduces that the general point with whole number coordinates is of the form

\[ X = (a^2 + 2ab - b^2) \frac{c}{2} \quad Y = (-a^2 + 2ab + b^2) \frac{c}{2} \quad Z = (a^2 + b^2) \frac{c}{2} \]

where \( a, b, \) and \( c \) are themselves whole numbers such that \( a, b, \) and \( c \) have the same parity.

However, if you search for non-zero whole number solutions to \( X^2 + Y^2 = 3Z^2 \), you won’t find any. What is the difference between \( X^2 + Y^2 = Z^2 \) or \( X^2 + Y^2 = 2Z^2 \) or \( X^2 + Y^2 = 3Z^2 \)? The answer comes from modular arithmetic.

Suppose there was a solution to

\[ X^2 + Y^2 = 3Z^2, \]

with \( X, Y, \) and \( Z \) non-zero whole numbers. We can arrange that no whole number bigger than 1 divides all of \( X, Y, \) and \( Z \) (if it did, simply divide each of \( X, Y, \) and \( Z \) by this common factor, and they still form a solution to the same equation. If need be, we repeat this process.

Note that as the numbers \( X, Y, \) and \( Z \) get smaller in absolute value, but remain whole numbers, this procedure must eventually stop.) Then there would be a solution to the same equation in arithmetic modulo 3. But in arithmetic modulo 3 we have

\[ 3 \times Z^2 \equiv 0 \times Z^2 \equiv 0 \mod 3 \]

and

\[ 0^2 \equiv 0 \quad \text{and} \quad 1^2 \equiv 1 \quad \text{and} \quad 2^2 \equiv 1 \mod 3, \]

i.e.,

\[ X^2 \equiv 0 \quad \text{or} \quad 1 \mod 3 \quad \text{and} \quad Y^2 \equiv 0 \quad \text{or} \quad 1 \mod 3. \]

Richard Taylor, who became a Professor in the School of Mathematics in January, is a leader in number theory who, with his collaborators, has developed powerful new techniques that they have used to solve important long-standing problems. With Andrew Wiles, he developed the Taylor-Wiles method, which they used to help complete the proof of Fermat’s Last Theorem. Together with Fred Diamond, Brian Conrad, and Christophe Breuil, he resolved completely the Shimura-Taniyama-Weil Conjecture in the theory of elliptic curves. With Michael Harris, he proved the local Langlands conjecture. More recently, Taylor established the Sato-Tate Conjecture, another long-standing problem in the theory of elliptic curves.
The only way we can have
\[ X^2 + Y^2 \equiv 0 \mod 3 \]
is to have \( X^2 \equiv Y^2 \equiv 0 \mod 3 \). This means that 3 divides \( X \) and \( Y \); so that 9 divides \( X^2 + Y^2 = 3Z^2 \); so that 3 divides \( Z \); so that 3 also divides \( Z \). This is impossible, because we had arranged that no whole number greater than 1 divided each of \( X \), \( Y \), and \( Z \). As we have reached a contradiction, the only possibility is that our initial assumption was false, i.e., there could not have been a solution to
\[ X^2 + Y^2 = 3Z^2, \]
with \( X \), \( Y \), and \( Z \) non-zero whole numbers.

This sort of argument works not only for this particular equation. A beautiful theorem of Hermann Minkowski (1890) and Helmut Hasse (1924) says that if \( Q(X_1, \ldots, X_d) \) is any homogeneous quadratic polynomial in any number of variables with whole number coefficients, then
\[ Q(X_1, \ldots, X_d) = 0 \]
has a non-zero solution in whole numbers if and only if it has a non-zero solution in all (real) numbers and a primitive solution modulo \( m \) for all positive whole numbers \( m \). (We call \( (X_1, \ldots, X_d) \) a primitive solution modulo \( m \) if
\[ Q(X_1, \ldots, X_d) \equiv 0 \mod m, \]
but no integer greater than 1 divides all the \( X_i \).) This is actually a very practical criterion. It may appear that one needs to check for solutions to our equation in arithmetic modulo \( m \) for infinitely many \( m \). However, one can find a single integer \( m_0 \) (which depends on the polynomial \( Q \)) with the property that, if \( Q(X_1, \ldots, X_d) \equiv 0 \mod m_0 \) has a primitive solution modulo \( m_0 \), then it also has a primitive solution modulo \( m \) for any other positive whole number \( m \).

However, for higher degree equations, the corresponding theorem can fail. For instance
\[ 3X^3 + 4Y^2 + 5Z^2 = 0 \]
has non-zero solutions modulo every positive whole number (and it has a solution in the real numbers), but it has no non-zero solution in whole numbers. (This famous example was found by Ernst Selmer, former IAS Member.) Nevertheless, when studying the whole number solutions to any polynomial equation, the study of solutions modulo \( m \) is often a key tool.

More than 1,800 years ago the Chinese text Sun Zi Suan Jing contained a statement of what is now referred to as the Chinese Remainder Theorem. This theorem gives a very efficient algorithm that reduces the study of the solutions to a polynomial equation in arithmetic modulo a whole number \( m \), to the study of the same equation in arithmetic modulo the factors of \( m \) of the form \( p^r \), where \( p \) is a prime number and \( r \) is a positive whole number. In fact, it turns out that the key case to consider is when \( m \) is a prime number. Thus, for the rest of this article, we will only consider arithmetic modulo a prime number \( p \).

Recall that a prime number is a whole number greater than 1, which is only divisible by 1 and by itself. Examples are 2, 3, 5, 7, 11, 13, 17, and 19, but not for instance 15, which is divisible by 3 and 5. Every positive whole number can be written uniquely as a product of prime numbers (up to order). In some way, prime numbers are a bit like the atoms of which all other whole numbers are composed.

The first really great achievement in the study of modular arithmetic was Carl Friedrich Gauss's proof in 1796 of his celebrated law of quadratic reciprocity, which had previously been conjectured by Leonard Euler and Joseph Lagrange. This was supposed to have been Gauss's favorite theorem, and he kept coming back to it during his life, giving eight different proofs. It states that

\[ p \text{ a prime number, then the number of square roots of an integer } n \text{ in arithmetic modulo } p \text{ depends only on } p \text{ modulo } 4n. \]

On the face of it, this may not seem surprising, but I would stress that there is no apparent reason why trying to solve the equation
\[ X^2 \equiv n \mod p \]
should have anything to do with \( p \) modulo 4n. Thirty years after I first learnt how to prove this theorem, it still seems miraculous to me.

Gauss's theorem also provides a very effective way of determining the number of square roots a whole number has in arithmetic modulo a prime number \( p \). For example, one could ask how many square roots 3 has in arithmetic modulo 20132011, which is a prime number. You could, in theory, check all the 20132011 possibilities and determine the answer, but (without a computer) this would take a very long time. On the other hand
\[ 20132011 = 1677667 \times 12 + 7 \]
so that 3 has the same number of square roots in arithmetic modulo 20132011 as it does in arithmetic modulo 7. But it is very quick to list the square roots modulo 7:
\[ 0^2 \equiv 0 \equiv 1, \quad 2^2 \equiv 4, \quad 3^2 \equiv 2, \quad 4^2 \equiv 2, \quad 5^2 \equiv 4, \quad 6^2 \equiv 1 \mod 7. \]

Thus has no square root in arithmetic modulo 7 and so by Gauss's theorem it has no square root in arithmetic modulo 20132011. (A good thing we didn't waste our time checking all 20132011 possibilities!)

One could ask for a similar method that given any number of polynomials in any number of variables helps one to determine the number of solutions to those equations in arithmetic modulo a variable prime number \( p \). Such results are referred to as "reciprocity laws." In the 1920s, Emil Artin gave what was then thought to be the most general reciprocity law possible—his abelian reciprocity law. However, Artin's reciprocity still only applied to very special equations—equations with only one variable that have "abelian Galois group."

Stunningly, in 1954, Martin Eichler (former IAS Member) found a totally new reciprocity law, not included in Artin's theorem. (Such reciprocity laws are often referred to as non-abelian.) More specifically, he found a reciprocity law for the two variable equation
\[ Y^2 + Y = X^3 - X^2. \]

He showed that the number of solutions to this equation in arithmetic modulo a prime number \( p \) differs from \( p \) by the coefficient of \( q^0 \) in the formal (infinite) product
\[ q(1 - q) ((1 - q^2)^2(1 - q^2)^2(1 - q^2)^2(1 - q^3)^2(1 - q^3)^2 \cdots = q - 2q^2 - q^3 + 2q^4 + 5q^5 + 6q^6 + 7q^7 - 2q^8 - 2q^9 - 4q^{10} + q^{11} - 4q^{12} + \ldots \]
For example, you see that the coefficient of \( q^0 \) is 1, so Eichler's theorem tells us that
\[ Y^2 + Y = X^3 - X^2 \]
should have \( 5 - 1 = 4 \) solutions in arithmetic modulo 5. You can check this by checking the twenty-five possibilities for \((X, Y)\) modulo 5, and indeed you will find exactly four solutions:
\[ (X, Y) \equiv (0,0), (0,4), (1,0), (1,4) \mod 5. \]

Within less than three years, Yutaka Taniyama and Goro Shimura (former IAS Member) proposed a daring generalization of Eichler's reciprocity law to all cubic equations in two variables. A decade later, André Weil (former IAS Professor) added precision to this conjecture, and found strong heuristic evidence supporting the Shimura-Taniyama reciprocity law. This conjecture completely changed the development of number theory.

In the mid-1980s, Gerhard Frey, Jean-Pierre Serre (former IAS Member), and Kenneth Ribet (former IAS Member) showed that the Shimura-Taniyama reciprocity law, if true, would imply Fermat's Last Theorem. Motivated by this, in 1995, Andrew Wiles (former IAS Member), partly in collaboration with the author, established many cases of the Shimura-Taniyama reciprocity law and hence finally proved Fermat's Last Theorem.

Meanwhile, in the mid-1970s, Robert Langlands (Professor Emeritus, School of Mathematics) had the extraordinary insight that the ideas of Eichler, Taniyama, and Shimura were a small part of a much bigger picture. He was able to conjecture the ultimate reciprocity law, an enormous generalization of what had gone before, which related to any number of equations, of any degree in any number of variables. In the last ten years, using the ideas introduced by Wiles, there has been much progress made on Langlands's reciprocity conjecture, but much more still remains to be done.

One striking feature of all the non-abelian reciprocity laws is that the formula for the number of solutions is given in terms of symmetries of certain curved spaces—an extraordinary connection between solving algebraic equations and geometric symmetry. In the case of the Shimura-Taniyama reciprocity law, the relevant symmetries are those of the "hyperbolic plane." The hyperbolic plane can be thought of as a circular disc (without its boundary), but with an unusual notion of distance. For two points near the center of the disc, their "hyperbolic" distance is similar to their usual distance, but distances are increasingly distorted near the edge of the disc. The hyperbolic plane and its symmetries were illustrated in some of Escher's woodcuts, like the one below. In the hyperbolic world, all the fish in Escher's print are to be thought of as having the same size.
has two solutions for half of all prime numbers \( p \) and no solutions for half of all prime numbers \( p \). This may seem a natural answer, but Dirichlet's proof was very subtle, combining Gauss's reciprocity law with ideas from complex analysis. In 1880, Ferdinand Frobenius generalized Dirichlet's theorem to any equation in one variable. For other equations, the correct answer may be harder to guess. For instance, the equation

\[ X^2 \equiv 2 \mod p \]

has no solution for 5/8 of all prime numbers \( p \); has two solutions for 1/4 of all prime numbers \( p \); and has four solutions for 1/8 of all prime numbers \( p \).

What about such density theorems for equations in more than one variable, like

\[ Y^2 + Y = X^3 - X^2. \]

In this case, Hasse showed in 1933 that the number of solutions in arithmetic modulo \( p \), which we will denote \( N_p \), is of the same order of magnitude as \( p \). More precisely, he showed that \( N_p \) differed from \( p \) by at most \( 2/\sqrt{p} \). He proved this for all cubic equations in two variables.

In 1949, Weil conjectured an enormous generalization of Hasse's bound to any number of equations in any number of variables of any degree. These celebrated conjectures led to a revolution in arithmetic algebraic geometry. Weil's conjectures were finally proved by Pierre Deligne (Professor Emeritus, School of Mathematics) in 1974.

Returning to the equation

\[ Y^2 + Y = X^3 - X^2, \]

Hasse's theorem tells us that asking for what fraction of primes this equation has—say, ten solutions in arithmetic modulo \( p \)—is not interesting; the answer will always be \( 0 \). Rather the natural question is to consider the normalized error term

\[ \frac{N_p - p}{\sqrt{p}}. \]

By Hasse's theorem, this will be a (real) number lying between \(-2 \) and \( 2 \), and one can ask how it is distributed in this interval. Is the error often as large as Hasse's theorem allows, or is it usually smaller and only rarely at the extremes? In 1963, Mikio Sato and John Tate (both former IAS Members) independently conjectured the correct density theorem—the error should be distributed like \((1/2\pi) \sqrt{4 \pi - 1} \), a "squashed semi-circle."

The Sato-Tate density theorem has recently been proven (by Laurent Clozel and Michael Harris, both former IAS Members; Nicholas Shepherd-Barron; and the author), not just for this equation, but for all cubic equations in two variables. The proof combines the arguments of Dirichlet and Frobenius with an infinite series of new cases of Langlands's reciprocity law. There should, of course, be density theorems for any number of equations in any number of variables of any degree, but these remain very much conjectural. The story is continuing...
I have lived in the proximity of these Woods for over half a century. They are a friend, a source of inspiration and restoration, and were they to disappear it would be like the disappearance of an old, beloved, and respected friend.

I needed a source of inspiration, as I was editing an anthology ArcticVoices: Resistance at the Tipping Point. At the time, I was realizing that there is an Arctic paradox: that oil, coal, and gas, the burning of which has caused unprecedented Arctic warming, are the same nonrenewable resources whose extraction projects are expanding rapidly in the Arctic—terrestrial and offshore.

There are resource wars—for oil, gas, coal, and minerals—everywhere in the Arctic—from Alaska to Siberia, with Nunavut and Greenland along the way. In Arctic Alaska, these wars have intensified since I first arrived there more than a decade ago.

You might wonder how someone with an Indian-sounding name like mine, someone from the south, comes to concern himself with all this northern malarkey. Here is how it all began. In 2000, I left my career as a scientist and was wandering aimlessly from Florida to British Columbia looking for inspiration for a photography project. I had found none when, in late October, I arrived with two friends in Churchill in subarctic Canada—a popular tourist destination. There, polar bears gather along the Hudson Bay and wait on land for the bay to freeze over. Once on ice, they hunt and eat. I took a photo of one bear eating another—

Not normal, I was told, but no one in town said the Arctic was getting warmer. I now read that the bears of Hudson Bay will disappear within a few decades at best, or within a decade at worst, because these days ice is forming later in autumn and melting sooner in spring, leaving the bears longer on land, where they must wait and starve. This gruesome photograph of death produced in me a desire to live in the wild, with the polar bears.

I use photography to raise awareness about the Arctic, but I never knew that I would see the photographs we would use on the U.S. Senate floor to argue against oil drilling in the Arctic National Wildlife Refuge—yet that is exactly what Senator Barbara Boxer did and won a crucial vote on March 19, 2003. Nor did I imagine that my exhibition at the Smithsonian Institution would be censored and become the topic of a Senate hearing at which Senator Richard Durbin would support my work, or that later a Senate investigation would follow. But when then-Senator Ted Stevens during a May 2003 Senate debate said that President George W. Bush and I were giving "misinformation to the American public"—effectively calling us liars—then I did fear possible deportation, and realized that if I were to have a voice in conservation in the U.S., I must become a U.S. citizen. So I did.

Secretary of the Interior Gale A. Norton, during a March 12, 2003, congressional testimony, famously described the Arctic Refuge coastal plain as an object of conceptual art—"a flat white nothingness." ... Then, on November 5, 2005, Senator Stevens said on PBS NewsHour with Jim Lehrer, "This is the area in wintertime. And I defy anyone to say that that is a beautiful place that has to be preserved for the future. It is a barren wasteland, frozen wasteland."

ArcticVoices paints a very different picture—we present the Arctic neither as a frozen wasteland nor as a pristine wilderness, but, instead, simply as the toxic as hazardous waste—a planetary tragedy of global interconnectedness. Marla Cone tells this tragic story in this volume—she calls it "Arctic Paradox."

As you can see, the Arctic is far from being a remote place disconnected from our daily lives. Instead, we’re all connected to the northern landscape. In this volume, we tell many stories of local, regional, and global interconnectedness—both celebratory and tragic.

The Arctic, after all, is big—it is the top of our earth, the ice cap, some call it, but it is so much more, and it’s that so-much-more that this book is about.

The Arctic has become our planet’s tipping point—climate change is wreaking havoc on them. Resource wars continue to spread. Industrial toxins continue to accumulate widely. But also, the voices of resistance are gathering, getting louder and louder—and that is the story this volume presents. It is the noise and the music of all our voices bundled together.

ArcticVoices doesn’t have a linear structure; it isn’t arranged chronologically or even geographically, but rather as a web of interconnections with loosely defined themes that you may read in any order you wish. I have found plenty of things in common between essays—for example, the spectacular elders that winter in the frozen Bering Sea, written about by Nancy Lord, also in the Teshepok Lake Wetland that Jeff Fair writes about; both writers, Julie Williams and Annie Pootoogook, use stories and art as an outlet for healing as they both address alcoholism in their unique ways; and common words take on new meaning, for example, Seth Kantner and Matthew Gilbert put the word subsistence on its head, while Andi Snaer Magnason tells us how Alcoa hijacked the word sustainability in Iceland and Greenland. It is finally such interconnectedness, and I surmise that you will begin to think and talk about the Arctic differently than you did before. And perhaps you’ll find an answer to the question, “Why should I care about the Arctic?”

“The effendiyya, groups of urban educated middle classes that emerged and expanded in the first half of the twentieth century, provided the fertile social grounds for the emergence of liberal, multivocal, and heterogeneous public spheres. They promoted and maintained freedom of the press, which encouraged and expanded public discourses both in Egypt and throughout the Arab world, and were responsible for the flourishing of a pluralistic culture of everyday life.”

BY ISRAEL GERSHONI

“Freedom is the ultimate virtue of mankind”; “Democracy is the only political system of modern man and modern society”; “Therefore, Egypt must be committed to freedom and democracy.” These are the words of ‘Abbas Mahmud al-Aqqad in his book Hitler fi al-Mizan (Hitler in the Balance), which aroused sharp publication interest in Egypt and the Arab world when it was published in Cairo in early June 1940. The book was written when Hitler was at the height of his military successes, and it was widely assumed that nothing would thwart his advances. ‘Aqqad’s book leveled a harsh attack on Hitler and Nazism. Through his analysis of Hitler’s complex and deranged personality, ‘Aqqad deconstructed Nazi racism, dictatorship, and imperialism. He portrayed Hitler and Nazism as the ultimate danger not only for freedom and democracy, but also for modernity, the very existence of modern man and enlightened culture. In ‘Aqqad’s view, the merits of a liberal democracy were rooted in: individual freedoms and civil liberties, constitutionalism, a parliamentary and multiparty system, the separation of powers, equality for all citizens, cultural pluralism, and the unenforceable legitimacy of political oppositions.

When ‘Aqqad (1889–1964) expressed these views in the early years of the Second World War, his liberal democratic worldview had fully coalesced. Already in his early fifties, he was an established and well-known intellectual active for more than three decades. In hundreds of articles published in the Egyptian press, and particularly in his book The Absolute Rule of the 20th Century (al-Jarida, the “Party of the Nation”) laidthe groundwork for the emergence of a liberal democracy. ‘Aqqad was by no means exceptional. His ideas and activities aptly reflected the mainstream current within the intellectual community. In this article, I will first describe the salient features of this community and the contexts in which they operated, and then focus on the liberal modes of thought developed by two of the most representative intellectuals. This intellectual current coalesced and exerted its influence during the interwar era (1919–39) until the mid-1950s, galvanizing and institutionalizing a strong tradition of liberal democratic thought in Egypt and in the Arab Middle East. The intellectual community was active in a relatively sympathetic and friendly environment underpinned by two essential elements: the first was the very existence of parliamentarism; the second was the emergence and development of a strong civil society.

From 1923 to 1952, parliamentary government served as the basic framework within which Egyptian political, social, and cultural life evolved. Following the Great War, the eruption of the anti-colonial revolution of 1919 forced British authorities to grant Egypt formal independence in February 1922. Egyptian independence facilitated the promulgation of a liberal constitution in 1923 that called for a two-house Parliament, Chamber of Deputies, and Senate, and the immediate establishment of a parliamentary monarchy headed by King Fu’ad. For the ensuing thirty years, Egyptian political life consisted of a parliamentary system in which political parties competed for office in periodic national elections. This system was also a liberal constitution, the Great War, and the declaration of the Republic of Egypt in 1953. It dismantled the autocracy of the Khedival rule, eroded the authoritarian political culture of the late Egyptian-Ottoman oligarchy, and weakened British colonial rule. It encouraged ethnic pluralism and religious tolerance, reduced the presence of the police and army, and cultivated rich cultural activity with minimal state intervention.

The relative success of Egyptian parliamentary government was based on a mature civil society that developed distinct liberal public spheres. It emerged in the late nineteenth century, reached maturity after the Great War, and flourished during the interwar era. This civil society gave birth to a liberal public sphere, one that I define as one that emerged out of the political revolution and the declaration of the Republic of Egypt in 1953. It dismantled the autocracy of the Khedival rule, eroded the authoritarian political culture of the late Egyptian-Ottoman oligarchy, and weakened British colonial rule. It encouraged ethnic pluralism and religious tolerance, reduced the presence of the police and army, and cultivated rich cultural activity with minimal state intervention.

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The effendiyya, groups of urban educated middle classes that emerged and expanded in the first half of the twentieth century, provided the fertile social grounds for the emergence of liberal, multivocal, and heterogeneous public spheres. They promoted and maintained freedom of the press, which encouraged and expanded public discourses both in Egypt and throughout the Arab world, and were responsible for the flourishing of a pluralistic culture of everyday life.”

Rut al-Yusuf reacting to the outbreak of the Second World War. “History repeats itself!” The end of Hitler at the hands of democracy.” Britain, France, and Egypt portrayed as Allied Forces against Nazi Germany. September 9, 1939.

Hukun al-Mudlaq fi al-Qarn al-Ishrin, published in 1929, ‘Aqqad reaffirmed his commitment to democracy and his rejection of any form of absolutism, oligarchy, aristocracy, and autocratic monarchical rule, and in particular Fascism, Nazism, and, in a different way, Communism. As a representative of the Wafd party in the Egyptian parliament, and later as the intellectual leader of the Sa’adist Party and its representative in the Chamber of Deputies, ‘Aqqad was one of the most consistently democratic activists in Egyptian politics and culture.

However, ‘Aqqad was by no means exceptional. His ideas and activities aptly reflected the mainstream current within the intellectual community. In this article, I will first describe the salient features of this community and the contexts in which they operated, and then focus on the liberal modes of thought developed by two of the most representative intellectuals. This intellectual current coalesced and exerted its influence during the interwar era (1919–39) until the mid-1950s, galvanizing and institutionalizing a strong tradition of liberal democratic thought in Egypt and in the Arab Middle East. The intellectual community was active in a relatively sympathetic and friendly environment underpinned by two essential elements: the first was the very existence of parliamentarism; the second was the emergence and development of a strong civil society.

From 1923 to 1952, parliamentary government served as the basic framework within which Egyptian political, social, and cultural life evolved. Following the Great War, the eruption of the anti-colonial revolution of 1919 forced British authorities to grant Egypt formal independence in February 1922. Egyptian independence facilitated the promulgation of a liberal constitution in 1923 that called for a two-house Parliament, Chamber of Deputies, and Senate, and the immediate establishment of a parliamentary monarchy headed by King Fu’ad. For the ensuing thirty years, Egyptian political life consisted of a parliamentary system in which political parties competed for office in periodic national elections. This system was also a liberal constitution, part of which was translated into Arabic first by Polybius and Cicero. The second major source was the British political tradition of the seventeenth through nineteenth centuries as well as the political thought from the French Enlightenment of the eighteenth century. Egyptian intellectuals demonstrated intimate familiarity with the Greco-Roman intellectual traditions, particularly with Rousseau and Montesquieu, and the political philosophy of the eighteenth century shaped their understanding of liberty and rights. The effendiyya, groups of urban educated middle classes that emerged and expanded in the first half of the twentieth century, provided the fertile social grounds for the emergence of liberal, multivocal, and heterogeneous public spheres. They promoted and maintained freedom of the press, which encouraged and expanded public discourses both in Egypt and throughout the Arab world, and were responsible for the flourishing of a pluralistic culture of everyday life.”

Israel Gershoni, a Member in the School of Historical Studies (2011–12), is teaching the history of the modern Middle East at Tel Aviv University. His recent book, coauthored with James Jankowski, Confronting Fascism in Egypt: Dictatorship versus Democracy in the 1930s, was published by Stanford University Press in 2010.
In promoting within this intellectual community of discourse were about liberal democracy and cultural claims. Some of them were more dominant: ‘Abbas Mahmu’d al-‘Aqqad, Ahmad Amin, Salama Musa, Tafiq al-Hakim, ‘Ali ‘Abd al-Raziq, and ‘Abd al-Razaq al-Sanhuri. The intellectual voices of women were equally important, particularly those of Huda Sha’arawi, Nabawiya Musa, and Labiba Ahmad. All of these intellectuals were of the same generation. They were born at the end of the nineteenth century and were active as public intellectuals, particularly in the interwar era. Two of these, however, were most exceptional: Taha Husayn (1889–1973) and Muhammad Husayn Haykal (1888–1956). The Egyptian-Arab public considered these two individuals to be representative thinkers of the day and the most authoritative proponents of a liberal democracy.

Despite their reliance on classical texts, Egyptian intellectuals emphasized that Egyptian liberal democracy was principally a modern concept. From their perspective, it was an integral part of the formation of a modern secular worldview and way of life. Therefore, their liberal democratic worldview was formulated as an antagonist to institutionalized religion, Khedival autocracy, authoritarian Ottoman political norms, and the Egyptian-Ottoman aristocracy and oligarchy. This liberal democratic idealism was intricately linked to rationalism, the primacy of human reason, science, progress, modernism, secularism, humanism, and a strain of separation between religion and the nation-state. As Albert Hourani described their worldviews in his classical book Arabic Thought in the Liberal Age, 1789–1939 (1962), “according to such thinkers, human society is standing, by the irreversible and irresistible natural law of progress, towards an ideal state, of which the marks will be the domination of reason, the extension of individual liberty … and the replacement of relations based on custom and status by those based on free contract and individual interest.”

From his role as a proponent of state subordination to government, which would ensure the natural rights to conduct through representative parliamentary institutions. Freedom of its citizens, and citizens, in turn, wouldView this image in full. Thus, government would ensure the natural rights to freedom of its citizens, and citizens, in turn, wouldView this image in full. Muslim intellectuals of the modern period and the colonial era were asked to respond to Fascist Italy’s brutal conquest of Albania during spring 1939. “Her guardian . . . her robber,” Mussolini: Come my dear, I will hug you because I want you. Albania: Please, loosen your grip, I am dying.” April 17, 1939

Despite his elitist concept, Haykal did not preclude open entry into this educated governing elite. Anyone, men and women, who met the criteria of education and

Contradicts the nature of man. A human being is both an individual and a social entity: society must ensure a citizen’s freedom and, in turn, a citizen must contribute to society. For Husayn, such a social contract and relations were achievable only in a liberal democracy. Husayn promoted the idea that only a truly free democratic citizen can be a loyal patriot. Thus, the purpose of education was to instill the notion of proper citizenship alongside loyalty to the nation-state, since only educated and free citizens who understand the depths of their own freedom will be willing to sacrifice themselves for their nation’s freedom. Husayn’s definition of Egyptian nationality was highly liberal and inclusive, extending to all dwellers of the Nile Valley—irrespective of their ethnic origin, language, and religion. In his book Mustafa al-Thaqqafa, he explicitly excluded language and religion from his conception of Egyptian national identity. As such, Muslims, Christians, Jews, and other ethnic or linguistic communities were all equally Egyptians. Husayn’s liberal, inclusive approach to Egyptian collective identity assumed that all Egyptians were equal citizens who should elect their representatives through the institutions and mechanisms of multiparty parliamentary government.

As part of his promotion of liberal democratic principles and values, Husayn waged a scathing attack on
SYMPLICITY PIECE (Continued from page 1)

chaos in the restricted three-body problem. This problem describes the movement of a satellite under the gravity of two bodies, say the earth and the moon, in a rotating coordinates system in which the earth and the moon stay at fixed positions. The chaos in the system is illustrated by putting about ten satellites initially at almost the same position with almost the same velocity. When the system starts evolving, the program shows colorful trackings of the paths of the satellites as they evolve from simple single orbit to a complex multicolored tangle of orbits, once the orbits of the different satellites start separating.

Among those in the audience at my 2010 IAS lecture was composer Derek Bermel, then the newly appointed Artist-in-Residence. As I got to know Derek, I realized that he was interested in mathematics. So when I began planning my upcoming program in symplectic dynamics, I thought it would be quite something if our resident composer wrote what we would come to refer to as “The Symplectic Piece”—a musical composition inspired by symplectic geometry.

Symplectic geometry is a large field in mathematics, with connections to physics, low-dimensional topology, and geometry, as well as the theory of dynamical systems. The term "symplectic" is a geometric term which mathematical systems originate in Henri Poincaré's work on celestial mechanics. The term "symplectic" was introduced in 1939 by Hermann Weyl, a Faculty member at IAS, as a verbum pro verbo for "complex" in his important work on the classical groups—the so-called linear complex group became the symplectic group.

I had several conversations during lunches about the potential for "The Symplectic Piece." And he continued to attend occasional lectures on the subject, searching for a way to map symplectic geometry onto a musical score. But despite many entertaining discussions, the crucial inspirational idea was missing. With the start of the symplectic dynamics program last fall, "The Symplectic Piece" was still just floating around in the ether. But the more I thought about it, the more I realized that he had a chance. I was inspired by the Look and Listen Festival in New York to compose a commissioned work to mark the one-hundredth birthday of the avant-garde composer John Cage, said to be one of the most influential American composers of the twentieth century. However, besides having too many commitments already, Derek felt that a Cage composition might be beyond his comfort zone as a composer, so he declined the offer. But as Cage once said: "Ideas are one thing and what happens is another."

Or, to put it another way, I just had to talk Derek into it.

Since good preparation is everything, I conducted some research via my subscription to the music service Rhapsody, searching for John Cage and selecting "Play All Top Tracks." Characteristically, it seemed my one-month-old headiet was already broken. Further investigation revealed that the most popular track—433—was a three-movement composition for any instrument where the score explicitly instructs performers not to play for the duration of four minutes and 33 seconds, the listener's experience consisting merely of ambient sounds in the surrounding environment. Composed in 1952, this ostensibly silent work came as a shock for a composer who had been trained to embrace the ghostly presence not only in spirit but in form. Cage wrote many compositions for open instrumentation (including 433). I was drawn to this concept for "The Symplectic Piece," since it would inject an element of controlled unpredictability—or "deterministic chaos"—into the performance. While an undergrad at Yale, I played several of Cage's Variations compositions (1958-67), in which the performers are given instructions for producing sound, but no actual notation of rhythm, pitch, or anything else. Though their actual manifestations could be compared to other 1960s "happenings," the formal structure of the Variations tends to be more rigorous and specific. Of course, the music is composed of vibrating atoms of air, I needed an analogy that was dynamic. Helmut suggested the title Orbit Design to me. It refers to the design of a robot in a scientific space mission, using the varying gravitational fields of the planets to find pathways that are both scientifically interesting and energy efficient. Orbit design seemed like a good model because it deals with the physical relationships of celestial bodies, where Newton's gravitational law is expressed through their chaotic dynamical interaction.

Of course, besides the mathematical imperatives mentioned above, there was another factor that influenced how we composed the piece: the performance of this music was to be a collaborative effort, with the performers publishing the慈悲 of the other performer's pure musical material, map out a composition using this material, and interact with the other performers. I also found inspiration in John Zorn's COBRA and Butch Morris's early Conducts, works from the 1980s that present a series of ground rules from which a composition takes shape. I eschewed the use of Cage's "chance" in favor of "risk," since (as Morris writes) "risk insinuates a certain kind of challenge; chance doesn't necessarily do that."

In Orbit Design, for three or more performers. A set of guidelines assists the performers to structure a path of decision-making as events unfold. The piece taxes their skills and perception via material chosen by them. I therefore leave the decisions—the "risk"—in the hands of the performers themselves. As Cage wrote, "My work became an exploration of non-intention . . . making my responsibility that of asking questions instead of making choices."

In Orbit Design, each performer establishes a unique vocabulary by making a selection from various musical parameters. Typical parameters might include: pitch (frequency—organized into modes, microtones, chords, and scales, which suggest the notion of octave equivalence, or other sets); pulse (elemental rhythmic units); note length (which might include grace notes); tempo; transposition (loudness); color (timbre, including specific effects and strength of timbral modulation); and spatial placement/motion (physical location of performers).

Combining these parameters generates compound musical events comprising series, sequences, or patterns. These compound parameters include: density (pitch + tempo); articulation (pitch + layer + tempo); melody (pitch + pulse) and contour (register + tempo).

A third, more complex level of relationship that occurs between performers—the overall language of the piece—includes: rhythm (layers of pulse); orchestration (layers of timbre); harmony/ cadence (layers of pitch); and counterpoint (layers of pitch + pulse).

My actual "composition" merely supplies instructions as to how groups or sets of performers should order the parameters to select their own narrow range of values that apply to their own musical parameters. For example, a flute player might choose initial pitch (and register) values by selecting from the set of chromatic half steps between c3 and f#3 inclusive; for initial pulse and tempo values, the flutist might select half notes (semimins) and quarter notes (crotchets) at forty beats per minute. The other performer (the percussionist) could select value ranges for volume, timbre, spatial placement in the room, and any other data relevant to the performers' vocabulary, making sure it is clearly notated.

The performers then decide which parameters will remain static (constant) and which ones will expand. For dynamic parameters, the performers indicate how (in which direction) they will expand and set range limits for this expansion. For example, the flutist might set range of pulse values so that it expands to incorporate whole notes (as well as the initial quarter and half notes). The performer might allow the pitch range to expand to all chromatic notes between c3 and c4 inclusive, and could also decide that the volume will remain constant, at mp. In this case, volume would be considered an inert parameter. The performer might also break a parameter order and the parameters will expand. Only one parameter at a time can be dynamic, so that the players can concentrate on tracking its expansion. The performer then remains at the outer limit of each completed parameter while expanding the following one, and so on, until the end of the piece. After all the parameters, their ranges, and the order of expansion have been determined, the performers assemble to try them out together. After a first playing/hearing, each performer makes adjustments to the scope of their own material, in order to complement their collaborators' particular design.

The most improvisatory, or "chaotic," element of the performance is orbiting. Orbiting requires a relationship with the other players, which involves hearing and interacting with what the others play from a vantage point that changes (Continued on page 13)
Finding Structure in Big Data

How do we navigate the vast amount of data at our disposal? How do we choose a movie to watch, out of the 75,000 movies available on Netflix? Or a new book to read, among the 800,000 listed on Amazon? Or which news articles to read, out of the thousands written every day? Increasingly, these tasks are being delegated to computers—recommendation systems analyze a large amount of data about the users’ behaviors, and use what they learn to make personalized recommendations for each one of us.

In fact, you probably encounter recommendation systems on an everyday basis: from Netflix to Amazon to Google News, better recommendation systems translate to a better user experience. There are some basic questions we should ask: How good are these recommendations? In fact, a more basic question: What does “good” mean? And how do they do it? As we will see, there are a number of interesting mathematical questions at the heart of these issues—most importantly, there are many widely used algorithms (in practice) whose behavior we cannot explain. Why do these algorithms work so well? Obviously, we would like to put these algorithms on a rigorous theoretical foundation and understand the computational complexity of the problems they are trying to solve.

Here, I will focus on one running example and use this to explain the basic problems in detail, and some of the mathematical abstractions. Consider the case of Amazon. I have purchased some items on Amazon recently: a fancy set of cutting knives and a top-of-the-line skillet. What other products might I be interested in? The basic tenet of designing a recommendation system is that the more data you have available, the better your recommendations will be. For example, Amazon could search through its vast collection of user data for another customer (Alex) who has purchased the same two items. We both bought knives and a skillet, and Amazon can deduce that we have a common interest in cooking. The key is: perhaps Alex has bought another item, say a collection of cooking spices, and Amazon can deduce that we have a common interest in cooking. So the message is: let’s talk about cooking! Of course, Amazon’s job is not so easy. I also bought a Kindle. And what if someone else (Jeff) also bought a Kindle? I buy math books online, but maybe Jeff is more of a Harry Potter aficionado. Just because we both bought the same item (a Kindle) does not mean that you should recommend Harry Potter books to me, and you certainly would not want to recommend math books to Jeff! The key is: What do the items I have purchased tell Amazon about my interests? Ideally, similar customers help us identify similar products, and vice-versa.

So how do they do it? Typically, the first step is to form a big table—rows represent items and columns represent users. And an entry indicates if a customer bought the corresponding item. What is the structure in this data? This is ultimately what we hope to use to make good recommendations. The basic idea is that a common interest is defined by a set of users (who share this interest) and a set of items. And we expect each customer to have bought many items in the set. We will call this a combinatorial rectangle (see image). The basic hypothesis is that the entire table of data we observe can be “explained” as a small number of these rectangles. So in this table containing information about millions of items and millions of users, we hope to “explain” the behavior of the users by a small number of rectangles—each representing a common interest.

The fundamental mathematical problem is: If the data can be “explained” by a small number of rectangles, can we find them? This problem is called the nonnegative matrix factorization problem, and it plays a large role in the design of real recommendation systems. In fact, there are many algorithms that work quite well in practice (on real data). But is there an efficient algorithm that works on every input? Recently, we showed that the answer is yes!

Our algorithm is based on a connection to a purely algebraic question: Starting with the foundational work of Alfred Tarski and Abraham Seidenberg, a long line of research has focused on the task of deciding if a system of polynomial inequalities has a solution. This problem can be solved efficiently provided the number of distinct variables is small. And indeed, whether or not our table of data has a “good” nonnegative matrix factorization can be rephrased equivalently as whether or not a certain system of polynomial inequalities has a solution. So if our goal is to design fast algorithms, the operative question is: Can we reduce the number of variables? This is precisely the route we took, and it led us to a (much faster) provable algorithm for nonnegative matrix factorization whose running time is optimal under standard complexity assumptions.

Another fundamental mathematical question is: Can we give a theoretical explanation for why heuristics for these problems work so well in practice? There must be some property of the data that we actually want to solve that makes them easier. In another work, we found a condition, which has been suggested within the machine learning community, that makes these problems much easier than in the worst case. The crux of the assumption is that for every “interest,” there must be some item that (if you buy it) is a strong indicator of your interest. For example, whoever buys a top-of-the-line skillet is probably interested in cooking. This assumption is known in the machine learning literature as separability. In many instances of real data, practitioners have observed that this condition is met by the parameters that their algorithm finds. And what we showed is that under this condition, there are simple, fast algorithms that provably compute a nonnegative matrix factorization.

In fact, this is just one instance of a broader agenda: I believe that exploring these types of questions will be an important step in building bridges between theory and practice. Our goal should not be to find a theoretical framework in which recommendations (and learning, more generally) are computationally hard problems, but rather one in which learning is easy—one that explains (for example) why simple recommendation systems are so good. These questions lie somewhere between statistics and computer science, but not quite in either. How much data do we need to make good recommendations (e.g., the statistical efficiency of an estimator)? Algorithms that use the bare minimum amount of data are all too often very hard to compute. The emerging question is: What are the best tradeoffs between making the most of your data, and running in some reasonable amount of time? The mathematical challenges abound in bringing these perspectives into not just recommendation systems—but into machine learning in general.

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SYMPLECTIC PIECE (Continued from page 12)

with time. As the performers develop and become comfortable with their own chosen material, it becomes easier to move beyond the fields of the orbits.

Over the course of our discussions, Helmut pointed out that the notion of orbiting around something is not exactly defined in physics. Nonetheless, if the bodies’ masses were about the same size, they could be said to orbit each other. He also drew a chart, which showed that if three celestial bodies A, B, C exist, they could be located either close to each other (ABC), far away from each other (AB — C), or in various other configurations: (AB) — C, (BC) — A, (AC) — B. Also, if B and C were of comparable size and A was much bigger, then the system (BC) could be said to orbit around A, and so forth. I felt that these maxims could apply directly to performers in Orbit Design.

Helmut had also noted that solutions exist to the three-body problem in which the bodies move from one configuration to another in random order. For example:

(ABC) ➔ (AB) — C ➔ (ABC) ➔ A — B — C ➔ (ABC) ➔ (AB) — C ➔ (AC) — B ➔ etc.

Each a “sentence” could map one realization of a performance of Orbit Design. Of course, there are many, many others. Indeed, as a consequence of the “open” nature of the score (which, as noted, consists only of written instructions), each performance necessarily ends up being distinct.

Recognizing the unique element, the festival directors scheduled the premiere on three successive nights with three completely different ensembles. On the first night, Orbit Design was performed by a percussion sextet featuring So Percussion Quartet, Doug Perkins, and Bobby Prevote; the second night it was played by the trio Forbidden Flute; and the third night it was realized by the string quartet Brooklyn Rider. The three incarnations differed vastly; each had its own profile and dynamic shape. The percussion was sprawling yet serene, the flutes sporadic and sinuous, the string quartet alternately comic and blissful. The players performed with formidable concentration, and afterward they expressed deep satisfaction with the opportunity to build their own configurations from "scratch."

As the date of the premiere grew near, I decided that there was no reason to restrict Orbit Design to musical realizations, as the instructions could apply equally well to dancers, actors, jugglers, or any kind of performer. My friend, choreographer Abigail Levine, who had helped me home some of the formal concepts, attended the performances and decided to choreograph the work for an upcoming project with Movement Research at the Judson Church in New York City. She paired it with a dance for three performers, titled Distance Measures, and I participated as one of the musicians, alongside Forbidden Flute. Thus the gravitational "choreography" to which Helmut alluded finally had a chance to manifest itself in real time and evolve into another dimension.
The Institute has received a $3 million grant from the Andrew W. Mellon Foundation to support one-year fellowships for assistant professors in the Institute’s School of Historical Studies. The donation will be matched by $3 million funded from the $100 million challenge grant provided by the Simons Foundation and the Charles and Lisa Simoni Fund for Arts and Sciences to initiate the Institute’s current $200 million campaign to strengthen its endowment. This will create a $6 million Andrew W. Mellon Fellowships for Assistant Professors Fund to provide a permanent endowment for fellowships to enable scholars to work at the Institute at a critical point in their careers.

The Mellon Foundation has been funding fellowships at the Institute for historians in the early stages of their careers since 1996. The new grant will provide stable and secure funding for the program, enabling future generations of scholars to benefit from the Institute’s distinct environment, where they are free to pursue long-term goals away from the teaching and administrative demands of university positions, and to interact with the Institute’s permanent Faculty and other more senior colleagues.

Since the inception of the program, some forty-four scholars have benefited from the Mellon Foundation fellowships. These fellows have come from many institutions and a diverse range of fields of historical study. “My time at the IAS was one of the most intellectually stimulating and productive periods of my life,” said Lauren Minsky, Assistant Professor at New York University in Abu Dhabi and former Member (2009–10) in the School of Historical Studies. “My fellowship allowed me the crucial opportunity to research, think, read, and reflect for a full year without the teaching and administrative commitments that come with regular academic life. I also had the invaluable opportunity to interact with other scholars from a wide range of fields and disciplines as colleagues and friends. It is impossible to fully express just how important and meaningful this opportunity was.”

Andrew W. Mellon Foundation Provides Critical Support for Assistant Professors

Daniel H. Saracino Endowment Supports Visiting Professorship in School of Mathematics

A bequest made by Daniel H. Saracino, the Neil R. Grabois Professor of Mathematics at Colgate University and former Visitor (1986) in the Institute’s School of Mathematics, will enable the establishment of a Visiting Professorship in the School. The Daniel H. Saracino Endowment will provide the School with the ability to invite a senior mathematician for a year or more to work with the School’s Faculty and Members in an environment devoted to fundamental research across many areas of pure mathematics, theoretical computer science, mathematical physics, and applied mathematics. Saracino was prompted to include the Institute in his estate plans out of his deep admiration and respect for the mission and work of the School and its Faculty, and in fond acknowledgment of his time as a Visitor.

“The Institute epitomizes excellence in mathematics, and I appreciate the way in which the School of Mathematics makes it possible for its Members and Visitors to devote themselves to their research in an ideal atmosphere, free of distractions and other responsibilities,” said Saracino. “My bequest to the School provides a way of doing what I can to further its work.”

Known literature from that period, which had been reconstructed in the Imperial Library in the late first century B.C.E. Centering on a detailed and comprehensive study of the material and textual properties of a 300 B.C.E. bamboo manuscript from the Southern Chinese state Chu, as well as some other manuscripts of similar provenance, the book demonstrates that early Chinese literature did not only consist of linear, logically consistent texts. One manuscript could combine different types of texts, e.g., a coherent argument could be supplemented with didactic catalogues that merely functioned as memory pegs, referring the reader in an indexical manner to previous instructions outside the text. In other cases, written texts merely functioned as repositories of textual material, often variants of the same content. Only in later redactions were such texts reinterpreted and shaped into the coherent linear texts, which were then transmitted to us through the two millennia of the Chinese empire.

PLANNED GIVING

Daniel H. Saracino Endowment Supports Visiting Professorship in School of Mathematics

Saracino’s current research interests include model theory—especially model theoretic algebra (existentially complete, quantifier-eliminable, and homogeneous structures in algebra)—and combinatorics. He earned his Ph.D. from Princeton University in 1972, and taught at Yale and Wesleyan before coming to Colgate. The recipient of Colgate’s Alumni Corporation Award for Distinguished Teaching (2003) and Phi Eta Sigma Professor of the Year (1995), Saracino has been recognized throughout his career for his outstanding teaching and mentoring, and was recently included in Princeton Review’s The Best 300 Professors.
Benedict H. Gross Elected to the Board of Trustees

The Institute has appointed Benedict H. Gross, the George Vasmer Leverett Professor of Mathematics at Harvard University, to its Board of Trustees, effective July 1, 2012. Gross was nominated by the Institute’s School of Mathematics and succeeds Andrew J. Wiles, Royal Society Research Professor at the University of Oxford, who had served on the Institute’s Board since 2007.

Gross, whose research is in number theory, received his undergraduate degree from Harvard in 1971, a master’s degree from the University of Oxford in 1974, and his doctorate from Harvard in 1978. He served as Assistant Professor at Princeton University from 1978–82, Associate Professor at Brown University from 1982–85, and Professor at Harvard beginning in 1985. He was Dean for Undergraduate Education at Harvard from 2002–03 and Dean of Harvard College from 2003–07; in these positions, he oversaw the first review of undergraduate education at Harvard in nearly thirty years.

The American Mathematical Society awarded Gross and his collaborators the Frank Nelson Cole Prize in Number Theory in 1987 for work on the L-functions of elliptic curves. Among other honors, he is the recipient of a MacArthur Fellowship and a member of the American Academy of Arts and Sciences and the National Academy of Sciences.

Gross is the author, with Joe Harris, of The Magic of Numbers (Prentice Hall, 2003), which introduces non-mathematicians to the mathematical mode of thought. A course on abstract algebra taught by Gross is available at www.extension.harvard.edu/open-learning-initiative/abstract-algebra.

Friends Bolster Campaign to Raise Capital Funds

The $200 million Campaign for the Institute, initiated in 2011 with a $100 million challenge grant from the Simons Foundation and the Charles and Lisa Simon Foundation for Arts and Sciences, is well underway and will continue through June 30, 2015. With major pledges from the Leon Levy Foundation (see page 1), the Starr Foundation (see page 3), the Andrew W. Mellon Foundation (see page 14), and others, the total raised now stands at more than $48 million, almost halfway toward qualifying for the $100 million challenge grant. Support from the entire Institute community will be essential to complete the Campaign, which is aimed at strengthening the endowment on which the Institute relies heavily—covering as much as 80 percent of annual operating expense in recent years.

The Friends of the Institute, whose generosity has made an indelible impact on the Institute’s financial well-being over the past three decades by providing IAS with its most significant source of unrestricted financial support, have joined the effort to raise capital funds for the Campaign. Building on years of success securing annual funds from Friends (over $770,000 was raised in 2011–12), Chair Jack Kerr, former Chairs Carolyn Sanderson and John Rassweiler, and members of the Development Committee have been working to engage Friends in the Campaign, with great results. Friends have already committed more than $500,000 in gifts and pledges and the Committee is looking to increase that sum significantly, as all Friends are given the chance to participate in the Campaign over the next three years.

“We want to see this unique opportunity for scholars continue into the future, building on the Institute’s phenomenal success since its founding,” notes Kerr and his wife Nora, Friends since 1998. “Access to the Institute enriches our lives in many ways. There are frequent opportunities open to the Friends to participate in the life of the Institute, whether at formal lectures about current research, informal lunches with Members in the dining hall, or the numerous social events organized by the Friends. The scholars in this community are very approachable and love to talk about their work, which is always interesting. It’s a terrific opportunity to engage the brightest minds of our generation.”

To learn more about the Campaign for the Institute, please contact Michael Gehret, Associate Director for Development and Public Affairs, at (609) 734-8218 or mgehret@ias.edu. To learn more about the Friends, please contact Pamela Hughes, Senior Development Officer and Friends Liaison, at (609) 734-8204 or phughes@ias.edu, or visit the Friends pages on the Institute’s website, www.ias.edu/people/friends.

Executive Committee of the Friends in May, front row: Cynthia Hilliar, Vicky Corradu, Emily Fronenich, Peter Goddard (then Director of the Institute), Carolyn Sanderson, Debbie Lunder, Francesca Liechenstein, Tina Greenberg, Florence Kahn, Vanis Shapero; back row: Jack McCarthy, Lew Maldby, Jack Kerr, John Haines, John Rasweiler, Wreezie Steffen, Michael Morandi, Luke Viscott, Lynn Johnston, Martin Choudjian, Brig Gehret

The Campaign for the Institute

Friends of Liberal Democratic Legacies (Continued from page 11)

Cultural refinement could take part in this aristocracy. In contrast to Husayn and his activity within the popular-oriented Wafd, Haykal was the intellectual leader of the Liberal Constitution Party, which promoted a patronizing and paternalistic liberalism and was largely a continuation of the early Hizb al-Umma and al-Jard. While Husayn viewed himself as a challenger of this school, Haykal viewed himself as a guardian of its social philosophy. Haykal assumed that the masses would follow the charismatic power of the prophetic philosophers and would accept their authority as the embodiment of the collective general will. Thus, the masses would be led to a modern democratic system “unaware” and without really understanding its essence.

However, at critical junctures, Haykal also demonstrated that he was in fact a liberal democrat. In the early 1930s, when the dictatorial regime of Isma’il Sidqi (1930–33) undermined the 1923 constitution and thereby threatened to destroy the parliamentary government, Haykal led a democratic struggle against Sidqi. In his book al-Syusi al-Misriyya wa al-Inqilab al-Dusturi (Egyptian Politics and the Constitutionalist Coup), published in 1931, Haykal waged a fierce and unrelenting defense of democracy from any authoritarian options of autocracy or dictatorship.

The collapse of Sidqi’s authoritative government and the restoration of the constitution and the reassertion of parliamentary life toward the mid-1930s were a triumph for Haykal and his liberal democratic orientation.

The defense of liberal democracy by Haykal, Husayn, and many of these intellectuals suffered from limitations, two of which I’d like to emphasize. The first is that the parliamentary system did not function smoothly throughout the entire period. In particular, the 1930s, ‘40s, and early ‘50s saw episodes of bitter conflict between contending forces that resulted in occasional constitutional adjustments, which impeded parliamentary performance. While the monarch conspired to undermine the democratic government and to guide it toward a more authoritarian orientation, radical extra-parliamentary forces, led by Young Egypt and to a lesser extent also by the Society of the Muslim Brothers, strove to delegitimize its very existence. British colonial intervention in politics similarly hindered its ability to function.

The second limitation was more substantial. It involved the question: to what extent was such an aim realizable within the colonial or semi-colonial context? Can intellectuals promote a true liberal democracy in a colonized environment? To be sure, the intellectuals whom I’ve discussed also grappled with these questions, and concluded that it was feasible. They assumed that their efforts were an integral element in Egypt’s struggle for liberation from colonial rule. They did not anticipate that the national struggle would be lengthy and that British colonial rule would last until the late 50s. It became increasingly difficult for them to overcome a glaring obstacle: the fact that the very European Western culture that provided concepts and models for liberal democratic ideas and institutions was simultaneously the imperial power that threatened their local culture. As newer and more radical forces emerged in the cultural and political arena, they rejected liberalism as a foreign imperialist institution. Worse yet, they claimed that Western liberal democracy’s purported freedom was a tool in the service of a narrow Western elite promoting Western colonial discourse, which usurped the freedom of the masses through its sham parliamentary system.

A newer radicalized nationalism aimed at decolonization of Egypt and the Arab Middle East undermined the intellectual project to institutionalize a liberal democracy in Egypt and the Arab world. The Free Officers’ coup d’etat of July 1952 and the emergence of the authoritarian republican regime abruptly ended this project. However, from a historical perspective, the intellectuals’ liberal democratic legacy has proven to be enduring. Their liberal texts were canonized and remained popular years after their deaths. They were continuously consumed by successive generations. To what extent this legacy may serve as a source of inspiration and legitimization in current conditions in Egypt remains to be seen.
Automatically discovered near CERN’s ATLAS detector, called the Higgs boson, is consistent with the boson predicted fifty years ago by Peter Higgs. Higgs presented his theory of how most fundamental particles acquire mass at an energy field that exists everywhere in the universe. Soon after the CERN announcement, Freeman Dyson sent a message to Higgs through a colleague, David Breshears: “Please give warm congratulations to Peter if you see him. What he did was beautiful and will outlast the temporary flood of hype.” Breshears met Higgs for dinner in Glasgow on July 24, and reported back to Dyson: “I think he was very appreciative.”

After nearly five decades of searching for confirmation of the existence of the Higgs particle that would result if Higgs’s theory is correct, Faculty and Members—along with Robbert Dijkgraaf on his fourth day as the ninth Director of the Institute—attended a predawn celebration in Bloomberg Hall to witness the announcement by Rolf Heuer, Director-General of CERN (page 4). The newswas momentous. Faculty and Members at the Institute have contributed many of the theoretical foundations of the Standard Model, which describes the fundamental building blocks of the universe and its possible modifications. The discovery of a particle that looks much like the Higgs—the final element of the Standard Model that needs to be confirmed experimentally—promises to further rekindle the energy of interest in helping to build, refine, and test the models of the universe that physicists have developed over the past sixty years.

Rolf Heuer, Director-General of CERN, and Richard Taylor, Professor in the School of Natural Sciences, wrote about new standards of precision and the quest for the “Standard Model beyond” (page 2). They described how the new particle’s properties have been measured and how the results have been checked by other experiments. David Breshears, Visiting Professor in the School of Natural Sciences, writes about the excitement of the moment among physicists and the “interplay between the world’s highest-energy and highest-energy laboratories” (page 6). He described the moment as a triumph for experimental and theoretical physics.

John Hopfield, Visiting Professor in the School of Natural Sciences, writes about wanting to understand how mind emerges from brain (page 1). Helmut Hofer, Professor in the School of Mathematics, and Derek Bremel, Artist-in-Residence, find a common ground between symplectic dynamics, music, and John Cage (page 1). Richard Taylor, Professor in the School of Natural Sciences, writes about understanding the “Standard Model beyond,” and about the “emotional and spiritual affinity between these types of explorations pursued by the individual who ‘chose one pattern for beauty’s sake, and pulls it down to earth, no one knows how. Afterwards the logic of words and of forms, after that is gone, is yet another path that the all-embracing life has to take’” (page 6).