



MATHEMATICS DEPARTMENT


NORTHWESTERN UNIVERSITY • THE JUDD A. AND MARJORIE WEINBERG COLLEGE OF ARTS AND SCIENCES • DEPARTMENT OF MATHEMATICS

SUMMER 2015 NEWSLETTER

FROM THE CHAIR

Jared Wunsch, *Chair, Department of Mathematics*

The 2015 Mark and Joanna Pinsky Distinguished Lecture Series | Northwestern University Department of Mathematics



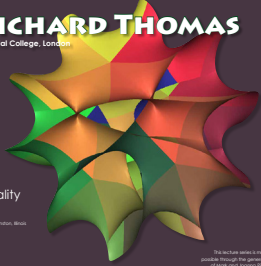
RICHARD THOMAS
Imperial College, London

Tuesday | April 21, 2015
Nodal curves, old and new

Wednesday | April 22, 2015
The KKV conjecture

Thursday | April 23, 2015
Homological projective duality

All lectures begin at 4:00pm | Lunt Hall 105

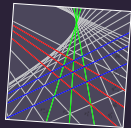
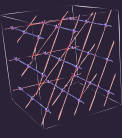


The 2015 Bellow Lecture Series | Department of Mathematics, Weinberg College of Arts and Sciences, Northwestern University

Yusufcan Yazgan, University of Utah

Ben Green

Approximate algebraic structure

Lunt Hall 105 | 4 pm

May 18, 2015
Approximate groups

May 19, 2015
Approximate polynomials

May 20, 2015
Problems about points and lines

May Midwestern Microlocal Meeting | May 16–17, 2015



Northwestern University
105 Lunt Hall
2033 Sheridan Road, Evanston, Illinois

Organizers
Eyal Gorenfeld, Andrew
Anthony Shi, Benjamin
Furter, James
Worland, Northwestern

Speakers
Dean Baskin, *Yusef Aidi*
Yaiza Canzani, *Harvard University and IAS*
Peter Hintz, *Stanford University*
Long Jin, *UC Berkeley*
Richard Melrose, *MIT*
Wilhelm Schlag, *University of Chicago*
Maciej Zworski, *UC Berkeley*

It's May as I write, and as always the combined effects of calendar and climate have brought an almost painful wealth of mathematical excitement to Lunt Hall. We've had both the Pinsky and Bellow lectures this year in fairly short succession, with the former being delivered in late April by Richard Thomas, of Imperial College London, and the latter, just this month, by Ben Green, of Oxford. Meanwhile we have what must surely be the most ambitious emphasis year ever at Northwestern, with our geometric analysts running an incredible array of activities which reach their peak with this month's *Workshop on Ricci Curvature*. At the same time, we're really excited to have Mike Hopkins visiting in conjunction with his Nemmers prize; he's giving a mini-course on algebraic and motivic vector bundles. This is in addition to the May *Midwest Microlocal Meeting*, a minicourse by visitor Gábor Székelyhidi on moment maps and stability in algebraic geometry, an undergraduate prize day lecture by Annalisa Crannell,... well, you get the idea: it's been wild but exhilarating.

I am incredibly pleased to announce that the department has been awarded an NSF Research Training Groups ("RTG") Grant in the area of Analysis on Manifolds. This \$2.18 million grant, with Ezra Getzler as its Principal Investigator, will fund the training of postdocs and students at every level

in geometric analysis. Among the first activities funded by the RTG will be our upcoming *Summer School in Geometric Analysis*



(again part of this enormous emphasis year) and the upcoming *Graduate Research Opportunities for Women* ("GROW") conference, organized by Laura DeMarco, Ezra Getzler, and Bryna Kra. GROW will bring undergraduate women interested in pursuing graduate degrees in math to our campus this October, for a program of research lectures and panel discussions.

In the fall, the department will be joined by a new assistant professor in number theory, Yifeng Liu. Liu, who joins us from MIT (where he is currently a Moore Instructor), is already a mathematician of impressive breadth. He has not only done profound work in a wide swath of number theory and arithmetic geometry, but he also has a rather impressive sideline working on infinity-categories. We are excited for his arrival. News of other of our recent hires has been very impressive, with both Laura DeMarco and Mihnea Popa awarded Simons Fellowships for next year, and Popa being elected a Fellow of the AMS. We were very proud that

continued on page 3



WEINBERG COLLEGE OF ARTS & SCIENCES



Department News

The math department was awarded a **National Science Foundation Research Training Group (RTG) grant** in geometric analysis. The \$2.18M grant will fund research and training of students and postdocs in this field over the next five years. **Ezra Getzler** is the project's Principal Investigator, with Co-Principal Investigators **Aaron Naber**, **Jared Wunsch**, **Laura DeMarco**, and **Ben Weinkove**.

Eric Zaslow won the Alumnae of Northwestern University Award for Curriculum Development for his course proposal, *Quantitative Reasoning*, which will be developed as part of the Bridge Program.

Donald Geman, Ph.D. '70, was elected to the National Academy of Sciences. Geman, whose NU thesis was entitled "Horizontal-window conditioning and the zeros of stationary processes," was recognized for his work in machine learning.

Deanna Haunsperger, Ph.D. '91, was elected President of the Mathematical Association of America.

Kate Juschenko received a Faculty Early Career Development (CAREER) Award from the National Science Foundation.

Laura DeMarco and **Mihnea Popa** were named 2015 Simons Fellows in Mathematics.

Mihnea Popa gave an invited address at the 2015 Central Spring Sectional Meeting of the American Mathematical Society.

Mihnea Popa was named to AMS 2015 class of fellows.

Sandy Zabell was appointed to a DNA Analysis Committee of the National Institute of Standards and Technology (NIST), tasked with promulgating forensic science standards and guidelines.

Incoming Faculty

YIFENG LIU, ASSISTANT PROFESSOR



Yifeng Liu studied Mathematics at Peking University in China, before coming to the US for his doctoral studies. He received his PhD from Columbia University in 2012. He was a C.L.E. Moore instructor from 2012-2015 at the Massachusetts Institute of Technology. His research interests are Algebraic Number Theory, Automorphic Forms, and Algebraic Geometry.

From the Chair, *continued from front page*

Aaron Naber spoke at last year's International Congress about his groundbreaking recent work on quantitative stratification and Ricci curvature bounds. And Kate Juschenko received a prestigious NSF CAREER Award for her proposal on "Amenable and Recurrent Actions of Finitely Generated Groups."

I am pleased to report that this is my last newsletter as chair—while it's been a fascinating job, I'm ready to take a

break. The job is especially easy to leave because it's clear that the department is going to be in excellent hands, with Paul Goerss (who has in fact done this before) taking over in September 2015. I would like to give my heartfelt thanks to our superb departmental staff, who made my life as chair as easy as they could, and mostly saved me from making a fool of myself for the last three years.



Springtime around Lunt Hall

UNDERGRADUATE NEWS

2014/2015 UNDERGRADUATE PRIZE WINNERS IN MATHEMATICS

*Outstanding Achievement in Mathematics by a
Graduating Senior*

Andrew J. Ahn, Xuchen Han, Jasmine Powell

*Honorable Mention for Achievement in Mathematics
by a Senior*

Paul J. Frigge

*Outstanding Achievement in Mathematics
by a Junior*

Michel G. Alexis, Joseph Breen

*Honorable Mention for Achievement in Mathematics
by a Junior*

Josiah Hyun Oh, Alberto Takase

*Outstanding Achievement in Mathematics
by a Sophomore*

Araminta Gwynne

*Honorable Mention for Achievement in Mathematics
by a Sophomore*

**Gavriel Hirsch, Mohammed Harris Khan,
Alexander Martin, Samuel Mosing**

Excellence in Mathematics by a First Year Student

**Tushar Chandra, Ethan Dlugie, Shreya Goel,
Zachary Herron, Aditya Jain, Hankyul Lee,
Mengtan Liu, Xiaoxiao Ouyang, Bo Peng, Paul
Salamanca, Jiaqi Shang, Jordan Todes, Di Xiao,
Zimin Zeng**

*Outstanding Achievement in Mathematics
by a High School Student*

Fiona Brady

*Outstanding Contributions to
Undergraduate Mathematical Life*

Joseph Breen, Paul J. Frigge

*Outstanding Achievement on the
William Lowell Putnam Examination*

Edward Kim, Zeyu Wang

*High Achievement on the
William Lowell Putnam Examination*

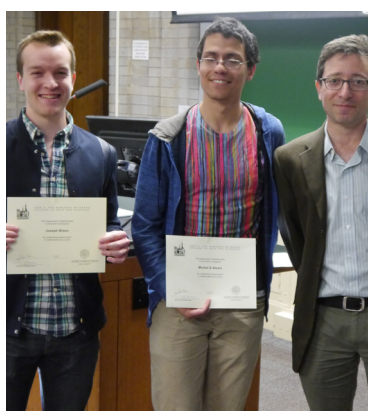
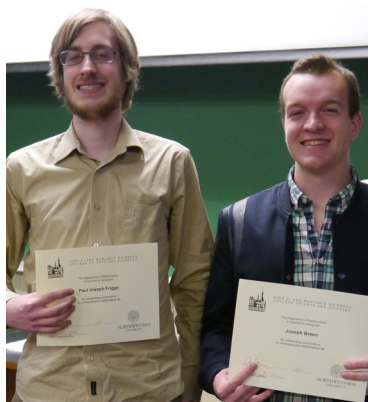
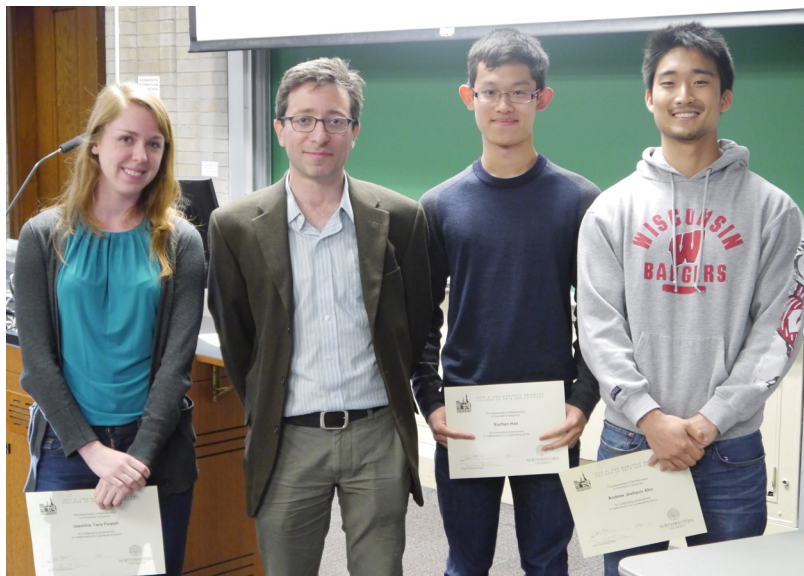
Andrew J. Ahn, Jiaqi Shang

Excellence as an Undergraduate Teaching Assistant

Joseph Breen, Julian Caracotsios, Jasmine Powell

*Certificate of Recognition for Service as an
Undergraduate Teaching Assistant*

**Julian Caracotsios, Do Hyung Kim, Billy Morrison,
Jasmine Powell, Abraham J. Schulte, Zeyu Wang**



The Undergraduate Program 2014-2015

By Mike Stein, Director of Undergraduate Studies

As I write this, it's been less than a week since we awarded our annual undergraduate prizes. Among the highlights were the undergraduate TA awards, and I was struck with how this program has developed in the 7 years since its inception.

We first proposed using undergraduate TAs many years ago, following a model at some of our peer institutions. It was a substantial battle over several years to obtain approval from the University Administration to try a small experiment.

From that beginning in Spring 2008 (6 TAs), we have grown to hiring about 15 undergraduate TAs each year, who collectively teach 33 discussion sections. We and they find it a highly rewarding experience. The best of our undergraduate TAs are among our best TAs overall, graduate students included. This year we awarded three "Excellence as an Undergraduate Teaching Assistant" prizes, to Joe Breen, Julian Caracotsios, and Jasmine Powell. Their collective average on student course evaluations was well over 5.0 (out of 6)!

At this moment there are 255 math minors and majors (a new record), a total certain to grow in the coming weeks as first-years declare their majors. We expect a little over 90 graduates from our department in June. Four graduating seniors – Andrew Ahn, Paul Frigge, Erik Johnson, and Jasmine

Powell – wrote honors theses. All of them, along with Xuchen Han, Abe Schulte, and Daniel Douglas (a 2013 graduate) will continue into PhD programs at MIT, UCLA, Stony Brook, Santa Barbara, Michigan, and USC. Other seniors will be attending grad school in math-related fields.

We are grateful to our graduates who donate to our department. The donations continue to increase from year to year and help fund our awards and many other departmental initiatives. (Information on how to make a gift to the Math Department can be found on the back page of this newsletter.)



(Left to right) Ursula Porod presented undergrads Joe Breen, Julian Caracotsios, and Jasmine Powell "Excellence as an Undergraduate Teaching Assistant" awards at the department's annual Undergraduate Awards ceremony.



"I could not have anticipated how much of my experience at Northwestern would be shaped by the math department."

By Joe Breen, class of 2016

After graduating from high school, I spent a good portion of the following summer fantasizing about my future life at Northwestern, painting a mental picture of all that I would do and accomplish. Looking back, I got nearly everything wrong --- I was rejected from clubs I wanted to join, I have yet to meet the love of my life, and I didn't walk on the basketball team and become a superstar.

Perhaps the most surprising reality, though, was my evolution as a student of mathematics. I could not have anticipated how much of my experience at Northwestern would be shaped by the math department. From the design and structure of MENU classes to the incredible professors that teach them, the academic environment here has done wonders for my blooming interest in mathematics. In high school, I enjoyed math because I did it independently, and I feared that adopting it as a major would kill the enthusiasm I had for the subject. Fortunately, it has done quite the opposite.

The fact that I still love math would not have been so surprising to 17-year-old me; what I really couldn't have anticipated is the passion I've developed for teaching

and mentoring. The department has given me a wealth of opportunities to give back to the undergraduate community in the best possible way. Between calculus peer tutoring, mentoring for MENU classes, and being an undergraduate TA, the experiences I've had and connections I've made have been some of the most rewarding of my life. Because of this, my identity as a Northwestern student is primarily defined by my ties to the math department. From my place as a student to my role as an educator, I could not feel more at home. Thankfully, I have one more year to spend as part of the community.

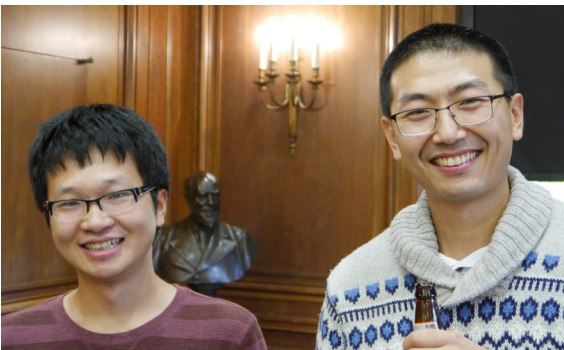
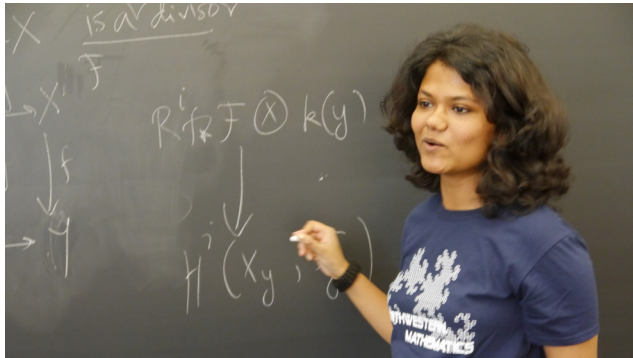
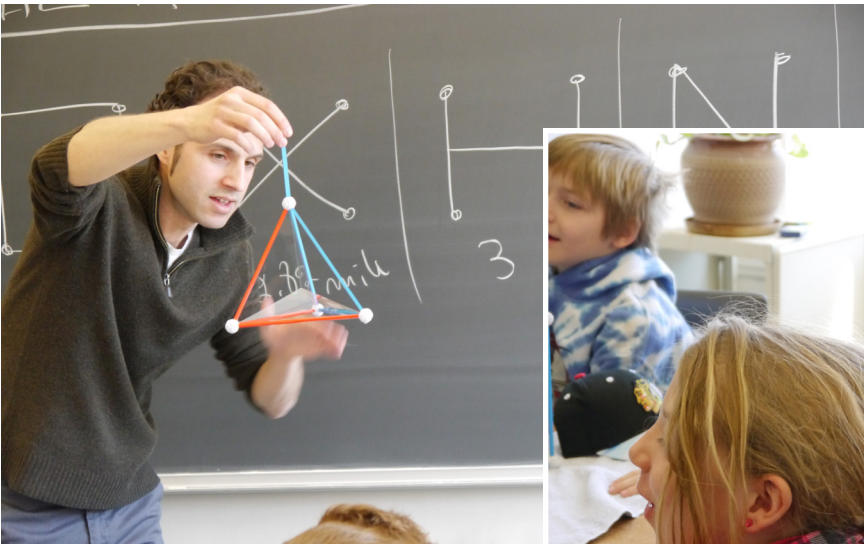
To the graduating seniors that don't have more time to spend: You have been a source of inspiration for me and many others, and I wish you the best of luck in your future endeavors. I am excited and scared to be in your position one year from now.

To the faculty, staff, and graduate students: The past three years have been the most challenging and fruitful of my life, and the support I have gotten from you has been immeasurable.

Though many of my high school fantasies remain unfulfilled, my career as a Wildcat and as a budding mathematician has been remarkably successful. I am fortunate to have another year here to achieve even more. As far as walking on the basketball team goes, I guess I still have one more season. I'm hopeful.

PHOTO GALLERY





**...reach
out, get
connected,
seek advice,
make
friends...**

*—From the interview with
Alexandra Bellow
on page 10*

Mike Hopkins

Winner of the Frederic Esser Nemmers Prize in Mathematics

By Paul Goerss



In the spring of 2015, we had the first of two extended visits by Professor Michael J. Hopkins, Professor of Mathematics at Harvard University, and the current winner of the Frederic Esser Nemmers Prize in Mathematics. With this award, Mike Hopkins was recognized for his fundamental contributions to algebraic topology and homotopy theory, both traditional strengths of the Northwestern Mathematics Department. In some sense this is a closing of a circle, for Mike holds three degrees from Northwestern (B.A. '79, Ph.D. '84, Dr. Sci. '13) and received much of his initial training here working with Professor Mark Mahowald. The Nemmers prize adds to Mike's many honors; for example, he was elected to the National Academy of Sciences in 2010, and in 2012 received the National Academy's Award in Mathematics. The list of winners of this last prize is a roll call of the giants of American mathematics; the list of winners of the Nemmers prize is equally prestigious, but more international in scope. Mike and Ingrid Daubichies are the only mathematicians to have won both.

Beginning with his work in the 1980s, Mike has fundamentally transformed the field of algebraic topology, using the techniques of homotopy theory across a broad range of areas of mathematics, solving old problems and creating new areas of study that could not even have been formulated in prior terms. This revolution is on-going and dynamic.

Most recently, with Doug Ravenel and Mike Hill, Mike has settled all but one case of the Kervaire Invariant One Problem—a problem that dates back to 1940s. It arose in multiple ways; the most geometric was a question of whether certain singular manifolds could be made smooth. Using an unexpected and ingenious new technique, Hill, Hopkins, and Ravenel settled the question in the negative; since the expectations were for a positive solution, this creates a host of new problems, thereby rejuvenating a field that had been dormant for twenty years. In a past visit, he talked about this work in the Pinsky Lecture Series.

During his recent visit, Mike gave a heavily attended lecture series on algebraic and motivic vector bundles, a topic which ranged over a variety of fields, from classical topology to modern algebraic geometry. Outside the lecture hall, Mike was a daily and exciting presence in the department, meeting with faculty and the large number of graduate students currently studying algebraic topology in one form or another. It was good to have him back.



Photos from top: Mike Hopkins. Paul Goerss (right) introducing Mike Hopkins at Mike's 2015 lecture series on algebraic and motivic vector bundles at Northwestern. Audience just before the talk.

Graduate Student News



By Eric Zaslow, Director of Graduate Studies

In the past year, our graduate students have continued their string of recent successes.

Nearly all of our graduates go on to research postdocs, about half in the very top schools. Last year, Boris Hanin (MIT) and Jesse Wolfson (Chicago) won NSF postdocs.

Among the active students, Xavier Garcia was recently awarded an NSF Graduate Research Fellowship. Many other students have existing fellowships, as well.

So, yeah, we're pretty awesome. But more than that, the "community" of graduate students seems to be thriving. We have our ups and downs, like everyone, but we enjoy hanging out together in the common room, chatting with our Big and Little Buddies at a café, playing intramural basketball, learning together at the graduate student seminar, or socializing at wine and cheeses and happy hours. The congenial atmosphere comes from the students themselves, and the hard work they put back into the community. Thanks to all who organize, particularly Ben Knudsen (wine and cheese), Brian Williams (basketball), and especially to last year's Gelfand Award winner Joel Specter.

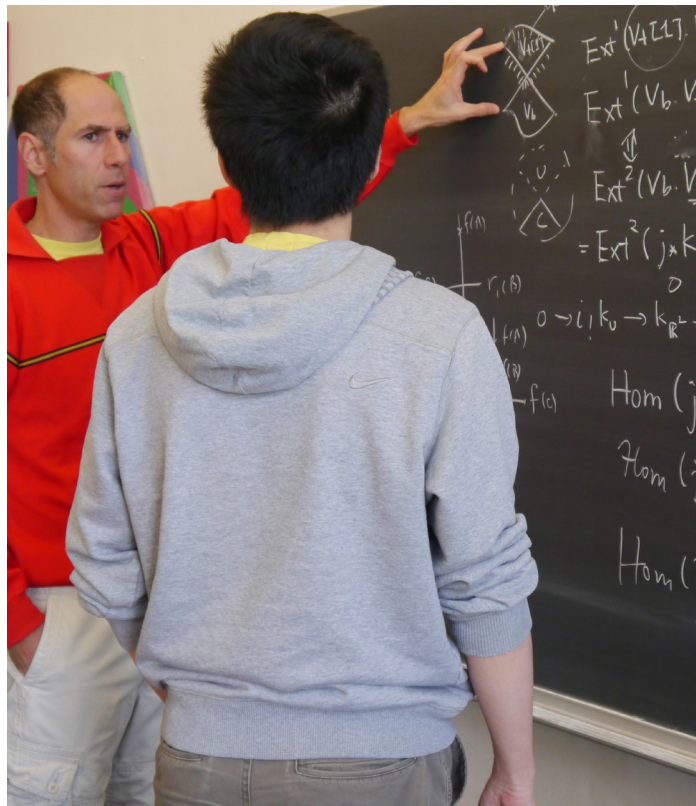
Our recruitment efforts attracted a whopping seven of the fifteen students who were invited to visit at Prospectives Day, a list comprising *all* domestic entering students.

This is a strong testament to the good vibes that our students send out.

For many years now we have been striving to increase the number of women graduate students. Unfortunately this year, the incoming class will not have any women. This unfortunate anomaly is a result of an unusually small pool of top women applicants, who evidently selected other institutions. (Word of mouth is that we are not alone in our struggle for gender

diversity for the incoming class of 2015.) That said, the students joining us are an impressive dozen, seven from the US and five from abroad.

The following students will be graduating this year: Yanxia Deng, Clemens Koppensteiner, Zhenan Wang, Ziyue Guo, Sheng-Fu Chiu.



Interview with

Alexandra Bellow, Professor Emeritus of Mathematics

Interview by Niki Koumoutsos

May 2015



Born in Bucharest, Romania in 1935, Alexandra Bellow received her PhD from Yale in 1959. She went on to a distinguished career working in ergodic theory and probability. Now Professor Emeritus of Northwestern University's Department of Mathematics, she has endowed the annual *Alexandra Bellow Distinguished Lecture Series*. The entire interview can be found at

<http://www.math.northwestern.edu/about/newsletter/alexandra-bellow-full-length-interview.html>

NK: You have mentioned in other interviews that you had loving and devoted parents and that they were both physicians: your mother was a child psychiatrist, your father, a neurosurgeon. How did your family react to your intention of studying math? How did you discover that you wanted to become a mathematician?

AB: My parents were indeed accomplished, dedicated physicians: my father founded the first clinic of neurosurgery in Romania, my mother was a pioneer of child neuropsychiatry. They both held mathematics in high esteem. My maternal grandfather had been a civil engineer who also taught math in high school; my mother wanted to follow in her father's footsteps, but the Polytechnic Institute in Bucharest did not admit women at that time (the early 1920s), so she chose medicine instead. My mother also had a strong interest in child education, she had her own playful techniques for teaching arithmetic and she loved experimenting on me. As a small child I became her willing, enthusiastic "guinea-pig" and, before I knew it, I had fallen in love with math. My father died when I was ten years old, but my mother was not a bit surprised (she may even have been secretly pleased) when I announced that I wanted to study math and become a mathematician.

NK: Considering that you grew up in Romania during and after WWII, you experienced totalitarianism first-

hand: a dictatorship of the right during WWII, and after, a dictatorship of the left. Given the nature of the political suppression of ideas and intellectual pursuits during that era, what did it mean for you to study mathematics?

AB: My last year in high school, 1953, was my definitive formative year. It coincided with the peak of the Stalinist terror in Romania and in the whole Eastern Bloc. It also coincided with my mother's political disgrace. This was very likely triggered by the fact that my mother, as Minister of Health in 1946-48, had asked the West for help and the West had sent food and medical supplies to war devastated Romania. The specter of a purge-style trial, arrest and possible annihilation hung over my mother and me. Fortunately, in the last years of high school, I had a superb math teacher. She was the most respected teacher in school. She was also fearless and determined to give me the support I needed. That's how I survived one of the darkest periods of my life. I came to feel that mathematics, perhaps more than any other discipline, can endow you with the independence of spirit needed to follow your intellectual pursuits and resist political pressures. The beauty of mathematics, its clarity, precision, elegance, and honesty are universally acknowledged. To quote Littlewood, mathematical work "has to be honest, not from any sense of moral superiority, but simply because in mathematics you cannot get away with *fakery*." The language of mathematics is universal; this gives mathematical refugees, coming to the States from oppressive regimes elsewhere, an instantaneous mode of communication, and a sense of belonging to the mathematical community at large.

NK: In 1957, you came to the USA with your first husband, the mathematician Cassius Ionescu Tulcea and you undertook a PhD at Yale. It is no secret or surprise that you were one of the few women on campus, and even fewer women in the math department. What was it like to arrive in the USA and at Yale? Now, we have many modes to keep groups of people in touch; what, if anything, did you and your fellow students do to support each other?

AB: Yes, I came to the States with Cassius Ionescu Tulcea, who had already established himself mathematically. He had been invited by Yale University to participate in a special program in functional analysis. I had graduated from the University of Bucharest with the equivalent of a master's degree in mathematics. When we arrived at Yale, I decided

to undertake a PhD in mathematics. We lived rather frugally, but leaving political oppression behind and discovering the freedom of American life were altogether exhilarating experiences. There were very few women among the graduate students in math at Yale and *no* women on the faculty. Consequently female moral support, which could have been invaluable, was nonexistent. I was also quite shy because I had trouble communicating within the Oxford-English and rigid grammar rules I had learnt at home. Thus, I spent most of my time in virtual isolation, studying math, deconstructing and rearranging my English. The condescending attitude of my male classmates, I have to admit, lasted only until I gave my first seminar talk. After that I was treated with respect.

I ended up choosing Professor Shizuo Kakutani for my thesis advisor: his math was beautiful, his English simple and accessible. It was a case of serendipity that I found an interesting problem to work on, that I finished my thesis quickly and that I got my doctoral diploma just before I turned 24. Years later my friends were still teasing me that I learnt to speak American-English with a sing-song Japanese accent!

NK: Eventually you took a post at Northwestern University. What was it like to have taken this position? How were you received in the department? Several sources tell me that you have interesting stories from your early years here. Are there any stand-outs that you can share?

AB: Professor Ralph Boas was Chairman of the Math Department at Northwestern, when he called to offer me a position for the coming academic year. I was 32 years old and I was thrilled by the offer, *a full professorship*. My husband at that time, C. Ionescu Tulcea, was already on the faculty as a full professor.

I am happy to report that Ralph Boas's confidence in me and his support of me never wavered. But given that I was the first woman full professor in the Department and that I spoke with a palpable foreign accent, I felt quite self-conscious and anxious to know what kind of reception I would receive. On my first day in Lunt Hall, one of my colleagues, an older professor, invited me to his office, closed the door, asked me to sit down and said to me half smiling, "You should know that this department is a place where everyone is for himself." In other words, don't count on me or on any of your colleagues for support. I realized then, that Professor Boas was a maverick who wanted to bring about change.

NK: Since becoming Professor Emeritus, you have endowed the annual *Alexandra Bellow Distinguished Lecture Series*. How would you describe it? What made you decide to endow a lecture series? What are your visions for its future?

AB: Three years ago I decided to make a gift to Northwestern University, specifically to the Math Department and also to honor the leadership of Bryna Kra¹. This gift was used to endow an annual lecture series, the purpose of which is to invite each year a world-class mathematician to come to Northwestern and lecture. It is my desire and hope that world-class women mathematicians be represented among the speakers over the years, so as not only to enhance the position of mathematics at Northwestern but also to raise the visibility of women in the field.

My main reason for making this gift was to express my gratitude to Northwestern University for giving me a secure home for so long. I taught and did research at Northwestern for nearly three decades. In those early days, before the advent of the computer, the internet, research was often a solitary enterprise and if done in collaboration, required the presence of other mathematicians. I am also grateful to Northwestern for allowing me to take a leave of absence whenever I needed to interact with mathematicians elsewhere and spend time as a visiting professor at other institutions. I retired from Northwestern in 1996.

NK: What advice do you have to young students, to graduate students currently finding themselves to be a minority in the department, and in particular to women? What would you have liked to know as you began your studies and career?

AB: Here is my advice to young students, and in particular to young women: (1) choose your field and, if possible, your life-partner with scrupulous care; (2) work, work, work - there is no substitute for hard work; (3) reach out, get connected, seek advice, make friends, for some of these friendships may last a lifetime and you never know what curve ball life may throw at you. With hindsight, my studies, my career, my life might have been easier, smoother, had I made a deliberate effort to break through my natural reticence and reserve.

¹ Professor Bryna Kra chaired the department from 2009-2012.

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