

# PRIME BITS

Department of Mathematics Newsletter  
University of Colorado, Boulder, CO 80309-0395

Fall 2012

Volume 14

## *Two new Assistant Professors bring shared passion for bicycling and math*

Two new assistant professors, **Katherine (Kate) Stange** and **Jonathan Wise**, joined the Mathematics Department faculty in the fall of 2012. At the request of *Prime Bits*, Stange and Wise each submitted the following bio-sketches:

**Kate Stange** wrote, "I grew up in Northern Ontario, buried in snow in winter, and surrounded by beautiful lakes in summer. In the snow, I amused myself by tunneling out grandiose snow bank mazes in my backyard, and in the summer I rode my bicycle. Math was my worst subject as a young student: I couldn't see the point of memorizing times tables and steadfastly refused. At the same time, I found myself pondering exactly how much time it would save to cross diagonally through the empty lot on my walk



**Jonathan Wise and Kate Stange at Eben G. Fine Park during the department's fall picnic**

home: should I walk quickly on the longer, but plowed, sidewalk route around two sides, or take on the deep snow that would slow me down along the shorter hypotenuse? How much shorter was it anyway? I didn't solve the problem then, but when I entered high school, an enthusiastic math teacher, Mr. Garret, finally made me realize that math was not about the times tables at all (I still don't know them well enough).

"It was only a few years later that I and my bicycle went to PROMYS, a summer camp about number theory for high school students. Since then, there has been no turning back.

*Continued on p. 2*

## **Publication of memoir by Professor Emeritus Baggett**



**Larry Baggett**

**Lawrence Baggett** announced that the Mathematical Association of America has published his memoir "In the Dark on the Sunny Side," a project that was long in writing. The following is copied from the published book's description:

### **"In the Dark on the Sunny Side: A Memoir of an Out-of-Sight Mathematician**

"Misfortune struck one June day in 1944, when a five-year-old boy was forever blinded following an accident he suffered with a paring knife. Few people become internationally recognized research mathematicians and famously successful university professors of that erudite subject, and not surprisingly a minuscule number of those few are visually impaired.

"In the Dark on the Sunny Side tells the story of one such individual. Larry Baggett was main-streamed in school

*Continued on p. 6*

***New Assistant Professors, (continued from p. 1)***

My undergraduate years were spent at the University of Waterloo in Ontario, where my number theory professor advised me to apply to Brown University for graduate work with Joseph Silverman; this I did, and was accepted. When I graduated and headed for the United States, my parents bought me a bright red racing bicycle. At Brown I joined, and eventually ran, the cycling team, competing in the Eastern Collegiate Cycling Conference and Collegiate Nationals to some success. My first experience with Colorado was at a training camp at the Olympic Training Center in Colorado Springs. It was standing in front of the only book shelf in the whole complex, a leave-one-take-one romance novel rack, that I realized that I could never give up math to compete on the bicycle “During my graduate years I took a semester off to see the world and visited and volunteered in Europe, Tunisia, Russia, Mongolia, China and Tibet. I took along one math book -- I think I picked it because it was paperback -- and didn't read it. But when I got back, my thesis made a little more sense, and I fell in love with my now husband, Jonathan Wise, who had been sending me letters while I was on the Trans-Siberian railroad.

“I graduated from Brown in 2008. In the next four years, I was fortunate enough to hold National Science Foundation, National Science and Engineering Research Council of Canada, and Pacific Institute for the Mathematical Sciences postdoctoral fellowships. I spent a year each at Harvard University and Stanford University, and nearly two years in Vancouver BC, at Simon Fraser University and the University of British Columbia. I work in elliptic curves, cryptography and arithmetic geometry in general, and I've been interested in elliptic divisibility sequences, a class of sequences generalizing the Lucas sequences such as the Fibonacci, but tied intimately to elliptic curves. I've also had the opportunity to dabble in game theory over the past couple years, and recently I've been very excited about a new topic: Apollonian circle packings. I'm very pleased to be in Boulder, building some red blood cells and joining the

vibrant number theory and geometry community here and in the Front Range in general. Jonathan and I are expecting our first child at the new year.”

At the request of *Prime Bits*, **Jonathan Wise** submitted the following bio-sketch. “I grew up in San Antonio, Texas with the dream of making computer games for a living. Sometime in college I discovered that what I really enjoyed about computer programming was the math, and that's been my passion ever since. In retrospect, maybe it should have been obvious: my mother loves to remind me that as a child I once observed from the back seat of the car that some numbers are "level" and the other are "unlevel." Apparently, I was talking about even and odd numbers.

I got my undergraduate degree from Stanford University and did my graduate work at Brown under the direction of Dan Abramovich. While at Brown, I met my wife, Kate Stange, who is this year's other new addition to the CU math department. After receiving my Ph. D., I returned to Stanford as a post-doctoral scholar. I spent a total of two years at Stanford during my post-doc, and another two years at the University of British Columbia, in Vancouver.

“My research is in algebraic geometry, the study of those geometric objects that can be defined using just the operations of addition, subtraction, and multiplication. I like to study algebraic curves inside of algebraic spaces and try to answer questions like, "How many curves pass through a given collection of points in a particular space?" Recently I have also been working in deformation theory, which attempts to describe how an algebraic object can be modified infinitesimally. I'm excited to be joining the faculty here at the University of Colorado. Kate and I are particularly excited to be living in Boulder because it offers such excellent terrain for one of our favorite hobbies, bicycling. I've been trying to keep up with Kate ever since our days on the Brown cycling team.”

**The CU Boulder Mathematics Department** has 50 graduate students, serves 300 undergraduate majors and minors and teaches mathematics to thousands of CU Boulder students. Faculty consists of 25 tenured and tenure-track faculty, five full-time Instructors and four postdoctoral fellows and visitors. Professor Judith Packer is currently in her third year as department chair. There are four administrative staff members. Research interests for our faculty include Algebraic and Differential Geometry, Combinatorics, Logic and Foundations, Mathematical Physics, Number Theory, Noncommutative Geometry, Operator Algebras, Probability, and Topology. For more information, see <http://www.colorado.edu/math>

**Burnett C. Meyer Instructorship**

**Rahbar Virk** became the second Burnett Meyer Postdoctoral Instructor in the fall of 2011. At the request of Prime Bits Dr. Virk submitted the following bio-sketch. “I grew up in India, first in a small town called Rajpura and then at boarding school in the foothills of the Himalayas. I did my undergraduate studies at The Colorado College. After graduating in 2005, I spent another year there working as the Mathematics Paraprofessional (a position unique to Colorado College). At this point I decided that mathematics graduate school was the right choice for me. So I moved to the University of Wisconsin-Madison in 2006. I received my PhD in 2011 and have been here in Boulder since.

## **Faculty Highlights**

**Jeanne Clelland** has been appointed Associate Chair for Undergraduate Studies for AY 2012-2013. Professor Clelland was recently awarded a three-year NSF grant for research on "Isometric Embedding and Other Problems in Geometry and Differential Equations," for the period 9/1/2012 - 8/31/2015. She worked with an honors thesis student, Brian Carlsen, last spring who did a very nice thesis and was awarded summa cum laude honors for it. She is currently working with another honors thesis student, Jonah Miller.

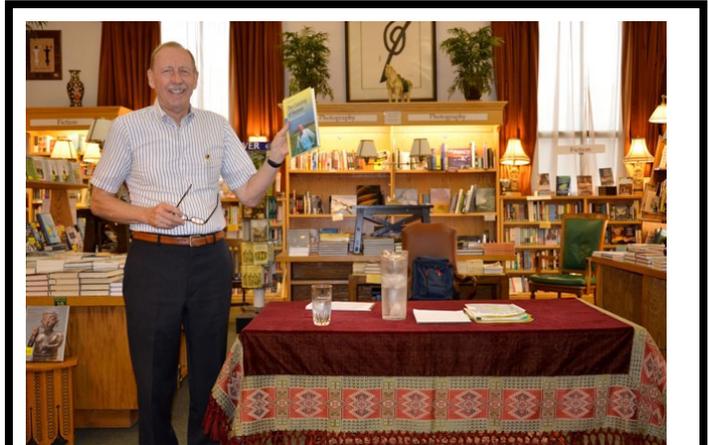
**Richard Green** is the author of a monograph, "Combinatorics of Minuscule Representations," that will be published by Cambridge University Press in the "Cambridge Tracts in Mathematics" series in early 2013.

**Sergei Kuznetsov** has become the Associate Chair for Graduate Studies for AY 2012-2013.

**Robert Tubbs** has resigned his position of Associate Chair for Undergraduate Studies to become Director of the Miramontes Arts and Sciences Program in the College of Arts and Sciences.

**Nathaniel Thiem** serves as the faculty coordinator for the Math Club.

**Eric Stade** reported that Colorado Campus Compact (CCC) in collaboration with CU Boulder / iSTEM offered a workshop on Service Learning in the STEM (Science, Technology, Engineering and Math) Disciplines, October 2012. This was an excellent opportunity for STEM faculty to learn how to integrate service learning into their courses. This sponsored program provides funding for free attendance, and opportunities for seed grant funding on future projects.



**Professor Karl Gustafson at Boulder Book Store**

**Karl Gustafson** was featured in June at The Boulder Book Store Author Event where he presented his recent book, **The Crossing of Heaven: Memoirs of a Mathematician (Springer 2012)**. Reading to a packed audience, Karl shared tales of early computing, espionage, famous mathematicians, and adventurous world travel. The event was a major success, with 37 of 40 available copies of his book sold on the spot! Since its publication in spring, 2012, Karl's memoir has been extremely well-received and earned numerous accolades. Here's a sample of the feedback:

"I was captivated. Gustafson is a story-teller of considerable skill. Extremely convincing." – Juha Haataja, Ministry of Education and Culture, Finland.

"A fantastic story." – Harald Atmanspacher, Editor-in-Chief of Mind and Matter

"A piece of art." – Maurice de Gosson, University of Vienna, Austria

"I enjoyed reading your heavenly book. It was such a joy!" – Kimmo Vehkalahti

"A very impressive accomplishment highlighting a very impressive life! I thoroughly enjoyed it." – Ed Russell

## **PRIME BITS**

Published by the CU Boulder Department of Mathematics

Editor: William B. Jones

William.Jones@colorado.edu

Production Editor: Kathleen H. Jones

---

## ***Undergraduate Student Awards and News***

### **William Lowell Putnam Competition.**

On December 3, 2011, CU Boulder undergraduate students participated in the 72<sup>nd</sup> annual Putnam Mathematics Competition with undergraduates throughout the United States, Canada and Mexico.

Receiving the first place prize on the CU team was **Marshall Carpenter**. In a three-way tie for second place were **Christopher Aicher, Keegan Boyle, Alec Jenkins**.

Faculty sponsors for the Putnam Competition were **Keith Kearnes, Alexander Gorokhovskiy and Sergei Kuznetsov**.

### **Undergraduate Mathematics Lecture**

**Professor Edward B. Burger** from Baylor University & Williams College was the speaker for the Spring 2012 Undergraduate Mathematics Lecture. The title of his talk was: **“Zero to Infinity: Great moments in the history of number.”**

### **John H. (Jack) Hodges Mathematics Scholarship**

Awarded to Justin Gerber

### **Actuarial Studies Program**

The Actuarial Studies Program held its annual Fall Open House on November 3, 2011 in the Meyer Lounge (Room 350 of the Mathematics Building). **Professor David Grant**, a co-founder of the program, serves as the Mathematics Department coordinator.

Actuaries are the chief professionals in the insurance industry with 20,000 working nationwide on insurance and pension plans for industry and government. There is a sequence of professional examinations to pass in order to become an actuary. Actuaries are highly respected and rewarded: the job of "actuary" was rated among the best jobs in America in the latest edition of The Jobs Rated Almanac.

---

## ***Graduate Student Awards and Degrees***

### **United Government of Graduate Students Top TA/GPTI AWARD**



Nathan Wakefield

### **Wolfgang J. Thron Mathematics Fellowship**



Scott Andrews



Charles Scherer

### **Burton Jones Teaching Award (Spring 2012)**

Tyson Gern  
Justin Keller  
Benjamin Purkis

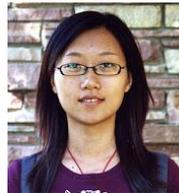
### **William E. Briggs Teaching Award (Fall 2011)**

Matthew Hartman

### **Adele V. Leonhardy Scholarship**

Ilana Bellowe  
Lauren Russell  
Kate Booth

### **Frances C. Stribic Scholarships**



Cui Cong



Amy Feaver



Kevin Selker



Michael Martinez

*Continued on p. 5*

**Graduate Student Awards and Degrees**, (continued from p. 4)

**Graduate Degrees**

Graduates are listed by name, degree, date (faculty advisor), title of thesis for Ph.D.

**Doctor of Philosophy**

**David Keyes**, Ph.D., Fall 2011, (David Grant), “Analytic proofs of McWilliams identities.”

**Robin Chestnut**, Ph.D., May 2012, (J. Donald Monk), “Independent partitions in Boolean algebras.”

**Benjamin Katz-Moses**, Ph.D., May 2012, (Brian Rider), “Small deviations of the B-Jacobi ensemble.”

**Stephen Limburg**, Ph.D., May 2012, (David Grant), “Space-time codes, non-associative division algebras and elliptic curves.”

**Camilo Mesa**, Ph.D., May 2012, (Alexander Gorokhovsky), “Getzler symbol calculus via deformation quantization.”

**Patrick Newberry**, Ph.D., May 2012, (Alexander Gorokhovsky), “Explicit computation of the cohomology of a symbol algebra.”



David Keyes



Robin Chestnut



Benjamin Katz-Moses



Stephen Limburg



Camilo Mesa



Patrick Newberry

**Master of Arts**

Margarita Echavarría, MA, Fall 2011 (Karl Gustafson)  
Elana Hartoonian, MA, Fall 2011 (Su-Ion Ih)  
Alissa Pajer, MA, Fall 2011 (Bart Kastermans)  
Daniel Prouix, MA, Fall 2011, (Robert Tubbs)  
Charles Scherer, MA, Fall 2011, (J. Donald Monk)  
Bryan Abbe, MA, May 2012 (Su-Ion Ih)  
Scott Andrews, MA, May 2012 (Nathaniel Thiem)  
Clifford Bridges, MA, May 2012 (Agnes Szendrei)  
Jessica Burkhart, MA, May 2012 (Jeanne Clelland)  
Derek Eby, MA, May 2012, (Sergei Kuznetsov)  
Fuchong Liu, MA, May 2012 (Alexander Gorokhovsky)  
Ryan Rosenbaum, MA, May 2012 (Eric Stade)  
Jinjoo Yoo, MA, May 2012 (Su-Ion Ih)

**Master of Science**

Jessica Kenigson, MS, May 2012 (Martin Walter)  
Mollie Stein, MS, May 2012 (Karl Gustafson)  
Rebecca Wilczak, MS, May 2012 (Stephen Preston)

**University Summer Fellowships**

Bryce Christenson  
Tyson Gern  
Jason Hill  
John Hower  
Justin Keller  
Chao Ma  
Michael Martinez  
Matthew Moore  
Andrew Moorhead  
Benjamin Purkis  
Will Stanton  
David Wayne  
Nathan Wakefield

***Retired Faculty News***



**Retired Faculty Annual Picnic.** Front: Martha Jones, Hank Hermes, Jean Hodges. Back: Bill Jones, Jack Hodges, Al and Virginia Lundell, Judy Ramsay, Frieda Holley, Arlan Ramsay, Wolfgang Schmidt, Jerry and Susan Malitz, Richard Roth, Walter and Chris Taylor, Bob and Sara MacRae and Pat Schmidt.

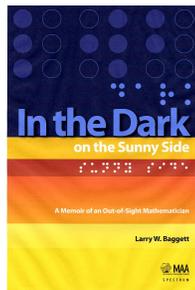
**Lawrence Baggett, (continued from p. 1)**

long before main-streaming was at all common. On almost every occasion he was the first blind person involved in whatever was going on — the first blind student enrolled in the Orlando Public School System, the first blind student admitted to Davidson College, and the first blind doctoral student in mathematics at the University of Washington.

Besides describing the various successes and failures Baggett experienced living in the dark on the sunny side, he displays in this volume his love of

math and music by interspersing short musings on both topics, such as discussing how to figure out how many dominoes are in a set, the intricacies of jazz chord progressions, and the mysterious Comma of Pythagoras. A hardcover version of this book is available in the MAA Store. Electronic edition ISBN:

9781614445135. The link given by Baggett is: [www.maa.org/ebooks/spectrum/IDS.html](http://www.maa.org/ebooks/spectrum/IDS.html).



somewhere, he hopes, on the West Coast. Jack enjoyed sharing with Justin his own experiences and how he became a teacher and what that has meant to him. Jack and Jean Hodges enjoyed a European River Cruise the last two weeks in August. Sailing from Budapest to Amsterdam, they stopped at picturesque villages in Germany and the Czech Republic, as well as large cities that included Budapest, Vienna, Koln, and Amsterdam. Jack was especially pleased that two life-long friends, the man who was the Best Man at the Hodges' wedding and his wife, accompanied the Hodges on this memorable trip.

**William B. Jones** began producing Prime Bits in 1990 when he was an active faculty member and has continued since his retirement working as a volunteer. The work is interesting, for it keeps him in touch with department activities and also in touch with 3000 plus Math alums. He is especially grateful to alums who send news for Prime Bits. For the past three years he has served the CU Retired Faculty Association (all three campuses) as Membership Secretary. Bill is currently doing joint research with Cathy Bonan-Hamada of Colorado Mesa University and Olav Njastad of the Norwegian University of Science and Technology on Continued fractions associated with Wiener-Levinson filters, frequency analysis, moment theory and polynomials orthogonal on the unit circle. He and his wife, Martha, made a car trip to the Atlantic coast in the spring and another to the Pacific coast in the fall. They hosted the 4<sup>th</sup> annual Retired Math Department Picnic in August.

**John H. Hodges** was pleased to attend the University of Colorado Scholarship Brunch on October 14 to meet the second student to receive the "**John H. (Jack) Hodges Mathematics Scholarship.**" Justin Gerber is a senior with a double major in physics and math. His home is Highland Ranch. He plans to continue his studies in graduate school

## **Staff News**



Sciences.

**Donna Maes**, the department Office Manager, reported that staff offices have recently been remodeled to be more efficient and student friendly. Also the Meyer Lounge has new furniture, which can be seen in a nearby photo. Funds to pay for the new furniture and a new projector came from the College of Arts and

several years with H&R Block. I have a bachelor's degree with major in accounting from Lady Doak College, Madurai, India.

I was born and raised in India, but moved to US with my husband Murali and have been in the US since 1993. We lived in Oregon for 10 years and it has been almost 10 years since we moved to Colorado. We have two kids, and our oldest son Vignesh is a junior at CU and our second son Arul is in seventh grade. I am really enjoying my new job here, the opportunities that it offers and most of all I am happy to be part of the wonderful staff of Math department. I am looking forward to working with everyone at the Math department.”

---



The Meyer Lounge



undergraduate students.

**Tiffany Dowd**, the staff Assistant for Undergraduate Studies, works with Professor Jeanne Cleland, the newly appointed Associate Chair for Undergraduate Studies, performing many administrative activities such as student advising, course assignments, instructor evaluations, policy meetings, etc. She also provides Prime Bits with news concerning



November 2011. Before that I worked as a Tax Advisor for

**Venkatalakshmi (Lakshmi) Muralidharan** joined the department staff as an Accountant Technician in fall 2012, replacing Denise Rodriguez.

At the request of Prime Bits, Lakshmi wrote the following: “Prior to joining the math department, I worked as Accounting Tech for the department of Journalism on Boulder campus, since

**Barbara Wojcik**, recently moved into the remodeled office previously occupied by the Accounting Tech. Now in



her fourth year as the Graduate Program Assistant, Barbara has come to know each of our graduate students and the things they need to know to make progress on their degrees. Prime Bits is grateful for the data she supplies of awards, scholarships, degrees granted and photos taken during the year.

## **The Math Corner**

The “Math Corner” is a creation by Professor Keith Kearnes highlighting in simple language some significant research by a faculty member of the CU Boulder Mathematics Department. This year’s Math Corner features work by Professor Peter D. Elliott.

### **Math Corner: Sophie Germain primes via shifted primes**

Primes, those positive whole numbers that cannot be expressed as products of smaller positive whole numbers, are the basic building blocks of the multiplicative structure of the system of whole numbers. Euclid proved in the ninth book of *The Elements* (c. 300 B.C.) that there are infinitely many primes. Dirichlet proved in 1837 that if  $a$  and  $b$  are positive whole numbers, then the sequence  $a, a + b, a + 2b, a + 3b, \dots$  contains infinitely many primes when  $a$  and  $b$  have no common factor and at most one prime when  $a$  and  $b$  have a common factor.

Dirichlet’s Theorem can be expressed as the statement that the linear function  $f(n) = a + bn$  represents infinitely many primes or at most one prime. Here a prime  $p$  is *represented* if  $a + bn = p$  for some positive whole number  $n$ . This note is about a more difficult question: must a *pair* of linear functions,  $f(n) = a + bn$  and  $g(n) = c + dn$ , represent infinitely many *pairs* of primes whenever they represent more than two pairs? For example, if  $f(n) = n$  and  $g(n) = n + 2$ , are there infinitely many positive whole numbers  $n$  such that  $(f(n), g(n)) = (n, n + 2) = (p, q)$  with both  $p$  and  $q$  prime? (Are there infinitely many *twin primes*?) For another example, if  $f(n) = n$  and  $g(n) = 2n + 1$ , are there infinitely many positive whole numbers  $n$  such that  $(f(n), g(n)) = (n, 2n + 1) = (p, q)$  with both  $p$  and  $q$  prime? (In such a pair, the smaller prime  $p$  is called a *Sophie Germain prime* after the woman who proved that, if  $(n, 2n + 1) = (p, q)$  is a pair of primes, then, in any whole number solution to  $x^p + y^p = z^p$ ,  $p$  must divide  $x, y$  or  $z$ .)

If  $(n, 2n + 1) = (p, q)$ , then  $\frac{q+1}{p+1} = \frac{2n+2}{n+1} = 2$ , so an alternative version of the question about Sophie Germain primes is: are there infinitely many pairs of *shifted primes*  $(p + 1, q + 1)$  whose ratio is 2? So far, no one knows.

CU faculty member Peter Elliott has investigated the problem of which rational numbers  $r$  are products  $r = (p_1 + 1)^{\varepsilon_1} (p_2 + 1)^{\varepsilon_2} \cdots (p_k + 1)^{\varepsilon_k}$ ,  $\varepsilon_i = \pm 1$ , of shifted primes and their inverses. The goal is to prove that every positive rational number  $r$  is expressible in this form in infinitely many different ways with only two factors. If, for example, a rational number  $r$  is expressible as  $(p_1 + 1)^{\varepsilon_1} (p_2 + 1)^{\varepsilon_2}$ ,  $\varepsilon_i = \pm 1$ , in infinitely many different ways, then it must be that one exponent is  $+1$  and one is  $-1$ , so  $r$  is a ratio of shifted primes.

Elliott has shown that at least a **third** of all positive rational numbers are representable in infinitely many ways as products of shifted primes and their inverses. He has also shown that if every positive whole number up to  $10^{387}$  is representable in at least one way as a product of shifted primes and their inverses, then all positive rationals are representable. (So far, only the positive whole numbers up to  $10^9$  have been checked.) Finally, he has shown that if all positive rationals are representable as products of shifted primes and their inverses, then at **most nine** shifted primes are needed in the representations. Until all positive rationals are represented using only two factors the champagne will remain on ice!

## **Alumnae/Alumni News**

**Nellie G. Amondson** (BA Math and Physics 1942) wrote that from 1943 to 1946 she served in the Women's Army Corp (WAC) where she received intelligence training, learned to fly and worked as a spy in Europe from 1944 to 1947. Her daughter has written about work she did with General Patton (unpublished). In 1961 she received a master's degree in mathematics from San Diego State University (SDSU) following which she taught mathematics (calculus, differential equations, etc.) at Mesa College. She retired in 2002 at the age of 81. She currently does volunteer work in code breaking. A recent stroke makes writing more of a challenge than it used to be. Favorite professors at CU Boulder were Dr. Aubrey Kempner (Mathematics) and Dr. William B. Pietenpol (Physics). Recollections of CU are that she had to work very hard. Nellie Amondson is now 90 years old and we hope to hear from her again; perhaps about espionage in Europe during World War II.

**Christopher Baltus** (MA Math 1983, Ph.D. Math 1984) is a Professor of Mathematics at the State University of New York at Oswego. Chris' CU thesis advisor was William B. Jones. He writes: "Thank you for your holiday newsletter. I still love teaching but have not learned to love being department chair. Assess this! Assess that! I have been reading old books on projective geometry, my latest project. And I did referee a continued fractions paper that had a lot of history in it, so I am not completely away from continued fractions."

**Kenneth Alan Beegles** (BS Applied Math 1975 and BA Geog. 1975) has worked for 30 years on Water Resources with the Colorado State Division Engineers. He does consulting on engineering and mapping. Ken is an active volunteer in Rotary, church, Mountain Club and Sailing Club. His youngest daughter is a 2011 CSU graduate in Mechanical Engineering. At CU Boulder Ken remembers the Viet Nam protests, beating Oklahoma (football), streaking, Norlin Library, The Dark Horse Saloon, the Sink and the Boulder bus system. Favorite faculty members were Dr. A. W. Smith, Gary and Novak. [beegles@frontier.net](mailto:beegles@frontier.net).

(Editor's note: In the 1970s the Viet Nam protesters maintained for months a large fire on Folsom Street west of the Engineering Center which resulted in closing Folsom north of Colorado Avenue. A marker of that protest was painted on the Folsom Street pavement and remained there until this past year when the asphalt pavement was replaced by a wide concrete walk.)

**David A. Field** (Ph.D. Math 1971) and **Thomas H. Jefferson** (Ph.D. Math 1969) had a reunion in New Jersey in 2012. The previous one was 38 years ago in San Francisco, CA. Both were members of the CU Boulder Continued

Fractions Seminar organized by W. J. Thron and William B. Jones. Both are now retired after careers by Dr. Field at General Motors Research in Michigan and by Dr. Jefferson at Lawrence-Livermore in California.



David A. Field and Thomas H. Jefferson

**Chuck Hursch** (son of the late **Jack Lionel Hursch**, Ph.D. Math 1964): "Hi Bill, I hope things are going well. I received a Prime Bits - Fall 2011 issue with an article on my father, Jack Hursch - many thanks for that. On flipping through the issue, I came across a couple of book references. The first caught my eye for the beauty of its cover: "The Crossing of Heaven", and I could recognize familiar territory in Shirt Tail Peak (I believe that is the name of the ridge running south from Bear Peak) and the Devil's Thumb. The second is Malitz's "Gullible Us", with a rather unique cover. I will add both these books to my reading list. Also good to see that Rearick is in good health. Best, Chuck"

**Sheila Miller** (Ph.D. Math 2007) was a doctoral student of the late Professor Richard Laver. We are very grateful for the In Memoriam remarks on the life and work of Richard Laver in the current issue of Prime Bits. Her research under the direction of Professor Laver was on "Free Left-distributive Algebras." At CU Sheila worked with Professor Eric Stade in the Outreach Program providing mathematical assistance at the Escuella Bilingual Pioneer elementary school in Lafayette, CO.

**William H. Myers III** (MA Math 1984) is an Associate Professor of Information Systems at Belmont Abbey College in Charlotte, NC. In March 2012 he received a Distinguished Service Award from the Consortium for Computing Sciences

*Continued on p. 10*

***Alumnae/Alumni News***, (continued from p. 9)

in Colleges at its annual meeting in Raleigh, NC for more than 20 years of service to the Consortium as Membership Secretary from 1990 to 1997 and as Treasurer from 1997 to the present time. Mr. Myers works as a Youth Director for the Ebenezer United Methodist Church in Belmont, NC. His favorite CU professor was Jerome Malitz.



**Walter (“Doc”) M. Reid** (Ph.D. Math 1978) retired as Professor of Mathematics following a 33-year career (1979-2012) at the University of Wisconsin-Eau Claire. At CU Boulder he was a member of the Continued Fractions Seminar organized by W. J. Thron and William B. Jones. Dr. Reid adopted the nickname “Doc” at an early age and it was used by all who knew him well. Doc Reid was

involved in teaching the basic mathematical curriculum (real analysis, abstract and linear algebra, complex variables, etc.) and when he saw the need for more instruction of mathematical statistics he put in much extra effort to be able to teach the subject at both elementary and advanced

levels. Doc is married to Barbara DeVries. Folk dancing has been a lifelong passion of Doc Reid, a hobby in which he is still active. At Eau Claire he founded the Eau Claire International Folk Dancers (ECIFD), which focuses on European line and circle dancing. ECIFD celebrated its thirtieth year in 2009 with eighty visitors from Midwestern states and Canada and continues to grow. A tradition adopted by Doc for each class he taught was to give students a taste of folk dancing. On the last day each semester Doc came to class wearing his dance shoes, bringing audiotapes and a boom-box and performing two or three folk dances.

**Becker Sidney Smith** (Ph.D. Math 2005) is a member of the faculty of Hampden-Sidney College in Virginia. Professor Jan Mycielski served as Sidney’s thesis advisor at CU. In 2010 Sidney received the Distinguished Service Award from Radford University. Among his professional activities is maintenance of an online resource for the mathematics community: links library, bookstore, quotes and online articles. Sidney’s wife, Wendy Hageman Smith received a Math Education Ph.D. from CU Boulder in 2003 and is an Assistant Professor at Longwood University, Virginia. website: [www.bsidneysmith.com](http://www.bsidneysmith.com)

**48<sup>th</sup> annual DeLong Lectures feature Vitaly Bergelson**

**Professor Vitaly Bergelson** was the featured speaker at the 48<sup>th</sup> annual DeLong Lecture series in spring 2012.

Professor Bergelson received his Ph.D. from the Hebrew University of Jerusalem under the guidance of H. Furstenberg in 1984, and was awarded the Landau Prize for his doctoral dissertation, which dealt with applications of ergodic theory to combinatorics. After graduation he accepted a postdoctoral position at Ohio State University and has remained on the faculty at OSU. His extensive research is mainly devoted to the interplay between dynamics, combinatorics, and number theory.

Professor Bergelson is actively devoted to the dissemination of mathematical knowledge; he has given hundreds of lectures throughout the world, including an invited address at the International Congress of



Vitaly Bergelson

Mathematicians in 2006 in Madrid, two plenary talks at American Mathematical Society meetings, a Mordell lecture at Cambridge, mini-courses in Italy, India, Mexico, Chile, the Czech Republic, South Korea, New Zealand and lectures at the CBMS Conference on Ergodic Ramsey Theory at Eastern Illinois University and at the School on Dynamical Systems in Trieste.

His three DeLong lectures given during the week of March 12, 2012 were: 1. "The Multifarious Poincare Recurrence Theorem;" 2. "Ultrafilters and Ergodic Ramsey Theory" and 3. "Generalized Polynomials, Uniform Distribution, and Dynamics on Nilmanifolds.

**In Memoriam**

**Robert Whitcomb Ellingwood (May 16, 1918 - May 23, 2012)**

**Robert Whitcomb Ellingwood** (May 16, 1918 - May 23, 2012), a member of the mathematics faculty at the University of Colorado from 1952 until 1997, died on May 22, 2012 in Boulder at the age of 94. He was born in Colorado Springs on May 16, 1918. In addition to being on the university faculty, Bob was a well-known Colorado historian and a mountaineer. He earned a B.S. degree in Mathematics and Engineering from Northwestern University and an M.S. degree in Geology from the University of Illinois. At the age of 15 Bob climbed Long's Peak with his father, a pioneer in Colorado mountaineering. Before becoming a Colorado resident, he spent summers surveying Colorado land, studying geology at Colorado College, exploring mountain towns, working as a tour guide in Colorado Springs, driving tour buses up Pikes Peak and helping park rangers find lost hikers.



House Manager for more than 15 years. He sang with the University Festival Chorus (1952 – mid 1980s), served as their business manager and then sang with the Denver Symphony Chorus from 1955 to 1956.

Ellingwood's avocation in geology continued throughout his career as he led geology field trips for the Colorado Mountain Club (served as president from 1955-1956), led CU math conference guests on tours of the mountains, and was a member since 1953 of the Pike's Peak AdAmAn Club. He made at least 22 grueling winter climbs with the club. He enjoyed serving as the Firemaster who supervised the midnight New Year's Eve fireworks display from the 14,110ft summit of Pike's Peak. Since retiring in

1997, Bob continued serving the Boulder community by giving lectures at local retirement homes. His topics covered the history of Boulder, CU, narrow-gauge railroads in Colorado, mountaineering adventures, the naming of the Fourteeners, and entertainment experiences. He also recorded eight oral history videos for the Boulder Public Library, which can be accessed online. When the American Mountaineering Museum opened in 2008, Bob was an enthusiastic supporter. He donated his father's mountaineering diaries, pictures, and climbing gear to the museum and collaborated for several years, sharing information with author, Jeff Arnold for his 2010 publication, *Albert Ellingwood: Scholar of Summits*.

Bob taught geology at CSU for two years before moving to Boulder. At CU his first work was designing astronomical equipment for Walter Roberts' High Altitude Observatory funded by Harvard University. In 1952 he began a 45-year career of teaching mathematics at the University of Colorado at Boulder, initially in the Engineering School Applied Mathematics Department and later in the College of Arts and Sciences Mathematics Department. He served as Marshal in over 75 commencements and as the Artist Series

**Richard Joseph Laver (October 20, 1942 - September 19, 2012)**

On behalf of the Mathematics Department, Prime Bits would like to thank Sheila Miller for writing the following remarks about Richard Laver's life and work. Please see **Sheila Miller** in Alumnae/Alumni News.

Richard Laver, celebrated set theorist and friend, died in Boulder, Colorado at the age of 69. Rich joined the faculty of the CU Department of Mathematics in 1974 and became Professor Emeritus in 2008. Born in Los Angeles, California, on October 20, 1942, Rich began playing chess in childhood, exchanging moves on postcards with correspondents all over the world. Marathon chess tournaments helped him develop the exceptional concentration he applied to mathematics and rock climbing. While climbing he reportedly demonstrated complete and characteristic calm in all climbing



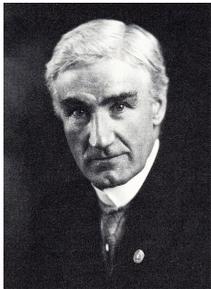
circumstances; while doing mathematics in Boulder coffee shops, he was able to focus so completely that he sometimes didn't see friends until they spoke to him. Rich earned a bachelor's degree from UCLA in 1964, and wrote his Ph.D. thesis *Well-quasi-orderings and Order Types* at Berkeley in 1969 under the direction of Ralph McKenzie, making him the academic brother of Keith Kearnes and the academic grandson of Don Monk, both of the CU Mathematics Department. His thesis resolved the long-standing Fraïssé conjecture and was published in the *Annals of Mathematics*.

Rich was a life-long athlete, hiking and walking even until the end of his life. A pole-vaulter in high school, Rich came to rock climbing as a consequence of his

*Continued on p. 16*

## ***Mathematics Department Endowment Funds***

Endowed funds for the Mathematics Department provide vital support for teaching, research and scholarship. It would be difficult to overstate the great benefit of these endowments for higher education. Their contributions continue in perpetuity in accordance with the will of each donor. If you are interested in contributing to an endowment (new or existing), please contact the department chair, Professor Judith Packer, Department of Mathematics, University of Colorado, Boulder, CO 80309-0395, [Judith.Jesudason@Colorado.EDU](mailto:Judith.Jesudason@Colorado.EDU) or Margot Jenson Neufeld, University of Colorado Foundation, Senior Director of Development, University of Colorado at Boulder, Boulder, Colorado 80309. Direct: (303) 492-2990 or [margot.neufeld@cufund.org](mailto:margot.neufeld@cufund.org). Following is a brief description of existing Mathematics Department endowments.



### ***Ira DeLong Lectures***

Professor Ira M. DeLong was essentially the Mathematics Department at CU Boulder from 1888 until his retirement in 1925. After DeLong's death in 1942 his bequest to the university of \$25,000 accumulated interest until 1963 when the faculty began using income from the endowment to fund an annual series of

DeLong Lectures and undergraduate prizes for the Putnam competition. DeLong lecturers are among the leading mathematicians of our time. Each one delivers three lectures and holds informal discussions with our faculty, students and visitors during his/her week-long visit to the Boulder campus.

### ***Frank F. Islam Scholarships***



With a gift of \$52,000 to the CU Foundation, University of Colorado alumnus **Frank F. Islam** endowed two annual scholarships for CU Boulder mathematics students with a gift of \$52,000 to the CU Foundation: The Frank F. Islam Mathematics Scholarship in Honor of **William B. Jones** (Emeritus Professor, Mathematics) and the Frank F. Islam Mathematics

Scholarship in Memory of **Wolfgang J. Thron** (Emeritus Professor, Mathematics).

In making this gift Islam said "These two individuals were the instruments of my successful life journey and the core belief that we must continue the giving in any way we can. I hope these scholarships will allow students in the Mathematics Department to pursue their dreams, choose a career and make their marks on the world. When I give money for a scholarship program, I strongly believe I am investing in the future. I had a great experience at CU, and I hope these scholarships will help the next generations of students to have the same great experience. I want to inspire others to have passion for philanthropy."

Born in India, Islam immigrated to the United States at 15. He earned bachelor's and master's degrees in computer science from the University of Colorado. After working extensively in the federal government, he founded QSS group, an information-technology company, one of his many successful ventures. Islam now serves as CEO of FI Investment Group LLC, which focuses on providing growth capital to emerging companies and manages specialized and branded funds.

Frank Islam is co-author of "Renewing the American Dream," a book concerned with giving citizens the opportunity to realize their potential by getting educated, working hard and getting a job that pays a living wage. See: [www.renewingtheamericandream.net](http://www.renewingtheamericandream.net) or [www.ffislam.com](http://www.ffislam.com).



John H. (Jack) and Jean Hodges

### ***John H. "Jack" Hodges Scholarship***

In 2010 with a gift of \$25,000, Emeritus Professor John H. Hodges endowed a scholarship for undergraduate mathematics students, providing for an annual award of \$1000 to a CU undergraduate with financial need who is a good student. He had considered bequeathing the scholarship funds but decided: "Who knows how long anybody is going to last? I'd like to do it while I'm still around."

Hodges was a member of the CU Boulder Mathematics faculty for 33 years (1960-1993) and continued teaching part-time for two more years. He served as department chair, directed dissertations for a large number of students and was

*Continued on p. 13*

**Endowment Funds,** (continued from p. 12)

the recipient of many teaching and service awards, including: The CU-student-initiated Teaching Recognition Award (1968), the Boulder Faculty Assembly Teaching Excellence Award (1990), the Outstanding Service to the University Award (1993) and the annual 1992 Burton W. Jones Teaching Excellence Award given by the Mathematical Association of America (Rocky Mountain Section). In reflection Hodges said: "I had the GI bill. It was a blessing for our whole country. The GI bill changed the character of education of the United States. I feel some desire to help carry that on for other people."



Aubrey Kempner (left) with Burton Jones at Kempner home in 1952

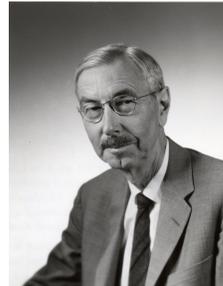
**Kempner Mathematics Colloquium**

The Kempner Colloquium began in 1963 in honor of Professor Aubrey J. Kempner who served as head of the Mathematics Department from 1925 until he retired in 1949. Kempner gave the inaugural lecture on Reminiscences of the University of Goettingen where he received his Ph.D. degree under Edmund Landau in 1911. Kempner continued to take an active interest in the department until his death in 1973. The Kempner Colloquium Endowment was established in 1995 by gifts from faculty (\$15,000), the College of Arts and Sciences (\$10,000) and CU Math alums, including a major gift of \$25,000 from Dr. William J. LeVeque (B.A. 1944). LeVeque wanted to perpetuate the memory of the CU professor Aubrey Kempner who had greatly influenced his life. The weekly colloquium on topics of broad mathematical interest is essential for maintaining a vibrant learning environment.

**William Reinhardt Memorial Lectures**

The William Reinhardt Memorial Lecture Endowment Fund was established in 2001 by family, colleagues and friends of Professor Reinhardt who was a Mathematics Department faculty member from 1967 until his untimely death on June 22, 1998 at the age of 59. Reinhardt was deeply interested in

the foundations and philosophy of mathematics, occasionally teaching courses in the Department of Philosophy.



Burton W. Jones



William E. Briggs

**B. W. Jones and W. E. Briggs Teaching Excellence Awards**

The Burton W. Jones Teaching Excellence Award was created in 1984 by gifts from the Mathematics Department faculty to honor their colleague for his long and distinguished service as a member of the faculty (1949 to 1971) and department chair (1949 to 1963). When Professor William E. Briggs retired in 1988, gifts were made by faculty of mathematics and other Arts and Sciences departments for a memorial in recognition of his distinguished service as a faculty member (1955-1988) and Dean of the College of Arts and Sciences (1963-1980). Since Briggs and Jones had been close friends who greatly valued good teaching, it was decided in 2007 to fund a separate William E. Briggs Teaching Excellence Award with both awards funded by a combined endowment. Each year the Burton W. Jones award is given to a veteran Math graduate student teaching assistant (TA) for outstanding teaching accomplishments. The William E. Briggs award is given each year to a first-year TA in the Mathematics Department for outstanding teaching accomplishments.

**Burnett Chandler Meyer Endowment**



The Mathematics Department has established a two-year postdoctoral position called the Burnett Meyer Instructorship, with the first appointment in August 2009. Candidates are considered who have a Ph.D. degree in any area of mathematics including mathematics education. Selection is based on strong evidence of teaching and research. The position has a teaching load of three courses per year. The Burnett Meyer Instructorship is funded by a bequest of more than \$2,000,000 from the estate of the late Professor Emeritus Burnett Chandler Meyer who was a member of the CU Boulder faculty from 1957 to 1990. The bequest is to be used for the benefit of students and faculty. A portrait and plaque in honor of Professor Meyer has been placed in the Mathematics Building.

*Continued on p. 14*

***Endowment Funds,*** (continued from p. 13)

***Adele Leonhardy Memorial Scholarship***

The Adele Leonhardy (B.A. 1924) Memorial Scholarship was established by a gift from her estate. Awards are made to graduate students or upper division A&S undergraduates majoring in mathematics. Recipients must demonstrate excellence in their studies and must be preparing to teach mathematics. Adele Leonhardy was born in Carbondale, Colorado and grew up in Fruita near Grand Junction. While attending the University of Colorado from 1917 to 1924 she taught elementary school in Boulder to pay for her college education. After graduate work at the Universities of Chicago and Missouri she taught mathematics at Stephens College until her retirement in 1967. Professor Leonhardy understood the difficulty of working one's way through college and she dedicated her life to teaching. Her gift to the University of Colorado will enable students from future generations to become teachers of mathematics.

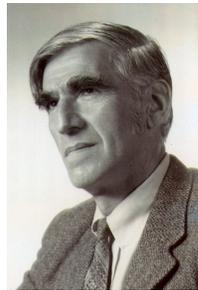


Frances Stribic and Dorothy (Happy) Martin

***Frances C. Stribic Scholarships***

Frances Stribic was a member of the Mathematics faculty from 1926 until she retired in 1965. Finding a need for someone to teach statistics, she prepared herself in that subject and not only taught it for a number of years but also did research applications jointly with psychology Professor Dorothy (Happy) Martin. Professor Stribic was an outstanding teacher, well respected by her students and colleagues. In 1990 her friend Happy Martin established the Stribic Scholarship awarded each year to a female graduate student chosen by the faculty for excellence in mathematics scholarship.

***Wolfgang J. Thron Mathematics Fellowship***



In 1999 Professor Emeritus Wolfgang Joseph Thron expressed his faith in and devotion to the University of Colorado with a gift of \$216,000 to endow the W. J. THRON MATHEMATICS FELLOWSHIP awarded each year to an outstanding graduate student in the Mathematics Department. Thron was a member of the Mathematics Department from 1954 until he retired in 1985. He served as department chair from 1972 to 1974 and he was thesis advisor for 21 Ph.D. students. In 1980 Thron was elected to the Royal Norwegian Society for Sciences and Letters (Det Kongelige Norske Videnskapers Selskap) for outstanding creative research in mathematics and for his great inspiration to others to do creative work. He was awarded the University of Colorado Medal for outstanding contributions to the university and for his distinguished career as a scholar, teacher and research mathematician.

---



Margarita Echavarria (M.A.) receives congratulations from Professor Judith Packer, Mathematics Department Chair, at the May 2012 commencement.

## **Mathematics Department Donors 2010-2012**

The Mathematics Department is grateful for the generous contributions by donors listed below. Gifts to endowments and funds make it possible to bring colloquium speakers (DeLong, Kempner and Reinhardt) to the CU Boulder campus, to offer scholarships (Hodges, Islam, Leonhardy, Stribic and Thron) and to reward outstanding teaching assistants (B.W. Jones & W.E. Briggs awards) and Putnam Contest winners. Gifts (cash or securities) can be sent by returning the enclosed form MATHEMATICS DEPARTMENT 2012 ANNUAL FUND to the CU Foundation. Contributions to the Mathematics Department through the CU Foundation are tax deductible.

Steven & Beverly Aanenson  
 Mohammad Ahmad Adra  
 Nellie Emma Amondson  
 Lee Wilson Badger, Ph.D.  
 M.R. & Catherine Bailey  
 Sharon & Alfred Balch, Jr.  
 Janet Heine Barnett, Ph.D.  
 Brian D. Bartlett  
 Kenneth Alan Beegles  
 Steven J. Benson  
 William A. Bernstein  
 Leslie & Rick Bishop  
 Delilah Ball Blount  
 Julie & Stephen Bricher, Ph.D.  
 Muriel M. Briggs  
 William L. Briggs, Ph.D.  
 Edgar Bright III  
 Barbara Benedict Brown  
 Kay & Charles Brown  
 Robert A. Burkhardt  
 Randall Wallace Burtis  
 Fred & Mary Burton  
 David B. Carrington, Ph.D.  
 Thomas John Carter, Ph.D.  
 Deanna Marie Caveny, Ph.D.  
 Shin-Shun Chow  
 Shu In Huang, Ph.D.  
 Richard James Clancy  
 Frederick Joseph Clare, Ph.D.  
 Adrian Lawrence Clark  
 James & Carol Clark  
 Kevin & Judith Compton  
 Marilyn Love Davis  
 Paul Taylor Diede  
 Kenneth & Jeanne Dukes  
 Amie J. Elcan, Ph.D.  
 Julia & Klaus Eldridge, Ph.D.  
 James & Brenda Elshof

Norman P. Farquhar  
 Norman Ray Franzen, Ph.D.  
 William & Ellen Frost  
 Aaron A. Glasenapp  
 Andrew & Kathleen Goforth  
 Robert & Wanda Gunning  
 Gary & Aleta Hacker  
 Margery & F. G. Hagin, Ph.D.  
 Brian Allan Hagler, Ph.D.  
 George W. Heine, III, Ph.D.  
 John H. & Jean Hodges  
 Micheline & Fredrick Humburg, Ph.D.  
 Jack & Andrea Hyatt  
 Frank F. Islam  
 Stephen & Linda Jacobs  
 Karen & Thomas Jefferson, Ph.D.  
 Ralph W. Jenne  
 Judith Packer & James Jesudason  
 Lloyd & Barbara Johnson  
 William B. & Martha Jones  
 Richard & Susan Jones  
 John Knox Karlof, Ph.D.  
 Rita & Joseph Katich  
 Benjamin F. Katz-Moses  
 Chad Landon Kearney  
 Vivian Joan Kennedy  
 Steven Douglas Kerr, Ph.D.  
 David King  
 Nathan & Zelda Kohn  
 Anita & Kim Kokkenen, Ph.D.  
 Donald Mark Labencki  
 Dennis & Joyce Landon  
 Charles J. LeCorchick  
 Kathryn Liebel  
 Jae Hyeon Lim  
 Jessica Blythe Linton  
 Tianchen Liu  
 Evan & Amy Markwood

Robert Mattick, Ph.D.  
 & Csilla Farkas  
 John Mark McArthur, Ph.D.  
 Joyce & Robert Mers, Ph.D.  
 Michael & Russett Meyer  
 Darren & Margaret Miller  
 George & Clara Moreno  
 Thomas M. Morse, Ph.D.  
 Ida & Nicholas Mousouris, Ph.D.  
 William H. Meyers, III  
 John & Jane Ott  
 Karla Jeanette Oty, Ph.D.  
 Dan Ernest Philipp  
 Mary Kathleen Porter  
 Marlene Rose Pratto  
 Paul Vincent Pryse, Ph.D.  
 Terrance John Quinn, II  
 Annette & William Ramaley, Ph.D.  
 Lisa Kim Rizzo  
 Richard Lewis Roth  
 Alaina Elise Rouse  
 Michael E. Samaniego  
 Paul & Robin Schachter  
 Ronald Shonkwiler, Ph.D.  
 & Cynthia Jeness  
 Tamira & Brad Shores  
 Douglas Alexander Siegal  
 Jean & Ronald Tidball  
 Eric & Margaret Wainwright  
 Karen & Errol Waligorski  
 Leonard Weiser  
 Sue Wilkinson  
 Joan & Mark Fiore Wills  
 Judith Sharon Zinn



Department of Mathematics  
395 UCB  
Boulder, CO 80309-0395

---

***Richard Joseph Laver***, (continued from p. 11)

deep generosity and insight into others: a friend at Berkeley was suffering from love-sickness, and Rich told this friend about some rock climbing classes and invited him to join, knowing that rock climbing demands complete attention. When the course was over, Rich asked his friend: “Feel better?”--- the first acknowledgement that Rich had his friend’s recovery in mind from the start. He did feel better of course, and so began two climbing careers. Rich took many mathematicians rock climbing, including Paul Erdős, and had hiking partners from mathematics, bridge, and all over Boulder. A dedicated UCLA Bruins basketball fan, Rich played Friday afternoon basketball with faculty members and graduate students for many years, fearlessly driving to the basket and accurate from long range, too. Even after he stopped playing due to his illness, his basketball sat in the entryway of his home.

There are few people as gifted in the art of sharing the joy of thought, mathematical and otherwise, as Rich Laver. Not only was he generous with his students, but he cultivated an extensive and diverse group of loyal friends who visited his ‘salon’ (aka living room) whenever they pleased, and especially when they had puzzles to work or

interesting topics to discuss. More than one person has made the observation that when they were around him, they ‘just felt good’. Rich’s impeccable mathematical taste and the depth of his results are among the traits for which he is known in the set theory community. Among his most brilliant results are (in chronological order) the resolution of the Fraïsse conjecture; the consistency of the Borel conjecture, for which he developed countable support iterated forcing; the consistency (relative to a supercompact cardinal) of the existence of supercompact cardinals  $\kappa$  indestructible under  $(<\kappa)$ -directed closed forcing; the consistency of the continuum hypothesis with the statement that there are no  $\aleph_2$  Suslin trees (joint with Shelah) ; the infinite version of the Halpern-Läuchli theorem; and the discovery of the relationship between the braid groups and certain elementary embeddings. In spite of his profound and influential contributions to set theory, he taught set theory without using any of the phrases: Laver reals, Laver forcing, Laver trees, Laver tables, Laver functions, Laver indestructibility, or Laver measurability, phrases that abound in the literature and in talks on set theory. His modesty was absolute.

---