Ryan Sayers Memorial Award
10th Anniversary

Department of Physics
Department of Applied Mathematics and Statistics
Colorado School of Mines
Jack (brother), Tom (father) and Ryan

Ryan with his girlfriend Katrin
Ryan Sayers Memorial Award
Tenth Year Anniversary Commemoration

Looking Forward »

This year marks the tenth anniversary of the Ryan Sayers Memorial Award established in 2003. It is fitting to reflect on the legacy of this program by honoring the outstanding graduates who have received the award. Each one was chosen on the basis of academic merit as well as their contribution to an undergraduate research project. Starting in May 2004, the award has been given at each spring commencement, where the honorees have been acknowledged from the podium. While each one received a monetary award the greatest honor is their association with the distinguished group of past and future recipients. As this booklet shows, the past honorees have all gone on to achieve additional levels of excellence in their careers beyond Mines.

We are grateful to the Sayers family for establishing this award in memory of Ryan. He was an honor student of high intellect and passion who unselfishly devoted himself to teaching others. His zest for life extended to all of his activities, including his enjoyment of mountain climbing. He was taken from us through a tragic lightning strike while rock climbing in Wyoming in June 2003.

Like Ryan, several of the awardees were double majors in both physics and mathematics. They all have demonstrated strong aptitudes in these areas. Some have done their research in the computer laboratory named for Ryan in Chauvenet Hall where a picture of him hangs at the entrance of the lab. Through their achievements and continued successes, the award winners have established a vital tribute to a remarkable young man and the principles to which he was devoted.

Ryan’s parents, Tom and Kathleen Sayers, have attended every commencement ceremony and met all ten awardees and their families in person. For the Sayers family, commencement day has become a day to remember and celebrate the life and achievements of Ryan. In 2008, the family created a second fund, the Ryan Sayers Memorial Scholarship Endowment. Through the endowment, the family offers a yearly scholarship to help students fulfill their academic goals. In 2011, Ryan’s brother, Jack, and his wife, Lindsey, received the Young Philanthropist Award for their exemplary efforts in supporting students at their alma mater.

On behalf of the Department of Physics and the Department of Applied Mathematics and Statistics, we thank the Sayers family for their continued support for Colorado School of Mines. We are looking forward to the next 10 years.

Thomas Furtak & Willy Hereman
Golden, May 10, 2013
Maxine von Eye was chosen to be the first recipient of the Ryan Sayers Memorial Award.

Maxine is one of our most gifted undergraduate students, with a major in Mathematical and Computer Sciences and a minor in Physics, and she is on the Dean’s List. She will pursue graduate studies in applied mathematics but hopes that her studies also will involve physics.

During the Spring of 2004 Maxine worked with Dr. Hereman and Dr. Colagrosso on the design of algorithms and Mathematica software to compute conservation laws for multi-dimensional partial differential equations. She was supported by an Award of the National Science Foundation (NSF) for Research Experiences for Undergraduates (REU). Maxine’s research builds on the homotopy operator software that Ryan helped design last summer. Her performance on the project has been outstanding.

Maxine worked closely with Ryan on the modeling of nonlinear optical response of laser propagation through various gases, sponsored by NSF and supervised by Dr. Durfee in the Physics Department.

**In Maxine’s own words:** I came to the Colorado School of Mines from Okemos, Michigan right out of High School. I came here for the skiing, the city of Denver, and the great people I met when I came to visit during my senior year in High School. Now that my time here is up, I plan on continuing my education at the University of Bath (U.K.). I will work on my Masters degree in Modern Applications of Mathematics there. When I complete that, I hope to do a Ph.D. in Applied Mathematics somewhere back here in the U.S.A. I hope that my studies in Mathematics will continue to involve Physics, because I enjoy the area of science where the two fields overlap. Before I head to England in the fall, I will travel to Australia for a month, and of course enjoy the summer here in Colorado.”

“I met Ryan Sayers in the summer of 2002. We had class together before that, but never really met. That summer, we both worked for Dr. C. Durfee. Our research was in Dr. Durfee’s field of interest, which is lasers, and was funded by NSF. When we would talk about the physics involved in our work, Ryan always seemed to be one step ahead of the game. He almost always had the answers to my questions, or at least some insight that would take me a little bit further along. Most days, we sat together in the computer lab in Meyer Hall and wrote code in Mathematica. Ryan taught me how to play the computer card game Free Cell that summer, and he would check our new climbing sights on the internet every chance he got.”
I have always enjoyed applying mathematics to other areas of science, and this has not changed over the last nine years since I left Mines. I left Colorado in October 2004 to do a masters degree in Modern Applications of Mathematics at the University of Bath, UK, which led to me doing a PhD in the Department of Applied Mathematics and Theoretical Physics at the University of Cambridge, UK, starting in October 2005. My PhD project involved using mathematical tools to study sea ice and oceanography in the Greenland Sea.

In the fall of 2009, I then spent four months in Pune, India doing an Engineers without Borders placement. I worked at Shelter Associates, which is an NGO that works in the redevelopment of slums and aims to bridge the gap between slum dwellers and the local government. I worked with them on managing and presenting their data. In addition to the fact that living in India was an eye-opening life experience, the work I did was another very interesting application of my mathematical (and programming) skills.

Since March 2010, I have been working for a small environmental consultancy in Bristol, UK called Eunomia Research and Consulting. We work primarily in waste management consulting, and my role involves working with local governments to improve their recycling services both in terms of improving recycling rates and reducing costs. The data analysis and modeling I do at Eunomia allow me to use the skills I have on very practical problems.

As for the future, I have no concrete, long-term plans. For the moment, I am really enjoying working for Eunomia and living in Bath, UK, and I am taking life as it comes. People say I seem pretty settled in the UK, but there are so many other interesting places to live! I am still playing water polo, as I did at Mines, and enjoy travelling; the above photo is from a recent trip to New York, and the one to the right is from my time in India.

I can’t believe it’s been almost 10 years since I left Mines, and still look back very fondly on the time I spent there. I still consider it a great honor to be the first recipient of the Ryan Sayers Memorial Award.
Robert “Scott” Danford was chosen to be the second recipient of the Ryan Sayers Memorial Award.

Scott is one of the most gifted graduating seniors in Mathematical and Computer Sciences. Scott's GPA is 3.844 and his area of special interest is physics. He is planning to enroll in the combined program which will enable him to finish with a Masters Degree in Mathematical and Computer Sciences from CSM. Scott plans to pursue a career in the sciences and hopes to get a job in a scientific or academic field.

During the Spring and Summer of 2004, Scott worked with Dr. Hereman and Dr. Colagrosso and three undergraduate students on the design of algorithms and Mathematica software to compute conservation laws for multi-dimensional partial differential equations.

Maxine von Eye, the first recipient of the Ryan Sayers Memorial Award, was also a member of the research team. The students were supported by an Award of the National Science Foundation (NSF) for Research Experiences for Undergraduates (REU). Scott’s research work built on the homotopy operator software that Ryan helped design in the Summer of 2003. Scott’s performance on the project was outstanding.

**In Scott's own words:** Though born in Texas, I grew up here in Colorado in a stable home of middle class parents. I excelled academically at Ponderosa High School and participated in Marching Band and Forensics, both at the State level, and I was a member of the Math Club. I became the silver medallist at the Math Olympiad and I represented Mines in the Putnam math competition twice. I have been a member of Kappa Mu Epsilon, the math honor society, since my freshmen year.

I have enjoyed my studies here, and truly believe that I made the best choice when I decided to attend the Colorado School of Mines. While at CSM I participated in several extra curricular activities. I played alto saxophone in the University's marching and concert bands. I also played bass flute in the flute choir. During my first two years, I studied judo with the judo club. I am a participating member of the Role-Playing Club.

Though I didn’t know Ryan personally, I heard about his untimely death during Summer Field Session. I am glad to have had the opportunity to continue Ryan’s research and to apply the homotopy operator software he had helped design.

I am greatly honored to be the recipient of the 2005 Ryan Sayers Memorial Award.
It was my great honor to receive the Ryan Sayers Memorial Award in 2005. I deeply value the recognition and encouragement that it has given me on my journey as a scientist.

Since the time that I received the award, I continued my studies in Mathematical and Computer Sciences, receiving a Master of Science, in 2006, via the combined program at the Colorado School of Mines. Following that, I considered careers in both algorithms research, and actuarial sciences.

In June of 2006, I began a career in algorithms research, in the field of target tracking, working for Numerica Corporation. Numerica Corporation is a small business headquartered in northern Colorado. It employs a talented technical staff to solve difficult information science problems, such as multiple target tracking and sensor fusion.

While working for Numerica, I have been an important contributor to the research and advancement of technology in bias estimation, orbit planning, target identification, data association, sensor resource management, and tracking systems. Funding for this research and algorithm development has come from several sources including the Missile Defense Agency, Air Force Office of Scientific Research, United States military, NASA, and subcontracts from large corporations such as Raytheon, Lockheed Martin, and Northrop Grumman.

I currently live in Loveland, CO less than a block from Numerica’s headquarters, where I still work. I walk to and from the office, every day, and usually home for lunch. Most days I also have the irreplaceable opportunity to enjoy the beautiful scenery and natural environment of the northern Colorado area, while walking my dog, Sandy. I continue to enjoy musical performance. I sing in my local church choir, and also play alto saxophone in small ensembles, from time to time. I also volunteer as a member of my community’s homeowner’s association board of directors. I still participate in games and role-playing groups, both local and online, when time allows.

For the foreseeable future, I fully intend to continue my career as a research scientist. I feel strongly that the recognition and financial encouragement of receiving the Ryan Sayers Memorial Award was a fundamental early step along that path, and I wish to express my sincere gratitude to the Sayers for choosing me.
Ann Hermundstad was chosen to be the third recipient of the Ryan Sayers Memorial Award.

Ann has excelled in every aspect of her academic career at CSM earning a perfect 4.0 majoring in Engineering Physics while minoring in Mathematical and Computer Sciences. Specifically, she has distinguished herself in research working with Dr. Lincoln Carr on non-linear many-body physics. Ms. Hermundstad began working with Dr. Carr in August of 2005. He started her off on an introductory research problem involving two atoms in two wells with hopping and on-site interactions. She showed up one week later with the full N-body solution - this, with no formal training in quantum many-body physics. Since then, she has moved on to the quantum dynamics of entangled states in a multi-band Hubbard model which constitutes an original contribution pushing the frontier of quantum mechanics. She is presently writing a substantial article on this work which will be submitted to a Physical Review journal. Her work, entitled "Macroscopic Quantum Tunneling and Entangled States in Bose-Einstein Condensates" with Dr. Carr and fellow student, Dimitri Dounas-Frazer, was accepted for presentation at the 2006 March meeting of the American Physical Society.

In Ann's own words: I grew up in Grand Junction, Colorado, with my parents and my younger sister, Amy. I chose to attend the Colorado School of Mines because of its great reputation in the sciences and because of its close proximity to the mountains. While I knew that CSM was a good school, I never expected to enjoy my time here as much as I have. My undergraduate education has given me the opportunity to explore many fundamental fields of science. While I have enjoyed both my classes and my research, I feel that my education was strengthened by the strong support of faculty in both the math and physics departments. The friendship and sense of community at CSM are invaluable to me.

In addition to my coursework, I have been a tutor and teaching assistant for our Physics 100 course. Teaching has given me the opportunity to share my love of learning with other students and has motivated me to pursue a career in education.

After graduation, I will spend a month traveling through Europe. I hope to spend additional time volunteering overseas teaching English or helping in local schools and orphanages. I will attend graduate school at either MIT or the University of California in Santa Barbara, where I hope to study either theoretical physics or biophysics. Eventually, I hope to teach at an undergraduate or graduate level.

I never had the opportunity to meet Ryan, but he is known by many to have been both an excellent student and a genuinely caring individual. I would like to thank the Sayers family for their commitment to CSM academics and their support for undergraduate research. I am honored to have received this award.
I am truly honored to have received the Ryan Sayers Memorial Award, and it has greatly impacted my educational and academic pursuits since.

After receiving the award, I pursued graduate studies in Physics at the University of California in Santa Barbara (UCSB). Advised by Professor Jean Carlson, I used computational and theoretical techniques to develop multiscale models of emergent phenomena in interconnected, nonequilibrium systems. My focus began in material systems, where I studied large-scale implications of granular-level interactions during earthquake rupture. However, I progressively moved toward more biologically-inspired problems, and by the time I was writing my dissertation, I was working with psychologists and biologists to understand the functional significance of anatomical patterns of connectivity in the human brain. In addition to research, I was actively involved in education and outreach at UCSB. I worked with faculty members, educational staff, and high school teachers to develop a new educational program at UCSB, the School for Scientific Thought (SST). SST encourages high school students to explore active areas of scientific research through participation in free topical courses designed and taught by graduate students in mathematics, engineering, and the physical sciences.

After receiving my PhD in Physics from UCSB in August of 2012, I accepted a postdoctoral research position working with Professor Vijay Balasubramanian in the Department of Physics and Astronomy at the University of Pennsylvania. Vijay, however, had already arranged to take a sabbatical in France during my first year of the position, so I packed my bags and moved to Paris in October of 2012. I currently spend my time at the Ecole Normale Superieure (ENS), conveniently located near the Pantheon in downtown Paris. “Parlez-vous francais?” you might ask. Un petite peu (but I’m learning...). At the ENS, I spend my time working on a variety of problems related to information processing in complex, adaptive biological systems. I am currently studying the functional role of random patterns of connectivity in the olfactory system and stereotyped patterns of connectivity in the visual system, with the goal of understanding how anatomy shapes and constrains function in sensory systems.

In the future, I plan to pursue a professorship in the physical sciences, as I hope to continue teaching and conducting research at the intersection of physics and biology. With the rapid development of new experimental and computational techniques, this is an exciting time to study fundamental questions about the complex nature of living systems.

It is with great appreciation that I thank the Sayers family for their continued dedication to undergraduate education and research. You have significantly impacted my life, both personally and professionally, and I am incredibly grateful for your support. Ten years ago, I could never have expected to be where I am today, working with engineers, mathematicians, and biologists on such a broad range of challenging problems. Thank you for helping me to achieve what I never thought possible.
Dimitri Dounas-Frazer was chosen to be the fourth recipient of the Ryan Sayers Memorial Award.

**Professor Lincoln Carr’s comments:** As Dimitri’s mentor and research adviser, I would like to comment on his research abilities. In 2005, I handed him a simple few-body quantum mechanics problem as a warm-up problem for a senior research project. A week later he came back with the solution to the N-body case. Since then, he has submitted two manuscripts to Physical Review Letters on the subject of quantum many-body dynamics and entanglement in ultra-cold atoms and has more articles on the way. He corresponds regularly with a half-dozen researchers in quantum physics who wrote him after viewing his work on the physics electronic preprints archive, arXiv.org, little knowing that he was “just” an undergraduate when he wrote his manuscripts. He won an award to give an invited undergraduate seminar at the American Physical Society DAMOP meeting and presented in the regular session at the 2007 American Physical Society March Meeting and at a quantum information conference at the California Institute of Technology. He has graduate school offers at all the top universities, including a full fellowship at the University of Illinois, Urbana-Champaign, one of the top programs in theoretical condensed matter physics in the world. The fact is that he is already producing at the level of an advanced physics graduate student at a top university. Lastly, he is unselfish with his time and enjoys helping his fellow students with their physics problems.

In concurrence with the Heads of the Departments of Mathematical and Computer Sciences and Physics, I would like to nominate Dimitri for the Ryan Sayers Memorial Award.

**In Dimitri’s own words:** I love the mountains: climbing up them, hiking through them, and sleeping on them. When I was 14, I got a job at a pizza place in Denver to buy gear. I skipped (and failed) all my classes at Lakewood High School so I could go climbing. Although my parents were obviously furious about my grades, my dad taught me how to lead climb in Clear Creek Canyon anyway. I first realized that I had a talent for mathematics when I was enrolled in a self-paced alternative school. To my surprise, I taught myself Algebra through Calculus in only two semesters. And I liked it. My sinuous path to high school graduation involved welding school and community college, and my parents were relieved when I finally walked the stage. The Colorado School of Mines was the only college to which I applied. Great science and great mountains; what can compete? At CSM, I majored in Mathematics and Physics while working as a tutor, mentor, laboratory technician, and research assistant. Weekends and summers were spent romping around the Rockies. My senior research with Ann Hermundstad and Dr. Lincoln Carr evolved into a Physics Master’s Thesis. This fall, I plan to continue my graduate studies in Physics at UC Berkeley. Over the last five years, I have embraced a philosophy of life that has brought me much happiness. In particular, teaching and volunteering have become very important to me. Ultimately, I hope to teach Mathematics and Physics at the University level. Until then (and hopefully thereafter), I will continue to tutor at the high school level or lower. Unfortunately, I never knew Ryan Sayers. However, I see many parallels between his life and mine. I think we would have been good friends. I am extremely proud to receive an award in his memory; it is truly an honor. I would like to thank the Sayers family for their commitment to the students of the Colorado School of Mines and to undergraduate research.
I graduated from Mines way back in 2006 and 2007 with my BS and MS degrees, respectively. Those days, I was doing numerical models of cold quantum gases with Lincoln Carr, a professor who had recently joined the Physics Department, and Ann Hermundstad, a good friend of mine and a fellow physics student. Since then, my research interests have expanded to include experimental atomic physics and physics education research.

In 2007, I started grad school at the University of California Berkeley. At the end of my first year, I joined Dima Budker’s research group. Dima has lots of projects, but the one I joined focuses on atomic parity violation in ytterbium. “Parity violation” means that our experiment and its mirror image give different results, an effect whose origins lie in the details weak interaction. In 2009, our team measured the largest-yet-observed parity violating asymmetry by illuminating a beam of ytterbium atoms with blue laser light (wavelength of 408 nm). Thereafter, we focused on improving our experiment by employing different experimental methods.

In addition to shining light on atoms, I also got involved in several educational organizations who serve underrepresented and/or underserved students. From 2009-2011, I taught developmental math and conceptual physics at San Quentin State Prison as a volunteer for the Prison University Project, a nonprofit that gives incarcerated men the opportunity to earn their Associate's Degree.

Starting in 2011, I began volunteering for the Compass Project, an award-winning, student-run organization at Berkeley whose mission is to improve physics education, foster community, and increase the retention of all students, especially those from groups underrepresented in the sciences (e.g., women, minorities, and first-generation college students). In Compass, I managed a mentoring program, established a high school outreach program, and helped run a fundraising campaign. I also co-designed and taught a laboratory course, and I’m currently working with some other Compass people on a research project to understand how this course is impacting students’ understanding of measurement uncertainty, systematic bias, and the regime of applicability of a physics model.

I’m using the Fall 2013 semester as an opportunity to explore different employment paths in physics education. My ideal position is one that takes advantage of my background in experimental physics and resonates with my passion for increasing diversity in the sciences, e.g., creating laboratory-based outreach programs.

I’m incredibly grateful to the Sayers family for their recognition of my work at Mines. In the next chapter of my life, I hope to honor Ryan’s memory by making high-quality math and physics education available to all students.
Rachel Miller was chosen to be the fifth recipient of the Ryan Sayers Memorial Award.

Professor Lincoln Carr’s comments: Rachel Miller is the most rigorous undergraduate physicist I have ever met. She is a natural mathematical physicist. I have served as her advisor and mentor for her senior design project over this last year, and am honored to continue to do so through her Master of Science degree next year. Her first project was the study of nonlinear scattering theory, applied to an atom laser. In this she was completely successful; her colleague Matthew Heller is now writing up their work on this subject for submission to a leading scientific journal. Her second project, which she is well into now, has two components: the generalization of nonlinear band theory to higher dimensions; and the analytical description of gap soliton trains, i.e. period-n solutions on the lattice. These are highly challenging problems, which I would struggle to solve myself. I have every confidence that Rachel will succeed. In addition to her research abilities, I would like to mention that Rachel has an unusually high level of integrity and is generous towards her classmates far above and beyond the normal level of giving between students.

In Rachel’s own words: I have lived in Colorado since 1993. I was home-schooled during my high-school years, and got my first taste of basic physics in 10th grade while working through the Saxon curriculum. At that time, I knew that I wanted to pursue a career as an astronaut, and therefore decided to major in science of some kind. However, my favorite subject was mathematics. I chose physics because of its significant math content, and I chose to attend Colorado School of Mines because of its location and the Physics Department’s stellar reputation.

At Mines, I realized quickly that the science side of physics is just as enjoyable as the math side. Also, some of the mathematics faculty members encouraged me to pursue a double major. This decision was somewhat scary, because I had previously been advised by other faculty and students that it is impossible to do well in the Physics Department with a double major. However, thanks in part to the high degree of support that I received from my mathematics instructors, I decided to go for it, and this is one of the best decisions that I have ever made. Mathematics and physics complement each other very well, and I have been challenged but not overwhelmed by the course load. My experience as a student at CSM has been incredibly wonderful.

In addition to classes, I have worked as a tutor and as a teaching assistant for C++ and introductory physics. My experience as a TA was one of the major factors influencing my decision to pursue a career as a college teacher. I really enjoy working with students, and want to pass on the enthusiasm and support that I have received during my time as a student.

I never knew Ryan, but those who did have made it clear that he was an enthusiastic and caring person who lived life to the fullest. It is an honor to receive this Award, and I am very grateful to the Sayers family for their continuing support of CSM students.
My career goal has long been to become a college teacher. I have always loved learning, and my experience as a student at CSM was marvelous. I want to share that enthusiasm with others and to help others reach their goals just as I was aided in reaching my own.

The Sayers Award helped me to continue on to graduate studies at CSM after receiving my B.S. degrees in 2008. I completed my M.S. in Applied Mathematics in May 2010. My project was the theory of Bose-Einstein condensate scattering on a square barrier. The project was intense but enjoyable.

Since that time, I have experienced several things which significantly altered both my personal and professional paths. Because I wanted to teach at the college level, the most natural next step after my M.S. studies seemed to be more graduate school. I was accepted to a physics Ph.D. program at the University of Toronto for 2010/2011. While traveling to Toronto, my mom and I were in a major auto accident. Thankfully, I was not physically injured, and my mom seemed to have only minor whiplash. We continued on to Toronto after my vehicle was repaired, but found that the delay had caused my housing plans to fall through. By that time, school was starting and no other housing options could be found. I made the difficult decision to return to Colorado.

Through the grace of God and the help of some dear friends, I was able to spend the next year re-evaluating my goals and priorities, as well as looking for a job. While I was unsuccessful in finding employment that year, it was a time of great personal growth. In the meantime, my advisors at CSM encouraged me to re-apply to graduate school. Since employment opportunities were not working out, this seemed to be a wise choice. I received a research assistantship at Vanderbilt University for the summer of 2011 and spent several months in Nashville working with Kalman Varga’s computational nanoscience group. Through that experience, I realized that scientific research was not my passion at all. I found that I did not want to devote the better portion of the next 4-7 years of my life to a research project. Rather, I wanted to be in the classroom interacting with students. I had taught at CSM during my graduate studies, so I had some teaching experience already. I knew that it was possible to teach with only a Master’s degree, so I began looking again for academic employment. This time, I was partly successful. I found a position as an adjunct math instructor at Red Rocks Community College.

I taught algebra at Red Rocks for one year. During that time, Todd Ruskell contacted me and indicated that CSM was likely to need a temporary physics instructor to fill in for Vince Kuo, who would be visiting the Petroleum Institute. I joined CSM in Fall 2012 as adjunct faculty. I am currently teaching both physics and differential equations at CSM while I seek a full-time faculty position. On a personal level, I am very involved with ministries at my church. I work with kids of several different age groups. This presents a whole new set of challenges and joys which are very different than with teaching adults. I enjoy working with the children and watching them grow. In my free time, I enjoy reading, playing the piano, playing old-school video games, and doing a variety of crafts.

Many people would say that I have not been successful. I disagree. While this was certainly not the path I expected to take, or even the one I would have chosen, I am a stronger person as a result. I enjoy being in the classroom and interacting with all kinds of different students. Teaching is more enjoyable than I ever imagined, and I look forward to gaining more experience in the classroom. I am grateful to the Sayers family for supporting me in my studies at CSM.
Benjamin Jones was chosen to be the sixth recipient of the Ryan Sayers Memorial Award.

Dr. Mark Coffey served as the advisor and mentor for Ben’s senior design project. **His comments:** Ben Jones is a very bright senior undergraduate student with a double major in Mathematical and Computer Sciences and Physics. After graduating, the next academic step for Ben is a Masters Degree in computer science, with a focus on computer graphics. I know Ben as his senior design advisor for a most challenging project. His investigation of quantum computing algorithms combines many facets of both computer science and quantum physics, including complexity theory and quantum search algorithms. Ben has mastered an array of topics in quantum computing that would be a daunting task for most students. Indeed, Ben has been grappling with difficult and important subjects, which relate to both the foundations of computer science and the solution of practical problems. Ben possesses a quiet confidence and has shown himself capable of working independently. After we had gone over background on quantum computing, he began developing numerical experiments and simulations for adaptive quantum search. He is a student that enjoys a good challenge.

**In Ben’s own words:** I grew up in Fort Collins, CO and chose to attend CSM because of its great reputation and its beautiful setting. Mines has exceeded my expectations by providing me with a broad range of academic and extracurricular activities that have prepared me for both my career and personal life. The physics and computer science departments have broadened my curiosity, while the Ultimate Frisbee team has taught me about teamwork and competitive spirit.

My interest in physics and computer science led me to research applications of quantum computing as my senior design project with Dr. Mark Coffey. We are investigating how to apply quantum search to scheduling problems to achieve square-root speedup in running time. Since scheduling problems occur in many segments of industry, from software design to delivery and distribution planning for nationwide companies, improvement of scheduling algorithms could have far reaching effects.

The courses I have taken at CSM in graphics and computational geometry have been intriguing and challenging. They have inspired me to pursue graduate study at either the University of Utah, or the University of British Columbia in computer graphics.

While I did not have the chance to meet Ryan, I have heard from many faculty members that he was a wonderful person. I am extremely grateful to the Sayers family for their commitment to CSM. I am honored to be considered for the 2009 Ryan Sayers Memorial Award.
Since graduating from CSM in 2009, I spent two years in Vancouver, BC earning my MS in Computer Science at the University of British Columbia. Under the supervision of Professor Michiel van de Panne, I developed new control strategies for physics-based character animation culminating in my thesis and a contribution to a paper at SIGGRAPH 2011.

After two rainy Vancouver winters, I opted to continue my graduate studies under sunnier skies at the University of Utah in Salt Lake City. I’m finishing the second year of my PhD working with Professor Adam Bargteil on physical simulation for animation. In my graduate studies, like in my senior design work with Dr. Coffey, I’ve been able to pursue my interests in computer science and physics. The background I gained at Mines has prepared me well for the rigors of research work, and I’m grateful to the terrific professors I worked with during my time in Golden.

When I finish at Utah, I hope to remain in the academic world as a professor, following in the footsteps of the many inspirational mentors I had the chance to interact with at CSM, UBC, and Utah. The experience I’ve gained working on exciting research and teaching during graduate school has convinced me to pursue this difficult, but rewarding career path. The Ryan Sayers Memorial Award has opened new doors for me on my educational journey and motivated me to continue my studies.

I’d like to thank the Sayers family for their continued, generous support of students at CSM. Their commitment to honoring Ryan’s memory is truly inspirational.
Kelley Commeford was chosen to be the seventh recipient of the Ryan Sayers Memorial Award.

Professor Lincoln Carr’s comments: Kelley Commeford is an excellent candidate for the Ryan Sayers Award. Aside from her high GPA, she is doing significant theoretical research on the dynamics of symmetry-breaking impulses in both optics and cold quantum gases. She is part of a joint project with the research team from Valencia that came to visit Mines this past summer. She will be going to Spain for the summer to work with that research group. Her work is completely analytical and highly mathematical and would therefore be appropriate for any joint award from the Mathematics and Physics departments. With respect to physics, she taught herself Feynman propagators and graduate quantum mechanics. At the same time she is very involved in athletics as a cheerleader; she is a sorority officer; and was spring queen – how she does this on top of her academic work and research, I have no idea. Although she is not a double major, in my opinion, she is the best candidate from physics. I am certain that the Sayers family will be very pleased with this nomination.

In Kelley’s own words: I have lived in Colorado for the better part of 13 years, ever since my father retired from the Air Force. Although constantly pressured to attend his Alma Mater, the Air Force Academy, my heart lied with CSM ever since I first drove through it. I attended high school in Cripple Creek, a small but beautiful gambling town in the heart of the Rockies. It was there that I joined the student council, and on our way to a statewide seminar, our adviser drove the group through the CSM campus. Mines offered everything I was used to -- a small campus, tons of outdoor fun, and a small family of students to grow and develop with. Although I had never even heard of Mines before that day, I knew I wanted to spend the next four years in Golden.

Ever since I can remember, I wanted to be an astronaut. I grew up with the glow of stars plastered all over my room and Lego spaceships occupying every open shelf. I knew I wanted to pursue a math and science degree since kindergarten, when I first started to excel in mathematics. I used to beg my father to teach me long division in 2nd grade when he would get home from work. We used to sit outside on the bench “expanding my brain” with fun problems, while other kids were crying about their addition homework.

Being from a small town, the schools were definitely sub-par. I wasn’t offered calculus until college, although I needed it Junior year of High School. I didn’t get my first taste of physics until Mines either, but my love for mathematics and science never wavered. I loved Physics 200 so much, that I stuck around for the next two years as a Teaching Assistant for the class. My time as a TA showed me that I LOVE to teach. After I complete my Masters degree in Applied Physics, I hope to spend at least two years as a “Teach For America Corps” member, doing my part to end educational inequality.

Although I never knew Ryan personally, I have heard that he was a genuinely caring individual, who did everything he could to help others succeed. I hope to follow in his footsteps in that respect, and maybe learn to rock climb in his memory, too. I would like to give a heartfelt THANK YOU to the Sayers family for continuing their support of CSM students, and for considering me for this award.
I have spent the last two years in the Rio Grande Valley teaching physics with Teach for America. Teach for America is a highly selective program that believes educational opportunities should not be determined by your family’s income or the neighborhood in which you live. A great education for all is the most effective means of ensuring equal opportunities for everyone. Teach for America is developing a movement of leaders who will help drive change at every level of our education system toward the goal of closing the achievement gap.

These past two years have opened my eyes to an entirely new culture. My Spanish has drastically improved due to the daily “tidbits” my students provide. My students are curious creatures: they never stop asking questions about physics, Colorado, Mines, even biology! By answering all of their questions honestly, I somehow managed to convince a student to attend Mines in the fall.

Before Teach for America, I stayed at Mines an extra year to earn my Masters degree in Applied Physics. I finished my degree remotely from Texas, and graduated this past December. I do NOT recommend teaching and writing a thesis at the same time! Your award helped me further my education, and I want to say THANK YOU again for your support.

I am currently in the process of applying to graduate school. I hope to attend UT-Austin next fall to pursue my PhD in physics. After that, I plan to stay in research and academia. Teach for America has taught me that I enjoy teaching, but I would prefer to do so at a higher level while still unraveling the mysteries of nature.
Janeen Neri was chosen to be the eighth recipient of the Ryan Sayers Memorial Award.

Professor Willy Hereman's comments: Janeen is a perfect candidate for the Ryan Sayers Memorial Award. In high school she had already taken the calculus sequence and courses in linear algebra and differential equations. In her first three semesters at Mines she completed most of the required courses for her Bachelor’s degree and started taking graduate courses two years ahead of schedule. Despite the advanced courses she maintained a perfect 4.0 G.P.A. As a member of my undergraduate research team, she investigates nonlinear partial differential equations with a method established by Peter Lax of the Courant Institute of Mathematical Sciences in New York. Janeen worked on a generalization of Lax’s method to semi-discrete equations. While studying the method she was able to spot and correct several mistakes in scientific publications. Janeen is eager to learn new mathematics and explore the power of symbolic computation. She has the potential to become a great researcher. It has been a great pleasure to work with Janeen. I am certain that the Sayers family will be very pleased with this nomination.

In Janeen's own words: For much of my childhood, I aspired to be an author. That started to change when I was offered the chance to take advanced mathematics classes in eighth grade. A few years later, I had exhausted all the mathematics classes at my (small) high school. Yet, I wanted more. So, I got a pre-calculus book and started teaching myself. On the recommendation of a teacher, I abandoned that plan and opted to take classes at the local community college.

By the time I graduated from high school, I had run out of classes there too. My grandfather, a retired mechanical engineer, suggested that I could keep doing mathematics by becoming an engineer and told me about CSM’s reputation among engineers. Mines was an adventure for me. I grew up in California and had never set foot in Colorado. Within a year, I knew that majoring in engineering would not satisfy me, and the mathematics and computer science program eventually won me over. Along the way, I got the privilege of being a Teaching Assistant for physics, another interest of mine. I also kept writing, becoming a satirist for The Oredigger, CSM’s weekly newspaper. After some graduate work, I hope to use the mathematics and computer science education I am getting at Mines to go work in industry.

I first heard about Ryan when I started doing research with Dr. Hereman. Based on Ryan’s work, I can tell that he was a very gifted and conscientious individual. I am grateful and honored to be considered for the Award in his memory. I would also like to thank the Sayers family for their continued support to the students of CSM.
I'm currently working as a software engineer for Disney Interactive. I wear multiple hats at my job. I was initially hired for frontend web programming and have since branched out to mobile and backend work. The most notable project I’ve taken part in was PiXEL’D, a mobile creativity app that was a finalist for this year’s SXSW Interactive awards. In addition to being one of the primary developers on the app, I made the initial proof-of-concept demo that convinced executives to greenlight the project.

At first I was skeptical about working for “the Mouse”, but it’s been a fantastic experience. I am constantly surprised by how fulfilling and challenging the work is, despite being aimed at kids.

I’m also getting my masters degree in computer science at CU Boulder. Work is my priority at the moment, so I’m creeping along at 2 classes a semester. Despite the difficulty of juggling a full-time job and school, I’m enjoying the classes a lot. This semester, I’m taking a proofs-heavy Algorithms class... I was pretty excited when I realized that I would get to do a proofs class in computer science.

Thank you again for choosing me to be a recipient of the Ryan Sayers award. I see it as a reminder to live up to high standards and to never stop improving myself.
Sara Clifton was chosen to be the ninth recipient of the Ryan Sayers Memorial Award.

Professor Willy Hereman’s comments: As a member of my Research Experiences for Undergraduates team, Sara helped me design a method to symbolically compute Lax pairs of nonlinear partial differential equations based on work by Peter Lax of the Courant Institute of Mathematical Sciences in New York. I greatly enjoyed working with Sara because she is inquisitive, mature beyond her age, eager to learn, reliable and personable. Sara is the perfect candidate for this award. She graduates as the top student in Applied Mathematics and Statistics with a perfect 4.0 GPA. She is exceptionally intelligent, insightful, focused, and organized. Her skills in science and mathematics are complemented with talent in music and the arts. Sara has decided to join the PhD program in applied mathematics at Northwestern University. I have seen first-hand how well she handles advanced mathematics. No doubt, she will become a leader in mathematical research and education.

In Sara’s own words: I cannot cite a single experience as the beginning of my love of mathematics and its applications. I was born with an insatiable curiosity about every aspect of the world around me, from music and art to biology and physics, but I always found myself best understanding these concepts when they were explained in terms of formulas and concrete rules. This curiosity about how things work led me to the Colorado School of Mines to pursue a degree in Mechanical Engineering. A year into the program, I discovered that engineering would not satisfy my desire to know the rules that govern the processes of the natural world. As I explored my other options at Mines, the courses in applied mathematics caught my interest, especially the introductory classes in mathematical biology, modeling, and partial differential equations. I now know that I have found the field to which I want to devote my career.

After graduation, I will be pursuing a PhD in Engineering Sciences and Applied Mathematics at Northwestern University, and hope to become a mathematics professor at an engineering school like Mines. I am honored to be nominated for this award in Ryan’s memory. This award is even more meaningful to me because I too am an avid rock climber. I sincerely thank the Sayers family for their many years of generous support of CSM’s students.
In the year since receiving the Ryan Sayers Memorial Award, I have moved to Evanston, Illinois, to study Engineering Sciences and Applied Math at Northwestern University. By the end of the academic year, I will have received my Masters Degree and will be well on my way to earning a PhD.

My first year living outside Colorado has been both exhilarating and extremely challenging. Besides adjusting to fast-paced city life and the not-so-lovely Chicago weather, I have tackled a full load of classes and studied hard to pass my preliminary exams. I also serve as the first year representative on my department’s leadership board, which works to improve both the department and the Northwestern community. To keep some semblance of balance, I play French horn in the university concert band, ride my bike along Lake Michigan, and fly back to Colorado on breaks to climb.

Starting this summer, I will begin research in dynamical systems or complex systems, with applications such as sociophysics, epidemiology, and climate change. In addition, I will help organize a First Year Foundations Workshop and oversee Prelim Exam Prep sessions for new graduate students.

After graduation, I hope to earn a post doc position at a research university near the mountains so I can resume all the outdoor activities that I love. Eventually, I want to become a professor at a small college like Mines.

I would like to thank the Sayers family again for their generous support of CSM. The Ryan Sayers Memorial Award has no doubt helped many Mines students succeed. In particular, the award has helped fund my climbing habit for the past few months, so I sincerely thank the Sayers family for keeping my hectic schedule in balance.
Linnea Jones was chosen to be the tenth recipient of the Ryan Sayers Memorial Award.

Professor Lincoln Carr’s comments: Linnea is a dedicated and highly successful undergraduate researcher in complex network theory, a cross-disciplinary field between physics, mathematics, computer science, biology, and several social sciences. Complex network theory is one of the most exciting areas of research today. It is used to treat diverse systems from the power grid to gene networks. Linnea has been applying complex network methods to text recognition, in particular, differentiating between fiction and non-fiction writings. We discovered that we could distinguish both with complex network measures, based on a few hundred words. Yet, we were puzzled as to what textual features our mathematical methods were picking up. In the Fall of 2012, Linnea joined our group and dove into this problem. In a few months, she figured out the key features of texts, using Mathematica to help solve the problem. She is co-authoring a paper on our findings. Linnea started at CSM at age 15, essentially skipping high school. At age 19, she is now accepted at the University of Chicago into a PhD program in Ecology and Evolution, where she will apply complex network theory to biological problems. I am honored to have served as Linnea’s adviser over her penultimate year at Mines. She is an outstanding candidate for the Ryan Sayers Memorial Award.

In Linnea’s own words: I have always had a passion for the natural world. In high school I started realizing that, because the environment is a system, the connections between species themselves are more important in determining the fate of an ecosystem than the actual species. I would like to spend my life pursuing ecological networking with the goal of identifying key species through network models for the restoration of ecosystems, and teaching others the skills to do the same. A voracious learner, keen on finding a challenge and pursuing my goal, I came to Mines in the Summer of 2009 at the age of fifteen. Majoring in engineering physics at Mines has challenged me to examine natural phenomena at a fundamental level. I minored in mathematical sciences to strengthen my foundation for both modeling and analysis, as well as to have fun with math problems. My second minor, in bio-engineering and life sciences, has given me some knowledge of biology. My senior design project with Dr. Carr focuses on complex network theory, an important part of ecological modeling, which is more fun than I could have imagined. After I graduate in May, I am headed to the University of Chicago for doctoral studies in Ecology and Evolution. I will be researching ecological networking by creating mathematical models of ecological networks, such as food webs and species interactions. After receiving my Ph.D., I hope to continue research in ecological networking and to teach mathematical modeling methods, particularly those relating to ecology, at a university. While I am not going into physics, I hope to bring the mind of a physicist to ecological networking, thus finding fundamental truths of the living world. I would like to sincerely thank the Sayers family for the honor of receiving this award in Ryan’s memory. I hope to spread a love of physics and mathematics to the field of ecology and I am grateful to do so through the generous support of the Sayers family to CSM students like myself.
Continuous and Discrete Homotopy Operators and the Computation of Conservation Laws

Willy Hereman, Michael Colagrosso, Ryan Sayers, Adam Ringler, Bernard Deconinck, Michael Nivala and Mark Hickman

Abstract. We introduce calculus-based formulas for the continuous Euler and homotopy operators. The 1D continuous homotopy operator automates integration by parts on the jet space. Its 3D generalization allows one to invert the total divergence operator. As a practical application, we show how the operators can be used to symbolically compute local conservation laws of nonlinear systems of partial differential equations in multi-dimensions.

Analogous to the continuous case, we also present concrete formulas for the discrete Euler and homotopy operators. Essentially, the discrete homotopy operator carries out summation by parts. We use it to algorithmically invert the forward difference operator. We apply the discrete operator to compute fluxes of differential-difference equations in (1 + 1) dimensions.

Our calculus-based approach allows for a straightforward implementation of the operators in major computer algebra systems, such as Mathematica and Maple. The symbolic algorithms for integration and summation by parts are illustrated with elementary examples. The algorithms to compute conservation laws are illustrated with nonlinear PDEs and their discretizations arising in fluid dynamics and mathematical physics.

Mathematics Subject Classification (2000). Primary: 37K05, 37J35, 35Q35; Secondary: 37K10, 35Q58, 37K60.

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