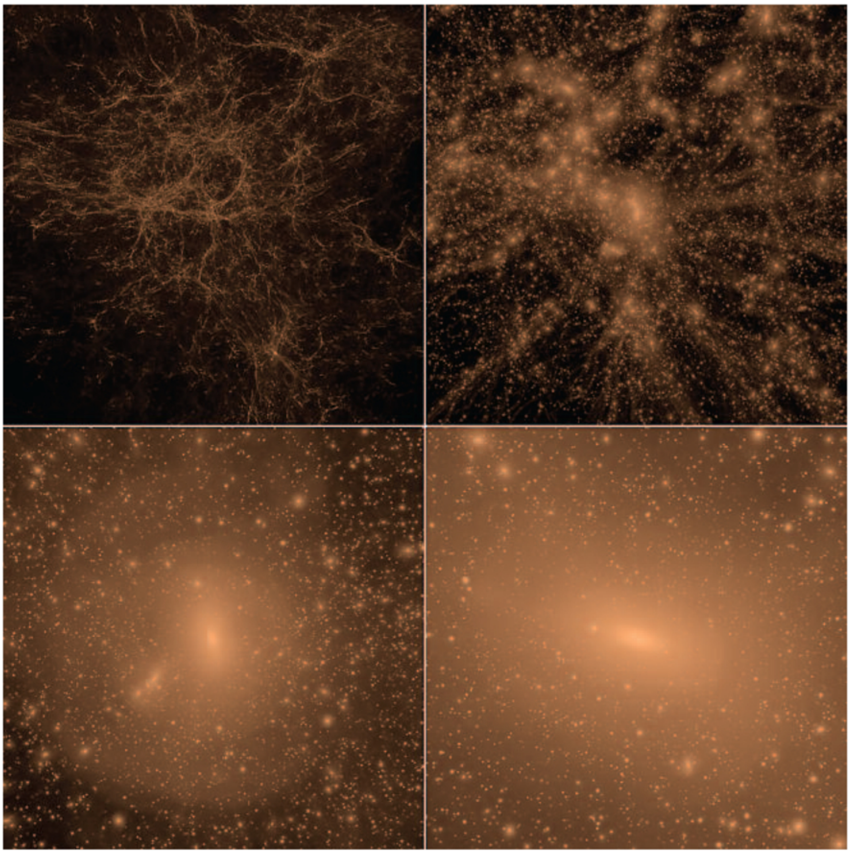
THE INSTITUTE LETTER



Dark Matter and Dark Energy

These four images highlight the gravitational clustering process of the dark matter in a galaxy-sized halo. Shown are projections through the central region of one of Member Michael Kuhlen's dark matter simulations, at several output times. The projections are 300 kpc on a side (1 kpc or kiloparsec is equal to approximately 3,000 light years or about 20 million billion miles), and brighter regions indicate a higher dark matter density. The top left panel is from a snapshot close to the beginning of the simulation, only 400 million years after the Big Bang. The top right is about a billion years later, and gravity has caused much of the dark matter to collapse into filaments and dense halos. At half the age of the universe (bottom left) the assembly of the inner parts of the host halo is mostly completed. The bottom right panel shows the dark matter distribution at the end of the simulation, 13.7 billion years after the Big Bang. By this time dark energy has halted the collapse process. Many individual lumps of dark matter have survived this hierarchical mass assembly and now orbit the center of the galaxy.

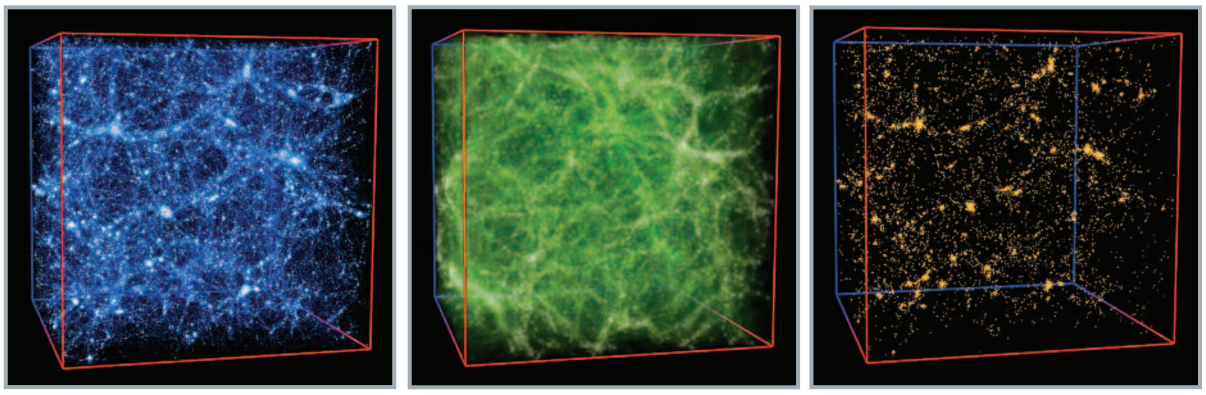
THE INSTITUTE LETTER

INSTITUTE FOR ADVANCED STUDY

PRINCETON, NEW JERSEY · SUMMER 2008

PROBING THE DARK SIDE OF THE UNIVERSE

One of the remarkable discoveries in astrophysics has been the recognition that the material we see and are familiar with, which makes up the earth, the sun, the stars, and everyday objects, such as a table, is only a small fraction of all of the matter in the universe. The rest is dark matter, possibly a new form of elementary particle that does not emit or absorb light, and can only be detected from its gravitational effects.



These three images created by Member Douglas Rudd show the various matter components in a simulation encompassing a volume 86 Megaparsec on a side (for reference, the distance between the Milky Way and its nearest neighbor is 0.75 Mpc). The three components are dark matter (blue), gas (green), and stars (orange). The stars form in galaxies which lie at the intersection of filaments as seen in the dark matter and gas profiles. The dark matter, as the dominant matter component in the universe, drives the formation of those filaments and structures and dark energy "pushes back," effectively stopping the growth of that structure and therefore galaxies.

In the last decade, astronomical observations of several kinds, particularly of distant supernova and the cosmic microwave background, also indicate the existence of what is known as dark energy, a uniform background field that is accelerating the expansion of the universe. The presence of dark energy suggests a fundamental gap in our current understanding of the basic forces of nature.

According to the standard cosmological model, dark matter comprises about 22 percent of the universe, while dark energy makes up 74 percent. "There is a few percent of residual dirt left over," says Scott Tremaine, Richard Black Professor in the School of Natural Sciences, "and that is us and the stars, the galaxies, and everything we know."

With the discovery of dark energy ten years ago, a better understanding of the properties of dark matter, and a more precise accounting of the composition of the universe, the two fields of astrophysics (the physics of the very large) and particle physics (the physics of the very small) are each providing some of the most important new experimental data and theoretical concepts for the other. Research at the Institute for Advanced Study has played a significant role in this development. The late Institute Professor John Bahcall, through his research on solar neutrinos, was a pioneer in demonstrating the importance of astrophysical phenomena for understanding fundamental physics.

Current knowledge of the fundamental forces of physics is based on two well-established theories: the Standard Model of particle physics, which gives an impressively accurate description of elementary particles and their interactions, but ignores gravity and only accounts for about one-sixth of the matter in the universe; and Einstein's theory of general relativity, which describes the observed gravitational behavior of large objects in the universe, such as galaxies and clusters of galaxies, but has yet to be reconciled with quantum principles.

(Continued on page 4)

NEW TRUSTEES APPOINTED TO THE BOARD OF INSTITUTE FOR ADVANCED STUDY

COURTESY OF GOOGLE INC.

Eric E. Schmidt

The Institute for Advanced Study has appointed Eric E. Schmidt and Curtis Callan to its Board of Trustees, effective July 1, 2008. Schmidt is Chairman and Chief Executive Officer of Google Inc., and Callan is the J. S. McDonnell Distinguished University Professor of Physics at Princeton University. Callan, who will serve as Academic Trustee for the School of Natural Sciences, succeeds Andrew Strominger, Professor of Physics at Harvard University, who served a five-year term on behalf of the School.

Schmidt earned his bachelor's degree in electrical engineering at Princeton University (1976), and obtained a master's degree (1979) and a Ph.D. (1982) in electrical engineering and computer science from the University of California, Berkeley. In 1983, he joined Sun Microsystems and rose to become its Chief Technology Officer. He was named Chairman and CEO of Novell in 1997, where he led the company's strategic planning, management, and technology development. Schmidt was recruited by Google in 2001 and became Chairman of the Board and CEO of the company in March and August of that year, respectively.

An internationally recognized technologist and business leader, Schmidt serves on the Board of Directors of Apple Inc. and is Chairman of the Board of Directors of the New America Foundation. He was elected to the National Academy of Engineering in 2006 and the American Academy of Arts and Sciences in 2007.

DENISE APPLEWHITE

Curtis Callan

Callan, winner of the Dirac Medal in 2004, was a Member in the School of Natural Sciences at the Institute on three occasions, in 1969–72, 1983, and 1993–94, and has been a frequent Visitor in recent years. Well known for the Callan-Symanzik equation, Callan was recently elected Vice President of the American Physical Society (APS). Callan was awarded the 2000 Sakurai Medal for Particle Theory of the APS and was elected to the National Academy of Sciences in 1987.

After receiving an AB in physics from Haverford College in 1961, he pursued graduate study in physics at Princeton, where he was awarded his Ph.D. in 1964. From there, he became assistant professor in physics at Harvard University. In 1972, he joined the faculty of Princeton, where he became J. S. McDonnell Distinguished University Professor of Physics in 1995. He currently serves as Chair of the Physics Department at the University. Callan is the founding Director of the Princeton Center for Theoretical Physics, which works to promote interaction among theorists and seed new directions in research, especially in areas cutting across traditional disciplinary boundaries.

NEWS OF THE INSTITUTE COMMUNITY

NIMA ARKANI-HAMED, Professor in the School of Natural Sciences, has been awarded the 2008 Raymond and Beverly Sackler International Prize in Physics, presented by Tel Aviv University. The physics prize alternates each year with one for chemistry, and is awarded to an outstanding scientist who is not older than 42. Arkani-Hamed was cited for his "novel, deep, and highly influential contributions to new paradigms for physics beyond the Standard Model."

The Royal Dutch Mathematical Society has announced that PHILLIP A. GRIFFITHS, Professor in the School of Mathematics, has been selected to receive the 2008 Brouwer Prize. Griffiths was cited for his work in complex algebraic geometry and (complex) differential geometry: "He combines, in a modern incarnation, the style and tradition of Henri Poincaré and Elie Cartan. His research of algebraic cycles and variation of Hodge structures has opened new roads, which were followed by many after him. Griffiths is senior author of several books which have raised generations of geometers of the last thirty years."

The Royal Netherlands Academy of Arts and Sciences has announced that JONATHAN ISRAEL, Professor of Modern European History in the School of Historical Studies, has been selected to receive the 2008 Dr. A. H. Heineken Prize in History. According to the prize committee, "Some scholars believe the Enlightenment began with eighteenth-century French philosophers such as Voltaire and Rousseau, whereas others trace its origins to England and to Newton and Locke. But these theories have been altered by the work of British historian Jonathan Israel, who emphasizes the significance of what went before: the early, radical phase of the Enlightenment, dominated by the ideas of the philosopher Spinoza (1632–1677)."

ARNOLD J. LEVINE, Professor in the School of Natural Sciences who leads The Simons Center for Systems Biology, has received the 2008 Kirk A. Landon-AACR Prize for Basic Cancer Research. The prize is designed to promote and reward seminal contributions to the understanding of cancer through basic cancer research. Levine was recognized for his significant contributions to the discovery of p53 as a tumor suppressor gene and his work in identifying its anti-cancer mechanisms. Levine has also been selected to receive the Dart/NYU Biotechnology Achievement Award in Basic Biotechnology from the NYU Biotechnology Center for his work in isolating, cloning, and characterizing the properties of the p53 gene.

ERIC S. MASKIN, Albert O. Hirschman Professor in the School of Social Science, and NATHAN SEIBERG, Professor in the School of Natural Sciences, have been elected to membership in the National Academy of Sciences for their excellence in original scientific research. In April, Maskin also received the 2008 EFR-Business Week Award for outstanding academic contribution in the field of economics.

JOAN WALLACH SCOTT, Harold F. Linder Professor in the School of Social Science, has been named a Fellow in the American Academy of Arts & Sciences. Joining her in the 2008 class of Fellows are Institute Trustees JAMES H. SIMONS, former Member (1972–73) in the School of Mathematics, and CHARLES SIMONYI, President of the Corporation.

Princeton University Press has published *Galactic Dynamics: Second Edition* by James Binney and SCOTT TREMAINE, Richard Black Professor in the School of Natural Sciences. The volume is a major revision of the 1987 original, which has become one of the most widely used advanced textbooks on the structure and dynamics of galaxies and other stellar systems, as well as one of the most cited references in astrophysics.

Mostly Miniatures: An Introduction to Persian Painting (Princeton University Press, 2001) by OLEG GRABAR, Professor Emeritus in the School of Historical Studies, has been translated into both Persian and Arabic. *Islamic Art and Architecture 650–1250* (Yale University Press, 2003) by Richard Ettinghausen, Grabar, and Marilyn Jenkins-Madina, has been translated into Polish.

The Internationale Spinozaprijs Foundation in the Netherlands has named MICHAEL WALZER, Professor Emeritus in the School of Social Science, as the recipient of the 2008 Spinoza Lens Prize. Walzer was cited as "one of the most important and versatile political thinkers of our time."

Institute Trustee ROGER W. FERGUSON, JR., has been named President and Chief Executive Officer of TIAA-CREF, the leading provider of retirement services in the academic, research, medical, and cultural fields. Ferguson has also been appointed President of Harvard University's Board of Overseers for the academic year 2008–09.

Institute Trustee CHARLES SIMONYI received a Doctor of Humane Letters at the May 23 commencement of the Julliard School. Simonyi was recognized for his contributions to computer technology, science programs, art organizations, and educational institutions.

NOGA ALON, Visiting Professor in the School of Mathematics, has won the Israel Prize in Mathematics for 2008. The citation for the prize notes that Alon is a world leader in combinatorics—the mathematics of discrete structures—focusing on graph theory and applications to theoretical computer science. Alon's work changed the face of modern combinatorics, introducing new notions, structures, and methods. He has solved several long-standing open problems in combinatorics, graph theory, and Ramsey theory, including a problem posed in the 1950s by Claude Shannon, the father of Information Theory.

CHEN-HSIANG YEANG, Systems Biology Member in the School of Natural Sciences, has been selected by the J. William Fulbright Foreign Scholarship Board as a Fulbright scholar grantee to Taiwan.

Former School of Social Science Member (2002–03) JOÃO BIEHL, Associate Professor of Anthropology at Princeton University, has won the 2007 Margaret Mead Award, one of the most prestigious honors for anthropological books. This is the sixth major award for Biehl's book, *Vita: Life in a Zone of Social Abandonment* (University of California Press, 2005). The honor, jointly awarded by the American Anthropological Association and the Society for Applied Anthropology, is given to a young scholar whose work interprets anthropological data and principles in a manner accessible to the public and brings anthropology to bear on vital social and cultural issues.

School of Historical Studies former Member (2002) and Visitor (2005–06) CELIA CHAZELLE, and former Member (2006–07) FELICE LIFSHITZ have edited *Paradigms and Methods in Early Medieval Studies* (Palgrave, 2007), which features contributions from several former Institute Members and is dedicated to the medieval studies seminar organized by the School of Historical Studies.

SIMON DONALDSON, former Member (1983–84) in the School of Mathematics and Royal Society Research Professor at Imperial College, London, has been awarded the 2008 Frederic Esser Nemmers Prize in Mathematics for his "groundbreaking work in four-dimensional topology, symplectic geometry, and gauge theory, and for his remarkable use of ideas from physics to advance pure mathematics."

DAVID DeVORKIN, former Member (1991) in the School of Natural Sciences, has been awarded the LeRoy E. Doggett Prize of the Historical Astronomy Division of the American Astronomical Association for "his seminal work in illuminating the origins and development of modern astrophysics and the origins of the space sciences during the twentieth century." DeVorkin also has received the American Historical Association's Herbert Feis Award for Public History, which recognizes distinguished contributions to public history during the previous ten years. DeVorkin is Curator of Astronomy in the Department of Space History at the National Air and Space Museum.

Former Members in the School of Mathematics JOHN G. THOMPSON (1978–79) and JACQUES TITS (1951–52, 1962–63, 1968–69, 1971–72), have been awarded the 2008 Abel Prize by the Norwegian Academy of Science and Letters. Thompson, Professor of Mathematics at the University of Florida, and Tits, an emeritus professor at the Collège de France, will share the $1.2 million prize for their work on "shaping modern group theory."

The Social Science Research Council has awarded the 2008 Albert O. Hirschman Prize to the late CHARLES TILLY, former Member (1970–71) in the School of Social Science, for his extensive career spanning the social sciences. Tilly was the Joseph L. Buttenwieser Professor of Social Science at Columbia University.

VAN H. VU, former Member (1998–99, 2005–06, 2007) in the School of Mathematics and Professor of Mathematics at Rutgers, The State University of New Jersey, has won the George Pólya Prize, presented by the Society for Industrial and Applied Mathematics (SIAM). The prize recognizes Vu's work in combinatorial theory.

ENDRE SZEMERÉDI, former Member (2007) in the School of Mathematics, has been selected to receive the 2008 Rolf Schock Prize in Mathematics by the Royal Swedish Academy of Sciences. Professor of Mathematics at Rutgers, The State University of New Jersey, and the Alfréd Rényi Institute of Mathematics at the Hungarian Academy of Sciences in Budapest, Szemerédi was selected "for his deep and pioneering work from 1975 on arithmetic progressions in subsets of the integers, which has led to great progress and discoveries in several branches of mathematics."

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.

DANIELLE ALLEN: POSING CHALLENGING SOCIOPOLITICAL QUESTIONS

"I am a person who loves books," says Danielle Allen, UPS Foundation Professor in the Institute for Advanced Study's School of Social Science. "I am happiest when I am reading and writing. And I am fascinated by politics."

Trained both as a classicist and a political theorist, Allen was selected to succeed Michael Walzer, one of the world's foremost political thinkers who retired last June after twenty-seven years and is now Professor Emeritus. Since joining the Institute last July, Allen has posed challenging sociopolitical questions—from examining the value of sound bites in democratic discourse; to leading the School's thematic seminar, "The Rule of Law Under Pressure"; to probing a heady array of issues related to democratic theory, political sociology, the linguistic dimensions of politics, and the history of political thought.

CLIFF MOORE

Danielle Allen

Allen was Dean of the Humanities Division at the University of Chicago and a MacArthur Fellow with two Ph.D.s when Professor Joan Wallach Scott contacted her in 2006 about the possibility of her joining the Faculty. "I knew of the Institute," says Allen, who had served on the University of Chicago faculty since 1997, "but I am not sure that it ever occurred to me that it was a place that hired."

Widely known for her work on justice and citizenship in ancient Athens and its application to modern America, Allen recently has been looking at sociopolitical change and how clusters of problems—the influence, for example, of statistics on public discourse and linear extrapolations—relate to issues of political agency.

"I come from a pretty political family," says Allen, who was raised in Claremont, California. Her father, a professor of political philosophy at Michigan State University, is a past chairman of the United States Commission on Civil Rights. "My father grew up in northern Florida and my mother grew up in Michigan. And they each came from families that were civically active. My grandfather on my father's side organized the first NAACP chapter in his part of Florida, which was a dangerous thing to do at the time. And my mother's grandfather did a lot of important work for the state of Michigan in various work-service roles related to youth education."

At Princeton University, Allen expected to be a political science major. But things changed when she took a course called "Athenian Democracy" taught by Josiah Ober. "I realized that a lot of the political issues that I wanted to study, I could also learn about through the context of historical study," Allen says.

After graduating *summa cum laude* from Princeton with a B.A. in Classics and a minor in political theory, Allen was awarded an M.Phil. and Ph.D. in Classics from Cambridge University, then went on to Harvard University, where she received her M.A. and Ph.D. in Political Science. She joined the faculty at the University of Chicago in 1997 as Assistant Professor of Classics.

"My hope is to contribute to equipping my generation with the conceptual tools to do intelligent political thinking," says Allen. "I would also like to try to help us evolve our understanding of democracy to meet the challenges of the world we live in now."

In a public lecture at the Institute in February, Allen offered a probing look at the role sound bites play in democratic politics. Tracing the Western roots of sound bites to Homer, who was the first purveyor of them, and Aristotle, who offered the first theory of them as maxims, Allen examined why sound bites are a necessary and valuable part of political conversation, while also considering the ways in which they are dangerous.

Allen explained that she became fascinated with sound bites eight years ago when the outcome of the presidential election between George W. Bush and Albert Gore was before the U.S. Supreme Court. "At the same time that I was consumed by this political question," Allen says, "I was also teaching Thucydides's *History of the Peloponnesian War*."

In particular, she was teaching books six and seven in which the primary protagonists, who debate whether to go to war, are Nicias, the elder statesman, and Alcibiades, the young Turk leading a new generation of politicians.

"As I was reading this, I suddenly realized that Thucydides was telling us something important about political language. Nicias's syntax was incredibly complicated, very woolly. Alcibiades, in contrast, was direct, blunt."

Allen started paying attention to the language being used by present-day political candidates. "It seemed to me we could probably attribute a significant portion of Bush's success to his capacity to speak directly," says Allen. "I began to use this general attention to syntax by politicians to judge what outcomes were likely."

A similar scenario repeated itself in 2004—if anything, Allen noted, John Kerry's syntax was more elaborate and more complex than Gore's had been. Interestingly, this year's primary elections, Allen observes,

(Continued on page 9)

THE RULE OF LAW UNDER PRESSURE

Each year, the School of Social Science designates a theme to create a sense of community among its Members. During the 2007–08 academic year, the theme was "The Rule of Law Under Pressure," in which Members looked at the pressure that comes from the "war on terrorism" (and other wars) and from the claim that military and political emergencies require the expansion of executive power and the violation of conventional moral norms.

"September 11th and the efforts of this country to deal with terrorism have put a lot of pressure on the question of what the rule of law is and how to maintain it over time," says Danielle Allen, UPS Foundation Professor, who led the seminar. "We have issues with habeas corpus and an administration working aggressively to expand executive power. These are historically important phenomena and it is critical to determine why certain actions do in fact undermine the rule of law or support it."

BENTLEY DREZNER

Trustee Peter Galison discusses his film Secrecy *with School of Social Science Member Mary Dudziak.*

How does the rule of law work to protect ordinary citizens? What is the role of judges and courts in maintaining the rule of law? When do the "needs of the hour" override constitutional limits? What does "necessity" mean in politics and war, and who decides when it comes into play? These are some of the questions that Members examined.

"It surprised me how hard it is to talk about," says Allen. "The first two seminars were pretty interesting because we thought we knew what the rule of law was and what it means. We discovered that each discipline has a very different idea of what the rule of law is. It took a number of sessions before we could even talk to each other properly." For Allen, the rule of law is "not just a set of procedures or a set of institutional norms. It is also a set of commitments. Those commitments relate to fairness, freedom from constraint and arbitrariness, and equality, which open up space for greater or increased human flourishing."

As an outgrowth of the seminar, Members initiated a monthly film-screening group called "Rethinking War." The March screening of *Secrecy* in Wolfensohn Hall included a discussion by filmmakers Peter Galison and Robb Moss. Galison, Pelligrino University Professor of the History of Science and of Physics at Harvard University, has been a Trustee of the Institute since 2004 and is a former Member (1994–95) of the School. The film, which explores the vast, invisible world of government secrecy and the tensions between our safety as a nation and our ability to function as a democracy, had its premiere at the Sundance Film Festival in January.

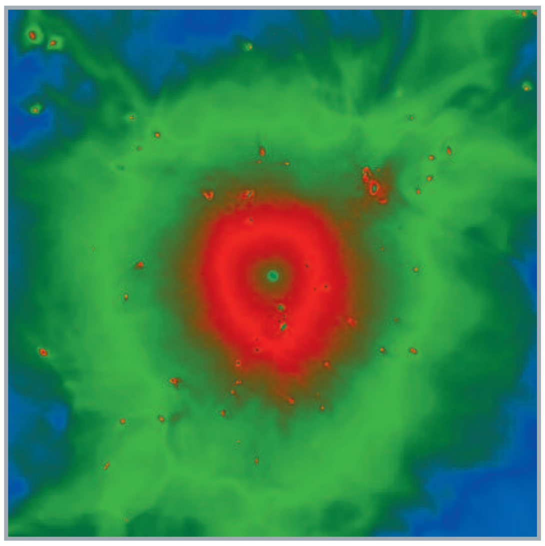
DARK MATTER/DARK ENERGY *(Continued from page 1)*

Institute Faculty and Members, who have contributed many of the theoretical foundations of the Standard Model and its possible modifications, have been at the forefront of trying to resolve the apparent incompatibility of general relativity and quantum theory that has been a central paradox of theoretical physics for several decades.

Today, the Institute is home to what is one of the world's leading groups of particle physicists—Professors Stephen Adler, Nima Arkani-Hamed, Juan Maldacena, Nathan Seiberg, and Edward Witten. They and other physicists who have worked at the Institute are responsible for many of the radically new ideas about the ultimate structure of matter and the nature of space and time that will be tested at the Large Hadron Collider (LHC), a particle accelerator expected to begin operating this year at the European Center for Nuclear Research (CERN) near Geneva.

At the same time, astrophysics research at the Institute, led by Tremaine and Professor Peter Goldreich, has contributed to many of the most significant advances in astronomy and astrophysics, from the formation of stars and planets to the discovery of black holes to the distribution and properties of dark matter.

The discovery of dark energy a decade ago showed that empty space is filled with a mysterious energy that is not diluted as the universe expands. While Einstein initially proposed a cosmological constant that could explain the dark energy (he prematurely discounted it as his biggest blunder when Edwin Hubble discovered the expansion of the universe in the 1920s), it is the amount of cosmologically observed dark energy that is difficult to reconcile with our current understanding of physics. Quantum fluctuations of the vacuum are thought to be a source of the dark energy field but most quantum field theories predict that it should be 10^{120} times larger than it is, meaning that the rate of acceleration would be so fast that galaxies and stars would not have a chance to form.



This image, produced by Member Douglas Rudd, shows the distribution of gas around a massive simulated galaxy cluster. The small clumps belong to galaxies that are falling into the cluster and in the process this gas will be stripped out of the galaxies. A smaller group of galaxies that is falling into the larger cluster is visible to the upper right of the image's center. The gas inside the cluster is heated to millions of degrees, causing it to be visible against the cosmic microwave background through the Sunyaev-Zel'dovich effect. Observations of this effect are being used to find clusters at high redshift and constrain the dark energy.

"Dark energy is really an embarrassment for particle physics," says Edward Witten, Charles Simonyi Professor in the School of Natural Sciences, who spoke about dark energy at the Space Telescope Science Institute in May. "Its discovery has greatly changed how we think about the laws of nature. The nature of the change depends crucially on whether dark energy is a 'cosmological constant.' For me, the discovery of cosmic acceleration/dark energy was the most dramatic finding in physics since perhaps the discovery of the J/ψ particle [a cornerstone of the Standard Model] in 1974."

In the coming years, astrophysical observations will play a complementary role to experiments conducted in high energy physics laboratories, most particularly at the LHC. The synergy of collider experiments and astrophysical observations may tell us what dark matter and dark energy are—potentially creating a revolution in our understanding of both particle physics and the universe (see article, page 5).

Particle physicists have turned more and more to astrophysics as a way of getting new data. Now, perhaps, in the next few years, the shoe will be on the other foot. With the LHC, particle physicists may, in turn, be able to discover things that will help the cosmologists understand what the universe is made of.

"Particle physicists have turned more and more to astrophysics as a way of getting new data," says Tremaine. "Now, perhaps, in the next few years, the shoe will be on the other foot. With the LHC, particle physicists may, in turn, be able to discover things that will help the cosmologists understand what the universe is made of."

Current research by Members in the School of Natural Sciences includes investigating the formation of dark matter substructure in our galaxy through analytical methods as well as numerical simulations; using large-scale computer simulations to study the growth and evolution of clusters of galaxies, and exploring their use as a probe of dark energy; studying the relationship between galaxies and dark matter from galaxy clustering to learn about cosmology and galaxy formation and evolution; and using weak gravitational lensing to answer a variety of astrophysical questions that will provide clues about the nature of dark matter and dark energy.

"Because the Institute has an exceptionally strong group of both particle physicists and astrophysicists, we are in an ideal position to understand any unexpected connections between particle physics and the cosmology as they emerge from either the LHC or new astronomical observations," says Tremaine.

From a physicist's point of view, "dark" matter or energy is something that does not emit or absorb any light, and thus does not interact with electromagnetic radiation in the same way that a table or the stars do. Since almost all astronomical observations are based on collecting light through telescopes, dark matter is extremely difficult to detect and characterize. Although the existence of dark matter was suggested in the 1930s, only in the last couple of decades have scientists made substantial progress in understanding its properties. We now know that every galaxy is surrounded by a halo of dark matter that can be detected indirectly by observing its gravitational effects. Still, there is no direct evidence about its actual nature.

"In galaxies, only a small fraction of the normal matter can give off light. The question is how can you use this tiny portion of bright things to probe the dark side—the dark matter and dark energy—and also, on the other hand, understand the formation and evolution of the bright side of these galaxies," says Zheng Zheng, a Member in the School of Natural Sciences. Zheng's current research involves using the halo occupation distribution—the relation between galaxies and dark matter at the level of individual dark matter halos—to learn about cosmology and galaxy formation and evolution.

Most cosmologists believe that the dark matter represents some new form of elementary particle that was formed in large amounts during the Big Bang, and has survived until the present day. "There is a question of whether the evidence for dark matter is really evidence for some new form of matter, or evidence that the law of gravity is breaking down in some way," says Tremaine. "There are people who argue that what we are seeing is not this invisible form of matter for which there is no other evidence, but a fundamental change in the laws of gravity on astronomical scales. I think the preponderance of evidence favors the interpretation that it is dark matter. But I have a lot of respect for several of the people who have been arguing for modifications to the laws of gravity. My guess is that dark matter is going to win out."

The leading candidate that might explain the fundamental makeup of dark matter is a hypothetical particle called the weakly interacting massive particle (WIMP) whose existence may be confirmed with NASA's recently launched Gamma-ray Large Area Space Telescope (GLAST).

While gamma rays originate from a multitude of high-energy, astronomical sources, such as black holes and exploding stars, current theory suggests they can also come from WIMPs. Predicted by supersymmetry, a theory that extends the Standard Model, WIMPs could annihilate when they interact or undergo free decay. In either case, if gamma rays were among the secondary particles, these might be detected by GLAST.

(Continued on page 6)

The School of Natural Sciences

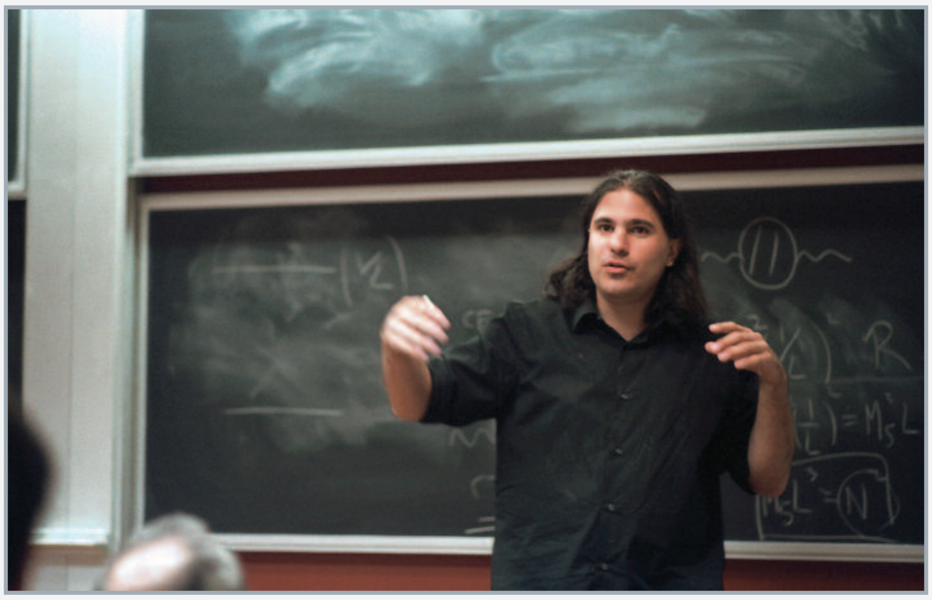
The Institute for Advanced Study's School of Natural Sciences focuses on the study of the very small (elementary particle physics and quantum field theory); the very large (astronomy and cosmology); and the very complex (systems biology).

Housed in Bloomberg Hall, the astrophysics group works alongside the particle physics group, whose activity centers on string theory and particle phenomenology, and the systems biology group, which involves the application of approaches to modern physics and mathematics to biological investigation. (See the Winter 2008 and Fall 2006 issues of *The Institute Letter* for more information about the research underway at the School's Simons Center for Systems Biology).

The work of the Institute's astrophysics research group encompasses the whole spectrum of astronomical systems, from nearby planets to distant stars, from the mysterious matter that fills the space between galaxies to the most distant known objects in the universe. The researchers employ an array of tools from theoretical physics, large-scale computer simulations, and ground- and space-based observational studies to investigate the origin and composition of the universe, and to use the universe as a laboratory to study fundamental physics.

From its earliest days, the Institute has been a leading center for fundamental physics, contributing substantially to many of its central themes, from the development of the new mathematics required to understand subjects such as string theory to proposing and interpreting experimental tests of fundamental physical theories. In recent years, a growing number of our particle physicists have worked on phenomenology, in particular the interpretation of the data that will emerge from the Large Hadron Collider, to better understand the ultimate structure of matter, space, and time and advance our understanding of the physical world.

Nima Arkani-Hamed: Unraveling Nature's Mysteries



RANDALL HAGADORN

Nima Arkani-Hamed

"Everything here is fraught with danger and excitement," says Nima Arkani-Hamed, Professor in the School of Natural Sciences. With a broad sweep of his hand, he motions to the diagram he has drawn on the chalkboard in his office of the range of distance scales for known phenomena—from 10^{-33} cm, which is associated with quantum gravity and string theory, to 10^{+28} cm, which is the size of the universe.

"Why is the universe big, why is gravity so weak? You would think after 2,000 years of thinking about physics we would have good answers to questions like that. We have lousy answers to these questions," says Arkani-Hamed. "Our current laws of nature—the Standard Model of particle physics—are perfectly consistent. No experiments contradict them, but they give such lousy answers to these questions that we think we are missing something very, very big."

With the imminent start-up of the Large Hadron Collider (LHC), a particle accelerator that will collide protons together and allow us to probe the laws of nature down to distances of 10^{-17} cm, a billion times smaller than the atom, and ten times smaller than the tiniest distances we have probed to date, fundamental particle physics is on the threshold of a new era.

Arkani-Hamed, one of the world's leading phenomenologists who joined the Faculty in January, has taken a lead in building models of the universe that relate to theories that can be tested at the LHC—from supersymmetry to large extra dimensions of space to the idea that our universe exists in a sea of universes, each governed by a different set of principles.

"I try to take ideas that are in the theoretical zeitgeist and see if they might be relevant to solving any of the outstanding mysteries, and then see what experimental consequences can be derived," says Arkani-Hamed. "Phenomenologists are jacks of all trades. We try to propose theories that extend things that we have seen, figure out the direct observational consequences of those theories, and work closely with our experimental colleagues to see how we can actually extract information about nature directly from an experiment."

Among the ideas that will be tested at the LHC is the existence of supersymmetry, which involves the ordinary dimensions of space and time having quantum mechanical partners, and the possibility that there may be extra spatial dimensions aside from the three spatial dimensions familiar to us. Both supersymmetry and extra dimensions are essential components of string theory, the leading candidate for unifying general relativity and quantum mechanics. These are all subjects that Institute physicists have taken a lead in developing.

Just as for every particle there exists an antiparticle, supersymmetry predicts that for every known particle there also exists a superpartner particle. Part of the strong theoretical appeal of supersymmetry is its possible connection to dark energy and the fact that it provides a natural candidate for dark matter—a new weakly interacting massive particle (WIMP) with mass close to the scale that will be probed at the LHC.

"Often people will describe the LHC or accelerators in general as microscopes for probing short distances. But normally, a microscope is looking at something. What is the LHC looking at? It is looking at the vacuum," says Arkani-Hamed. "People like to say the dark energy is very mysterious and we don't know what it is but that is a bit of an exaggeration, because there is an extremely simple thing that it could be. It could be the energy of the vacuum. It's not that we don't know how to accommodate it in our equations. We definitely know how to accommodate it. The problem is that we get it 120 orders of magnitude bigger than it apparently is."

To accommodate dark energy in particle physics requires unnatural fine-tuning, which also arises in another aspect of Arkani-Hamed's research—a paradox of the Standard Model called the "hierarchy problem" that relates to the extreme weakness of gravity in comparison to the other forces of nature—electromagnetism, the strong nuclear force, and the weak nuclear force. Violent short distance quantum fluctuations in the vacuum would naturally lead to the prediction that the strength of gravity is thirty orders of magnitude larger than its observed strength, requiring inordinate fine-tuning for the parameters of the theory.

"Fine-tuning is like walking into a room and seeing a pencil standing on its tip in the middle of a table," says Arkani-Hamed. "If you saw it, you would think that maybe there is a little string hanging from the ceiling that you missed, or maybe there is a little hand holding it up or something. The dark energy problem and the hierarchy problem are conceptually identical puzzles. In both cases, we have to do a tremendous amount of fine-tuning in order to explain some very obvious property of our world because we don't yet see any dynamics or any mechanism for explaining why it is what it is."

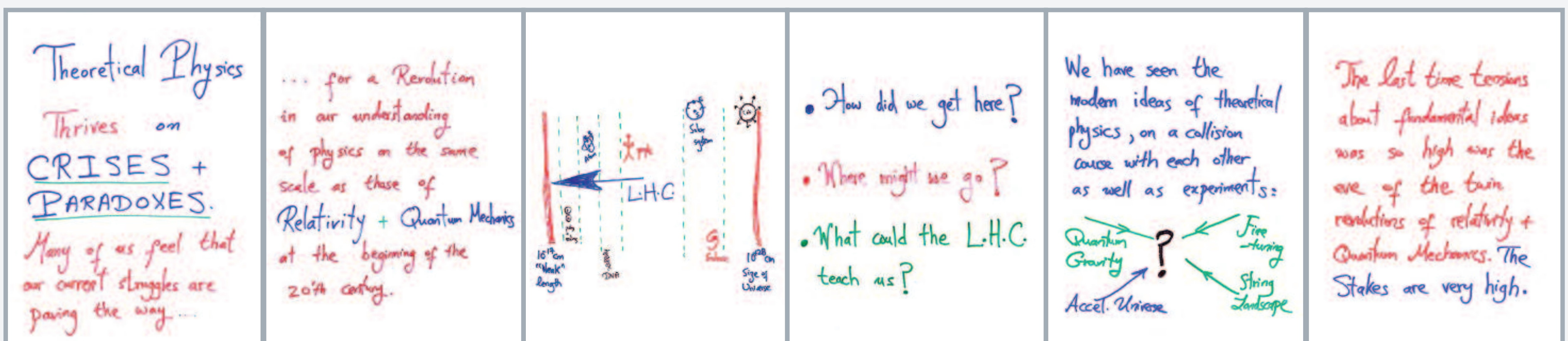
Particle physics data point to another mysterious component of empty space, the Higgs field, a force that fills space and gives particles the property of mass and might be related to dark energy. Arkani-Hamed is willing to bet several months' salary that the Higgs particle, the last element predicted by the Standard Model that has not been confirmed experimentally, will be discovered at the LHC.

While supersymmetry is the most popular solution to the hierarchy problem, Arkani-Hamed has proposed other possibilities, including the existence of large extra dimensions of space, which dilute gravity's strength, and a theory called split supersymmetry, in which only half of all particles have superpartners. "One of the confusing things about supersymmetry," says Arkani-Hamed, "is that people have mounted tons of experiments to look for possible signals of these partner particles and so far there has been no hint of it directly or indirectly."

Split supersymmetry finds a common explanation for the cosmological constant and the hierarchy problem. It relates to the theory of the multiverse, in which our entire observable universe might be a tiny part of a much larger multiverse, in which many universes function according to distinct and self-containing physical laws with one common exception: gravity, which can travel freely between them. "This is a very controversial idea, because to invoke universes you can't see to explain properties of our own universe is obviously a tricky proposition," says Arkani-Hamed. "But it is not obviously wrong. It is a subject of lots of continuing activity and thinking right now."

In a multiverse, a near-infinite number of universes exist, but ours is the only one we can observe because it is the only one in which we can live—a concept also known as the anthropic principle. "It is very interesting that the observed value of the cosmological constant, the observed value of the vacuum of dark energy, if you

(Continued on page 6)

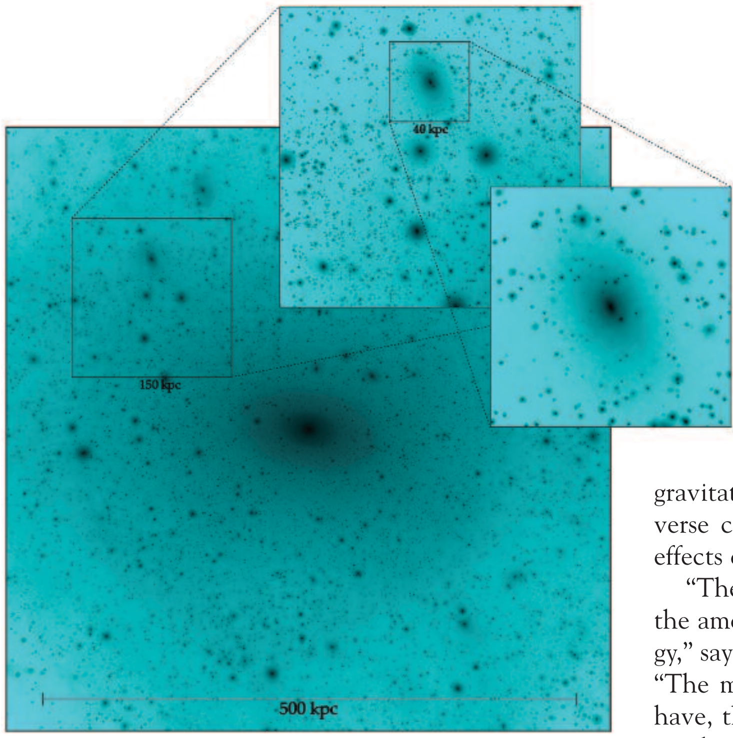


Slides drawn from Arkani-Hamed's talk "The Future of Fundamental Physics"

DARK MATTER/DARK ENERGY *(Continued from page 4)*

Elaborate computer simulations have provided clues about the nature of dark matter and how clusters and superclusters of galaxies evolved out of a slight lumpiness in the early universe. Over time, gravity has amplified the lumpiness (see cover illustration).

Member Michael Kuhlen has worked on modeling the lumpiness of dark matter, employing the highest resolution numerical simulations available, including a recently completed one billion particle simulation that resolves dark matter structure in the very inner, dense regions of a galaxy like our own (see illustration, right). “We start very early on and create an artificial computer representation of the dark matter distribution, and we allow it to evolve forward in time by solving just the equations that govern how dark matter clumps under the influence of gravity,” says Kuhlen. “Then we can look at the distribution of dark matter today after a simulation has progressed for 13 billion years on the computer.”



These images highlight the abundant structure in the dark matter distribution of “Via Lactea II,” a one billion particle simulation by Member Michael Kuhlen and his collaborators that resolves dark matter structure in the very inner, dense regions of the dark matter halo that envelops the Milky Way galaxy. The insets zoom in on one of the dark matter subhalos orbiting the center of the Milky Way, and show that dark matter lumpiness continues down to the smallest scales resolved by the simulation. The dark matter subhalo itself is orbited by even smaller sub-subhalos. The annihilation of dark matter particles in the centers of subhalos is one of the possible signals that NASA’s Gamma-ray Large Area Space Telescope (GLAST) might detect in the near future.

By calculating a wide range of dark matter particle masses and interaction probabilities based on particle physics calculations, Kuhlen and his collaborators have predicted that GLAST might very well detect the signatures of annihilations in dark matter clumps. “We want to know how we could possibly detect it because so far we only know about dark matter through indirect measurements, by detecting the influence of its gravity,” says Kuhlen.

Gravitational lensing is another way to discern evidence of dark matter in images of large clusters of galaxies. Strange optical effects are formed when the light from a very distant, bright source is warped by the gravitational pull of matter in the cluster. The intensity of the distortion indicates the strength of the cluster’s overall gravitational field and total mass.

Member Rachel Mandelbaum has been working on using gravitational lensing to measure the properties of the distribution of dark matter and dark energy. “My main area of research is weak gravitational lensing, the very small perturbations in the shapes of distant source galaxies due to massive foreground galaxies and clusters,” says Mandelbaum. “There are many useful applications of weak lensing due to the fact that it is sensitive to the full matter density projected along the line of sight, regardless of whether that matter is luminous—visible through a telescope—or not—the mysterious dark matter.” In one project, Mandelbaum and her collaborators have been comparing weak lensing by and gravitational clustering of galaxies in an effort to constrain and possibly exclude theories of modified gravity, which cast doubt on the existence of dark energy and the theory of general relativity.

“With dark matter, there are all sorts of approaches by which we might reasonably expect to learn a lot more,” says Goldreich. “Dark matter clusters gravitationally, so we more or less know where it is. We think that it is composed of a non-relativistic particle that moves in the gravitational fields of galaxies about as fast as the stars do.”

“Dark energy doesn’t appear to cluster. Our best guess is that it is a pervasive ether that bathes the universe. At the moment we don’t have any clever idea of how to investigate its properties other than to accurately measure the history of the expansion of the universe and the growth of structure. Trying to sense dark energy is like trying to sense the air in a room. You can feel the air when you wave your hand, but we lack a comparably sensitive detector for dark energy.”

Since the late 1920s, astronomers have known that the universe is expanding. Physicists thought that the combined gravitational pull of galaxies would gradually slow cosmic expansion, but in 1998 two independent research teams discovered what has become known as dark energy. By monitoring the light from distant supernovas to measure how the expansion rate of the universe had changed over time, the researchers found that while the universe’s expansion had been slowing down for its first few billion years, more recently it had started speeding up. Current theory is that when the universe was young and dense, the gravitational attraction of matter held sway. As the universe continued to expand and thin out, the repulsive effects of dark energy became dominant.

“The abundance of galaxy clusters is very sensitive to the amount of dark matter and the amount of dark energy,” says Member Douglas Rudd (see illustration, page 1). “The more dark matter you have, the more matter you have, the more objects you form. The more dark energy you have, the more formation is suppressed. So there is a competition between dark matter and dark energy.”

Rudd uses numerical simulations to test the relationship between what is known as the Sunyaev-Zel’dovich effect and the mass of galaxy clusters (see illustration, page 4). The SZ effect, which is the imprint left on the cosmic microwave background when light travels through the hot gas in a cluster’s core, allows researchers to locate galaxy clusters over cosmic history. By measuring the number of clusters at many different redshifts, or times, in the universe, researchers can map out how dark energy starts to affect the growth of structure.

“We can predict the number of dark matter halos very well from theories and from simulations that have been done over the last several decades,” says Rudd. “What is not clear is how to go from observations of the SZ effect to mass very accurately, which is necessary if you want to get information about dark energy.”

Although scientists since Einstein had recognized that some form of dark energy was a theoretical possibility, it was regarded as nothing more than some exotic possibility for which there was no independent evidence. Over the last decade, it was gradually realized that if you added a component of dark energy to more sophisticated models of the properties of the universe—its expansion history, the clustering of galaxies, the clustering of the background radiation—suddenly everything fit much better, and over the past decade, that fit has continued to improve.

The hope is that the LHC will provide new data that will eliminate a lot of possibilities that have been discussed as no longer consistent with the data, while providing enough clues for particle physicists to move forward and gain a better understanding of basic laws that drive the universe. That increased understanding would then lead to definite predictions about the properties of the universe that would give more insight to cosmologists. “It is far from certain that the LHC or other projects will enable us to achieve the goal of understanding the nature of dark matter within the next few years,” says Tremaine, “but the prize will be really wonderful if it comes to pass.”

ARKANI-HAMED *(Continued from page 5)*

interpret the dark energy as a cosmological constant, is right around the value where if it was a little bigger then the universe would be empty,” says Arkani-Hamed.

In his recent talk on dark energy at the Space Telescope Science Institute, Edward Witten, Charles Simonyi Professor in the School of Natural Sciences, addressed the theoretical possibility of a multiverse in which the aim is not to explain why the vacuum has a very tiny energy but rather to look for a theory that generates all kinds of vacua with different properties that are realized in different times and places in a multiverse, perhaps as a result of cosmic inflation.

The good news, if we are living in a multiverse in which the only vacuum we can observe is the one that allows our existence, Witten says, is that the Standard Model as we know it may be fairly accurate. “If the universe is really a multiverse, finding the vacuum state we observe should be like searching for a needle in a haystack,” says Witten. “But this comes with a hefty dose of bad news: if the vacuum of the real world is really a needle in a haystack, it is hard to see how we are supposed to be able to understand it.”

At the Institute, Arkani-Hamed will be looking at LHC data to interpret signals that underscore these and other theoretical possibilities while helping to attract and mentor highly talented postdoctoral fellows, with a diversity of theoretical skills, in anticipation of a golden era of discovery. Speaking of his decision to come to the Institute from his position as Professor of Physics at Harvard, Arkani-Hamed says, “This is a very, very special group. I couldn’t possibly ask for better or more stimulating colleagues in high energy theory and string theory, quantum field theory, and astronomy.”

“Here I have the ability to really focus very sharply on doing science. Again, I keep bringing this up because it looms so large in most of our minds: an experiment like the LHC is a once-in-a-lifetime opportunity. There really seem to be very fundamental scientific issues at stake. And there really is a chance to unravel them and learn something potentially revolutionary and new about nature. You can’t give up on opportunities like that.”

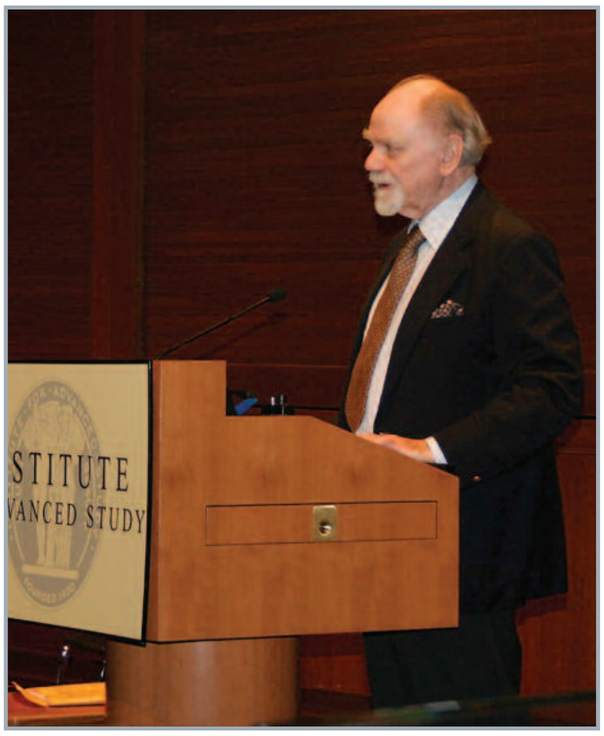
Nima Arkani-Hamed was one of the organizers and lecturers of the School of Natural Sciences’s 2008 Prospects in Theoretical Physics program, “Strings and Phenomenology.” The July 14–25 program was designed for string theorists wanting to learn about issues of compactification relevant to phenomenology and cosmology, and for cosmologists seeking to learn about strings and their applications to phenomenology.

MODERNISM BETWEEN WEIMAR AND THE THIRD REICH

Conceptions of war and of its uses, and the interaction of the arts with politics and ideology, are two different but often related areas of research in which Peter Paret, Professor Emeritus in the School of Historical Studies, specializes.

A dramatic example of this interaction was explored by Paret in "Modernism between Weimar and the Third Reich," a talk he gave in March prior to a Sunday Afternoon Chamber Series performance by the Princeton Symphony Orchestra in Wolfensohn Hall. The program featured music by the Jewish romantic composer Felix Mendelssohn and two modernists, Erwin Schulhoff, and Anton von Webern, whose works were discredited or banned by the Third Reich in its effort to purify music from alien or degenerate elements.

Between the 1920s and 1945, a culture war was waged by National Socialism against certain forms of modernism in the arts. Paret suggested that while Mendelssohn's, Schulhoff's, and von Webern's compositions were different, they were attacked for the same underlying reason: Hitler's belief in the ideological significance of the arts. He saw them as an arena in which good and evil forces fought over the nation's present and future.


DINAH KAZAKOFF

Peter Paret

Hitler, Paret continued, had the insight to recognize that "in a democratic political system, which was socially and economically battered by the First World War, one way of mobilizing people to support reactionary politics was to alert them to works they would regard as senseless or revolting, but that nevertheless were praised in newspapers, exhibited or performed, and given prizes by the state."

Hitler accepted works of modern art in a variety of forms and styles, as long as they had what he considered healthy subjects, and as long as they treated their subjects descriptively or with humor, or idealized them. In fact, Paret observed, under Hitler's urging the Third Reich sought out modern design and integrated it in mass culture, from the Autobahn and the Volkswagen to the design of furniture, lamps, dishes, and cutlery. But Hitler rejected distortion in the arts and their exploration of psychological conflict or social misery—frequent stylistic and thematic characteristics of modernism.

After Hitler gained power, the new government's cultural policy remained uncertain for a time. "Hitler's intentions being not yet clear, party leaders filled the vacuum with their own policies," noted Paret. "Concerts and exhibitions prohibited in some parts of Germany were permitted in others, and it was possible to think that as the party became accustomed to govern, it would modify its extremes of rhetoric and policy."

But Hitler's very broad definition of unwanted art, and the use of undesirable music as a symbol for alien forces that threatened the German people's sense of self, were gradually institutionalized and became central to his cultural policies, which Hitler further linked to the elimination of Jews from Germany.

Paret gave the example of the *Reichsmusikkammer*, which controlled music by granting or withdrawing the right to work. At first Jews, especially if they had served in the World War, were accepted, but by March 1936, more than 2,000 Jews and those associated with them through marriage or ancestry had been weeded out. For a time, composers or performers of twelve-tone or atonal music could still belong if they had influential sponsors. That was the case with von Webern, who remained a member even after he was officially denounced as a major practitioner of twelve-tone music, but who was not allowed to perform or teach.

Good art has often been made under repressive regimes, either in subversive opposition to its measures, or in agreement with them, or by ignoring them as much as possible, observed Paret. But after the first few years of the Third Reich, Hitler's vision of totality subsumed every element of society and culture, from politics to war, from art to ethnicity, under the same ideological demand.

"It is one thing to manipulate ideas freely in an environment that affords scope to diversity, and another to do so under the constant threat of physical repression, and, indeed, of extinction," concluded Paret. "For creativity to move in new directions in the closed society of the Third Reich, to break away from officially approved norms, and survive in the face of organized terror, was so difficult as to approach the impossible. Whether the circumstances of that time and place can be generalized to apply to comparable conditions in the future is a question that may be worth asking even if it cannot be answered."

This fall Peter Paret will give the 2008 Lees Knowles Lectures on the History of War at the University of Cambridge, in which he will discuss four varieties of history of the same episode: narrative; cultural history; political and institutional history; and theoretical analysis. A second project is an exhibition, to open in March at the Princeton University Art Museum, of Ernst Barlach's illustrations—remarkable and controversial achievements of Weimar modernism—of two German literary works, the Nibelungen epic and the Walpurgis Night in Goethe's Faust.

LEON LEVY LECTURE: "THE LOT OF THE UNEMPLOYED"


COURTESY OF ALAN KRUEGER

Alan Krueger

Job search by the unemployed is a topic of much interest in labor economics and economics more generally. Alan B. Krueger, the Leon Levy Member (2007–08) in the School of Social Science, discussed "The Lot of the Unemployed" in his Leon Levy Lecture in April, which was funded by the Leon Levy Foundation.

Bendheim Professor of Economics and Public Affairs at Princeton University and former Chief Economist at the U.S. Department of Labor (1994–95), Krueger has published widely on labor economics, the economics of education, the economics of terrorism, and environmental economics. He was recently selected to serve on the Board of Directors of the John D. and Catherine T. MacArthur Foundation.

According to Krueger, while the unemployment rate has been modest by historical standards, the consequences of unemployment are greater than they have been historically. "Even though the unemployment rate has been trending down at least since the last twenty years," explained Krueger, "the average duration of an ongoing spell of unemployment looks like it has worsened. Since the late 1960s, there has been an upward trend in the duration of unemployment for those who become unemployed." He also noted that the unemployment rate has jumped up in the current economic slowdown.

In discussing the life of the unemployed, Krueger referenced two surveys: the American Time Use Survey, which the Bureau of Labor Statistics has collected since 2003; and the Princeton Affect and Time Survey, which was designed by Krueger and his Princeton colleague Daniel Kahneman and implemented by Gallup in the summer of 2006.

The Bureau survey was used to measure how an unemployed person spends his or her day (sleeping, searching for a new job, watching television, shopping, caring for others). The Krueger and Kahneman survey assesses how the unemployed and employed feel moment to moment (happy, sad, stressed, interested, pained, tired).

"There is a view in economics that unemployment is like leisure, but I don't think that is the right view," said Krueger. "People who are unemployed do spend time searching for a new job and, more importantly, they are not very happy with their lives or free time."

According to Krueger, unemployment "seems to scar individuals, which is quite surprising to researchers who work in this area because there is a well-known phenomenon in psychology that people tend to adapt to their circumstances." Yet the longer a person is unemployed, the more likely he or she is to stop searching for a job and drop out of the work force entirely; their life satisfaction is also permanently lower.

Krueger also examined the effect of unemployment insurance benefits on job search activity. "Economists worry a lot about an unintended consequence of unemployment insurance known as 'moral hazard,'" said Krueger, "which means that because benefits are available to people they might not search for a job as hard."

In addition to advocating that unemployment insurance benefits be extended to part-time workers who pay unemployment insurance taxes but are not eligible in many states to receive unemployment benefits, Krueger emphasized the importance of improving the automatic triggers that extend unemployment insurance benefits beyond the typical twenty-six weeks.

"In the old days, meaning before the Reagan administration, a higher unemployment rate would automatically trigger extended benefits." said Krueger. "Now the triggers are much harder to reach. It is very rare that extended benefits are triggered, which is unfortunate because you might think of extended benefits as an automatic stimulus to spur consumption when the economy slows down." In March, Krueger testified before the U.S. Senate Committee on Health, Education, Labor, and Pensions that unemployment benefits should be extended in the current slowdown if automatic triggers that extend benefits are not fixed. In June, Congress voted to extend benefits for thirteen weeks, and the President signed the bill on June 30.

THERE ARE NO EXCUSES IN PARADISE

The Institute for Advanced Study has remained small but its influence has been wide and profound through the achievements of its Faculty and Members, the impact it has on their academic development, and through the new institutions, ever growing in number, that have been modeled on or inspired by the vision of Founding Director Abraham Flexner, as realized by his Institute.

At the inauguration of the Freiburg Institute for Advanced Studies in May and at the recently opened Institute for Advanced Study at the Hong Kong University of Science and Technology in January, Director Peter Goddard spoke about the Institute's influence under the title, "There are No Excuses in Paradise—The Institute for Advanced Study: Past, Present, and Future."

Examining the origins of the Institute, viewed as an academic paradise since its earliest days—"the one true Platonic Heaven"—that some have called the "Institute where there are no excuses for failing to do something important," Goddard explained how the absence of prescriptive expectations creates self-imposed pressures on Institute Members to achieve great things. He also offered his perspective on how Flexner's view—that the research that has the most profound impact on knowledge and understanding is that driven by curiosity rather than the prospect of immediate application—has provided a highly successful model, which has inspired a growing host of institutes internationally.

At the beginning of the twentieth century, Goddard noted, the great American universities had not yet assumed a leading position in the worlds of science and scholarship. As much as any other individual, Flexner—following his careful analysis of such institutions as All Souls College, Oxford, the Collège de France, and the late nineteenth-century German universities—recognized the need for an advanced research institution in the United States.

Flexner, who was born in Louisville, Kentucky, in 1866, the sixth son of German immigrants, studied at Johns Hopkins University in Baltimore, which was the first American university to be centered on research and advanced study, following in the German tradition initiated by Wilhelm von Humboldt.

Humboldt, in 1810, convinced the King of Prussia to found Berlin University based on Friedrich Schleiermacher's liberal ideas on academic freedom, and the importance of seminars, laboratories, and research. The object, as Schleiermacher put it, was to make it "second nature for [the students] to view everything from the perspective of scholarship ... and thus acquire the ability to carry out research, to make discoveries."

In late 1929, his reputation established by several highly influential books on American higher education and medical education, Flexner was invited to meet Louis Bamberger and his sister Caroline Bamberger Fuld, who were considering establishing a medical school in Newark, New Jersey. Flexner asked the Bambergers if they had ever dreamed a dream, and proceeded to tell them his: the establishment in America of a purely graduate university, devoted to research rather than undergraduate teaching. He convinced the Bambergers to abandon the idea of a medical school, to make available $5 million for what was to be named the Institute for Advanced Study, and to locate it in Princeton so that it could be near a great academic library and the wider intellectual community of a major university.

Examining the origins of the Institute, viewed as an academic paradise since its earliest days, has provided a highly successful model, which has inspired a growing host of institutes internationally.

By May 1930, the Bambergers had designated Flexner as the first Director and, on the 20th of that month, the Institute was formally established. In October 1931, Flexner presented a carefully drafted confidential memorandum to the Board of Trustees, setting out his plans in more detail:

"The Institute should be small and plastic (that is flexible); it should be a haven where scholars and scientists could regard the world and its phenomena as their laboratory, without being carried off in the maelstrom of the immediate; it should be simple, comfortable, quiet without being monastic or remote; it should be afraid of no issue; yet it should be under no pressure from any side which might tend to force its scholars to be prejudiced either for or against any particular solution of the problems under study; and it should provide the facilities, the tranquility, and the time requisite to fundamental inquiry into the unknown. Its scholars should enjoy complete intellectual liberty and be absolutely free from administrative responsibilities or concerns."

Later, Flexner articulated his philosophy in a famous article, "The Usefulness of Useless Knowledge," which went through a number of versions, and was published in *Harper's* magazine in 1939. In this article he sought to examine the utilitarian value of purely intellectual pursuits.

The prime example Flexner gave was that of the work of James Clerk Maxwell on the theory of electromagnetism. Maxwell, seeking to understand the relationship between electricity and magnetism in a more comprehensive, unified, and mathematically consistent way, set out his famous four equations in 1861. From the solutions of the equations, he concluded that visible light was an electromagnetic wave and that electromagnetic waves of long wavelength, radio waves, might be observed. These were indeed observed in 1887 by Heinrich Hertz, working in the Berlin laboratory of Hermann von Helmholtz.

It took another fourteen years before Marconi gave a definitive demonstration of the utility of these developments by sending radio waves across the Atlantic. However, Flexner argued that the key step in this was Maxwell's research, driven not by considerations of practical value but rather by a desire to understand the basic laws of nature.

Today, this pursuit is fostered by an increasing number of institutes for advanced study. What do they produce? Why are they successful? They produce research. They have impact on the lives of those who work there. At the Institute, there are 28 permanent Faculty and 170 or so Visiting Fellows, or Members, at any one time. The Members come from all over the world, 60 percent from outside the Unites States, and they range from young postdoctoral fellows to senior professors. Most stay a year but many of the younger scholars stay for two, three, or even up to five years. For the Members, a stay at the Institute is often a life-changing experience.

When Quentin Skinner, now Regius Professor of Modern History in Cambridge, first came to the Institute in his mid thirties, he was at a stage of his career in Cambridge where, he has said, the amount of teaching he was doing was beginning to overwhelm him. He had been working for several years on what was to become *The Foundations of Modern Political Thought*—listed in 2000 by *The Times Literary Supplement* as one of the 100 most influential books of the last 50 years—but he saw little chance of finishing. He views the period he spent at the Institute as altering his life.

"One thing which struck me in the first year I was there," Skinner has said, "and which has always remained with me, was an image of professionalism. It permanently captured me. There was a sense ... that being a scholar was a twenty-four hours a day business, that the issues were far larger than we were ... "

Earlier, Raoul Bott was invited to the Institute by Professor Hermann Weyl, who thought Bott's solution of an important problem relating to electrical networks was interesting mathematically and suggested that Bott might write a book on Network Theory.

But when Bott arrived at the Institute in 1949, he became interested in the other exciting mathematical work going on around him. He went to Professor Marston Morse, who was at that time in charge of the postdoctoral fellows, and timidly asked, "Do I really have to write this book?" Without hesitating for a moment, Morse replied, "Of course not. Here you are free to do what really interests you."

During his second year, Bott, who went on to become a professor at Harvard and one of the most influential mathematicians of the last sixty years, started to do more constructive work. He later observed, "There was no question that my whole career would have been completely different if I had not had the remarkable opportunity of participating in a place that is so single-mindedly determined to let

(Continued on page 9)

COURTESY OF THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

COURTESY OF THE FREIBURG INSTITUTE FOR ADVANCED STUDIES

Director Peter Goddard spoke at the recently opened Institute for Advanced Study at the Hong Kong University of Science and Technology in January (left), and at the inauguration of the Freiburg Institute for Advanced Studies in May (right).

THERE ARE NO EXCUSES *(Continued from page 8)*

COURTESY OF THE INSTITUTE FOR ADVANCED STUDY ARCHIVES

Founding Director Abraham Flexner and the first Board of Trustees

your own imagination flourish."

When Bott returned to the Institute in the mid 1950s, he met, worked with, and became lifelong friends with Fritz Hirzebruch from Germany, Michael Atiyah from Great Britain, and Isadore Singer from the United States. Hirzebruch, Atiyah, and Singer founded institutes of their own: Hirzebruch, the Max Planck Institute in Bonn in 1980, which, with his earlier regular workshops, had a major influence on the development of mathematics in Germany from the late 1950s onwards; Atiyah, the Newton Institute in Cambridge in 1992; and Singer, with former Members Shiing-Shen Chern and Calvin Moore, the Mathematical Sciences Research Institute (MSRI) in Berkeley in 1982.

Bott, Hirzebruch, Atiyah, and Singer continued to collaborate as increasingly major figures on the mathematical scene; they brought their students together and some of them collaborated with one another; and the students also came in their turn to the Institute and to the other institutes that had been founded and so on. A whole international community had been born.

Other examples demonstrate the influence of the Institute in all parts of the world. While at the Institute, renowned differential geometer Chern developed his work on the Gauss-Bonnet formula. In a letter to Institute Director Frank Aydelotte, Chern wrote, "The years 1943–45 will undoubtedly be decisive in my career, and I have profited not only in the mathematical side. I am inclined to think that among the people who have stayed at the Institute, I was one who has profited the most, but the other people may think the same way." In addition to helping establish MSRI and serving as its first director, Chern founded two mathematics institutes in China, at the Academia Sinica in Nanking and at his alma mater, Nankai University in Tianjin.

In March 1943, Loo-Keng Hua, a Member from 1946–48, described his reasons for wanting to come to the Institute in a letter to Weyl: "I should like to take the opportunity to express one of my believeness, though my poor English prevents me to do it properly. The old country is on the way for recovery. Science is extremely needed. Thus any help to the young scientists would mean a great help of the reconstruction of the country; and any influence to the young scientists would mean an influence to the history of science in China. The aim for my intention to come to Princeton is not for the personal sake, but for my country. On the country's name, I wish to have a thorough training in mathematics, and then to develop mathematical science in China along a right way, which seems to be a part of reconstruction."

With little formal education, Hua became an eminent Chinese mathematician. He returned to Tsinghua University in 1950 and became involved in mathematical education reform on the graduate level.

Goddard noted that these examples might seem distant—one could quote more recent ones—but, notwithstanding governmental and other pressures to use instantly calculable metrics of performance, which are really only proxies for performance, it is often only on such timescales that the true importance of developments on the highest levels can be judged.

These examples also illustrate the way institutes seem to have propagated. One institute has inspired the formation of another. Perhaps in part motivated by the then absence of the social sciences at the Institute, the Center for Advanced Study in the Behavioral Sciences at Stanford University, was established in 1954. The Institut des Hautes Études Scientifiques was brought into being with the support of then Institute Director J. Robert Oppenheimer in 1958.

Now institutes for advanced study are being founded at a rapid rate around the world. In March, a cover story in the *Times Higher Education Supplement* reported on the increasing number of institutes for advanced study in the humanities in the United Kingdom alone.

What are the reasons for this proliferation? Goddard cited several: existing institutes are regarded as effective and successful; there is a multiplier effect from having many talented academics together, all excited by the freedom of being relieved from teaching and administration and able to make new contacts and begin or finish major projects (as one put it recently, "it is like arriving at summer camp"); and heightened pressures of funding mechanisms and evaluation within universities in many countries constrain research. Funding bodies are increasingly prescriptive about purposes of grants, leading to objective-driven rather than curiosity-driven research. Institutes can provide environments in which there is a greater freedom to pursue curiosity-driven research rather than predetermined outcomes. And establishing an "institute for advanced study" itself has come to be seen as a way for universities to demonstrate an aspiration for excellence in research.

Flexner's dream continues to be realized in numerous ways he could not have foreseen. He was prescient in seeing the need for an institution that crosses disciplinary boundaries and is not constrained by an undergraduate curriculum; that provides scholars and scientists of proven achievement the opportunity to pursue research driven by their own intellectual curiosity; that selects only on the basis of ability, attracting the ablest researchers from around the world; whose structure is flexible ("plastic") so that it can change with time; and which remains relatively small so that it retains a sense of community, a true academic village—a community of scholars.

DANIELLE ALLEN *(Continued from page 3)*

involved an important battle about the value of sound bites. "We are seeing in the exchange of sound bites between candidates a real argument about the role of language in politics," says Allen, "and its capacity, or lack thereof, to be the basis of building communities, institutions, and common understandings of who and what we are, as well as the capacity of those principles to motivate action."

So what are sound bites? Typically, they employ mnemonic techniques, such as alliteration and antithesis, to make them easy to remember. "At their core, they are about portability," says Allen. "You hear them, and you remember them easily; you can carry them around. And so they become one of the elements that is essential to the replication of culture over time."

Ultimately, the entire point of a sound bite is that the question of ownership should disappear. "You want a sound bite to become authoritative," says Allen. "You want it to become a bit of commonly spoken language that circulates across time and space and solves problems that bedevil communication. One can consider a sound bite successful when no one can any longer claim authorship to it."

According to Allen, sound bites do cultural work. Using Aristotle's concept of judgment in the *Rhetoric*, Allen describes sound bites as contributing to the crafting of a common culture. Aristotle believed that we get our principles for judgment through maxims. His argument in the *Rhetoric* is that character is expressed through a person's words. "Democratic citizens, perhaps consciously and perhaps not, ask themselves when they listen to a politician whether they want the bundle of principles entailed in or implied in whatever maxims or sound bites the politician has offered them," says Allen.

The danger of sound bites is their ability to degrade political discourse through pleasure and discomfort. "We can spell out the types of pleasure in sound bites," says Allen. "They are sonic or embodied pleasure; all that alliteration—it is not just that it helps us remember. We enjoy it in the same way that we enjoy the taste of chocolate or a gentle breeze across our skin. It is literally that physical."

There is also the pleasure of recognition, or as Aristotle called it, "easy learning." "There is pleasure in being bound in community with someone one admires," says Allen. But this sense of pleasure also "makes it possible to abuse sound bites by marshaling the pleasures they offer to suppress reasoning capacities." Likewise, sound bites can be used to exploit confusion. "In the same way that sound bites can generate pleasure and cause pleasure," says Allen, "equally when they fail, they cause discomfort."

The healthcare debate is one context where confusion and discomfort are exploited, says Allen, who surveyed healthcare literature to try to figure out what certain terms—national, universal, compulsory, provide, premium, planned, program, and healthcare—actually mean. "I learned that these words are used in shifting and contradictory ways," says Allen. "The healthcare conversation is confusing because these words mean whatever amalgam of concepts a speaker deems worthy of advocacy. I say this with regret because this is an important issue, and it is in fact precisely because we have become so bad at talking about it that it makes it hard to deal with."

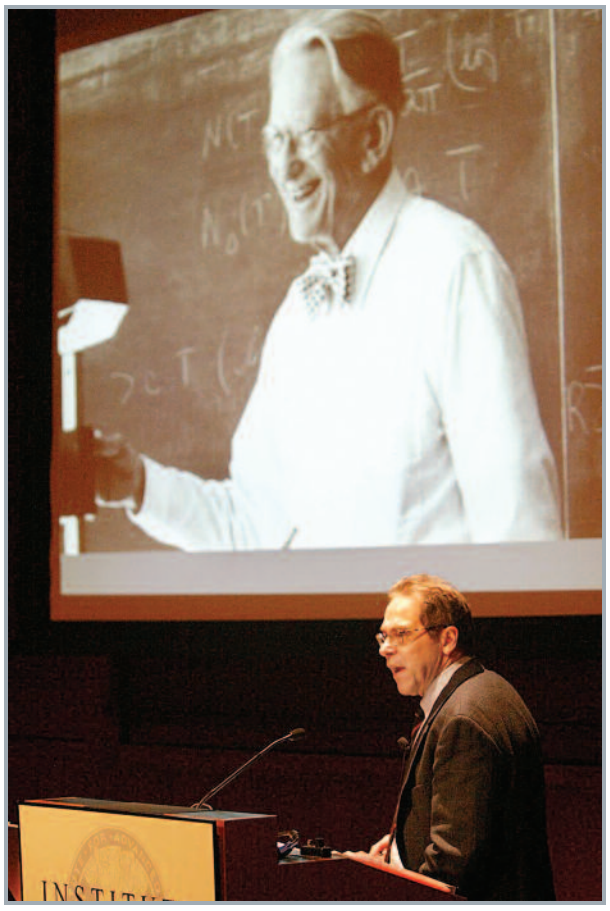
According to Allen, the best protection against propaganda, against the abuse of the pleasures and discomforts of sound bites, is an education in the verbal arts and in close reading and listening. "Education fosters capacities with words," says Allen. "It is the capacity of words to help a community define itself through its practices, habits, and institutions that I take to be their most important political function."

REMEMBERING ATLE SELBERG

Throughout a career spanning more than six decades, mathematician Atle Selberg (1917–2007) made significant contributions to modular forms, Riemann and other zeta functions, analytic number theory, sieve methods, discrete groups, and trace formula. The Institute, where he had served on the Faculty in the School of Mathematics since 1951, hosted a program of remembrance and celebration on January 11 and 12. Family, friends, and professional colleagues gathered in Wolfensohn Hall to honor Professor Selberg's memory and influence. Some highlights from the event follow.

I did not know Selberg as well as many of you did, but I did know him well enough to be able to enjoy his sharp wit and personal warmth, about which we've had so many reminiscences so far. I should also say that I feel very lucky to have been able to work on some of the mathematics that Selberg has bequeathed to us all.
— James Arthur, University Professor, Department of Mathematics, University of Toronto (former Member, School of Mathematics; former Academic Trustee for the School of Mathematics)

I discussed all kinds of subjects with Atle. In mathematics, it was an advantage for me to be in a different field, since he would then explain his thoughts in a more elementary way. He did not like fat books and big papers! He told me that he considered himself an amateur compared to some of his colleagues. He wanted to work on his own, penetrating the problems by his own thinking and at his own pace. His knowledge outside of mathematics was extremely impressive, in botany, zoology, history, geography, and many other subjects as well, and his memory was hard to beat! He had very clear and well-founded opinions, and when asked about something, you could always be certain to get his honest opinion without any unnecessary wrapping.
— Nils Baas, Professor of Mathematics, Norwegian University of Science and Technology (former Member, School of Mathematics)



Dennis Hejhal

Atle was one of my friends and we talked together often, not just about mathematics, but also about other things—for example, where in the Institute Woods you can find the good mushrooms. Atle told me there are two kinds of mathematicians. Some mathematicians tackle a difficult problem and they find a simple solution and then we build on that. There is another type of mathematician who works on very difficult problems and, after the solution is found, those problems remain very difficult. It is clear that Selberg was in the first group. He always looked for simplicity, elegance, and depth.
— Enrico Bombieri, IBM von Neumann Professor, School of Mathematics

Family members attended the program, including Atle Selberg's widow, Betty Selberg (right); nephew, Erik Hjorth-Hansen (lower right, pictured left) and son, Lars Selberg (lower right, pictured right); grandson Michael Selberg (lower left, pictured left), family friend Nick Hobson (lower left, pictured center), and grandchildren, Cayal and Maya Mathura (lower left, pictured right). Mathematician John Nash (left), a former Member at the Institute, looks at the photos, historical documents, and other memorabilia from Selberg's life, which were on display in the Wolfensohn Hall lobby throughout the duration of the memorial.

If I were to describe how, in one word, Atle affected me over all these years, I think the word I would say is "inspiration." When Atle passed away this past August, I lost someone who was for me not only a wonderful mathematical colleague and mentor, but also a dear friend. In the 1970s, when I was at Columbia, Atle and I met regularly, once every few weeks or so, as I prepared volume one of my book on the Trace Formula, and I remember how, after we got done discussing math, I always went back home feeling so inspired to work. I was twenty-six years old then. It's strange … but even thirty-some years later, whenever Atle and I discussed math, he still had the *same* effect on me. I'll miss that.
— Dennis Hejhal, Professor of Mathematics, University of Minnesota and Uppsala University (former Member, School of Mathematics)

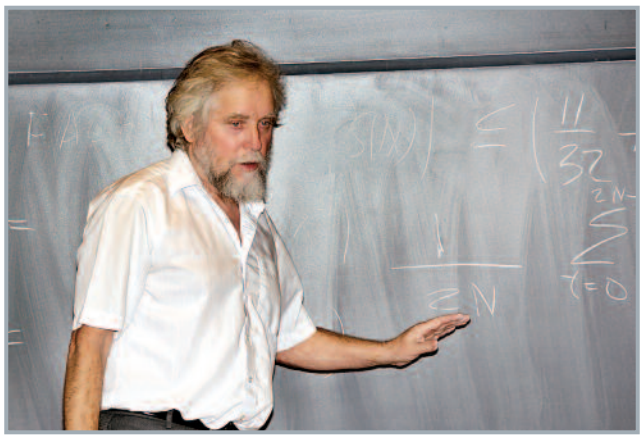
Selberg was a great source of inspiration to me. I was quite intimidated by him, which I regret a bit now, as I did overlap with him when I was here. But at least I did come up with the courage once to ask him to autograph my copy of his collected works. I'm very glad I did, and that's a prized possession that I have.
— Kannan Soundararajan, Professor of Mathematics, Stanford University (former Member, School of Mathematics)

Selberg was my thesis advisor for my doctoral study at Princeton University in the early 1980s. Selberg offered me the opportunity of staying on at the Institute by appointing me as his assistant, which was not quite true. He was assisting me most of the time. Even after I had returned to Hong Kong to reunite with my family and to teach there, his help continued. I once asked Selberg if he believed in luck. His reply was that luck certainly plays a not-insignificant role in one's life. I fully concur with him. I have been most fortunate to have Selberg as my teacher and friend in my life, and I will miss him forever.
— Kai-Man Tsang, Professor of Mathematics, University of Hong Kong (former Member, School of Mathematics)

ALL PHOTOS ANDREA KANE

HOT TOPIC: ARITHMETIC COMBINATORICS

Member Ben Green (left) with Professor Jean Bourgain



Endre Szemerédi

Participant Alex Kontorovich with Professor Peter Sarnak (right)

C. J. MOZZOCHI

During the first term of 2007–08, School of Mathematics Professor Jean Bourgain and Member Van Vu of Rutgers, The State University of New Jersey, ran a program on arithmetic combinatorics. The Members in residence for the program ranged from Endre Szemerédi, one of the fathers of the subject, to Ben Green, a young leader in the field, and included five recently graduated Ph.D.'s.

Combinatorics is concerned with counting problems. The theorems in the subject typically do not assume much structure and apply quite generally. Arithmetic is concerned with algebraic operations on the integers or in mathematical structures, called finite fields, and is usually a very structured study. There have been a number of striking results proved in recent years, which are based on the interplay between arithmetic and combinatorics and this has resulted in a flurry of activity. This was the reason that the topic was added to the yearlong program, "New connections of representation theory to algebraic geometry and physics," as a second short "hot topic" program.

An example of a basic and powerful theorem in arithmetic combinatorics is the "Sum Product Theorem" of Bourgain, Nets Katz, and Terence Tao. It is an elementary but fundamental quantitative combinatorial fact about the way addition and multiplication work in finite sets of integers (stated precisely in the box, right). Given its basic nature, it is not surprising that it and its generalizations have wide applications to algebra, number theory, theoretical computer science, and most recently to group theory.

Many of these striking applications were presented in the seminars and mini-courses during the term. These included the proof by Bourgain and Alexander Gamburd of Alex Lubotzky's "expanders in finite groups conjecture" and the work by Harald Helfgott, which opened the door to this development. Members Gamburd and Helfgott were among the many experts who were present for the term. For some years now, "expanders" have been a popular topic in the School with Herbert H. Maass Professor Avi Wigderson and Visiting Professor Noga Alon applying them to problems in combinatorics and complexity and Professor Peter Sarnak to problems in number theory.

Another very interesting subject, central to the program, was the application of combinatorial methods to the proofs of theorems about arithmetic progressions in sets of integers and similar results about primes. An example of such an application is the Green-Tao theorem, which states that the prime numbers contain arbitrary long arithmetic progressions. [For example, 5, 11, 17, 23, 29 is a sequence of five primes equally spaced, and so in arithmetic progression, the Green-Tao theorem says that you can find sequences of equally spaced primes which are as long as you like, though the spacing between them might be bigger.]

A third very active topic in arithmetic combinatorics is the study of discrete random matrices of large size. Van Vu's minicourse explained a number of the striking recent advances, some of which were also presented by Visitors and Members in the weekly seminar. A survey of these developments can be found in Tao's Milliman Lectures (http://terrytao.wordpress.com/tag/milliman-lecture).

The weekly seminars on Tuesday afternoons were especially well attended and elicited lively discussions about varied applications of new breakthroughs, a number of which were made during the term. To end the program Bourgain, Sarnak, and Vu ran a three-day mini-conference. It drew Members involved in the program as well as many experts who traveled to the conference.

Sum Product Theorem

If p is a prime number, we can define addition and multiplication of the numbers {0,1,2, . . . , p –1} by the usual processes of addition and multiplication but taking the remainder when the answer is divided by p. The numbers {0, 1, 2, . . . , p –1} with addition and multiplication defined like this constitute what is called the finite field F_p.

If e is any positive number, the theorem states that we can find another positive number d such that, for large enough prime numbers p, and for any subset A of the p integers F_p, with at most p^{1-e} elements, either the number of elements in A.A or the number of elements in A+A is larger than $|A|^{1+d}$. Here A.A is the set of all products x.y, and A+A is the set of all sums x+y, where x, y are any integers in F_p, and $|A|$ is the number of elements in A.

EINSTEIN LEGACY SOCIETY: ASHVIN CHHABRA SPEAKS ON MODERN FINANCIAL MARKETS

BENTLEY DREZNER

Ashvin Chhabra

At an Einstein Legacy Society event on March 5, Ashvin Chhabra, the Institute's Chief Investment Officer and a former financial investment executive with Merrill Lynch, spoke to the Institute community on "Modern Financial Markets: Rational Expectations and (recovering from) Irrational Exuberance."

Chhabra, who joined the Institute last year and has a Ph.D. from Yale in applied physics, introduced his talk by presenting two questions he said he would not answer: What do you think of the current market? Where are the interesting investment opportunities today? "Those are day trader's questions," Chhabra explained. "The Institute is an investor, not a trader, and is concerned with long-term performance and risk reduction."

Chhabra outlined guidelines for a sound investment strategy whether applied to the Institute's endowment or to a more modest portfolio: diversify among asset classes; develop an appropriate asset allocation strategy; and have reasonable return expectations. The challenge is to maintain the investment discipline over varying market conditions. Maintaining a desired asset allocation often requires cutting back on assets that have increased in value and buying assets that have been out of favor. Over the long term, this creates a discipline of buying low and selling high. However, many investors allow the emotions of fear and greed to take hold, buying into a rising market and then panicking and selling assets as they plummet in value, which, over the long term, creates a buy high, sell low strategy—a failsafe recipe for losing money.

The Institute has been an excellent steward of the philanthropic dollars entrusted to it. In recent years, its endowment has performed better than most retail and institutional investors. By working closely with members of the Finance Committee to find the best managers, the Institute has grown its endowment to over $650 million.

The audience also heard from Nina Cohen, Managing Director of Philanthropic Advisory Services for Glenmede Trust, who spoke on "Charitable Life Income Plans: Better to Give and Receive." Cohen explained several types of planned gifts that incorporated a financial return to the donor as a part of the gift.

JOIN THE EINSTEIN LEGACY SOCIETY

The Einstein Legacy Society was created to recognize those individuals who have included a commitment to the Institute for Advanced Study in their financial or estate plans. All types of planned gifts, such as life income gifts, charitable lead trusts, gifts from retirement plans or insurance policies, and bequests, play a vital role in sustaining important support for the Institute and its mission. For further information on Planned Giving, please contact Peggy Jackson, Planned Giving Officer, at (609) 951-4612, or pjackson@ias.edu.

JOSEPH CONRAD AS MAESTRO

By Siobhan Roberts

DINAH KAZAKOFF

An opera based on Joseph Conrad's Heart of Darkness *was performed at the Institute last fall.*

On an autumn night at the Institute, a sold-out audience gathered in Wolfensohn Hall for the latest evolution of an unlikely addition to the cultural canon—an opera based on Joseph Conrad's *Heart of Darkness*. The librettist, London artist Tom Phillips (a perennial Director's Visitor, he is due to return in the fall), introduced the performance by offering interpretative outtakes from his umpteen readings of the classic novella, published in 1902.

The first time he read it, as a teenager in the 1950s, Phillips came to the same conclusion his son reached after reading the book: "Nothing happens." The second time he picked it up, Phillips was trekking across the Kalahari Desert, turning pages by the light of campfire. For the fifth reading, he borrowed a girlfriend's copy and marked up the margins with notes. "It spoke," he said. "Bits kept screaming out in a special way: 'I'm a libretto! I'm a libretto! I'm a libretto!'" Phillips obediently wrote down this libretto, using only words from the original text and Conrad's *Congo Diary*. "It is lifted straight from the Conrad," he said.

On special occasions like these, Phillips likes to wear two pashminas, in Oxford and "shrill Brazil" blues, artfully draped at the neck—not exactly the standard kit for someone who is also a zealous ping-pong player (Salman Rushdie is a longtime opponent, a "sloppy" player whom he almost always manages to defeat; at the Institute the only individual to beat Phillips is employee Herman Joachim). His collaborator is a "top-tip" composer, the sartorially snappy Tarik O'Regan, favoring cashmere overcoats and herringbone trousers. At thirty, he is a two-time British Composer Award winner.

Before raising the curtain on their opera—in one act comprising twenty-four scenes, running an hour and fourteen minutes, no intermission—the maestros encouraged the audience to watch and listen with a critic's senses. The feedback, both at the Institute and during another workshop at American Opera Projects in Brooklyn, would help in preparations for the full-scale production, slated for 2009 ("There is already a fight for it," said Phillips).

"If you fall asleep for ten minutes, please tell us where," O'Regan advised. "If you fall asleep for an hour, don't bother."

O'Regan's score roused a visceral response, the main theme of lower octave melodies leavened with passages of "pulsing polytonality" à la Philip Glass. He acknowledged his main influence was the British composer Benjamin Britten (*Turn of the Screw*; *Rape of Lucretia*), who in the 1940s popularized the form of chamber opera—an opera of reduced instrumental forces meant to accommodate the desire for works that could easily be toured and quickly mounted in small spaces. O'Regan composed the *Heart of Darkness* for eight singers and a thirteen-piece orchestra, though for the workshops the only instrumentation was a SUV-sized Model D Steinway. And there were no costumes or sets; the cast conveyed the story with expressive yet measured dramatizations, as well as the odd prop: a flask, a pack of tobacco, a diary, a letter. Backstage, the singers were popping Oreos to keep their sugar levels up.

Put the prospect of *Heart of Darkness*, The Opera to a well-read class of readers and inevitably someone will burst into song, offering the book's most famous and operatic line in mock booming bass: "The horror! The horror!" But otherwise, this intensely interior and highly symbolic novel—chronicling Marlow's psychological journey during a steamboat journey up the Congo River—is not obvious opera material. In 1938, Orson Welles mounted it as a radio play, and had designs on a screen adaptation for his Hollywood debut, but his producers nixed the idea after reading the costly and politicized script. Then, in 1979, came Francis Ford Coppola's *Apocalypse Now*, an epic production during which the director nearly lost his wife, his mind, and on three occasions threatened to take his life. But the work had never been set to music and sung.

"Conrad himself said *Heart of Darkness* is a musical thing," noted Phillips, citing for corroboration the author's own remarks in the preface to the 1917 edition: "It was like another art altogether," observed Conrad. "That somber theme had to be given a sinister resonance, a tonality of its own, a continued vibration that, I hoped, would hang in the air and dwell on the ear after the last note had been struck." Conrad, Phillips felt, would approve.

Canadian journalist and author of King of Infinite Space: Donald Coxeter, The Man Who Saved Geometry, *Siobhan Roberts has written for the* New York Times, *the* Boston Globe, *and* Seed, *among other publications. While a Director's Visitor at the Institute in 2007–08, Roberts began research on her second book, a biography of Princeton mathematician John Horton Conway.*

CLIFF MOORE

School of Historical Studies Member Roy Laird gave a talk about why, after almost 400 years, the condemnation of Galileo still disturbs the Catholic Church.

After Hours Conversations

After Hours Conversations, a program conceived and organized by Caroline Bynum of the School of Historical Studies and Piet Hut of the Program in Interdisciplinary Studies, was launched in February to encourage inter-School conversations in an informal and relaxed environment. Each Monday, Tuesday, and Thursday evening in February and March, a member of the Institute Faculty, a Member, or a Visitor gave a ten minute talk on a topic close to their academic interests followed by twenty minutes of group discussion. Each of the talks took place in Harry's Bar on the upper level of the Dining Hall and was attended by between fifteen and fifty members of the Institute community, who actively participated in sharing their views on the topics presented.

After Hours Conversations will continue in the coming academic year, with talks planned for October and November 2008, and February and March 2009. A webpage has been created for the 2008–09 program (www.ids.ias.edu/conversations0809.html), and will be updated as dates and speakers are scheduled.

Tina Greenberg: Bringing Friends to a Whole New Level

ANDREA KANE

Tina Greenberg

Tina Greenberg, who had served as Chair of the Friends of the Institute for Advanced Study since 2004, stepped down at the end of June.

The Friends flourished under Greenberg's leadership. During her four years as Chair, contributions by Friends increased by over sixty percent, from $343,000 in fiscal year 2004, to $562,000 in fiscal year 2008.

Two new levels of giving were initiated during Greenberg's tenure. In 2004, the 25th Anniversary Circle was created to commemorate the 25th anniversary of the founding of the Friends. Friends who became members at this new level were invited to name a guest Friend for one year. This turned out to be a wonderful way to introduce potential Friends to the Institute and the Friends program. In 2006, the Founders' Circle was added to provide a unique opportunity for Friends who wished to make an even deeper commitment to the Institute at a $25,000 giving level. In the first year, five Friends stepped up to become members of the Founders' Circle, and enjoyed the benefit of naming a current Member at the Institute.

As Chair, Greenberg directed a strong focus on membership. She launched the Friends Membership Committee, and worked closely with Membership Chair John Pallat to recruit new Friends, with great success. In fiscal year 2008, thirty-six new Friends joined. Greenberg had served on the Friends Executive Committee since 1997 and was elected Chair Emerita in May.

Martin Chooljian, a member of the Institute's Board of Trustees, has come to know Greenberg well through his role as liaison to the Friends Executive Committee. When asked to comment on Greenberg's leadership, he remarked, "As Chair, Tina Greenberg has helped to bring the Friends to a whole new level. Contributions have risen, membership continues to grow, and the profile of the Friends group has risen in the Princeton community and beyond. I and my colleagues on the Board extend our sincere gratitude to Tina for all she and the Friends Executive Committee have done for the Institute."

BECOME A FRIEND

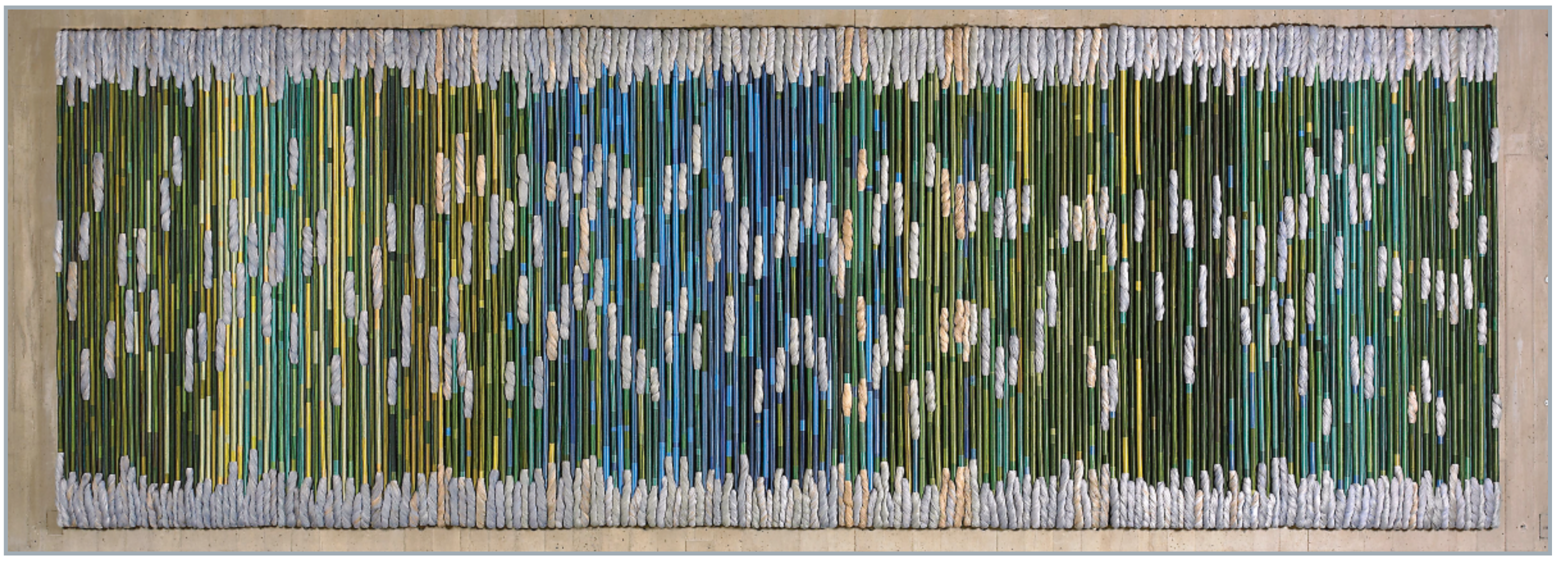
Friends of the Institute for Advanced Study are partners in the advancement of research and scholarship at the highest level and, as such, are encouraged to participate in the intellectual and cultural life of the Institute. Friends participate in an exchange of immense value. They provide the Institute with significant discretionary income every year, supplying stipends for Members, matching funds necessary to secure grants from other sources, and contributing in many other estimable ways to the sustainability of the Institute's mission.

In recognition of their support, Friends receive many opportunities to participate in the intellectual and cultural life of the Institute. A full program of lectures, talks, concerts, films, and more take place throughout the academic year. For further information about the Friends, please visit www.ias.edu/about/friends, or call (609) 734-8204.

Green Silk Forest: A Gift to the Institute

Through their foundation, Educational Ventures, Inc., Bob and Lynn Johnston, who are Friends of the Institute for Advanced Study, donated a silk tapestry by artist Sheila Hicks, which was installed in the Dining Hall in December. The Johnstons provided additional funds for the restoration of the piece.

Sheila Hicks writes:



BRUCE M. WHITE

Sheila Hicks's Green Silk Forest

When I created the tapestry/bas-relief *Green Silk Forest*, also known as *Rain Forest*, in my Paris studio Atelier des Grands Augustins in 1976, my intention was to design a large scale, abstract composition constructed entirely by hand with natural linen, silk, and cotton. The only tools I used were a semi-circular needle, scissors, two clamps, a stapler, and a wooden working frame to draw the silk background cloth into tension.

Originally commissioned by AT&T for their corporate headquarters in Basking Ridge, New Jersey, the *Green Silk Forest* tapestry was installed on walls that encased a spiraling glass staircase in the atrium of their building. It welcomed visitors to a public reception area and consequently there were individual reactions and varied interpretations of its significance but, I am told, it did not go unnoticed. For instance, for some viewers it evoked a walk in the forest, streaks of light between trees, organic growth, musical notes, or coded markers. However, I believe the strongest impression was that of a dynamic assemblage of color: emerald green, turquoise, lime, royal blue, navy, and citron. And the inevitable desire to touch the seductive soft textures.

AT&T relocated thirty years later and my artwork was acquired, or rescued, by Educational Ventures, Inc., a foundation formed by Bob and Lynn Johnston. I was consulted about restoring it. My assistant Eva Zeibekis, who had helped me fabricate the original project, returned to meet this challenge. We sought additional support and accomplished our goal in my Paris studio Cour de Rohan.

Educational Ventures, Inc. donated the renewed *Green Silk Forest* tapestry/bas-relief to the Institute for Advanced Study where it is permanently installed in the dining room of the building by architect Robert Louis Geddes. The tapestry hangs on a concrete wall and extends 28 feet. It consists of nine panels: each measures 96 inches in height and the widths vary from 24 to 43 inches. The dissimilar widths help disguise the joints and enhance the overall appearance.

It is hard to say what influenced my concept for this large public artwork but as an art and art history student at Yale I painted under the guidance of the Bauhaus master color theorist Josef Albers. I also studied ancient Andean cultures, particularly Pre-Incaic weaving, with Dr. George Kubler. Both contributed to inform my perception and to affect my work: a language based on color and linear, textural, pliable structures.

On October 7, Sheila Hicks will discuss her work at the Institute. Born in Hastings, Nebraska, she received her B.F.A and M.F.A. degrees from Yale University, and divides her time between New York and Paris, where she has worked since 1963. Her artworks are in the permanent collections of the Metropolitan Museum of Art, the Museum of Modern Art, the Philadelphia Museum of Art, the Museo de Bellas Artes in Chile, and the Musée des Arts Décoratifs in Paris.