In this 1953 diagnostic photograph from the maintenance logs of the IAS Electronic Computer Project (ECP), a 32-by-32 array of charged spots—serving as working memory, not display—is visible on the face of a Williams cathode-ray memory tube. Starting in late 1945, John von Neumann, Professor in the School of Mathematics, and a group of engineers worked at the Institute to design, build, and program an electronic digital computer—the physical realization of Alan Turing’s Universal Machine, theoretically conceived in 1936. As George Dyson writes in the following pages, the stored-program computer broke the distinction between numbers that mean things and numbers that do things.

The properties of a digital universe, as modeled by Turing and implemented by von Neumann, are based on the translation of information across space and time. In his book, Turing’s Cathedral: Origins of the Digital Universe (Pantheon, 2012), Dyson explains:

A digital universe—whether 5 kilobytes or the entire Internet—consists of two species of bits: differences in space, and differences in time. Digital computers translate between these two forms of information—structure and sequence—according to definite rules. Bits that are embodied as structure (varying in space, invariant across time) we perceive as memory, and bits that are embodied in sequence (varying in time, invariant across space) we perceive as code. Gates are the intersections where bits span both worlds at the moments of transition from one instant to the next.

Perceptions of space and time are explored in a number of articles included in this issue—from time-domain astronomy, which tells us that the particular space we occupy in the Universe is rather strange, to Dipesh Chakrabarty’s ideas about the transferability of political, economic, and social formations across eras and localities (page 1), to the idea of wartime as a gap in history when time itself is suspended (page 4), to the tension between emergent and mythic time embedded in a fifteenth-century painting (page 6).
Dipesh Chakrabarty Appointed Professor in School of Social Science

Dipesh Chakrabarty, a social historian whose research has transformed understanding of nationalist and postcolonial historiographies, particularly in the context of modern South Asia, has been appointed to the Faculty of the School of Social Science at the Institute, with effect from July 1, 2013, succeeding Joan Wallach Scott as Harold F. Linder Professor. Scott has served on the Faculty of the School since 1985, and will become Professor Emerita from July 2013.

Chakrabarty is currently Lawrence A. Kimpton Distinguished Service Professor in the Department of History and the Department of South Asian Languages and Civilizations at the University of Chicago. His interdisciplinary analyses of the claims, procedures, and evolution of historical knowledge and its profound involvement with questions of nationalism, colonial rule, modernization, economic and political development, and politics at large have placed him among the leading figures in the field.

“Dipesh Chakrabarty is a historian of extraordinary range and depth whose work has reshaped our understanding of colonial and postcolonial history,” said Peter Goddard, Director of the Institute. “His work, characterized by exceptional rigor, originality, and brilliance, has been widely influential. We look forward to his joining our community.”

“I am delighted and honored to have the opportunity to contribute to and share in the rich and innovative intellectual life of the Institute,” said Chakrabarty. “I look forward to being part of the academic conversations and interactions the IAS makes possible.”

Regarded as one of the founders of a new comparative and transnational history,

(Continued on page 13)

Extrasolar Planets and the New Astronomy

BY ARISTOTLE SOCRATES

The desire to discover distant, rare, and strange objects dominated twentieth-century astronomy, for which increasingly larger and more sensitive telescopes were constructed.

The act of carrying out this objective has brought enormous—and somewhat unbelievable—rewards: We now accept that we orbit a thermonuclear furnace, the Sun, whose physical properties are quite common, so common that there are nearly 100 billion Sun-like stars within our galaxy, the Milky Way. It was discovered that the Milky Way was not, in fact, the entire Universe; the observable Universe is of order many billions of light years across (that’s big), and there are of order 100 billion galaxies like our own floating around within it. In the center of these galaxies there happen to be super-massive black holes whose masses can be up to 10 billion times the mass of the Sun. When these enormous black holes are built up by in-falling gas, they are called “quasars,” and produce the equivalent of 100 trillion Suns worth of light within a volume comparable to our solar system. The greater the separation between any two galaxies or quasars, the greater the rate at which they move apart or, in other words, the Universe is expanding. Perhaps even more surprising, the Universe is primarily made up of stuff that we can neither see nor feel, i.e., dark energy and dark matter. The strategy of building bigger and more sensitive telescopes, meanwhile, has produced a growing number of “smaller” results that continue to employ regiments of astronomers: gamma-ray bursts, pulsars, X-ray emitting binary stars,

(Continued on page 10)

‘An Artificially Created Universe’: The Electronic Computer Project at IAS

BY GEORGE DYSON

I am thinking about something much more important than bombs. I am thinking about computers.

— John von Neumann, 1946

There are two kinds of creation myths: those where life arises out of the mud, and those where life falls from the sky. In this creation myth, computers arose from the mud, and code fell from the sky.

In late 1945, at the Institute for Advanced Study in Princeton, New Jersey, Hungarian-American mathematician John von Neumann gathered a small group of engineers to begin designing, building, and programming an electronic digital computer, with five kilobytes of storage, whose attention could be switched in 24 microseconds from one memory location to the next. The entire digital universe can be traced directly to this 32-by-32-by-40-bit nucleus: less memory than is allocated to displaying a single icon on a computer screen today.

Von Neumann’s project was the physical realization of Alan Turing’s Universal Machine, a theoretical construct invented in 1936. It was not the first computer. It was not even the second or third computer. It was, however, among the first computers to make full use of a high-speed random-access storage matrix, and became the machine whose coding was most widely replicated and whose logical architecture was most widely reproduced. The stored-program computer, as conceived by Alan Turing and delivered by John von Neumann, broke the distinction between numbers that mean things and numbers that do things. Our universe would never be the same.

Working outside the bounds of industry, breaking the rules of academia, and relying largely on the U.S. government for support, a dozen engineers in their twenties and thirties designed and built von Neumann’s computer for less than $1 million in

(Continued on page 8)
News of the Institute Community

DIDIER FASSIN, James D. Wolfensohn Professor in the School of Social Science, has published La Force de l’Ouvrier: Un Anthropologue de la Police des Quatres (Le Seuil, 2011). The book provides the first ethnography of the police in France and sheds light on contemporary politics of security.

PETR SARNAK, Professor in the School of Mathematics, has been awarded the Mahler Lectureship by the Australian Mathematical Society. He was honored for “major contributions to number theory and to questions in analysis motivated by number theory.”

FREEMAN J. DYSON, Professor Emeritus in the School of Natural Sciences, has been elected as a Foreign Member of the Russian Academy of Sciences.

The 2012 Wolf Prize in Mathematics has been awarded to LUIJS CAFFErellI, former Professor (1986–96) and member (2009) in the School of Mathematics, for his work on partial differential equations, and to MIChaEL ASChBACHER, former Member (1978–79) in the School of Mathematics, for his work on the theory of finite groups. Caffarelli is Professor of Mathematics at the University of Texas at Austin. Aschbacher is the Shuler Arthur Hanisch Professor of Mathematics at the California Institute of Technology.

The National Academy of Sciences has awarded the 2012 Public Welfare Medal to HAROLD T. SHAPIRO, an Institute Trustee and President Emeritus and Professor of Economics and Public Affairs at Princeton University. Shapiro was honored for his efforts to distill, debate, and resolve complex aspects of controversial scientific issues.

The National Endowment for the Humanities has awarded the National Humanities Medal to AMARYTA SEN, former Institute Trustee (1987–94); ROBERT DARNTON, former Member (1979, 1982, 1981) in the School of Social Science and Visitor (1979–82) in the School of Historical Studies; and TEOFIOLO F. RUIZ, former Member (1983–84) in the School of Historical Studies. Sen is Thomas W. Lamont University Professor and Professor of Economics and Philosophy at Harvard University. Darnton is Carl H. Pforzheimer University Professor at Harvard and Director of the Harvard University Library. Ruiz is Distinguished Professor of History at the University of California–Los Angeles.

PAUL MORAVEC, former Artist-in-Residence (2007–08) and Artistic Consultant (2008–09), is one of four composers to be awarded the 2012 Arts and Letters Award in Music from the American Academy of Arts and Letters.

The Federalist Society has awarded its Paul M. Bator Award for excellence in legal scholarship, teaching, and public impact, to EUGENE KONTOROVICH, Member in the School of Social Science.

RAZHID SUNYAEV, the Maureen and John Hendricks Visiting Professor in the School of Natural Sciences at the Institute, has won the 2012 Benjamin Franklin Medal in Physics. Sunyaev was recognized for his contributions to the understanding of the early universe and the properties of black holes. He is Director of the Max Planck Institute for Astrophysics in Garching, Germany, and Chief Scientist at the Russian Academy of Sciences Space Research Institute.

THERESE P. STEELE PRIZE, awarded for Mathematics Exposition was awarded to former School of Mathematics Members MICHAEL ASCHBACHER (1978–79), Shuler Arthur Hanisch Professor of Mathematics at the California Institute of Technology; RICHARD LYONS (1978, 1985–86, 1991), Professor of Mathematics at Rutgers, the State University of New Jersey; and RONALD SOLOMON (2003), Professor of Mathematics at the Ohio State University. They were honored, along with Stephen Smith, for their paper “The Classification of Finite Simple Groups: Groups of Characteristic 2 Type” in Mathematical Surveys and Monographs 172 (2011).

JACOB Bekenstein, former Member (2009–10) in the School of Natural Sciences, has been awarded the 2012 Wolf Prize in Physics for his work on black holes. Bekenstein is Polak Professor of Theoretical Physics at the Racah Institute of Physics at the Hebrew University of Jerusalem.

JENNIFER CHAYES, former Member (1994–95, 1997) in the School of Mathematics, has received the Women of Vision Leadership Award from the Anita Borg Institute. Chayes is Distinguished Research Managing Director at Microsoft Research New England.

JOSEPH WARREN DAUBEN, former Member (1977–78) in the School of Historical Studies, received the American Mathematical Society Albert Leon Whitman Memorial Prize, which honors exposition and scholarship on the history of mathematics. Dauben is Distinguished Professor of History and the History of Science at Herbert H. Lehman College and a member of the Ph.D. Program in History at the Graduate Center of the City University of New York.

Former School of Mathematics Members DENNIS DETURCK (1989–90) and HERMAN GLUCK (1962, 1990), along with Daniel Pomerleano and David Shea Vela-Vick, have won the 2012 Chauvenet Prize of the Mathematical Association of America for their paper "The Four Vertex Theorem and Its Converse," published in Notices of the American Mathematical Society 54 (2007). DeTurck is Dean of the College at the Arts and Sciences, Robert A. Fox Leadership Professor, and Professor of Mathematics at the University of Pennsylvania. Gluck is Professor of Mathematics at the University of Pennsylvania.

ROBERT DIJKGRAF, a former Member (1991–92) and Visitor (2002) in the School of Natural Sciences who will become Director of the Institute in July, has been awarded the first Comenius Prize of the Comenius Museum in Naarden, Netherlands, for his advocacy of science and its connections with society, education, politics, and the media. Dijkgraaf is currently President of the Royal Netherlands Academy of Arts and Sciences and Distinguished University Professor of Mathematical Physics at the University of Amsterdam.

BJORN ENQUIST, former Member (1991–92) in the School of Mathematics, has received the George David Birkhoff Prize in Applied Mathematics, awarded jointly by the American Mathematical Society and the Society for Industrial and Applied Mathematics. The award recognized Enquist’s contribution to a wide range of powerful computational methods. He holds the Computational and Applied Mathematics Chair I at the University of Texas at Austin.

ROMAN HOLOWINSKI, former Member (2006–07, 2009–10) in the School of Mathematics, has been awarded the 2011 SASTRA Ramanujan Prize. The prize citation recognized Holowinsky’s work in analytic theory and theory of modular forms, including work done with former School of Mathematics Members Valentin Blomer (2009) and Kannan Soundararajan (1999–2000, 2009), who is a previous recipient of the prize. Holowinsky is Assistant Professor at the Ohio State University.

ULRICH LEHNER, former Member (2009) in the School of Historical Studies, has received the American Catholic Historical Association's John Gilmary Shea Prize for his book Enlightened Monks: The German Benedictines (1740–1803) (Oxford University Press, 2011), which he worked on while in residence at the Institute. Lehner is Assistant Professor and Associate Director of Undergraduate Studies at Marquette University.

The American Mathematical Society Award for Distinguished Public Service was awarded to WILLIAM MCCALLUM, a former Member (1995–96) in the School of Mathematics, for his “energetic and effective efforts in promoting improvements to mathematics education.” McCallum is University Distinguished Professor and Head of the Mathematics Department at the University of Arizona.

The National Academy of Sciences has awarded the James Craig Watson Medal to JEREMIAH OSTRIKER, former Visiting Assistant Professor (2004–05, 2005–06, 2007) in the School of Natural Sciences. The Academy recognized Ostriker for his contributions to the theory of the interstellar and galactic medium, cosmological simulations, the theory of dark matter halos around galaxies, and the development of the Sloan Digital Sky Survey. Ostriker is Professor of Astrophysical Sciences at Princeton University.

SCOTT SHEFFIELD, former Member (2006–07) in the School of Mathematics, has been awarded the 2011 Lime and Michel Lotze International Prize in Probability. Sheffield is Professor of Mathematics at the Massachusetts Institute of Technology.

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

The American Mathematical Society has awarded the Leroy P. Steele Prize for Seminal Contribution to Research to WILLIAM F. THURSTON, a former Member (1972–73, 1976, 1984–85) in the School of Mathematics, for his contributions to low-dimensional topology. Thurston is Jacob Gould Schurman Professor of Mathematics at Cornell University.

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Questions and comments regarding the Institute Letter should be directed to Kelly Devine, Senior Publications Officer, via email at kdevine@ias.edu or by telephone at (609) 734-8091. Issues of the Institute Letter and other Institute publications are available online at www.ias.edu/about/publications. Articles from the Institute Letter are available online at www.ias.edu/about/publications/ias-letter/articles. To receive monthly updates on Institute events, videos, and other news by email, subscribe to IAS eNews at www.ias.edu/news/etnews-subscription.
Bourgain Awarded Crafoord Prize in Mathematics

The Royal Swedish Academy of Sciences announced that it has awarded the 2012 Crafoord Prize in Mathematics to Jean Bourgain, IBM von Neumann Professor in the School of Mathematics at the Institute, and Terence Tao, former Visitor (2005) in the School and current Professor of Mathematics at the University of California, Los Angeles. Bourgain and Tao were cited for their brilliant and groundbreaking work in harmonic analysis, partial differential equations, ergodic theory, number theory, combinatorics, functional analysis, and theoretical computer science.

“Their deep mathematical erudition and exceptional problem-solving ability have enabled them to discover many new and fruitful connections and to make fundamental contributions to current research in several branches of mathematics,” the citation reads. “On their own and jointly with others, Jean Bourgain and Terence Tao have made important contributions to many fields of mathematics—from number theory to the theory of non-linear waves. The majority of their most fundamental results are in the field of mathematical analysis. They have developed and used the toolbox of analysis in groundbreaking and surprising ways. Their ability to change perspective and view problems from new angles has led to many remarkable insights, attracting a great deal of attention among researchers worldwide.”

Bourgain, who joined the Faculty of the Institute in 1994, is the winner of the 2010 Shaw Prize in Mathematics. Among his many other honors are the Fields Medal (1994), the Empain Prize (1983), the A. De Leeuw Danny–Bourlart Prize (1985), the Langevin Prize (1985), the Élie Cartan Prize (1990), the Ostrowski Prize (1991), and the Vernadsky Gold Medal (2010). Bourgain is a Foreign Member of the Académie des Sciences in France, the Polish Academy of Sciences, the Royal Swedish Academy of Sciences, and the Academia Europaea.

The Crafoord Prize promotes international basic research in disciplines that complement those for which the Nobel Prizes are awarded. These include astronomy and mathematics, geosciences, and biosciences. There is also an occasional prize awarded in polyarthritis (also known as rheumatoid arthritis, the disease from which the prize’s founder suffered) when a special committee recognizes major advances in the field. The Crafoord Prize will be presented in Lund in May, in the presence of Sweden’s King Carl XVI Gustaf.

A sign and eight low buildings pass unnoticed in a field the size of Central Park: a walk-flower by a college town. Wandering its halls, one chair offices, bare egg white walls, nothing stands out until I reach a lounge where mathematical notations—fractals, equations, powers, roots, Greek letters, brackets, slashes—be geometric figures and infant stars for paper napkins and nibbled chocolate bars, on slate where palimpsests and marginalia in colored chalks suggest a coffee break authored this text a plaque below it warns, DO NOT ERASE.

“The Institute”
By Dan Burt

Today’s news is no better than yesterday’s: three suicide bombings in the “cradle of civilization”; a dowager billionaire in Voltaire’s homeland gives her daughter’s patrimony to a decorator; tar balls seed hot beaches in a spoiled land whose citizenry always blame others; immortality remains elusive and, sub specie aeternitatis, there will be nothing. The same is forecast for tomorrow, the one bright patch a blackboard crammed with symbols I cannot understand, guarded by three words, DO NOT ERASE.

From We Look Like This (Cancanet, 2012) by Dan Burt, former Director’s Visitor

The Campaign for the Institute

The $200 million Campaign for the Institute now underway is aimed at raising new endowment funds to ensure the Institute’s financial independence, which enables it to perform its essential role in providing its scholars with the freedom to pursue fundamental research in the sciences and humanities. The $100 million unrestricted challenge grant from the Simons Foundation and the Charles and Lisa Simonyi Fund for Arts and Sciences, announced last summer, serves as the basis for the Campaign, and it must be matched by funds from donors within the next four years. All irrevocable gifts and grants of endowment or annual support will be matched dollar for dollar, and will be counted toward the campaign goal and the Simons and Simonyi challenge (see ELS article, page 12).

Recent gifts toward the Campaign from Institute Trustees are helping to move the Institute closer to its goal. Robert Fernholz, a Trustee of the Institute since 2010, and his wife Luisa have donated funds through the Fernholz Foundation to support a Visiting Professorship in the School of Mathematics. The first Robert and Luisa Fernholz Visiting Professor is Karen Uhlenbeck, Professor and Sid W. Richardson Foundation Regents Chair in Mathematics at the University of Texas at Austin, who is spending the spring term at the Institute. The Fernholzes have provided support to the Institute’s School of Mathematics since 2006. Robert Fernholz is Founder and Chairman of the Investment Committee of INTECH Investment Management, and Luisa Fernholz is Professor Emerita of Statistics at Temple University. The MacMillan Family Foundation has pledged funds to the Simons Center for Systems Biology in the School of Natural Sciences. Nancy MacMillan, a Trustee of the Institute since 2001, and her husband Duncan MacMillan have also supported work in the Institute’s School of Mathematics over the years, including establishing the Herbert H. Maass Professorship in Theoretical Computer Science, a chair currently occupied by Avi Wigderson. The MacMillans have been Friends of the Institute since 1993 and members of the Friends Chairman’s Circle since 1997. Nancy MacMillan is the publisher of Princeton Alumni Weekly, and Duncan MacMillan is one of the founders of Bloomberg LP.

The Director’s Visitors program is of enormous value to the Institute, and John and Maureen Hendricks have agreed to fund the entire program this year and next. The Director’s Visitors, scholars who work in a variety of fields, including areas not represented in the Schools, contribute much to the vitality of the Institute community. They are invited by the Director for varying periods of time, depending on the nature of their work. Past Director’s Visitors have included Subhanbaker Banerjee, an environmental activist, photographer, and writer; George Dyson, a historian of science and technology and author of Turing’s Cathedral (see article, page 1); and Tom Phillips, a painter, writer, and composer. Since 2010, John and Maureen Hendricks have supported the appointment of Rashid Sunyaev, the Maureen and John Hendricks Visiting Professor in the School of Natural Sciences and one of the world’s most distinguished astrophysicists. John Hendricks, Founder and Chairman of Discovery Communications, has been a Trustee of the Institute since 2010.

There are many ways to give to the Institute, including donations of annual support, endowment and program support, and gifts made in conjunction with the estate planning process. For more information or to make a donation, please contact Michael Gehret, Associate Director for Development and Public Affairs, at (609) 734-8218 or mgehret@ias.edu.
The Idea of Wartime

By MARY L. DUDZIAK

Does war have a time? The idea of “wartime” is regularly invoked by scholars and policymakers, but the temporal element in wartime is rarely directly examined. I came to the Institute in 2007–08 in tandem with exploring the history of war’s impact on American law and politics, but assumptions about wartime were so prevalent in the literature that I first found myself puzzling over ideas about time. Ultimately, this resulted in a book, *War-Time: An Idea, Its History, Its Consequences* (Oxford University Press, 2012).

The idea that time matters to warfare appears in Thomas Hobbes’s Leviathan: “War consisteth not in battle only, or the act of fighting, but in a tract of time, wherein the will to contend by battle is sufficiently known; and therefore the notion of time is to be considered in the nature of war.” Time’s importance calls for critical inquiry, but time is often treated as if it were a property of war: this form of war, with that era, and in that climate. Yet our ideas about time are a product of social life, Emile Durkheim and others have argued. Time is of course not produced by clocks, which simply represent an understanding of time. Instead, ideas about time are generated by human beings working in specific historical and cultural contexts. Just as clocktime is based on a set of ideas produced not by clocks but by the people who use them, wartime is also a set of ideas derived from social life, not from anything inevitable about war itself.

Yet war seems to structure time, as does the clock. Stephen Kern argues that World War I displaced a multiplicity of “private times,” and imposed “homogeneous time,” through an “imposing coordination of all activity according to a single public time.” During World War I, soldiers synchronized their watches before heading into combat. In Eric J. Leed’s description of trench warfare, war instead disrupted time’s usual order. Battle became an anachronism. Combat in *Measuring Time, Making History* (2004), *Anew Kind of Time* (2004), *Making Time, Losing Time* (2005), and *Temporality in the Modern World* (2007) are all examples of this view: that time had no sequence. And so one meaning of “wartime” is the idea that battle suspends time itself. War also breaks time into pieces, slicing human experience into eras, creating a before and an after. It often marks the beginning of one historical period, and the end of another. Once historical time is divided, war is thought to occupy a certain kind of time: a wartime.

Wartime is more than a historical signpost, a passive periodizer. It is thought to function as an abstract historical actor, moving and changing society and creating particular conditions of governance. We think of wartime as doing things in history.

The idea that wartime is exceptional can lead to determinism. During the French Revolution, Lynn Hunt suggests in *Measuring Time, Making History*, “a new kind of determinism” appeared. Bertrand Barère, a leading member of the Committee of Public Safety and viewed as a driving force behind the Reign of Terror, “excused his actions as the product of his time.” Barère claimed that he did not shape his revolutionary epoch. Instead, he “only did what I had to do, obey it.” Barère argued that his time “sovereignly commanded so many peoples and kings, so many geniuses, so many talents, wills, and even events that this submission to the era and this obedience to the spirit of the century cannot be imputed to crime or fault.” In American wartime thinking, there is also a powerful sense of determinism. Actions that would normally transgress a rule of law are seen as compelled by the era, as commanded by time. And, as did Barère, individuals defend themselves by arguing that their actions were compelled or justified by the times.

But is war really bound in time? Particular conflicts have endings, but when we look at the full timeline of American military conflicts, including the “small wars” and the so-called forgotten wars, there are not many years of peacetime. War seems not to be an exception to normal peacetime, but instead more of an enduring condition.

In spite of its persistence, wartime often serves as a justification for a rule of law that bends in favor of the security of the state. This distortion is tolerated because wartime is thought to be a temporary rupture of the usual state of affairs. The assumption of war’s temporariness becomes an argument for exceptional policies. And those who cross the line during war sometimes argue that circumstances deprive them of agency; their acts are driven or determined by time.

September 11, 2001, is thought to have opened a new war era. That day countless people in the United States and around the world were thrown together in time as they watched the effects of the terrorist attacks unfold in “real time” on television. It was a moment of “simultaneity,” in Benedict Anderson’s terms, as the shared experience of horror generated feelings of solidarity among Americans who felt that they and their nation were under attack. Fault lines would soon appear, but a common element was a sense of time.

Many felt that the terrorist attacks had shattered time, and ushered in a new era of history. This new wartime resulted in broad U.S. government interventions. The United States went to war in two nations, but the war era was framed in a way that escaped the usual boundaries in space and time. For President George W. Bush, it was a “war on terror,” and for President Barack Obama, a “war on Al-Qaeda.” Even in Obama’s more focused formulation, this was a war that could last as long as the existence of Al-Qaeda affiliates intent on harming Americans in the world. Wartime, then, is conceptualized as a war that transcends the Cold War and other topics in twentieth-century American legal history.

From the IAS website:

**Maude Barlow on the Global Water Crisis**

“We are a planet now running out of fresh water sources. The water is somewhere on the planet, but we’re either polluting it or diverting it or moving it from where we can access it to where we cannot at an absolutely astounding rate using modern technology that we didn’t have fifty years ago,” says Maude Barlow, Chair of the Council of Canadians and of Food and Water Watch, who presented “The Global Water Crisis and the Coming Battle for the Right to Water” at the Institute last fall.

“A very important concept that you’re going to hear more and more about in the next few years is called virtual water, and that virtual water is the water that is used to produce or grow something, usually commodities. If you export that commodity out of your country, you’re actually exporting the water. You don’t think of it as export of water. We think about export of water as being a pipeline that you put into a lake or whatever. . . . Americans are amazed when I tell them that you use—and you have a crisis of water in parts of this country, a very serious one—fully one-third of all your domestic water consumption every day to grow crops that are then exported out of the country. So fully a third of your domestic water use every single day leaves your country, and it’s mostly from states that don’t have the water to be able to afford that in the first place. So it’s a very serious issue and one that you’re going to hear a lot more about in the coming years.”

Barlow’s talk was part of the Institute’s annual series, Lectures on Public Policy, which aims to address issues relevant to contemporary policies, social conditions, and scientific conditions of broad import. A video of Barlow’s lecture is available at http://video.ias.edu/barlow-public-policy.
Unpacking the Bachelor Pad

BY JESSICA ELLEN SEWELL

The mid-1950s saw the invention of a new, highly mythologized housing type, the bachelor pad, articulated most fully in the pages of Playboy and in films. The bachelor pad is an apartment for a single professional man, organized for entertaining and pleasure, and displaying tasteful consumption. The bachelor pad was cultured, elegant and had a particular historical moment because it linked a culture increasingly focused on consumption and what sociologists and cultural commentators in the late 1950s argued was a “crisis in masculinity.” The bachelor pad provided a compelling fantasy of individual consumption and economic and sexual power to counter that crisis, but at the same time, helped to produce the masculinity crisis by problematizing straight male domesticity.

As described in Playboy, the pad “is, or should be, the outward reflection of his [the bachelor’s] inner self—a comfortable, livable, and yet exciting, tasteful environment in which to satisfy his consumer desires, but his control over men was also understood as spatial—as Philip Wylie argued in Playboy, women had taken over bars, clubs, and workplaces, and “wanted to invade everything masculine,emasculate it, cover it with dainty, occupy it forever.” The house similarly had become “a boodao-kitchen-nursery, dreamed up by women, for women, and as if males did not exist as males.”

The bachelor pad’s interior needed to be stylish, because style is essential to the persona of the Playboy bachelor and his upwardly mobile aspirations. However, any interest in interior design was very clearly gendered, then as now, and was associated both with women and with gay men. Thus the design needed to be clearly masculine. Traditional modes of masculine design, however, modeled on the men’s club and the hunting lodge, were too completely homosocial, and inappropriate for a straight man who should want to entertain and seduce women in his home. Without these models to resort to, the design cues of heterosexual masculinity were subtle. While the dead animals and club chairs of these older homosocial spaces have no place here, their traces remain in the evocation of hunting and fishing goods. In contrast, Brad’s leather furnishings. One wall is of bare brick, and most of the others are covered in textured bark-like wallpaper. Straight masculinity is also performed through quite modernist absentees; in Playboy’s 1956 penthouse apartment, “lamps, which would impede the clean, open look of the place, are virtually dispensed with; there is a complete absence of bric-a-brac, patterned fabrics, pleats and ruffles.”

The bachelor pad provided a compelling fantasy of individual consumption and economic and sexual power to counter that crisis, but at the same time, helped to produce the masculinity crisis by problematizing straight male domesticity, and the hunting lodge, were too completely homosocial, and inappropriate for a straight man who should want to entertain and seduce women in his home. Without these models to resort to, the design cues of heterosexual masculinity were subtle. While the dead animals and club chairs of these older homosocial spaces have no place here, their traces remain in the evocation of hunting and fishing goods. In contrast, Brad’s leather furnishings. One wall is of bare brick, and most of the others are covered in textured bark-like wallpaper. Straight masculinity is also performed through quite modernist absentees; in Playboy’s 1956 penthouse apartment, “lamps, which would impede the clean, open look of the place, are virtually dispensed with; there is a complete absence of bric-a-brac, patterned fabrics, pleats and ruffles.”

Liquor and technology also help to masculinize the pad. Each pad has not just one, but several bars, which permit “the canny bachelorto remain in the room while mixing a cool one for his intended quarry. No chance of... leaving her cooly curled up on the couch with her shoes off and returning to find her mind changed, purse in hand, and the young lady ready to go home, damn it.” Liquor serves as a marker of masculinity, but more importantly the bar is the center of entertainment, by means of which guests are both served drinks and entertained by the bachelor’s skill as a bartender. Technology similarly helps to entertain guests. Entertainment systems combining stereo and TV with the latest in entertainment gadgets not only allows a bachelor to play music for his guests, but also become conversation pieces in themselves. Similarly, kitchen gadgets help him entertain guests with his “electric showmanship” as he demonstrates his conveyorbelt cabinets, induction range, and “automatic electric cooking utensils.” Technology heightens the masculinity of the bachelor pad in several ways: it brings with it the associations of science and technology, it helps in displaying commandship of both gadgets and music, and it functions as the means to total mastery of the environment. This mastery is expressed in the ubiquitous control units, which allow the bachelor to control nearly every aspect of the environment of the bachelor pad, including lights and sound, and the control panel. Control panels serve not only as a means of performing masculine fantasies, but also of orchestrating the seduction, including mood music, lights, and door locks. The entire apartment serves as a machine of seduction, which the bachelor controls in order to attract, inebriate, and eventually trap his female prey. This motif of seduction serves to heterosexualize the bachelor pad and its pleasures, helping to diffuse the queer implications of the bachelor’s interest in design and interest in marrying a queer man.

The bachelor pad is centered on individual pleasure and stylish consumption, framed in the context of the sexual conquest of women, but with much more complex meanings and potential uses. It enables a kind of fantastic escape from suburbia, serving as an architectural dream double of the suburban house. It is a site for men to imagine what a masculine interior that expressed their own personality might be, and a way to learn how to use consumption to construct a new model of manhood for themselves, one made necessary by the masculinity crisis that the pad also helped to construct. ■

1 “Playboy’s Penthouse Apartment," Playboy, October 1956, 65
3 Wylie, Womanization, 77
6 “Playboy’s Penthouse Apartment," Playboy, October 1956, 70
7 “Playboy’s Penthouse Apartment," Playboy, September 1956, 59
Embedded Portraits: Appending a New Myth to an Old Myth

BY CHRISTOPHER S. WOOD

Religious art of the late Middle Ages and Renaissance in Europe was marked by the creeping presence of the prosaic, the concrete, the familiar, the everyday. Vivid descriptions of furniture and clothes, local flora and landscapes, hometown buildings and skylines, vignettes of laboring and sporting peasants threatened to distract the devout beholder from the sacred narrative. The purpose of the painting, after all, was to train the mind on the episodes of the lives of Christ, the Virgin Mary, and the saints. A dramatic instance of this profanation of the cult image was the embedded portrait, the topic of my research at the IAS in Fall 2011.

The embedded portrait is the image of a real, modern person, usually the donor or person who paid for the painting, introduced into the narrative. The donor has himself or herself depicted in an attitude of pious attentiveness. A good example is the Nativity of Christ by the Flemish artist Rogier van der Weyden, painted in the middle years of the fifteenth century—the exact date is unknown—and today in the Gemäldegalerie in Berlin. This is the central section of a three-paneled altarpiece, or triptych, perhaps once mounted on an altar in a chapel, perhaps displayed in an altar-like space in a home. Mary and Joseph, sharing quarters with an ox and an ass, contemplate the naked body of the Child. The stall is pictured as an ancient building in ruins, a symbol of the Jewish and pagan belief systems that Christianity was meant to supplant. The city in the background resembles neither Bethlehem nor Jerusalem but rather, with its spires, gables, and tiled roofs, a modern northern European town. The gentleman, in the right-hand panel, finally, wears an expensive-looking fur-lined coat and wooden clogs to protect his fine pointed shoes. He presses his hands together in reverence. This is the donor. He is not identified by an inscription or a coat of arms. But there is good reason to believe, on the basis of the painting's whereabouts in the seventeenth century, that he is Pieter Bladelin, a man of respectable origins who rose through political acumen to a high station in the court of the Duke of Burgundy, Philip the Good, in Bruges.

The painting does not have this weapon in its arsenal. Now suddenly the portrait makes the factual world reappear inside paintings. The embedded portrait casts doubt on the factuality of the persons and events described by the rest of the picture. The portrait lands inside the religious painting, the depicted myth, as a foreign body. It is a hard fragment of the real that suggests that everything sacred is a mere fiction, a product of a weaker form of significance. By introducing irreducible fragments of real life, in the form of portraits and other individuated descriptions like the cityscape in the background, the painted image opened its borders to lived experience. For experience, the world is emergent. It is always unfolding in time. Painting has difficulty representing this kind of time. The portrait tries to do that, paradoxically, by representing the individual fixed in historical time. For that individual, and we know this from our own experience, painting is exposed in every way to the passage of time. The portrait with its hidden reserve of life reveals the characters surrounding it to be mere characters. The real subject of Rogier van der Weyden's painting is the tension between emergent time and mythic time.

The portrait with its hidden reserve of life reveals the characters surrounding it to be mere characters. The real subject of Rogier van der Weyden's painting is the tension between emergent time and mythic time. The painting emphasizes Bladelin's incomplete participation in the scene. The portrait is set like a gem in the midst of the painting. The dense description of the bowed head is radiant. Bladelin's physiognomy is more memorable than the generic heads of Mary and Joseph. The artificial worlds that the religious imagination builds are unlike the world experienced every day as fact. The painting acknowledges that dissimilarity by staging a clash between two different modes of pictorial signification. On the one hand, there is the Holy Family, the birth-stall, the ox and the ass, and the angels. The picture summons these elements of the myth by quoting other pictures. The painter's own picture cannot stray too far from established pictorial conventions or its subject will not be recognizable. The beholder must believe that the pictorial tradition supporting this painting is rooted in antiquity and transmits reliable knowledge about the historical Nativity. On the other hand, there is the portrait of Bladelin. That portrait does nothing other than point to something real in the world. Rogier van der Weyden has passively transcribed a patch of reality. Bladelin's person is a singular fact that almost surely had never before been depicted. The significance of that fact—Bladelin's is an appearance—is not clear. Why is a sacred image needed to record that appearance? The depictions of the Holy Family, derived from tradition, carry with them bundles of associations and meaning. Bladelin's portrait does nothing other than anchor the painting, and the altar and chapel it adorns, to Bladelin the man. But the portrait has another significance that emerges only when the way it is linked to the factual world is compared to the way the rest of the picture is linked to reality. The portrait's strong referential link to the world is achieved by the painter's dazzling technical skill. The portrait convinces us of its own fidelity to its model even though we don't have the model to compare it to. Before the fifteenth century in Europe, painting did not have this weapon in its arsenal. Now suddenly the portrait makes the factual world reappear inside paintings. The embedded portrait casts doubt on the factuality of the persons and events described by the rest of the picture. The portrait lands inside the religious painting, the depicted myth, as a foreign body. It is a hard fragment of the real that suggests that everything sacred is a mere fiction, a product of a weaker form of significance. By introducing irreducible fragments of real life, in the form of portraits and other individuated descriptions like the cityscape in the background, the painted image opened its borders to lived experience. For experience, the world is emergent. It is always unfolding in time. Painting has difficulty representing this kind of time. The portrait tries to do that, paradoxically, by representing the individual fixed in historical time. For that individual, and we know this from our own experience, painting is exposed in every way to the passage of time. The portrait with its hidden reserve of life reveals the characters surrounding it to be mere characters. The real subject of Rogier van der Weyden's painting is the tension between emergent time and mythic time.

So there are two ways of looking at the painting. We can almost see the painting "flip" as we look at it first one way, then the other. One might choose to see the portrait of Bladelin as a blank, unwellcome dead spot in the scene that contributes nothing to our confidence in the historical reality of the Nativity, and nothing to our understanding of the meaning of the event. From that point of view, the portrait has only a minimal capacity to generate meaning. It is not really a symbol of anything, it just is. It is sub-artistic, in the same way that photography is in some sense sub-artistic. Or one might choose to see the portrait as the living core of the painting, animating a dead Biblical story by throwing it open to human experience and subjectivity. That view makes the dark aperture through which we glimpse Bladelin, one of them covered by a grill, opening onto a subterranean cavity. That cellar is the prison-house of the satanic energies that Christ will one day subdue through his sacrifice. Is it not also the painting's metaphor for the recesses of the self—for the unconscious, we would say today—where the conflicts of the mind with itself must be contained for the sake of social life? The image of the donor appends a new myth to the old myth: the powerful modern myth of human subjectivity, with its depths of feeling and self-awareness, as the ultimate source of meaning. The modern devotee is no longer the presumptuous intruder at someone else's event. Now it starts to seem possible that the sacred event is nothing other than the creature of his imagination.
The History of Historical Practice and the Study of the Middle Ages

BY PAUL ANTONY HAYWARD

A natural starting point for any attempt to know a past society is its histories—the texts with which its members recorded what had happened and was happening in their world. Many precious witnesses of this kind have survived from medieval Europe, but they are not easily used to answer the questions that modern historians would like to ask.

In essence, three types of historical writing flourished in the Middle Ages: chronicles, hagiography, and the rhetorical monograph. The first category refers to seemingly simple lists of events or, to use the current jargon, “factoids.” These texts usually arrange their factoids in some sort of chronological order; many assign them to the anni, or years, in which they took place, for which reason they are often called “annals.” The second type comprises records of things that God has done in this world, through the grace that he has bestowed on his saints and their devotees. The third category refers to narratives that celebrate or criticize the acts of rulers, dynasties, or communities.

All three types clash with modern ways of thinking. Hagiographical texts baffle, because they are the most overtly empiricist and yet, it often seems, the most unreliable. They ask us to believe that God was an active presence in the life of a certain saint and his or her people, that whenever he or she requested divine help he provided diverse wonders, extending from food and water in times of need to the resurrection of the dead. They ask their readers to accept as actual fact events that most of us find implausible.

ChRONICLES favor the mundane, but many incorporate miracle stories, and they typically lack two qualities that modern readers require of a proper historical text: “narrativity” and a metahistorical voice. That is, their authors fail to guide their readers with comments that point them toward a particular interpretation—they fail to connect events in ways that tell stories and explain how one gave rise to the next. The third type, on the other hand, has these “missing” elements in excess.

Historical texts like Loucher, Memoirs of the Reign of Antependius or “Tit-for-Tat” (ca. 950), or the history of Norman Sici- lity attributed to “Hugo Falscum” (ca. 1175?) are full of reflexive comments. Their authors are continually telling their audiences how to read their narratives. They often reveal immense learning and a degree of critical intelligence, but they rarely use these faculties for serious research. They favour fantasy, gossip, and slander. These texts are fact-light but spin-heavy. Thus, whereas the chronicles are often deni- ed for being stupid and random, the rhetorical histories are slammed for being biased and deceitful.

Some scholars would like to see the rhetorical histories as a more advanced type, to argue that the form evolved out of the chronicle and that it represents a step toward the modern historical monograph; but it is difficult to construe dishonesty as “progress,” and in any case, all three types thrived simultaneously. The saints’ lives and the chronicle did not give way to the monograph—not in the Middle Ages, at any rate. There are examples, indeed, of leading intellectuals who worked in all three modes. William of Malmesbury (d. 1143), for example, wrote three rhetorical histories, five saints’ lives, and the chronicle.

One might wish for better sources, but these are the sorts of history that the medieval world produced, and making them work for us presents a stimulating challenge. If we are to make sound use of them, we need to grasp the cultural sys- tems and practices that governed their production and consumption. We cannot escape the need to look for nuggets of fact, but recognizing them and utiliz- ing them to good effect requires sensi- tivity to the criteria by which medieval authors selected and adapted them for inclusion in their histories.

Many scholars now recognize, however, that the writing of a historical text is itself an event, one that can be perceived with greater certainty than those that have traditionally occupied the attention of his- torians—the many “mainstream” phenomena known only at considerable remove, refracted through the distorting lenses of the texts. By investigating these texts as acts of scholarship and as oratory or propaganda we can gain genuine insights into the life and preoccupations of the communities that produced and used them.

This is especially true when the authors’ working practices can be reconstructed in detail. For this purpose, it is sometimes the earlier sections of the texts—that is, cover periods remote from their authors’ own time—that reveal the most, in part because it was frequently risky to write explicitly about the present, but also because it is often possible to tell exactly what material was available for the researching of these sections and how the author has adapted it to suit his purposes. Thus, contrary to expectations, it is sometimes possible to establish exactly what material was available about the ancient and early medieval worlds rather than their own time that reveals most about their methods and concerns.

The possibility of achieving sound results with this sort of inquiry has advanced greatly in recent decades as scholars have discovered and published many texts that were previ- ously unavailable (or at best only in incomplete editions), as they have defined and traced the contents of particular manuscript libraries, and with the creation of vast digital data- bases that allow us to identify what sources were being used. Access to a powerful array of such tools is just one of the advantages that Princeton University and the Institute for Advanced Study offer to scholars working in this area.

For the past decade, I have been studying various histories produced in the eleventh and twelfth centuries with a view to comparing the full range of medieval practices in this period. The subject of my present project at IAS is a set of chronicles, drawn from many parts of Europe, which are united by an interest in a par- ticular topic: how the first eighty or so popes created the institutions of the Church, especially its liturgy. The emergence of this theme offers telling insights into the processes that governed the composition of this type of history.

The chroniclers’ interest in the topic cannot be explained by postulating a single text on which all the others depend or as a function of the operation of a cultural frame- work or mentality. To be sure, some shared habits of mind and uses of material were involved. As clergymen or monks, all the authors had vocational reasons for being interested in the origins of the Church. All of them took data from a collection of papal biographies known as the Liber pontificalis and from a book of ecclesiastical law known as the “False Decretals of Pseudo-Isidore.” But these sources had long been available: the former had been circulating since the sixth century, the latter since the ninth. Why then is it only from the late eleventh that the compilers of this type of history begin to research this theme, and in what context?

Part of the explanation lies in the immense impact of the papal reform movement, yet not all of these chroniclers sympathized with this cause. Rather, many were induced to take a serious interest in the papacy’s role in the early history of the Church by works about the liturgy and canon law that were produced in the 1090s by adherents of the movement. They may not have won many converts among our chroniclers, but they appear to have inspired them to research this topic for the sake of their projects. The implica- tion is that the processes involved in constructing this type of history, far from being “stupid and random,” could instead be sophisticated and purposeful. ■

A detail from the Winchcombe Annals (London, British Library, MS Cotton Tiberius E. IV, fol. 8r). The addition in the righthand margin, linked by its initial to the year AD 487, describes how Pope Gelasius provided for the ordination of priests and deacons during the four ember weeks. It is one of around ninety entries recording papal deeds that were added to the core text of this chronicle in the 1140s, almost as soon as it was made.

A leaf from the Later Winchcombe Annals (London, British Library, MS Cotton Faustina B. I, fol. 23v). The layout of these annals—the wide margins between the core and the items in the margins were to be left unruled.
under five years. "He was in the right place at the right time with the right connections with the right idea," says Aydelotte. Willis Ware, fourth to be hired to join the engineering team, "setting aside the hassle that will probably never be resolved as to whose ideas they really were." As World War II drew to a close, the scientists who had built the atomic bomb at Los Alamos wondered, "What's next?" Some, including Richard Feynman, vowed never to have anything to do with nuclear weapons or military secrecy again. Others, including Edward Teller and John von Neumann, were eager to develop more advanced nuclear weapons, especially the "Super," or hydrogen bomb. Just before dawn on the morning of July 16, 1945, the New Mexico desert was illuminated by an explosion "brighter than a thousand suns." Eight and a half years later, an explosion one thousand times more powerful illuminated the skies over Bikini Atoll. The race to build the hydrogen bomb was sand times more powerful illuminated the skies over Bikini Atoll. The race to build the hydrogen bomb was

In March of 1953 there were 53 kilobytes of high-speed random-access memory on planet Earth. Five kilobytes were at the end of Olden Lane, 32 kilobytes were divided among the eight completed clones of the Institute for Advanced Study's computer, and 16 kilobytes were unevenly distributed across a hundred other machines. Data, and the few rudimentary programs that existed, were exchanged at the speed of punched cards and paper tape. Each island in the new archipelago constituted a universe unto itself.

In 1936, logician Alan Turing had formalized the powers (and limitations) of digital computers by giving a precise description of a class of devices (including an obedient human being) that could read, write, remember, and erase marks on an unbounded supply of tape. These "Turing machines" were able to translate, in both directions, between bits embodied as structure (in space) and bits encoded as sequences (in time). Turing then demonstrated the existence of a Universal Computing Machine that, given sufficient time, sufficient tape, and a precise description, could emulate the behavior of any other computing machine. The results are independent of whether the instructions are executed by tennis balls or electrons, and whether the memory is stored in semiconductor or on paper tape. "Being digital should be of more interest than being electronic," Turing pointed out.

Von Neumann set out to build a Universal Turing Machine that would operate at electronic speeds. At its core was a 32-by-82-by-40-bit matrix of high-speed random-access memory—the nucleus of all things digital ever since. "Random-access" meant that all individual memory locations—collectively constituting the machine's internal "state of mind"—were equally accessible at any time. "High speed" meant that the memory was accessible at the speed of light, not the speed of sound. It was the removal of this constraint that unleashed the powers of Turing's otherwise impractical Universal Machine.

Handwritten note and examples of punch cards related to Nib Barricelli's work using the computer
undertake such a project," since the government laboratories were only building devices for "definite, often very specialized purposes," and any industrial company, on the other hand, which undertakes such a venture would be influenced by its own past procedures and routines, and it would therefore not be able to make as fresh a start."
The physical processes that lead to planet formation produce solar systems that are unlike our own. The overwhelming majority of the planets depicted in this graph orbit Sun-like stars. (Data: www.exoplanets.org)

EXTRA SOLAR PLANETS

HD 80606b is a gas giant planet, like Jupiter. At HD 80606b is approximately 1500 K. The eccentricity of an ellipse is given by

\[ e = \sqrt{1 - \frac{b^2}{a^2}} \]

where \( b \) is the semi-minor axis of the ellipse.

clusters of galaxies, cosmic microwave background radiation, and the list goes on.

The general pursuit of the twentieth century continues with the planned construction of the billion-dollar-plus U.S.-led Giant Magellan and Thirty-Meter Telescopes, as well as the European Extremely Large Telescope. However, a new strategy for discovery has emerged in the twenty-first century: time-domain astronomy. Rather than finding faint and distant sources, searching in the time-domain enables the discovery, for instance, of small variations of relatively bright nearby objects, such as stars. An exciting source of such small brightness variations are extrasolar planets or, in other words, planets that orbit other stars.

The basic approach of time-domain astronomy is easy enough to state. Look somewhere in the sky and then look at it again, some time later. If anything has changed, study it further. The time it takes for the instrument to reobserve the same patch of sky is referred to as the “cadence.” By using the old strategy of looking deep and far into the Universe, sources of a given brightness are methodically mapped out in a three-dimensional volume. In time-domain astronomy, sources that vary with some brightness with a rate equal to the inverse of the instrument cadence can be steadily mapped out. In a way, the time-domain adds another dimension, given by the frequency equal to the inverse cadence, to the properties of observed phenomena.

Interestingly, one can either go deep with a relatively big telescope, coming back to the same field of view every once in a while, or one can go shallow with a relatively small telescope and a short cadence. Since we don’t know what’s out there, each approach seems equally valid.

An important point to keep in mind: small telescopes typically have relatively large fields of view in comparison to big telescopes. Since small telescopes are much cheaper to construct than big telescopes, the cost of mapping out the Universe in the time-domain may be done more efficiently with smaller instruments that have rapid cadence. Perhaps the next century of astronomical discovery will be dominated by several small groups of enterprising individuals, armed with batteries of modest telescopes, competing with one another to map out the time-domain. For years, such a view of astronomy’s future was enthusiastically advocated by the late Bohdan Paczynski of Princeton University (a frequent visitor in the School of Natural Sciences between 1974-81), who initiated two successful time-domain campaigns: the All-Sky Automated Survey and the Optical Gravitational Lensing Experiment.

Paczynski realized early on that the only way to achieve this was to take full advantage of astronomy’s impending digitization. Modern telescopes equipped with CCD cameras (like the one in your cell phone), rather than the old photographic plates, produce pixel-by-pixel electronic images of the sky that can be stored and manipulated by a computer. Only with the help of massive amounts of custom-built software and fast processors would it be possible to explore massive volumes of the Universe in the time-domain with great precision.

Consider repeatedly scanning a huge number of Sun-like stars in the Milky Way with high cadence at great precision, in order to look for small differences in their emitted light. As previously mentioned, an interesting source of such small differences may be a planet that orbits around its host star, much like our own planet. In the case where a planet passes in front of its host, a small (about 1 percent for a big planet) momentary depression in its brightness, or an eclipse, can be observed. Such an eclipse is usually referred to as a “transit” and is one of the most successful methods of detecting extrasolar planets. Today, we know the properties of approximately 1,000 extrasolar planets. Twenty years ago, at the beginning of the digital age, that number was zero. Paczynski was right.

The primary motivation for studying extrasolar planets is to find another place in the Universe that resembles our own Earth. Since an Earth-sized planet is quite small in both size and mass in comparison to its stellar host, its ability to deform the appearance of its host is correspondingly limited. Its transit in front of a Sun-like star would lead to a depression in brightness that is of order 1 percent of 1 percent. Only now are instruments sensitive enough to detect an Earth analogue. If they are out there in significant number, the recently launched Kepler space observatory, a high-precision extrasolar-planet-transit-detecting-machine, should report on their discovery any day now.

But, what about the 1,000 or so extrasolar planets whose properties (mass, radius, orbit, etc.) we know? Figure 1 clearly shows that other solar systems are commonly quite unlike our own.

The shape of a planet’s orbit is well approximated by an ellipse where the stellar host resides at one of the focus points (see box, right). In the limit that the ellipse is a perfect circle, the eccentricity is \( e \) is equal to zero, and in the other extreme, where the orbit is a parabola, \( e \) is equal to one. Figure 1 tells us that, unlike our solar system, the eccentricity of big planets, like our Jupiter, can take on almost any value. Note the orange magenta point in Figure 1, which depicts HD 80606b, the most eccentric planet known to date, with \( e = 0.93 \). Figure 2 depicts what its orbit would look like if it were placed in our solar system.

It is generally presumed that gas giants are formed at large separation from their host stars. Therefore, the cluster of gas giant planets with short orbital periods, known as the “hot Jupiters,” is quite a surprise. In order to account for their close-in orbits, the concept of “migration” is often invoked, meaning the planet was formed far away from its stellar host and then some mechanism removed its orbital energy such that its average heliocentric distance was reduced by a factor of 100 or more. Such a notion seems unbelievable, but the fact that the hot Jupiters exist in relatively large numbers (about 1 percent of all Sun-like stars have one) forces us to seriously consider it.

A popular class of hot Jupiter migration scenarios involves the introduction of a third body, such as another giant planet or a stellar companion (about half of all stars are binaries). The gravitational interaction between the third body and a gas giant can exchange orbital angular momentum, but roughly conserves orbital energy. In the event that most of the energy stored in the tides flow exchange orbital angular momentum, the orbit would look like if it were placed in our solar system.

The Keplerian Orbit

Johannes Kepler realized that the shape of a planet’s orbit was given by an ellipse, rather than a circle. Newton realized that such a shape followed directly from the (fairly) laws of motion, given that the gravitational force between any two objects varies with the inverse square of their distance (i.e., a Keplerian orbit). The orbital period \( P \) is related to the semi-major axis by

\[ P^2 \propto e^3 \]

the angular momentum of the orbit \( J \) is related to the semi-major axis and eccentricity by

\[ J^2 \propto (1 - e^2)^{3/2} \propto \tau \]

where \( \tau \) is the distance of closest approach (the periastron). The energy \( E \) of the orbit is negative and follows

\[ E \propto \frac{1}{a^{3/2}} \]

The eccentricity of an ellipse is given by

\[ e = \sqrt{1 - \frac{b^2}{a^2}} \]

where \( b \) is the semi-minor axis of the ellipse.

Basic Assumptions

The angular momentum in the orbit is much greater than the spin angular momentum of the planet. So to first approximation, the orbital angular momentum \( J \) remains fixed during evolution

\[ \frac{dJ}{dt} = 0 \]

If the planets are formed in a steady state, the continuity relation that describes its distribution \( N \) satisfies

\[ \frac{dN}{dr} = \frac{S}{r} \]

where \( S \) is a constant that specifies the rate at which gas giant planets are formed at large orbital separation, presumably far from the region under consideration.

Orbital Evolution: A Simple Result

For high values of eccentricity \( e \) the shape of the orbit near periapsis is a parabola. Consequently, the energy loss per periapsis passage \( AE \) is independent of \( e \) in the high-\( e \) regime. It follows that for super-Keplerian orbits, the rate at which tidal friction drains the orbital energy is given by

\[ \frac{dE}{dt} \sim -\frac{E}{P^2} \propto \frac{e^3}{a^{3/2}} \]

where \( P \) is the orbital period. Since \( E = \frac{1}{2} a \frac{d^2}{dt} \)

\[ \frac{dE}{dt} \sim \frac{1}{a^{3/2}} \frac{dE}{dt} \]

By inserting this into the continuity relation we can solve for the number distribution \( N \) of planets at a given semi-major axis

\[ \frac{dN}{dr} = \frac{S}{a} \frac{e^{3/2}}{a^{3/2}} \frac{dE}{dt} \]

or in other words, there should be an increasing number of super-Keplerian planets with increasing orbital period.

More details can be found in our paper, located at http://arxiv.org/abs/1110.1644.
I approach to the stellar host slowly removes orbital energy, shrinking the orbit, but conserving angular momentum equal to 5 days. For reference, the orbits of the inner three planets of our solar system are shown of our Jupiter. The sequence of ellipses of diminishing eccentricity illustrates how tidal dissipation affects planets with eccentricities, with the orbit of HD 80606b's orbit angular momentum, but with an orbital period of twelve years, equal to that of the Earth.

Figure 3: Depiction of high-e migration of HD 80606b (magenta). The outer ellipse corresponds to a planet with HD 80606b's orbital angular momentum, but with an orbital period of twelve years, equal to that of our Jupiter. The sequence of ellipses of diminishing eccentricity illustrates how tidal dissipation affects planets with eccentricities, with the orbit of HD 80606b's orbit angular momentum, but with an orbital period of twelve years, equal to that of the Earth.

What Do Judges Do?

by W. Bentley MacLeod

In 2003, the Supreme Court of the United States heard the case of Grutter v. Bollinger and upheld the right of the University of Michigan Law School to use race as a criterion for admissions. At the time, the majority speculated that in twenty-five years the considerations of race may no longer be necessary in admissions. This year, the Supreme Court will hear the case of Fisher v. University of Texas, which turns on the same issue. In other words, we may have a change in the law in less than ten years!

The second is a statute passed by Congress, Title VI of the Civil Rights Act of 1964, which bans discrimination by agencies that receive federal funds. In Grutter v. Bollinger the judges created new law. They argued that the state had a compelling interest in allowing schools to use race as a factor in admissions. In essence, judges, rather than elected politicians, created a new law that allows universities to choose students on a basis that is arguably inconsistent with the Constitution of the United States.

The enormous power of the Supreme Court raises questions about what judges do, and how they reach such momentous decisions. In February, the economics workshop at the Institute for Advanced Study aired a discussion between three leading experts to discuss these issues. The subject is of interest to economists because the rule of law is considered to be an essential ingredient for successful economic growth. Courts are regularly called on to make decisions with large economic consequences, such as deciding on liability for the losses arising from the September 11 attacks, and whether or not ObamaCare is constitutional. Our goal is to understand the process by which these decisions are made.

The session began with a Charles Cameron of the Department of Politics at Princeton University and Lewis Kornhauser of the New York University School of Law who presented work for their book project, which builds on a seminal paper by Kornhauser, "Modeling Collegial Courts II: Legal Doctrine," published in 1992 in the Journal of Law, Economics and Organization. The book is concerned with how courts make decisions. As a problem of collective decision-making, court systems are both sufficiently complicated to combine many problems such as hierarchy and collegiality that appear in many more complex environments and sufficiently simple that we have some hope of understanding them. The long-term goal is to provide a micro foundation of judicial decision-making that may shed light on the macro questions of the role of law in economic growth. The discussion began with a brief review by Cameron and Kornhauser of what the courts do. The main goal of a court is to resolve a dispute. When a case is brought before a court, a decision must be made in favor of one party or the other. The significance of this is that courts must render judgment or make a decision, even when they are uncertain of the correct outcome or how to apply the law in a particular case. This results in courts having two roles.

The first role is like that of a bureaucrat. Judges apply legal rules to the evidence before them. The difficulty is that the law is not always clear. For economists, the fact that rules are not clear is analogous to the problem of incomplete markets that leads to, among other things, meltdowns in financial markets. Over time, the courts have evolved a second role for judges. Namely, the judgments they render have the force of law that binds in future cases (so-called stare decisis).

Legislators cannot anticipate all actions by parties in the future, and hence there will be times when it is not clear how to apply a rule. In a civil-law jurisdiction, judges apply the law as best they can. However, the reasoning underlying a decision for a case is typically not recorded, and cannot be used in a future case. In contrast, in a common-law jurisdiction, the reasoning of appellate courts is recorded and can be cited by future cases. Cameron and Kornhauser advocate a "case-based" approach to judicial decision-making. The basic idea is that previous cases and the evidence before them constrain judges’ behavior in predictable ways. They explain that the Supreme Court is revisiting Grutter v. Bollinger and the environment has changed, and there may no longer be a compelling public interest in providing an exception to the Fourteenth Amendment.

The discussants will consider the future institution providing a constraint on this behavior. As I write this, we do not know how the courts will decide the case. Fisher v. University of Texas; however, the policy-space approach would predict that if the decision changes, it will be due to the fact that the Court is now more conservative, rather than a change in the facts of the case.

There is some evidence to show that the political views of judges do have an effect on outcomes. Yet a well-functioning legal system requires predictability and that judges rule for the most part in ways that are consistent with the law. Thus, in practice, the effects of both case-based and policy-space approaches are present. The discussion concluded that an important open question is the extent to which the discretion of judges should be limited. Some systems, such as civil-law jurisdictions, explicitly try to limit the power of judges. In other systems, such as in soccer, the judge/referee has the ultimate authority to decide as he or she wishes, with effectively no system of appeals.

In contrast to a court case where a judge is required to reach a decision, we were not required to reach a consensus. Rather, the seminar ended with the case undecided and a call for future research, an activity for which the Institute for Advanced Study is well suited.

EXTRASOLAR PLANETS (Continued from page 10)

process within a solar system seems unbelievable, but again, the observations require that we seriously consider it.

IAS Members Subo Dong and Boaz Katz, Professor Scott Tremaine, and I have proposed a simple test of this "high-e" migration scenario. Our arguments begin with a rather unsophisticated fact: stars in the Milky Way are formed roughly in a steady state shortly after the birth of the Universe. Since planet formation is a byproduct of star formation, planets are therefore formed in a steady state as well. So, if we see some number of gas giant planets with moderate eccentricities that may end up becoming short-period hot Jupiters, we should see many super-ecentric gas giants on their way in (see box, page 10, bottom right). In fact, for every HD 80606b, there should be several gas giant planets with record-breaking eccentricities. One reason why these super-ecentric Jupiters have not been detected so far may be due to previous limitations in detector sensitivity and observational strategy. Interestingly, the Kepler space observatory does not suffer from such deficiencies, and we predict that it should detect anywhere from a handful to a dozen super-ecentric gas giant planets if high-e migration is at work.

In the last century, bigger and bigger telescopes were built largely to find sources of light that are far away and strange. On the way to discovering rare beasts, like quasars, we realized that we orbit a rather common star, which itself orbits within a rather common galaxy, and the Universe contains billions of each. By mapping out the vast wilderness that is the Universe, the notion that we are quite ordinary was unexpectedly reinforced.

By examining close-by stars similar to our Sun with great precision in the time-domain, the basic expectation was to find solar systems that are like our own. We now realize that the architecture of our solar system is not typical—it is only one of a vast variety of possibilities. In our attempts to confirm that there are places in the Universe like our own, we have found that the particular place we occupy is, in some ways, rather strange.

Is there any meaning to all of this? Probably. But, I am running out of space and expertise. What I can say for sure is that the Universe has a tendency to disregard our expectations. Maybe there is a lesson in that.
The Institute for Advanced Study’s Park City Mathematics Institute (PCMI) has run a summer program for secondary school mathematics teacher-leaders since 1994. About fifty nationally selected secondary mathematics teachers participate in the three-week institute each year. Gradually over the years, the program, with its three components—doing mathematics, reflecting on practice, and becoming a resource to colleagues and the profession—has developed into one of the premier programs for the professional development of mathematics teachers in the United States. It is arguably unsurpassed in overall quality.

However, the small numbers of teachers that can be served directly by this program, together with its sizable cost (long supported by the National Science Foundation), have brought the program to a crossroads of sorts. The PCMI Secondary School Teachers Program must either increase its influence on national mathematical development at the secondary level or reduce the cost of its program and so, inevitably, its quality.

Happily, the program arrives at this crossroads at a most fortuitous moment in our nation’s educational history. The reason for this is the advent of the Common Core State Standards in Mathematics (CCSSM), a common set of norms for curriculum and practice at each grade level, that has been voluntarily agreed to by forty-four of the fifty states. (Readers wishing to familiarize themselves with the content of CCSSM are referred to www.corestandards.org.) CCSSM cannot, however, be implemented gradually in the nation’s classrooms over the coming decade. This is by far the closest our nation has ever come to national standards and a common curriculum in the teaching of mathematics. The common mathematical experience at comparable grade levels, long the practice in most other nations, is coming within reach in the United States!

The advantages in terms of coherent progressions in learning, transferable from distrubute content and one mathematically mature society, are clear. The opportunities for our nation’s mathematics teachers themselves are perhaps less apparent but equally real. It is in this area that the IAS Park City Mathematics Institute has a new, distinctive, and potentially influential role to play.

CCSSM sets the bar for the nation’s teachers and students at the high end of the current U.S. spectrum. Many mathematics teachers are prepared and fully ready to implement the skills and practices, mathematical and pedagogical, demanded by this new “common text.” But it is likely that many more are not. Add to that the fact that the number of mathematics teacher-leaders is so large that only teachers themselves can form a critical leadership mass to take on the major task of supporting their colleagues through this change. It will take sustained work of teacher-leaders with individuals and small groups of colleagues to fuel the successful implementation of CCSSM. It is precisely in the formation and sustenance of this group of teacher-leaders that the future of the IAS Park City program lies.

Each year, teams consisting of a currently practicing mathematics teacher and a development or educational consultant working together to identify six national teacher-leaders to join its Community of Mathematics Teacher-leaders. This nine-member ad hoc committee to work cooperatively to help spur the development of mathematics teacher-leaders.

As an important companion-piece to these efforts on the national front, PCMI runs a one-week international seminar each summer. Through the generosity of a private donor, we learn in depth about the teaching of mathematics in other societies around the world. Each year, teams consisting of currently practicing mathematics teachers and in their lives. These intended gifts represent the donors’ current plans and can be modified to accommodate changing circumstances. Those who notify the Institute of their intentions are recognized as members of the Einstein Legacy Society. We are pleased to welcome: Betty W. (Tina) Greenberg, Friend of the Institute for Advanced Study and former Chair of its Executive Committee; Bruce McKellar, former Member (1966–68, 1999) in the School of Natural Sciences, and his wife Loris; Albert Nijenhuis, former Member (1953–55, 1961–62) in the School of Mathematics; and Daniel Saracino, former Member (1986) in the School of Mathematics.

Planned gifts play a vital role in ensuring the Institute’s financial independence and standing as one of the world’s leading centers for theoretical research and intellectual inquiry. Planned gifts can be large or small, and many can be structured to benefit the donor, as well as the Institute. Please contact Catie Newcombe at (609) 951-4542 or catnewcombe@ias.edu if you would like to discuss planned giving options.

The Institute has received several planned gifts that have been counted toward the $200 million Campaign for the Institute (see article, above), as well as a Charitable Gift Annuity established by Michael Gehret, Associate Director of the Institute, and his wife Loris; and a contribution to the School of Natural Sciences endowment fund made by Scott Tremaune, Professor in the School, and his wife Marilyn.

Bequest Intentions: Several donors have recently named the Institute for Advanced Study as a beneficiary in their estate plans, in recognition of the Institute’s role in the world and in their lives. These are gifts are intended to represent the donors’ current plans and can be modified to accommodate changing circumstances. Those who notify the Institute of their intentions are recognized as members of the Einstein Legacy Society. We are pleased to welcome: Betty W. (Tina) Greenberg, Friend of the Institute for Advanced Study and former Chair of its Executive Committee; Bruce McKellar, former Member (1966–68, 1999) in the School of Natural Sciences, and his wife Loris; Albert Nijenhuis, former Member (1953–55, 1961–62) in the School of Mathematics; and Daniel Saracino, former Member (1986) in the School of Mathematics.

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On March 1, the Institute for Advanced Study's plans for Faculty housing received unanimous approval (10–0) from the Regional Planning Board of Princeton. The plan, as approved, allows the building of eight townhouse units and seven single-family homes on a seven-acre parcel of private land adjacent to the Institute's campus and provides for a 200-foot buffer zone alongside the Princeton Battlefield State Park, with an additional ten acres adjacent to the Park scheduled to be conserved permanently as open space. In casting its vote, the Board agreed with the Township planning and engineering staff that the Institute had met all requirements to proceed with its plans.

“We are immensely pleased to receive unanimous approval for our Faculty housing plans from the Regional Planning Board of Princeton,” said Peter Goddard, Director of the Institute. “This plan not only enables us to maintain the essential residential character of our community of scholars, but will also help to promote the improvement of the interpretative materials in the Park so that visitors might gain a greater understanding and appreciation of the Battle of Princeton. We look forward to partnering with local, state, and regional bodies to this end.”

The plan was approved with amendments that resulted from discussions between the Institute’s commitment to preservation (the Institute has conserved in perpetuity more than 75 percent of its land holdings as the Institute Woods and farmland), the archi-technological protocol will ensure the proper detection, documentation, and deposit of any remaining artifacts before and during the building of the residences, which are essential to the Institute’s future as a residential community of scholars. More information about the Institute’s Faculty housing plans and the preservation and historical contexts is available on the Institute’s website.

CHAKRABARTY APPOINTMENT  (Continued from page 1)

Chakrabarty has reshaped the field of history through his analyses of political, economic, and social formations and spurred reformulations of core concepts in the social sciences. “The global impact of Chakrabarty’s scholarship, his personal commitment to involving students and colleagues in the reaching range of his research network prepare him well for the thoughtful, energizing leadership expected of Faculty at the IAS,” noted Danielle Allen, UPS Foundation Professor in the School of Social Science. “We are delighted that he will join us.”

Initially trained in physics, Chakrabarty earned a B.Sc. from the University of Calcutta in 1969 and a Postgraduate Diploma in Management (an MBA equivalent) from the Indian Institute of Management Calcutta in 1971. During his business school years, Chakrabarty became interested in India’s political and social development, and in particular the challenges faced by the country, as seen through the lens of India’s colonial past and postcolonial present. He obtained his Ph.D. in History from the Australian National University in 1984, working under D. A. Low, the noted historian of modern South Asia and Africa. Chakrabarty’s graduate research on Bengal’s working class at the turn of the nineteenth century served as the basis for his first book, Rethinking Working-Class History: Bengal 1890–1940 (1989). Inspired by E. P. Thompson’s The Making of the English Working Class (1963), Chakrabarty confronted the question of whether European models could be applied to the history of the Indian working classes and challenged whether the category of “working class” was too deeply tied to its European origins to transfer effectively to any part of the world, wherever a recognizable labor force exists. The book introduced new methodological innovations and led to the development of a historiographic method that closely scrutinized the relations among historically specific social formations, the conceptual tools of social analysis arising from them, and the relative transferability of those tools to different contexts.

Chakrabarty’s second book, Provincial Europe: Postcolonial Thought and Historical Difference (2000; second edition, 2007), he systematically investigated how and in what sense European ideas that were labeled “universal” were drawn from very specific intellectual traditions and historical contexts that left their marks on these ideas even when they could claim a degree of universal validity. In his examination of historical thinking and postcolonial perspectives, Chakrabarty used the context of the middle-class Bengali culture in which he grew up to explain how the “heterotemporal horizons” of locality anchor the structures of sentiment, emotion, and practices that inform the terms used for universalizing purposes. In employing new tools of social analysis, Chakrabarty’s goal was to understand “how universalistic thought was always and already modified by particular histories, whether or not we could excavate such pasts fully,” and he advocated that such an approach was necessary to compare different political and social formations. Chakrabarty is among the founders of the highly influential field of inquiry known as subaltern studies, which draws on the idea that peasants, once ridiculed by Marx and other social thinkers for their “rural idiocy,” may have a positive political role to play in effecting social transformation in postcolonial countries. India, in particular, provided fertile ground for examination into these concepts; when its constitution was enacted in 1950, it granted the right to vote to all adult Indians, the majority of whom were rural and illiterate, effectively turning peasants into the Institute’s Woods and farmland, the archi-technological protocol will ensure the proper detection, documentation, and deposit of any remaining artifacts before and during the building of the residences, which are essential to the Institute’s future as a residential community of scholars. More information about the Institute’s Faculty housing plans and the preservation and historical contexts is available on the Institute’s website.

Chakrabarty’s current work is centered on a project on anthropogenic climate change and its implications for historical and political thinking; its launching point was his influential essay, “The Climate of History: Four Theses,” published in Critical Inquiry in 2009. He is also pursuing a major project on the history of “historical truth” with a focus on the Indian historian Sir Jadunath Sarkar (1870–1938). In a forthcoming book, “The Calling of History,” Chakrabarty explains how, before history became a profession in India in the 1930s, historians questioned and debated the practices of source criticism, research in history, the transformation of old papers into “records,” the institution of the archive, the idea of historical truth, and related questions. Chakrabarty posits that while disciplines have a global life at the level of journals and publications, they also have plural and heterogeneous social lives through the histories of the institutions in which they operate and their different national contexts. Additionally, Chakrabarty is developing two other long-term projects: one on democracy and political thought in South Asia and the other on a cultural history of Muslim-Bengali nationalism.

Chakrabarty has lectured extensively throughout the world, and his books and articles have been or are being translated into many languages, including Arabic, French, Spanish, Italian, Korean, German, Chinese, Turkish, Polish, Portuguese, and Hungarian. He serves as a coeditor of Critical Inquiry, is a founding editor of Postcolonial Studies, and is on the editorial boards of leading scholarly publications in the United States, India, Europe, and Australia. Chakrabarty is a Fellow of the American Academy of Arts and Sciences and is an Honorary Fellow of the Australian Academy of the Humanities. In 2007, he received the Eminent Scholar Award of the Global Development Section of the International Studies Association. He was awarded a D. Lit. (Honoris Causa) from the University of London (2010) and an honorary doctorate from the University of Antwerp (2011). In 2011, his alma mater, the Indian Institute of Management Calcutta, honored him with a Distinguished Alumnus Award on the fiftieth anniversary of the Institute. Chakrabarty is currently Chair of the Provostial Ad Hoc Faculty Committee on the Proposed University Center in India, and he is a member of the Board of Advisors on non-Western Art and Museums of the Humboldt Forum in Germany.