(*Pol'e math*) A person of much or varied learning;
one acquainted with various subjects of study.
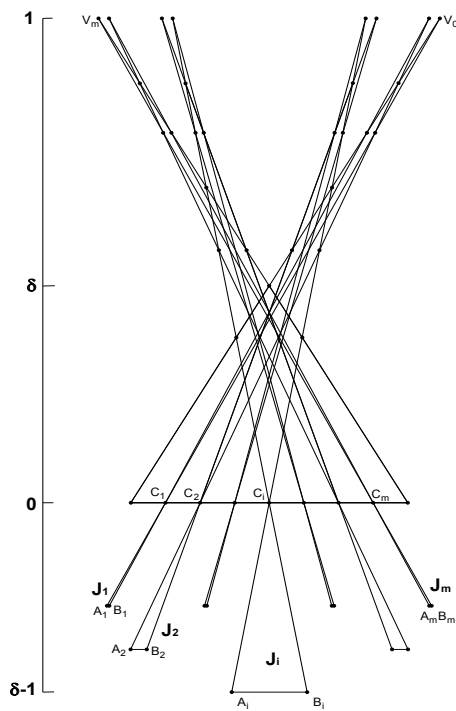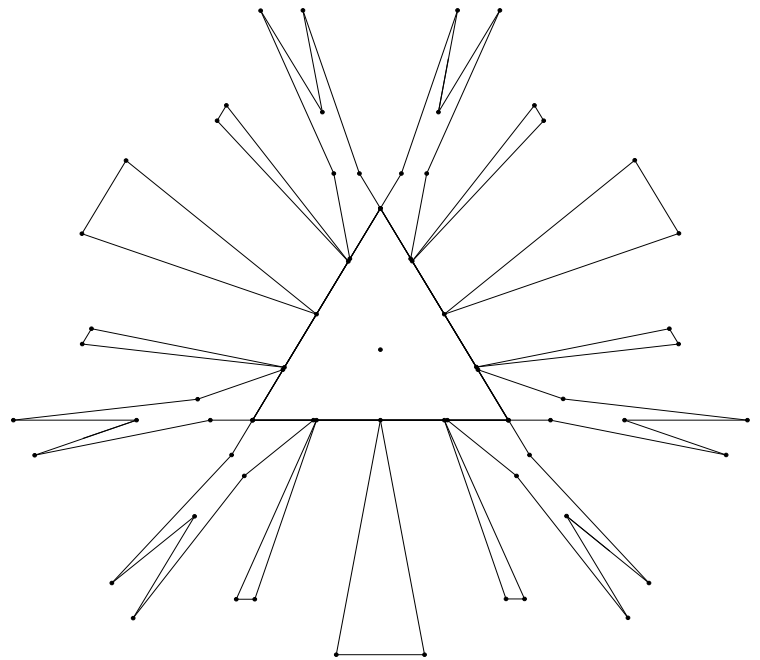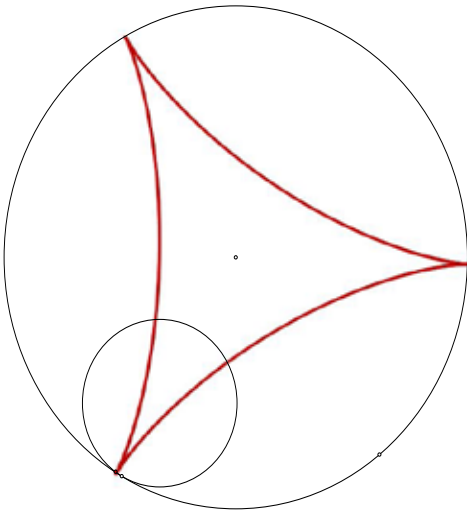
Dr. Dylan Retsek and undergraduates Sean Gasiorek and Tina Woolf show optimality in Cunningham's Theorem.

See Page 4
for
Cover Article

Letter from the Department Chair - Dr. Don Rawlings

Aside from the budgetary woes we currently face, there is positive news to report this year. Foremost, we are extremely pleased to have Dr. Amelie Schinck and Dr. Stan Yoshinobu join the ranks of our Mathematics Education faculty. Within our group of math educators there is a sense of rejuvenation and excitement. You'll find short biographies of Amelie and Stan inside.

Beginning with the 2009-2011 catalog, our majors will have more curricular choice. We have kept the teaching concentration, revised our general curriculum, and added two new concentrations (one in Applied Mathematics and one in Pure Mathematics). Loosely speaking, our curricular reorganization blends the prescriptive curriculum of 25 years ago (consisting of the applied, finite, and teaching options) with the more flexible general curriculum of recent times. We feel confident that these changes will have broad appeal with our students.

In case you have not already noticed, our website <math.calpoly.edu> has had a facelift. Our aim was to make the site more appealing to students. Upon opening the site, you will now find pictures of some recent graduates who embody the spirit and enthusiasm of our students. Also featured is a weekly puzzle (in the quick links section). As some of you may know, our tradition of a weekly puzzle died out a few years ago and was recently revived by Dr. Morgan Sherman. For fun, I invite you to test your skills in solving the weekly puzzles; all correct solutions are acknowledged, and the best are posted.

Professors Art DeKleine, Myron Hood, and George Lewis have each completed their participation in the Faculty Early Retirement Program. And Professor Kent Morrison retired as of Spring 2009. We wish all of them the best as they pursue new interests.

As always, there is nothing we enjoy more than hearing from you. If you are ever in the area, please drop in and say hello. I also invite you to keep in touch by submitting a note to our newsletter.

Finally, I want to express our deep gratitude to those who have supported us through their donations. Your thoughtfulness, much appreciated by students and faculty alike, helps support many important activities in the Department. Thank You!

Table of Contents

A Kakeya set is a plane set K within which a unit segment can be maneuvered so as to switch the location of its endpoints. Elementary Kakeya sets include the solid disk of radius 1/2, the deltoid, and the three-cusped hypocycloid. Originally posed in 1917, the Kakeya problem asks for the Kakeya set of least area.

In 1928, Besicovitch proved the astonishing fact that there is no Kakeya set of least area. Precisely, given any $\varepsilon > 0$ there exists a Kakeya set of area less than ε. The idea of the proof is to "parallel park" the needle via an intricate dance of "turns and slides" through a central "nucleus" of very small area. The Kakeya sets in Besicovitch's proof are very "spiny" (think of a two-dimensional sea urchin) and not at all convex. If one insists that K be convex, then one gets a whole new Kakeya question and answer; the convex Kakeya set of least area is the equilateral triangle of altitude one (Pal, 1921). Somewhere between requiring convexity and making no restrictions at all is to require that K be star-like.

A plane set K is called star-like if there exists a distinguished point O in K such that for any other point in K the line segment from that point to O lies entirely within K (imagine a two-dimensional museum that can be guarded with a single security camera).

Dylan Retsek with Sean Gasiorek
(not shown is Tina Woolf)

In 1971, Cunningham showed that every star-like Kakeya set has area at least $\pi/108$, but to this day no one knows if this lower bound is sharp! Cunningham's method of proof is to center a small disk of radius 1/6 about the distinguished point O of the star-like Kakeya set K and then keep careful track of how much area the unit segment sweeps out inside and outside this disk. No matter how one exchanges the location of the endpoints, the total area is always at least $\pi/108$. Under the direction of Dr. Dylan Retsek, Cal Poly mathematics majors Sean Gasiorek and Tina Woolf generalized the lower bound estimate for Cunningham's method of proof by considering disks of arbitrary small radius R. The lower bound formula they obtained for arbitrary R is $L(R) = (R(2R-1)\pi^2)/8$, which indeed has a maximum of $\pi/108$ when R=1/6. Thus, $\pi/108$ is the maximum lower bound attainable through Cunningham's method.

Cal Poly Mathematics Department Summer Research Program 2009

Six Cal Poly Mathematics Department faculty members and 13 undergraduate and graduate mathematics majors worked on research projects during the spring and summer of 2009. These projects were funded by the Cal Poly College-Based Fee Initiative.

Dr. Anton Kaul worked with Cal Poly students Erin Kelly, Michael Mazzella, and Josh Pollitz on the project "Shellability in Group Theory." In this project, they examined the behavior of lexicographic shellability in infinite groups. In the course of the investigation, they proved that local shellability is preserved under various group theoretic constructions, including free products and, more generally, free products with amalgamation.

Anton Kaul (left) with Michael Mazzella, Josh Pollitz, and Erin Kelly

Paul Choboter (right) with Dana Duke, Paul Sinz, and JP Horton

Dana Duke, JP Horton and Paul Sinz, working with Dr. Paul Choboter, explored the dynamics of wind-driven coastal upwelling and downwelling. Coastal upwelling occurs off the west coast of North America when winds drive the near-surface ocean water away from the coast, causing deep water to be drawn up to the surface. Downwelling happens when winds in the opposite direction push surface waters toward the coast and down into the deep ocean. The group used a theoretical model of upwelling and downwelling that reduces the dynamics to a set of coupled non-linear Partial Differential Equations (PDEs). The students successfully proved that a certain family of functions solves the PDEs, and they explored these analytic solutions in detail. The students also performed numerical simulations of upwelling and downwelling with a numerical model that featured more complete dynamics than was included in the theoretical model.

Cal Poly students Casey Kelleher (Math and Physics) and Mathew Werber (Physics) worked with Dr. Charles D. Camp on "Pattern Detection in Climatic Time Series." The time series of climatic data records are both short and noisy, often making it difficult to extract information about the underlying processes creating the data. The students used new and traditional time series analysis techniques, such as Empirical Mode Decomposition and Principal Component Analysis, to extract the interannual variability from atmospheric time series and from recent climate model output. This work was also supported by an NSF grant.

Charles D. Camp (left) with Matthew Werber and Casey Kelleher

Toeplitz matrices have all their diagonals (from upper left to the lower right) being constants. The question of when a Toeplitz matrix is normal was studied more than a decade ago by several authors. Eventually, a simple and elegant answer was given. Hankel matrices have all their skew diagonals (from lower left to upper right) being constants. The question of when a Hankel matrix is normal seems much more difficult and is still open. Based on a recent paper by two Russian numerical analysts and a general framework for related problems developed by Professor Caixing Gu and Dr. Linda Patton in 2003, Dr. Caixing Gu and the graduate student Yu Huang were able to characterize all five by five normal Hankel matrices during the summer research.
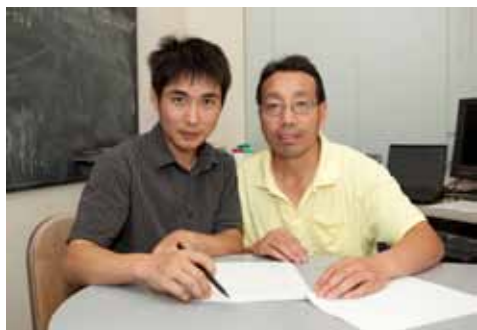
Caixing Gu (right) with Yu Huang

Perelman's proof of the Poincare conjecture used Hamilton's Ricci flow in an essential way. The Ricci flow can be thought of as an evolution equation for the metric on a Riemannian manifold. In many cases, it is known to converge to a "best" metric, where "best" metric might mean a metric of constant curvature or one with a lot of symmetry. During the summer, Dr. Joe Borzellino, with students Allan Boone and Ryan Ward, looked into the behavior of the Ricci flow on 2-dimensional Riemannian orbifolds (a generalization of a Riemannian manifold). Their goal was to determine to what extent the Ricci flow converges to the "best" metric. The summer research was promising, and they hope to get publishable results with more work.
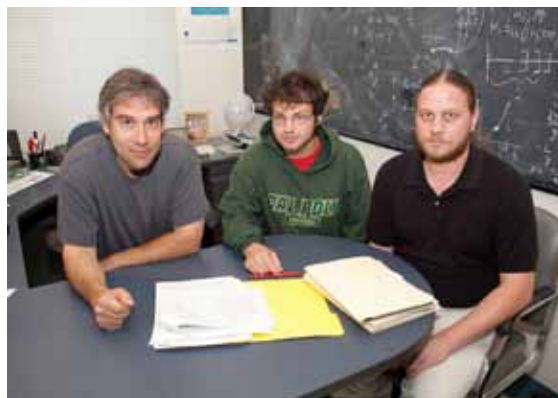
Joe Borzellino (left) with Allan Boone and Ryan Ward

2008 - 2009 Honor Roll

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The Department of Mathematics is grateful to the following corporations, foundations, and organizations who made gifts for general and special purposes and for matching gifts.

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2008 - 2009 Graduates

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Laura Nicole Baldwin*
Antigone Electra Bennett
Robert James Brunner
Kyle Leland Chapman
Wade Thomas Dillon**
Aaron Spencer Donley
Ruth Anne Emerick
Matthew Charles Forman
Christopher Joseph Fredericks

Thomas Kintaro Furukawa
Mark Aquino Gabaya
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Sean Justin Melling Gasiorek
Patrick David Perl
Kasandra Joi Phillis

Sunny Lynn Sawyer
Madeline Louise Schroth-Miller
Kelly Ann Seal
Aaron B. Shev
Kyle M. Smith
William Paul Taylor
Dustin Tidyman-Jones
Kathryn Ann Vaughan*** ✧
Shea Llewellyn Williams
Tina Michelle Woolf*** ✧
Daniel Thomas Young

♦   *Cal Poly Scholar*
✧   *Honors Program*
*   *Cum laude*
**   *Magna cum laude*
*** *Summa cum laude*

Alumni News

Jeff Duff, MS 1993 - email: jeffduff@air-streams.com

Vice President, Airstreams Renewables, Inc.

Life is very busy in the renewable energy sector.

Received my latest copy of **Polymath**, it was good to see some I still recognize.

Family is doing well - wife Chris, Rachel (15.5), Jeremy (14).

Running a company has kept me from in-depth mathematics study, but I still keep my pencil sharp.

Our company has moved into the realm of technical education and training. Our curriculum is being taught in a number of community and technical colleges and we have some speaking engagements at various higher ed arenas. If there is any interest in renewable energy, I'd be up for a quick trip to put on a presentation about the opportunities, specifically in Wind Energy.

From a math perspective we have engaged more statistics in the work I have focused on, white papers on our web site. However, most are interested in the general overview of the industry.

Eric Schadt, BS 1991 Mathematics, Applied Mathematics Concentration- received his Ph.D. in Biomathematics from UCLA. He is now the Chief Scientific Officer for Pacific Biosciences in Menlo Park.

Recently, the New York Times' Science section had an article about Dr. Schadt, in which it describes his work in biomathematics. From 1999 until recently, Dr. Schadt worked as the head of genetics and bioinformatics for Rosetta Inpharmatics, a company based in Seattle. Founded in 1996 by Dr. Hood, Dr. Friend and the biologist and Nobel laureate Lee Hartwell, Rosetta was bought by the pharmaceutical giant Merck in 2001 for $620 million. At Merck, the Rosetta team was provided with resources beyond those usually available in academia. Rosetta built one of the fastest supercomputers in the drug industry, running 16 trillion calculations a second. The company now has in clinical trials eight drugs that emerged out of Rosetta's platform. When Dr. Schadt left Merck, he took on two jobs — as the co-director of Sage with Dr. Friend, and as the chief scientific officer of Pacific Biosciences, a company founded in 2004.

2009 Cal Poly Math Noyce Program

Last June, the directors of the Cal Poly Math Noyce Program, Dr. Todd Grundmeier and Dr. Elsa Medina, offered a three-day workshop for Noyce Scholars. Fifteen Noyce Scholars from Cal Poly and other universities attended the workshop to discuss pedagogical issues related to the teaching of mathematics and to prepare for the first year of teaching. The directors received an NSF grant of $52,670 to continue offering these workshops in coming years.

The attached picture shows the fifteen Math Noyce Scholars, the directors of the Math Noyce Program, Dr. Todd Grundmeier and Dr. Elsa Medina, as well as the mathematics department chair, Dr. Don Rawlings, and the dean of the College of Science and Mathematics, Dr. Phil Bailey.

Row 1 L-R: Lana Grishchenko, Katie Vaughan, Kelsey Prancevic, Jessica Ellis, Elsa Medina, Caixing Gu, Don Hartig, Jonathan Shapiro

Row 2: Bill Demarest, Sheryl O'Neill, Wade Dillon, Amelie Schinck, Dana Paquin, Mike Mogull, Don Rawlings

Row 3: Phyllis Brudney, Maureen Rosenberg, Todor Todorov, Sean Gasiorek, Jim Mueller, Richard Neufeld

Row 4: Carole Simard, Kate Riley, Dylan Retsek, Mike Robertson

Row 5: Ryan Harris, Liz Czapla, Adrienne Riley, Stan Yoshinobu, Yu Huang, Vince Bonini, Morgan Sherman, Ben Richert, Dave Camp

Row 6: Mark Stankus, Todd Grundmeier, Cami Reece, Bill Hesselgrave, Al Jimenez, Allan Boone, Harvey Greenwald, Steve Agronsky, Joon Jung, Rob Webb, Joe Borzellino, Anton Kaul, Clint Hahlbeck, Jeff Liese, Colleen Kirk, Tony Mendes

Introducing New Mathematics Department Faculty

Amélie Schinck is happy to join the Cal Poly Mathematics faculty this fall. Amélie recently completed her Ph.D. in Curriculum and Instruction with a specialty in Mathematics Education from the University of North Carolina at Charlotte. She completed her M.Sc. in Mathematics (Number Theory) at Concordia University in Montréal, Canada. Amélie is committed to the teaching of mathematics, K-12 teacher preparation, and to extending her scholarship in the field of mathematics education. In addition to mathematics and its education, her interests include swimming, hiking, and good food enjoyed with friends.

Stan Yoshinobu started his career in Real Analysis, studying under John Garnett (UCLA). Currently, Stan specializes in Mathematics Education, focusing on teacher preparation and training at both the K-12 and college levels. Stan previously was an associate professor at Cal State Dominguez Hills and a postdoctoral fellow at the University of Arizona. In his free time, Stan enjoys cycling, hiking, watching sports, listening to Jazz, photography and spending time with his family.

Faculty Publications and Conference Talks 2008-2009

J. Borzellino and V. Brunsden, *A Manifold Structure for the Group of Orbifold Diffeomorphisms of a Smooth Orbifold*, Journal of Lie Theory, 18 (2008) no. 4, 979-1007.

J. Borzellino was an invited speaker for the *Workshop on Global Riemannian Geometry, Orbifolds, and related topics* at Middlebury College, Middlebury, VT, October 2009.

J. Borzellino was an invited speaker in the Special Session on Global Analysis on Homogeneous Spaces at the AMS 2009 Fall Central section meeting at Baylor University, Waco, TX, October 2009.

J. Borzellino was an invited speaker in the Special Session on *Global Riemannian Geometry* at the AMS 2009 Fall Western section meeting at University of California, Riverside, CA, November 2009.

C.D. Camp, K.K.Tung, and J.Zhou, *Constraining model transient climate response using independent observations of solar-cycle forcing and response*, Geophy.Res.Lett.,35,L17707,doi:10.1029/2008GL03420.

C.D. Camp, X. Jiang, S. Pawson, J. E. Nielsen, R.-L. Shia, T. Liao, V. Limpasuvan, and Y. L. Yung, *Interannual Variability and Trends of Extratropical Ozone. Part I: Northern Hemisphere*, J. Atmos. Sci., 65, 3013-3029, doi:10.1175/2008JAS2665.1.

C.D. Camp, X. Jiang, S. Pawson, J. E. Nielsen, R.-L. Shia, T. Liao, V. Limpasuvan, and Y. L. Yung, *Interannual Variability and Trends of Extratropical Ozone. Part II: Southern Hemisphere*, J. Atmos. Sci., 65, 3030-3041, doi:10.1175/2008JAS2793.1.

C.D. Camp was an invited speaker, 1st PRIMA (Pacific Rim Mathematical Association) Congress, University of New South Wales, Sydney, AU, July 6-10, 2009. *Pattern detection in multivariate climatic time series: detecting the inûuence of solar variability on the Earth's atmosphere.*

C.D. Camp received, as Principal Investigator, GRANT: NSF/ATM-0808375 subcontract *Modeling the Influences of the QBO, the Solar Cycle and ENSO on the Strength of the Stratospheric Polar Night Vortex,* Subcontracted from Univ. of Washington, Principal Investigator: Ka-Kit Tung. Dates: May 2009 - April 2011, Amount: $65,298.

A. Kaul and M.E. White, *Centralizers of Coxeter elements and inner automorphisms of right-angled Coxeter groups*, Int. J. Algebra, Vol. 3, no. 10 (2009), 456-473.

Dana Paquin, Doron Levy, and Lei Xing, *Multiscale Registration of Planning CT and Daily CBCT Images for Adaptive Radiation Therapy*, Medical Physics, Volume 36, Number 1, January 2009.

Lawrence Sze (with Hoang Mai and Ben Ford), *Self-conjugate simultaneous p- and q-core partitions and blocks of An*, Journal of Number Theory 129 (2009), 858-865.

Lawrence Sze (with David Aukerman and Ben Kane), *On simultaneous s-cores/t-cores*, Journal of Discrete Mathematics, Vol. 309, p. 2712-2720, 2009.

Todor Todorov, *Algebraic Approach to Colombeau Theory of Generalized Functions*, a seminar talk at University of Vienna (Austria), in the DIANA-Seminar Research Group, June 26, 2009 .

Todor Todorov and Hans Vernaeve, *Power Series in a Non-Standard Setting*, International Conference on Logic & Analysis, York (UK), August 3-7, 2009.

Todor Todorov, *Special Colombeau Algebras of Generalized Functions and Non-Standard Analysis*, International Conference on Generalized Functions, Vienna (Austria), August 29-September 4, 2009.

IBL Workshop, Summer 2009

In July, Mark Stankus, Dylan Retsek, and Stan Yoshinobu (workshop director) attended the 2009 Inquiry-Based Learning Workshop in Austin, Texas. At the weeklong workshop with 23 other mathematicians, Mark, Dylan, and Stan discussed practical ways to implement a student-centered teaching method, called Inquiry-Based Learning (IBL), in undergraduate Mathematics courses. Development and implementation of IBL courses at Cal Poly is planned for the next two years. For those interested in learning more about IBL, please contact Stan Yoshinobu (styoshin@calpoly.edu).

Math Club Activities by Jose Valdez

The Math Club held bi-weekly meetings to discuss upcoming events, trips, and t-shirt ideas. They came up with a t-shirt "Why Math?" which is shown here. Their big trip of the year was to Big Sur where they camped out for a weekend. They would also have game-nights frequently at Kyle Chapman's house.
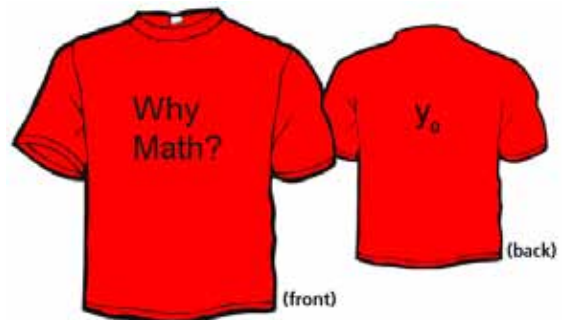
Most Fridays, the Math Club joined the Physics Club to play some kind of sport such as dodgeball, volleyball, indoor soccer, or ultimate frisby.

Putnam Math Competition 2008

In December 2008, the Cal Poly team of Kyle Chapman, Paul Coombs, and Thomas Furukawa, along with eight other Cal Poly students, participated in the Putnam Competition. The team placed 74th out of 545 teams entered in the competition. The high scorer from Cal Poly was Kyle Chapman, with a score of 22, followed by Paul Coombs, with 19 points.

Mathematical Contest in Modeling 2009

Kevin Lamb, Kyle Chapman, and Megan Evans

Allan Boone, Erin Kelly, and Alex Eames

Cal Poly, led by coach Jonathan Shapiro, had two teams in the Mathematical Contest in Modeling. Team 5730 consisted of Kevin Lamb, Kyle Chapman, and Megan Evans. Team 5731 consisted of Allan Boone, Erin Kelly, and Alex Eames. Each team tackled the problem of designing more efficient traffic circles. Each team was given a "Successful Participant" designation.

You can see all of the results of the Mathematical Contest in Modeling at the following website:
http://www.comap.com/undergraduate/contests/mcm/contests/2009/results/

End-of-Year BBQ and Softball

Undergraduates
VS.
Faculty and Grads

The Faculty Team won this round, 11-8. This stopped the Undergraduate Team's winning streak at one and could be the beginning of another good streak for the Faculty side.

Sixth Annual Math Awards Banquet

Robert P. Balles Mathematics Scholarships
Kendall Rosales, Joshua Pollitz

Raytheon Company Scholarship
Logan Lossing, shown with
Department Chair Don Rawlings

Carol S. and W. Boyd Judd Scholarship
Yashar Bahman (not shown)
Shown are Anita Judd and Carol Judd

George H. McMeen Scholarships
Ashley Cascio, Klsey Grantham, Nel
Grantham, Trevor Jones

Ralph M. Warten Memorial Scholarship
Dana Duke, Logan Lossing, Kendal Rosales, Matthew Roy, and
Ryan Milhous (not shown)

Volmar A. and Viola I. Folsom Scholarships
Lauren Huyk, Alyssa Eubank, Levi Reynaga, Brent Davis,
Rachel Gohres, Melinda Wiles,
Yashar Bahman (not shown), and Kristina Dyer (not shown)

George C. Laumann Scholarships
Dana Duke, EmilyCallahan

Davina White and Family

Robert Noyce Scholarships
Emily Tietjen, Sarah Spence, Raquel Rusing,
Sarah Lyons, Katie Seim (not shown)
shown wth Professors Todd Grundmeier
and Elsa Medina

Marie Porter Lehman Math Educator Scholarship
Kathryn Vaughn
shown with Department Chair Don Rawlings

W. Boyd Judd Award
Matthew Roy
shown with Department Chair Don Rawlings
and Anita and Carol Judd

Kappa Mu Epsilon Founders Award
Erin Kelly
shown with KME advisor
Professor Jonathan Shapiro

TC Reece Mathematics Award
Hunter Glanz
shown with Cami and Terry Reece

Mathematics Department Service Award
Maddie Schroth-Miller
shown with Department Chair, Don Rawlings

Ralph E. Weston Memorial Award
Kyle Chapman, Paul Coombs (not shown)
shown with Department Chair Don Rawlings and
Putnam Team Coach, Jonathan Shapiro

Outstanding Students

Outstanding Teaching Associate
Kelsey Ryska
shown with Graduate Coordinator,
Professor Matthew White

Outstanding Mathematics Educator Awards
Davina White and Kelly Seal
shown with Department Chair Don Rawlings and
Professors Todd Grundmeier and Elsa Medina

Accenture Outstanding Junior in Mathematics
Kendall Rosales
shown with Department Chair Don Rawlings

Charles J. Hanks Excellence in Mathematics Award
Kyle Chapman
shown with Department Chair Don Rawlings

Bryant Russell Memorial Awards
Kathryn Vaughan, Tina Woolf
shown with Department Chair Don Rawlings

Outstanding Seniors in Mathematics
Sarah Lyons, Erin Malloy
shown with Professors Tony Mendes and Dylan Retsek

What's New With You?

We would love to hear from you!

Please drop us a line and let us know what you'd like to share in the "Alumni News" of _Polymath_.

Name:_____ Graduation Year _____B.S./ M.S.

E-Mail: _____ _Okay to print so other alumni can reach you?_ Yes/ No

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Current job title and employer: _____

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