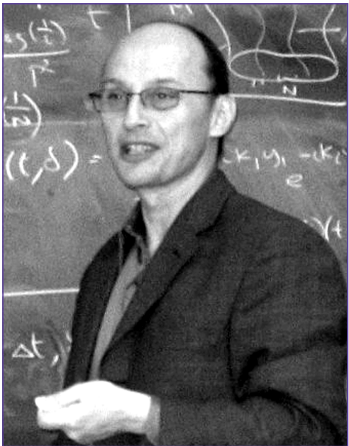


# Courant Institute of Mathematical Sciences

## Letter from the Director

Dear Alumni, Colleagues and Friends,

I am delighted to be addressing you as the new Courant director. At the time of this writing, I have been on the job for precisely 50 days and I'm still on the steep part of the learning curve. Chuck Newman, my predecessor, has returned to research and teaching as Professor of Mathematics, although he can't avoid my frequent calls for advice. We are all indebted to him for his years of leadership.



As I'm sure you all know, NYU has been undergoing some dramatic changes. There are exciting initiatives underway in every division of the University, providing new opportunities for Courant students, postdoctoral researchers, visitors, and faculty. Active collaborations are taking place, for example, in biology, medicine, economics, finance, multimedia, and dance. These opportunities strike me as crucial, since I believe that, over the next few decades, the key new areas for significant progress in the mathematical sciences will be driven, either directly or indirectly, by applications.

Such opportunities are not free of risk. The effective coupling between mathematical and computational innovation, on the one hand, and laboratory or field research, on the other, is a complex process. Our goal should be to take on a clear leadership role in addressing the research and educational challenges that will arise. The Courant Institute is ideally qualified for this, because of the vast array of talent we can draw on from the faculty, research staff, and students, because of our network of alumni and collaborators, and because of the integrated view of mathematics, computation, and their applications that is our unique legacy.

Our special thanks go out to all who have contributed in so many ways to our community, including the hundreds of individuals who made donations totaling \$163,881 to our Annual Fund – by far our best year ever.

We wish you and yours a wonderful holiday season.

Sincerely,

Leslie Greengard  
Director, Courant Institute

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## Holiday 2006 Puzzle: JAM SESSION

The young man turned out to be a Special Forces colonel. "Name is Carl," he said introducing himself. He began right in:

"Our spy in enemy territory has a weak transmitter that transmits one bit per millisecond simultaneously to two receivers, one east and one northwest. The enemy can't detect our transmitter but knows we are there so has a jamming device that broadcasts noise in focused directions. The jamming device rotates through a full circle every 10 milliseconds. When the jam signal intersects the spy's signal at a receiver, the jam signal may flip at most one bit at that receiver. Therefore, it can flip at most one in every 10 bits at the east receiver and a different bit (again at most one in every 10) at the northwest receiver.

"Our spy must send reliable messages, so we plan to encode the transmission with redundant bits. We should be able to do something fairly efficient given that we have two receivers that will retransmit what they receive to headquarters."

Easy Warm-up: Suppose our only goal were to detect whether there were an error and we had just one receiver. How could we ensure detection using only one redundant bit in every 10 bits sent?

Solution to Easy Warm-up: Use the concept of parity. Send 9 data bits and then one "parity" bit with the property that if there are no errors among the 10 bits, the total number of 1s sent would be even. Then if headquarters counts the number of ones and finds that the number is odd, it has discovered that there is an error.

"Here are the questions," Carl said. "Suppose that the jammer may cause bits to flip at each of the two receivers, but these must be different bits. Our spy is sending the same message to both receivers.

"1. Suppose further that the times of the flipped bits at the two receivers must differ by an odd number of milliseconds, i.e., 1, 3, 5, 7, 9. In this situation can our spy always communicate 8 data bits for every 10 bits transmitted?

"2. What if the flipped bits at the northwest receiver are known to occur in the  $i$ th timeslot in each 10 millisecond window, when they occur, for some  $i$  between 1 and 10, and those at the east receiver occur in the  $i+4$ th timeslot (strictly, the  $i+4 \bmod 10$  timeslot)? For short, this is called an offset of 4 milliseconds.

"3. Can you generalize your approach to other offsets?

"4. What if the offset is only known to be 4 or 6 milliseconds. But suppose that there are buffers of 10 bits at the receivers and they can be used to rearrange the order in which each group of 10 bits is sent. Can it help to use different reorderings at the two receivers?

"5. Can you generalize your approach to other pairs of offsets summing to 10?"

**For the solution, email [courant.alumni@nyu.edu](mailto:courant.alumni@nyu.edu)**

## Climate and Sea Levels

Rising sea-levels pose one of the most menacing threats associated with global climate change, and yet the most significant factor influencing such trends – the melting of the polar ice sheets – has yet to be studied with the kind of scientific rigor it clearly deserves. While considerable empirical data are available regarding the above-ground environmental forces affecting this process, to date there has been little to no field study of the physical effects of sea-water slipping under the Greenland and Antarctic ice sheets.

This knowledge gap is now being addressed by Courant Associate Professor David M. Holland, Director of the Institute's Center for Atmosphere-Ocean Science. Thanks in part to grants from the Office of the Provost of NYU, the NSF, and private funding from the Calvert Group, a firm specializing in "socially-responsible" investments, Holland has been able to organize an expedition to the Jakobshavn Fjord in Greenland where his team will deploy a remotely controlled "autonomous underwater vehicle" (AUV) in conjunction with a number of radio-transmitter release floats to collect a full array of data. The team will also install a weather station in the area which will provide remote monitoring of this environment via satellite link.



An autonomous underwater vehicle (AUV) and accessories of the type being employed by Prof. David Holland for his field research in Jakobshavn Fjord, Greenland.

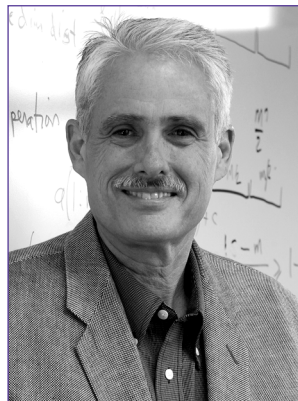
At that point Holland will be able to apply the mathematical and computational techniques for which the Courant Institute is renowned and develop models that will truly further our understanding of this critical phenomenon. To follow the developments of Prof. Holland's research, please go to [http://efdl.cims.nyu.edu/project\\_oisi/realistic/jakobshavn](http://efdl.cims.nyu.edu/project_oisi/realistic/jakobshavn).

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## Ken Kennedy's Incredible Journey Started Right Here at Courant

Ken Kennedy, the John and Ann Doerr University Professor of Computational Engineering in the Computer Science Department at Rice University, is undoubtedly one of Courant Institute's most distinguished graduates. He spoke with us recently about his fond memories of Courant, and the social and academic atmosphere of the late 60's and early 70's.



Ken Kennedy

One of the first PhD's at the Courant Institute in Computer Science back when it was a brand new field, Ken Kennedy began his career with Jack Schwartz, his advisor and the man responsible for switching him from Mathematics to Computer Science.

Ken loved his time in New York, describing Courant as "a terrific place with an incredible intellectual atmosphere. So many interesting and exciting people were there then – I even rode in an elevator with Richard Courant once. There were so many people whose work I studied as an undergraduate and there they were in the flesh!"

The late 1960's were a seminal time in the development of Computer Science and Courant's Computer Science Department, and Ken was one of the very first graduate students in that field. According to Ken, "It never dawned on me that Computer Science was an actual field that you could really study and do research in. I credit Jack Schwartz with showing me that."

"Jack captured my imagination," Ken continued. "He was one of the smartest people I've ever known. He taught me pragmatic computer usage, since Courant had one of the first CDC 6600's in the country. There were only three of that model at that time; they were the leading supercomputers." Ironically, Ken is now a director of Cray Inc. (the supercomputer company founded by Seymour Cray, the designer of the 6600). "Back then, it was so exciting to have one of the fastest computers in the world one floor below Jack's office," Ken explained.

One of Ken's most vivid memories of his time at Courant centers on the antiwar protests at NYU. As he told the story, "The students occupied the building and no one could use the computer. When they exited the building, they apparently left explosives under the computer – one of the staff saw a lit fuse and stamped it out right as it was going to detonate. Miraculously, that staff person saved one of the most important computers in the world."

When asked how he would sum up his time at Courant, Ken said, "It was a great thing to be at Courant. My whole career in research on high-end computing was started at Courant, where computing was a very important component of the graduate student education and I had access to the very best facilities available, namely one of the three fastest computers in the world."

Ken also had some fascinating thoughts about the future of computers. He explained, "The computational capability of today's supercomputers is limited by our ability to power and cool them. As a result, the design of computer hardware and software is being driven by the goal of maximizing performance per watt. This, in turn, is making the architecture and software more complex, with multiple processors of different kinds on each chip and the need to balance power consumption among them. A lot of interesting challenges await us."

### Take a Step Back in Time... Part 2

We continue our series of excerpts from interviews with scientists who were working at the Institute in the 1950's, when computers first became a research tool. These interviews are the result of an ongoing oral history project conducted jointly by CIMS and the NYU TV center, supported by your generous contributions to the CIMS Annual Fund.

#### 2<sup>nd</sup> Interview

##### Dr. Herbert Krantzer,

*Professor Emeritus, Adelphi University*

The last Ph.D. student of Richard Courant, Dr. Krantzer describes some of his experiences as a graduate student and postdoc at the Institute, which included working with the first computers at NYU.

"It was the beginning of the computer era. We had a new computer, the UNIVAC, which seemed so much faster than anything around. Before the UNIVAC arrived [installed in 1953], computing was done in a room with six or seven people pushing buttons on machines made by Monroe or Fridan. [Editor's note: these were calculating machines of the time, used to do arithmetic quickly]. They were electro-mechanical and made a lot of noise. Computing had to be split up among different people and none of them could really see what was going on except the person that was in charge of the project. But when the UNIVAC came along, you could program it to do your whole job. However, you had to have a lot of energy and stamina because the computer was going 24 hours a day; we would fight over getting the 3:00am time slot. Then computers got faster. Toward the end of my time here, we had the IBM 704, which I guess was 100 times as fast as the UNIVAC."



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## New Faculty Profiles



**Jinho Baik**, associate professor of Mathematics. Jinho earned his Ph.D. here at NYU's Courant Institute in 1999, and then taught at Princeton University and the University of Michigan. He is the recipient of the AMS Centennial Research

Fellowship, a Sloan Research Fellowship, and the CMFT Award for outstanding young researcher. His research interests include: integrable systems, random matrices and their applications to combinatorics, probability theory, and mathematical physics. He has worked on longest subsequence problems in combinatorics, symmetrized permutations, certain last passage percolation models, exclusion processes, discrete orthogonal polynomials, and sample covariance matrices.



**Jinyang Li**, assistant professor of Computer Science. Jinyang received her Ph.D. from the Massachusetts Institute of Technology in 2005. Her research interests include distributed systems and computer networks with an emphasis on the design of efficient

search in large distributed systems. Currently, her projects include building practical peer-to-peer storage, indexing, and resource discovery systems using social relationship hints among peer nodes' owners. She is also working on building MAC and routing protocols for multihop urban mesh networks to achieve high throughput and robustness.



**Assaf Naor**, associate professor of Mathematics. Earning his Ph.D. from the Hebrew University in Jerusalem in 2002, Assaf comes to NYU from the Theory Group of Microsoft Research in Redmond. His honors include the Clore Fellowship, a European Union

Marie Curie Fellowship, the Klein Prize for Excellence in Teaching from the Hebrew University, and the Israeli Parliament Prize. His research focuses on applications of analysis to problems in metric geometry, combinatorics, mathematical physics, and theoretical computer science. A large part of his work applies sophisticated mathematical

methods to computer science, and has yielded numerous approximation algorithms for NP hard problems and efficient data structures.



**Aaditya Rangan**, assistant professor of Mathematics. Adi received his Ph.D. from the University of California, Berkeley in 2003. Recently, his research has focused on large scale network models of the mammalian primary

visual cortex, as well as numerical methods specifically tailored to simulate these large networks. His work has provided explanations for many recently observed experimental phenomena and has challenged the classical assumptions underlying mean-field network analysis. His current research interests include modeling other neurological and biological systems.



**Lakshminarayanan Subramanian**, assistant professor of Computer Science. In 2005, Lakshmi earned his Ph.D. from the University of California, Berkeley. For the past year he was a postdoc with the Technology and Infrastructure for Emerging

Regions (TIER) project at the Intel Research Laboratory in Berkeley. His "classical" research interests span Internet routing, network security, overlay networks, wireless networks, and technologies. He is also deeply involved in technology research that can help to address special problems of developing countries, such as access to medical care for people in remote locations.



**Akshay Venkatesh**, associate professor of Mathematics. Akshay received his Ph.D. from Princeton University in 2002. Subsequently, he was a C.L.E. Moore instructor at MIT and a Clay Research Fellow at Courant; he has also received a Hackett fellowship and

the J.A. Woods Memorial Prize. His research interests include automorphic forms, number theory, and analysis and dynamics on homogeneous spaces. He is particularly interested in the interplay of spectral and dynamical techniques.



Following a "Roundtable" event for an audience of almost thirty current students this past October 19, Courant computer science alumni Susan Puglia, BA '81 (foreground), and David Kaufman, BA '80, follow up with an animated informal discussion. The returning graduates who are, respectively, a Vice President at IBM, and Senior Vice President and Chief Information Officer at ARAMARK, addressed the topic: "How our Courant Computer Science Classes Impacted our Career Trajectories."

## Poincaré's Conjecture

We're happy to note that, as widely reported in the media, Dr. Grigory Perelman, who was a Visiting Member of the Courant Institute in 1993 before he returned to St. Petersburg, has resolved celebrated problems in three dimensional topology and geometry, including the hundred year old Poincaré Conjecture.

The International Congress of mathematicians, at its meeting in Madrid last summer, announced that Dr. Perelman was one of the four outstanding mathematicians on whom it would confer the Fields Medal, though Dr. Perelman declined the prize.

The great French mathematician, mathematical physicist and scientific philosopher Henri Poincaré had conjectured at the beginning of the 20th century that the three dimensional sphere (the manifold

consisting of the points of distance one from the origin in four-dimensional Euclidean space) could be characterized among all closed, three dimensional manifolds by its being simply-connected (i.e., having the property that any circle on it could be filled in by a disc on it).

This topological characterization of the three dimensional sphere is key in the general question of classifying three dimensional manifolds, which has been pursued via geometrization (decomposing three dimensional manifolds into pieces with one of several standard geometries).

Perelman's seminal work used as a basic initial building block Richard Hamilton's "Ricci flow" on spaces of metrics; Perelman's work thus involved profound and creative analytic as well as geometrical ideas.

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