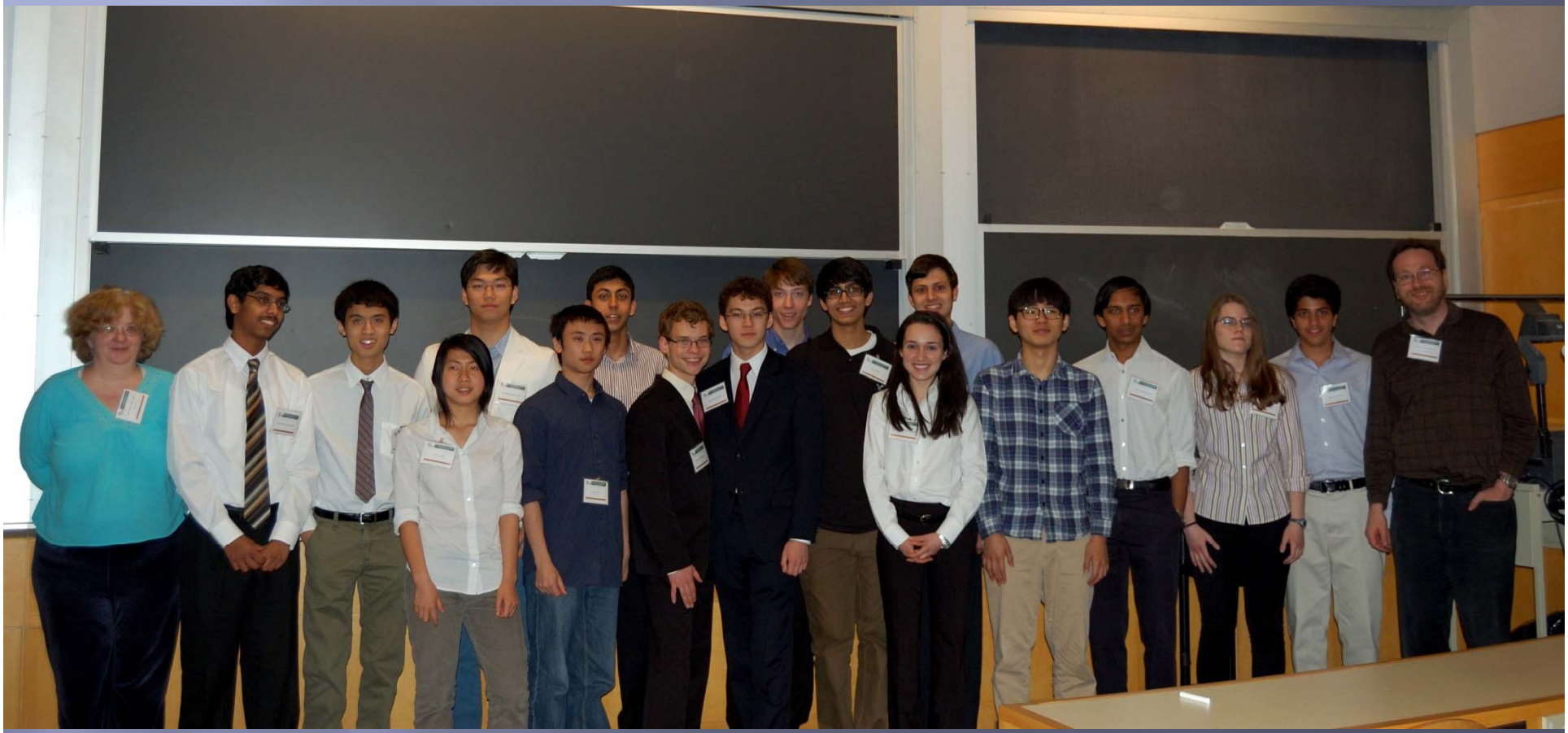
PRIMES

Program for Research In Mathematics,
Engineering and Science for High School Students

Pavel Etingof and Slava Gerovitch

28 April 2014

Divisions of PRIMES

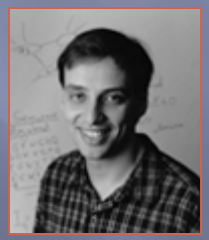


- **MIT PRIMES:** year-long research program for talented high school students from Greater Boston in mathematics, computer science, and computational biology
- **PRIMES-USA:** a distance mentoring mathematical research program for high school juniors across the U.S.
- **PRIMES Circle:** mathematical enrichment program for local sophomores and juniors with disadvantaged backgrounds

Faculty Coordinators of MIT PRIMES

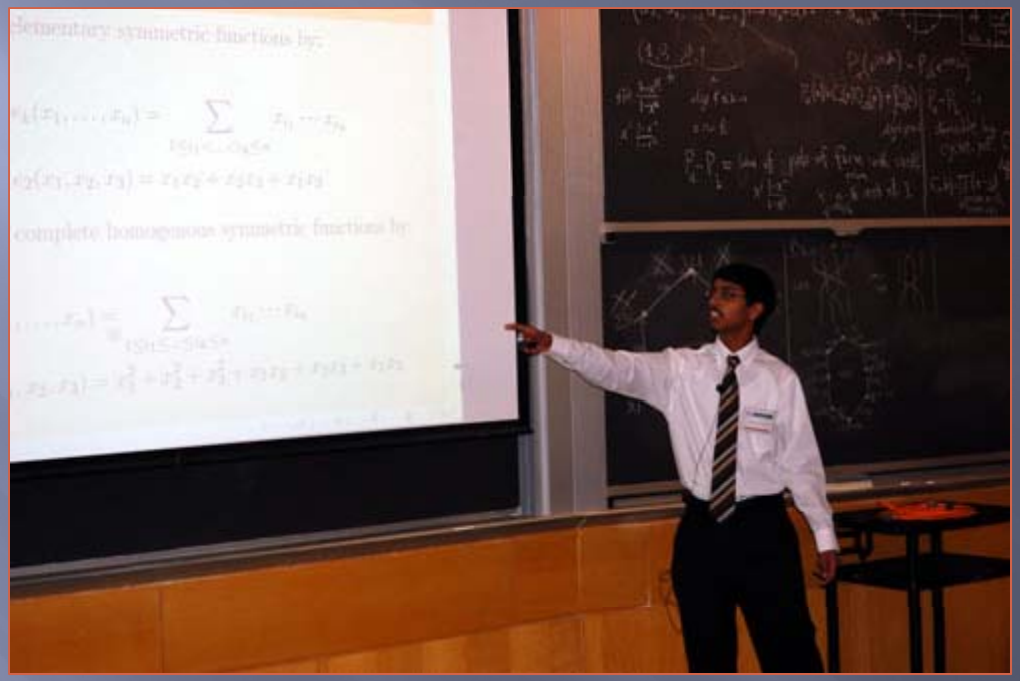
Professor Pavel Etingof, PRIMES Chief Research Advisor and Math Section Coordinator

Professor Srini Devadas, Computer Science Section Coordinator



Professor Leonid Mirny, Computational Biology Section Coordinator

Founding principles of PRIMES



- Real, open-ended research problems of interest to faculty
- Realistic (year-long) time scale
- Learning through hands-on research experience (e.g., computer simulations)
- Focus on collaboration, not competition
- Integration into community: interaction with faculty, grad students, and undergrads
- Academic culture: writing and oral presentation

PRIMES facts

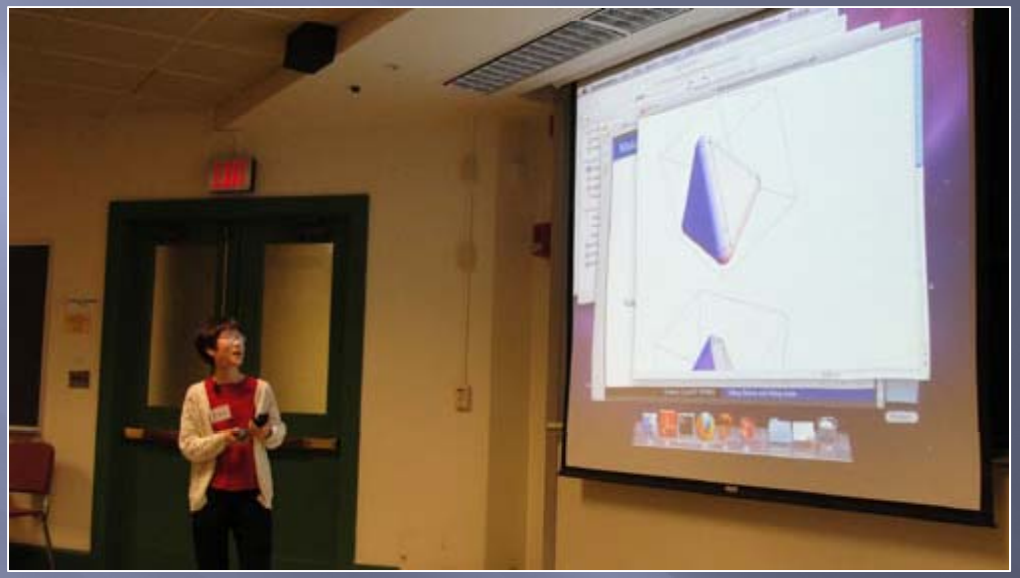
- The only year-long research program for high school students in the U.S.
- 60 students work on research projects and study in reading groups in mathematics, computer science, and computational biology
- Students from grades 9-12
- Many students stay more than one year
- Students work on original research problems suggested by faculty
- Graduate students serve as mentors
- Students meet weekly with their mentors
- Students write a final research paper
- Students give a talk at an annual PRIMES conference at MIT (this year: May 17-18)

Areas of Research

- Mathematics - combinatorics, algebra, graph theory, and number theory (15-19 students)
- Computer Science – concurrent data structures, distributed algorithms, algorithmic game theory, language processing, functional programming, machine learning, network analysis, and medical informatics (10-16 students)
- Physical and Computational Biology - molecular dynamics simulations for 3-D DNA data analysis (2-6 students)

PRIMES annual conference

PRIMES results, 2011-2013



- 67 research projects in 3 years presented at the annual conferences;
- 40 research papers posted online; many of them submitted to academic journals, and six already published in *Representation Theory*, *the Journal of Algebra, the Journal of Algebraic Combinatorics, the Electronic Journal of Combinatorics, Transactions of the American Mathematical Society,* and *College Mathematics Journal*;
- Intel Science Talent Search: 3rd Prize ($50,000), 4th Prize ($40,000), and 10th Prize ($20,000), and 25 national finalist and semifinalist awards;
- Siemens Competition in Math, Science & Technology: 2nd Prize (two awards; $50,000 scholarship), 5th Prize (two awards; $20,000), and 27 regional finalist and semifinalist awards;
- 32 projects accepted for the MAA Undergraduate Student Poster Session of the Joint Mathematics Meetings in 2012-2014, and six received an Outstanding Presentation award.

PRIMES student story: Bill Kuszmaul

- entered PRIMES as a freshman in 2011, studied in a computer algebra lab
- paper published in *the Journal of Algebra* (December 2012)
- group project in 2012
- paper published in *the Electronic Journal of Combinatorics* 20:4 (2013)
- individual project in 2013
- Siemens Competition: regional finalist (2011 and 2012), semifinalist (2013)
- 2013 Davidson Fellow
- 2014 Intel STS 3rd Prize
- Accepted to MIT

PRIMES alumni

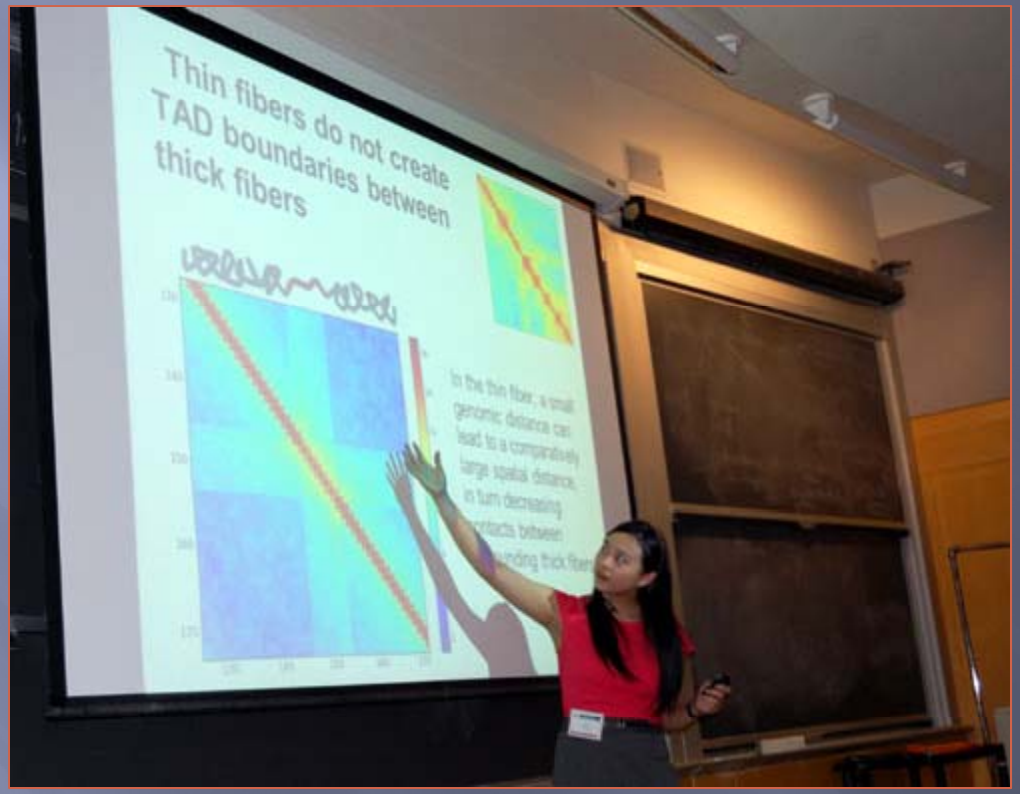
Student	Year at PRIMES	College
Dhroova Aiylam	'12 '13	MIT
Anish Athalye	'13	MIT
Leigh Marie Braswell	'13 '14	MIT
Surya Bhupatiraju	'11 '12 '13	MIT
Christina Chen	'11 '12 '13	Harvard
Yongyi Chen	'11	MIT
Sheela Devadas	'11 '12	MIT
Fengning Ding	'11 '12	Harvard
Boryana Doyle	'12 '13	MIT
Dash Elhauge	'11	Brown
Caroline Ellison	'11	Stanford
Ying Gao	'13	MIT
Xiaoyu He	'11	Harvard
Campbell Hewett	'11	Brown
Steven Homberg	'12 '13	MIT
Sylvia Hürlimann	'11	Caltech
Ravi Jagadeesan	'12 '13 '14	Harvard
Saarik Kalia	'11 '12 '13	MIT
Andrew Kim	'11	Harvard
Skanda Koppula	'12 '13	MIT
William Kuszmaul	'11 '12 '13 '14	MIT
Jason Li	'11	Carnegie Mellon
Carl Lian	'11	MIT
Patrick Long	'12 '13	WPI
Bryan Oh	'13	Brown
Stephanie Palosz	'11	Stanford
Rohil Prasad	'12 '13	Harvard
Eli Sadovnik	'12	MIT
Ziv Scully	'11 '12	MIT
Dong-Gil Shin	'11	MIT
Jonathan Tidor	'12 '13	MIT
Dai Yang	'12	MIT
Michael Zanger-Tishler	'12 '13	Yale
Ziling Zhou	'12	Harvard
Peijin Zhang	'12 '13	Carnegie Mellon

PRIMES Circle

- Enrichment program for talented sophomores and juniors with disadvantaged backgrounds from local public high schools
- Groups of two students
- Meet weekly with their mentors (undergraduate students) during spring and fall
- Study topics in geometric games, knot theory, probability theory, and combinatorics
- Expository presentations at a mini-conference at MIT in December
- 2013: 8 students; 2014: 10 students

Criteria for selecting research projects

- Accessible beginning: low-threshold entry point
- Flexibility: easy to modify
- Computer/experimental component: gives hands-on research experience
- Faculty involvement: related to faculty research
- Big picture/motivation: connection to wider research context and mentor's thesis research
- Learning component: encourages to learn new areas of math
- Feasibility: new results are obtainable within 1.5 months of full-time research



Thanks for listening!
Visit us on the web at web.mit.edu/primes