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Inside: NOVA far
detector celebration

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A record number of
new faculty

Annual Magazine
ISSUE 15

SCHOOL OF

UNIVERSITY OF MINNESOTA

Physics and Astronomy



**New Physics
building**

Inside the newly-opened Physics and Nanotechnology
building.

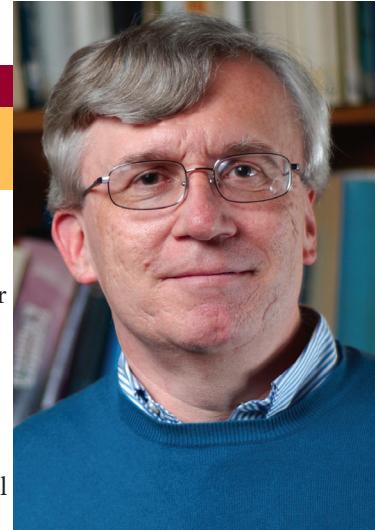
A letter from the Head of the School

Ronald Poling, School of Physics & Astronomy

In January of this year the School began moving most of our research programs in experimental physics into the brand new 144,000-square-foot Physics and Nanotechnology (PAN) building. The moves are now almost complete and PAN (see page 6) is providing us with capabilities for experimental research that we have never had before. Its labs are designed to meet the needs of current and future programs, with fourteen-foot floor-to-ceiling clearance and basement pits to accommodate large experimental apparatus, electronically shielded rooms, a mammoth high-bay lab for building and testing detectors for particle physics and cosmology, ample fume hoods, and many other specialized features. PAN is also a beautiful space, with the stunning 3M Lobby and adjacent conference rooms, and efficient and comfortable offices for 25 professors and about 125 grad students, postdocs and staff members. PAN is already delivering great benefit in competitiveness in recruiting faculty and students, and in obtaining grant support for new projects.

An \$85M building project for physics on our campus is an extraordinary milestone, but there is even more in the pipeline. We completed the schematic design of a \$92.5M renovation of the headquarters for physics in Minnesota, Tate Laboratory. This renovation (see back page more info) will preserve the historic character of Tate as an integral part of Northrop Mall and provide a modern 230,000 square-foot home for the School administration, educational programs, and research in astrophysics and theoretical physics, including both the Minnesota Institute for Astrophysics and the W. I. Fine Theoretical Physics Institute. It will also be the new location of the Department of Earth Sciences, currently dispersed over numerous buildings across campus. While the design is not yet final, the new Tate will have a beautiful atrium providing daylight in the core of the building, a new entrance on Church Street, greatly improved environmental

control and energy efficiency, and modern lecture halls with better visibility, access and circulation. Funding for the Tate renovation was included in the 2014 State of Minnesota bonding bill signed by Governor Mark Dayton in May, and we have an aggressive schedule calling for a two-year shutdown beginning in June 2015 and a return to the renovated Tate during summer 2017.



There are so many other great developments in the School during the past year that I can only scratch the surface in this short report. We have four new professors: condensed matter experimentalist Vlad Pribiag, experimental biophysicist Elias Puchner, and condensed matter theorists Andrey Chubukov (the new William I and Bianca M. Fine chair in FTPI) and Natalia Perkins. Thanks to a generous faculty development grant from the National Science Foundation, we are now searching for an experimentalist in space physics, our first hire in that area in 20 years. Just a few months ago construction was completed on the NOvA far detector, with School faculty members managing construction and operating the \$40M far-detector laboratory near Orr, Minnesota, and also building (with mostly student labor) the more than 10,000 detector modules that are now assembled into the 14,000-ton far detector. The past year has seen many research highlights and high-profile publications produced by School faculty and their groups, including the leading role of Professor Clem Pryke in the exciting BICEP2 results on the B-mode polarization of the cosmic microwave background. As usual, our faculty and students garnered many well-deserved honors.

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Jenny Allan, Editor

You can always find more information on School events, news and the achievements of our faculty and students at our web site (www.physics.umn.edu). If you haven't visited campus for a while, please drop in soon for a glimpse of our future in PAN and a nostalgic stroll through Tate.

SCHOOL NEWS

NOvA Collaboration Celebrates Completion of Far Detector



The University of Minnesota celebrated a major milestone on July 24, 2014, with the completion of building a 14,000-ton detector in northern Minnesota. The event was held at the NOvA Far Detector Laboratory in Ash River, MN. Speakers included University of Minnesota Regents Richard Beeson and Clyde Allen, President Eric Kaler, Pepin Carolan from the U.S. Department of Energy and Regina Rameka from Fermilab. More than 700 University of Minnesota undergraduate students in 24 different academic majors built the detector over four years in a 125,000-square-foot factory in Minneapolis. The NOvA experiment consists of two huge particle detectors placed 500 miles apart. Its job is to explore the properties of an intense beam of ghostly sub-atomic particles called neutrinos. Neutrinos are abundant in nature, but they very rarely interact with other matter. Studying these neutrinos could unlock clues about the beginning of the universe.

Humphreys named honorary RAS Fellow



Roberta Humphreys was made an honorary fellow of the Royal Astronomical Society. Humphreys joins a list of only 35 other American Astronomers who have been honorary RAS fellows.

Goldman wins Buckley Prize



Allen Goldman has won the 2015 Oliver E. Buckley Condensed Matter Physics Prize for his "discoveries and pioneering investigations of the superconductor-insulator transition, a paradigm for quantum phase transitions."

Dahlberg receives Nicholson Medal



Dan Dahlberg won the 2013 Nicholson Medal for Outreach "through the development and continued leadership of the program The Physics Force."

Veit wins Apker Award



Recent alumni Michael J. Veit has won the 2014 Leroy Apker award of the American Physical Society.

2014 Undergraduate Scholarship Recipients



The 2013 Undergraduate Scholarship recipients are:
Erwin Marquit and Doris Grieser Marquit Undergraduate Scholarship: Henry Duran

The Hagstrum Award: Kevin Nangoi, Isaiah Gray, Adiv Paradise, Michael Veit, Matt Epland

The A. O. C. Nier Undergraduate Scholarship in Physics: Kelly Stifter

Harry and Viola St. Cyr Scholarship for Undergraduate Research: Nicholas Krueger

Edmond B. Franklin Scholarships: Staci Tiedeken, Alexander Engel, Ben Ihde, Jared Matzke, Quynh Nguyen, Kali Ask

J. Morris Blair Scholarship: Ian Jaeger

Jeffrey Basford Scholarship for Undergraduate Research: Timothy Gburak

Front row: Nicholas Kruegar, Timothy Gburak, Kevin Nangoi

Second row: Staci Tiedeken, Kelly Stifter, Matt Epland, Isaiah Gray, Alexander Engel, Third row: Kali Ask, Jared Matzke, Michael Veit, Ian Jaeger, Ben Ihde

SCHOOL NEWS

Four New APS Fellows



Jorge Vinals for "his contributions to pattern formation in nonequilibrium systems, especially quasi crystalline patterns in Faraday waves, domain coarsening in modulated phases, and the general study of coarse grained fluids described by an order."



Robert Lysak for "pioneering contributions to the theory of Alfvén wave processes, including kinetic effects, their role in magnetosphere ionosphere coupling in planetary magnetospheres and development of global models of MHD wave processes in dipolar geometries."



Thomas W. Jones for "For fundamental contributions to our understanding of thermal and non-thermal radiation from extragalactic sources, and the morphology and physics of radio sources."



Alex Kamenev "for advancing the methods of quantum kinetic theory MHD wave processes in dipolar geometries."

Two New AAAS Fellows



Priscilla Cushman was named a Fellow of the American Association for the Advancement of Science (AAAS). Cushman was named to the section on Physics. She will be presented with a certificate and pin at a ceremony in February, 2015.



Marvin Marshak was named a Fellow of the American Association for the Advancement of Science (AAAS). Marshak was named to the section on Physics. He will be presented with a certificate and pin at a ceremony in February, 2015.

Lysak awarded Alfvén Medal



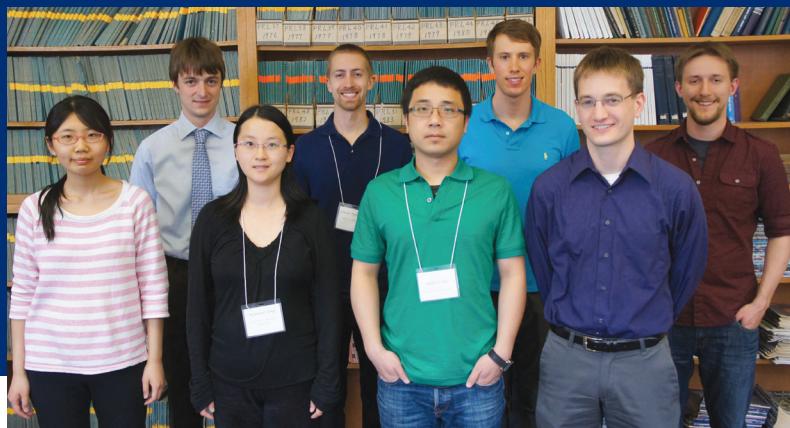
Robert Lysak has been awarded the Hannes Alfvén Medal by the European Geosciences Union. The Medal honors scientists who have achieved exceptional international standing in Solar-Terrestrial Sciences. Lysak will deliver a lecture and receive the medal at a meeting in Vienna, Austria in 2015.



Vainsthein wins Wess Award

Arkady Vainshtein has won the 2014 Julius Wess Award, presented by the Karlsruhe Institute of Technology Center for Elementary and Astroparticle Physics for "outstanding experimental or theoretical scientific achievements, which extend and deepen our understanding of the fundamental laws of nature." Vainsthein will present a lecture and receive the award at a ceremony in Karlsruhe, Germany in December 2014.

2014 Graduate Fellowship Recipients



The 2014 Graduate Fellowship recipients are:
Anatoly Larkin Fellowship: Mike Schechter
Hoff Lu Fellowship: Tanner Prestegard
Leonard F. Burlaga Fellowship: Xiangwei Tang
Robert O. Pepin Fellowship: Tobias Gulden
Aneesur Rahmen Prize: Qianhui Shi
Outstanding TA Awards: Dan Endean, Sean Kalafut, Justin Wilmert, Hannah Rogers, and Jared Hennen.

Front row: Qianhui Shi, Xiangwei Tang, Chien-Te Wu and Dan Endean
Second row: Tobias Gulden, Tanner Prestegard, Sean Kalafut, Justin Wilmert

SCHOOL NEWS



Burnell receives CAREER Award

Fiona Burnell has received an NSF Faculty Early Career Development (CAREER) Award. Burnell's project is titled "Topology and Symmetry in Physics beyond the Landau Paradigm" and has received grant support for five years at \$90,000 per year. There are only about 600 CAREER Awards given out per year across all fields of scientific endeavor.



Fernandes receives Early Career Research Grant

Rafael Fernandes is one of only 35 scholars across the country to receive an Early Career Research Grant from the Department of Energy. The program seeks "outstanding scientists early in their careers" and provides an award of \$750,000 over five years. Fernandes was cited for his paper "Competing Orders in Correlated Materials: Impact of Disorder and Non-Equilibrium Perturbations," by the Office of Basic Energy Sciences.

C-SPIN

The end is near for CMOS technology, and Paul Crowell is trying to do something about that.

"CMOS" stands for "complementary metal-oxide-semiconductor," and CMOS technology is responsible for all the calculators, laptops, cell phones, tablets, and just about every non-abacus computing device in the world. Over the past 70 years or so, scientists and engineers have consistently made CMOS transistors smaller and more energy efficient, which is why your cell phone has more computing power than the most powerful mainframe in 1960. But the smaller transistors get, the more they leak electric current, which makes them less energy efficient and more difficult to keep from overheating. Experts predict that there will be no more room for improvement – literally – sometime around 2020.



So what's next?

Paul Crowell is part of a nationwide effort to answer that question. As the co-Director of the Center for Spintronic Materials, Interfaces, and Novel Devices (C-SPIN), currently housed in Keller Hall, he is guiding an effort to replace the CMOS transistor with one based on an electron's spin. To put it another way, the scientists in C-SPIN are trying to figure out how to make a computer whose binary information is not coded by means of electric current, but the spin direction of electrons in super-small magnets. If they succeed, they will push the absolute limits of transistor size down the road and develop computers that operate on a fraction of the energy today's computers require.

It's a tall order, which is why C-SPIN involves 32 professors and over 100 graduate students and postdoctoral researchers from 18 universities around the country. Funded by the Center, these experts in particle physics, nanotechnology, computer architectures, device design,

materials science, and other disciplines are collaborating to tackle the many unknowns associated with spin-based technology.

Crowell's research for C-SPIN is based primarily on groundbreaking work he did before the Center opened in January 2013. Crowell developed methods for testing the various "spin properties" of materials – that is, how well their electrons can switch spin direction and how easily they pass spin direction to other electrons. The better the spin properties, the lower the energy needed to process and store information. C-SPIN scientists from around the country send Crowell materials for testing, and Crowell sends his results to theoreticians who try to figure out the relationship between the material and its spin properties. These results get sent back to fabricators, who try to make "new and improved" spin materials.

Crowell's C-SPIN research has, like much basic science, led to a number of surprises. Many materials with good spin properties become useless when connected to others, and some materials have had much better spin properties than predicted. As the collaborative process is becoming more efficient, Crowell hopes that he and his fellow scientists can identify the best spin materials and begin fabricating and testing spin-based devices sometime in 2015.

Crowell is also responsible for writing quarterly research reports for the Center's sponsors, enabling him to see possibilities for pooling resources and specialties and to initiate several new collaborative research projects.

Crowell thinks it likely that the computers of the future will have components based on several technologies that currently do not exist, including spin-based technologies. He also emphasizes that spin-based technologies can be used in sensors, magnetic data storage disks, and many other electronic devices that can turn spin properties into useful information. So while the end of CMOS may be near, the beginning of a spin-based electronic future may be just beginning.

The grand opening of THE PHYSICS AND NANOTECHNOLOGY BUILDING

Welcome to PAN



The Physics and Nanotechnology grand opening was held on April 23-24, 2014. It was attended by around 400 people, including many of the legislators and University administrators who helped with the project. The project was completed on time (within two years of ground-breaking) and on budget (\$84.5 Million).

President Eric Kaler, Dean Steve Couch, Richard Beeson of the Board of Regents, Commissioner Larry Pogemiller and Senator Amy Klobuchar all delivered remarks for the occasion.

Highlights of the open house included self-guided tours of the 43,000 square feet of modern and highly flexible physics laboratory and laboratory support space and more than 15,000 square feet of nanotechnology space (including a 5,000-square-foot clean room designed for class-100 chip fabrication and class-1000 bio-nano work). All told, the facility contains 40 new research laboratories.

Visitors entered via the 3M lobby, featuring a video display wall with images of research and a slideshow of the

The new Physics and Nanotechnology building (PAN), features a "social staircase" with seating and charging stations for electronics

building construction. Self-guided tours included the Clean Room, High Bay, Shaul Hanany's cosmology lab, Martin Greven's Quantum Materials Physics Laboratory, the CMS group, the NOvA control room. Groups from industry were present as well, with several buses of visitors from 3M.

Visitors enjoyed the public art located just outside the building titled Spannungsfeld. The sculpture by German-born artist Julian Voss-Andrae consists of two stainless steel figures, a man and a woman, seated across from one another.

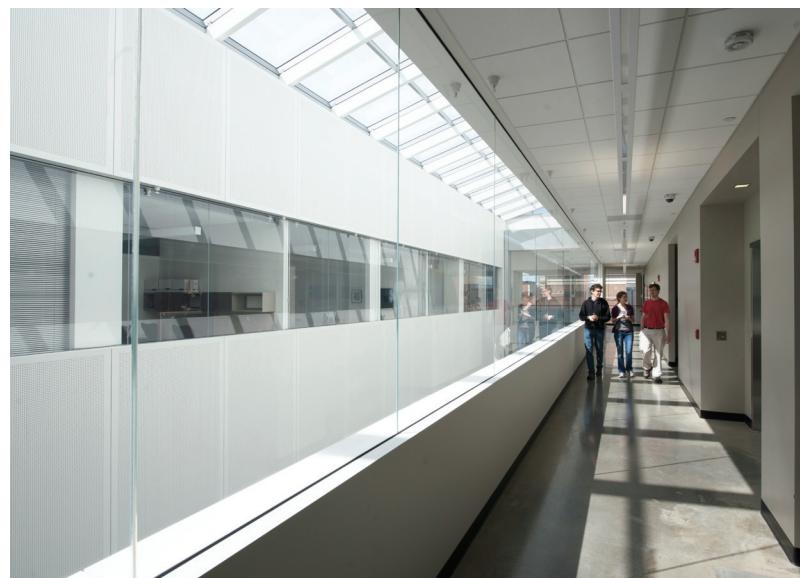
When viewed head on one of the sculptures will disappear and the other will come into view. The work has been widely enjoyed by the whole U of M community and was nominated for a CODAworx public art award.



High bay in the new Physics and Nanotechnology Building.

Feature Story
PAN GRAND OPENING

The Physics and Nanotechnology Building houses 150 School faculty, post doctorate and graduate students, and visiting researchers with meeting and discussion space throughout the building for student interaction with faculty. The process of moving laboratories to the new building is complete.



*Upper left: Peter Hansen and Jared Turkewitz at work in a laboratory.
Upper right: Thomas Hofer , Matt Fritts and Priscilla Cushman use one of the discussion spaces in the new building.*

Lower left: One of Julian Voss-Andreae's disappearing steel sculptures called Spannungsfeld

Lower right: the atrium of the Physics and Nanotechnology building provides natural light for interior offices and corridors.

UNCONVENTIONAL BEHAVIOR

Andrey Chubukov is a condensed matter theorist working in the area of unconventional behavior of electrons: superconductivity, strongly-correlated electron systems, and quantum magnetism. Chubukov says this is an old area, superconductivity was discovered a century ago, in 1911, but that it took fifty years to understand what was going on. “Developments in the last twenty years have been the most important to understanding the physics.”

In the area of strongly correlated electron systems, Chubukov uses the analogy of a demonstration or a protest. If the police go to individuals it is not difficult to arrest them, but if they hold hands, it is very difficult to stop them. “Electrons behave the same way. Superconductivity is when the electrons hold hands and they will not be broken apart. They can then conduct electricity without losses.”

In the case of a non-Fermi liquid, a very strongly interacting system, the electron becomes a diffusive particle with completely random motion. Again Chubukov uses the analogy of people holding hands: “If you have two people who are moving in straight line, they attract each other, and form a pair, but the pair is moving. It is easy to take these pairs and make them to move in same directions. Now imagine these pairs have random motion and are constantly interacting. Now you have people talking and moving at random and you want to force all of them to hold hands and start moving in the same direction.”

“What we are trying to do is to understand why randomness disappears below a certain temperature. It was very easy when there was no randomness in the first place. Chubukov says this is a more difficult problem than conventional superconductivity. “Taking an individual out of the conducting crowd means energy losses. These are the energy losses that we want to avoid, and why our electric bills are so high!” When the electrons were already moving in the same direction it was easy to keep them together and prevent energy losses, but with randomness it requires more effort.”

Superconducting materials based on copper become superconducting at around 100 Kelvin (-100 Celsius). A newer class of materials is based on iron, which one would expect would not work because iron is magnetic. But it turns out that they actually



superconduct at a higher temperature of around 60 Kelvin.

The mechanism of superconductivity in conventional superconductors called the weak vibration effect. If you start out with a system where the atoms have the same charge, they are repulsed by one another and you do not expect them to form a pair. “One atom flies through a lattice and disturbs it slightly, causing a slight vibration. Another atom comes into this area afterwards and ‘feels’ this vibration.” With ferromagnetic superconductors, this lattice effect is too weak to make much difference. So how is superconductivity forming?

“There were very few choices, and people came back to the idea of Coulomb repulsion between the electrons as the cause.” Despite being repulsive, the atoms were capable of producing superconductivity. “If you have enough (on the order of 10^{23}) electrons they occasionally do what is called over-screening. Other interactions cause the sign of the original interaction to change. You can get superconductivity with even a very small over-screening. A lit bit of attraction and you get a pair.”

Chubukov says his goal is to search for something new, “I might make a series of exotic-looking proposals and some of them may work,” he says. One of the main goals of the field of superconductivity is create a superconductor that works at room temperature. He has no doubt that it will be discovered eventually.

STEPS TOWARD QUANTUM COMPUTING

Exotic Phases of Matter

Fiona Burnell is a condensed matter theorist who studies exotic phases of matter. These materials do not display long-ranged order at low temperatures (which is typical of low-temperature behavior in many materials, such as magnets), but are also not ordinary metals. One of the most bizarre examples of an exotic phase is a fractionalized system, where there appear to be particles that carry a fraction of the charge of the electron.

"This seems very surprising because we know that you can not subdivide an electron."

Fractionalization is an example of a collective phenomenon where the whole can behave differently than the sum of its parts. Burnell explains that if you want to understand waves in the ocean, the best approach is not to study the motion of the individual water molecules, but to consider the behavior of the fluid as a whole. Similarly when you zoom in close on a fractionalized system, you'll see only the electrons from which it is made. As you zoom out, though, you will see the collective behavior that makes it look like you have particles carrying (say) a third of a charge of the electron.

One potential application of fractionalized phases is quantum computing. In a quantum computer, information is stored and manipulated in a quantum system. Imagine using the presence or absence of an electron in a nano-scale "box" to represent one of the bits in a hard drive (either a one or a zero). Quantum mechanics tells us that the electron can be simultaneously in the box and not in the box. This strange fact allows information to be manipulated in ways that are not possible on conventional hard drives, making certain problems that are difficult using conventional computers much easier. One big challenge with quantum computing is ensuring that the information captured in these quantum bits is not lost over time: a single electron interacts with the outside world, so that typically your quantum bit will quickly change its state randomly between 0 and 1.

One of the exciting things about the fractionalized systems that Burnell studies is that they encode information in a non-local way, meaning that it is stored in the pattern of correlations of all of the constituent particles of the system, rather than in a particular particle at a fixed location in space. This opens the possibility of more robust ways to store and process quantum information.

One device that Burnell has studied which could be promising for quantum information involves tiny "topological superconducting" wires. In these systems the state of the bit --whether it is counted as a one or a zero--is distributed between the two ends of the wire. The hope is that physicists will be able to change the bit by using a series of manipulations involving other wires. "We are a long way from that right now. The current challenge is to determine whether the systems that are being built in the lab are actually storing electrons in the way that theorists have predicted." Burnell's proposal suggests a way to test such devices to see if they behave in a way that is useful for computation.



Fiona Burnell next to the Wall of Discovery near the Physics and Nanotechnology Building.

CLASS NOTES

1946

Charles E. Jahren (M.S. 1946, Advisor: J.W. Buchta) My experience at the School was extremely interesting and satisfying. My favorite courses were C.N. Wall's Physics (intermediate to advanced), Tate's Electromagnetics and Britchfield's, Quantum Theory. After graduation I worked as a field assistant in the MN Geological Survey. I married and had four children. I am currently retired, living in Austin, TX (present age- 90.)

1950

Clark Johnson (B.S. 1950, Advisor: A.O. C. Nier) I got my M.S. in Electrical Engineering in 1961. After graduation I worked at 3M Corporation. I worked nine years at 3M and then as a high tech entrepreneur, starting five companies. I am now working on radically new data storage technology. I have been married three times with six kids and four grandkids. I travel a lot by train and play duplicate bridge. My favorite memory of the school was finding the gaseous diffusion column to separate U238/U235 that was buried in the stairwell. I remember that William Fuller Brown, Jr. was an impressive and motivating teacher that made physics exciting and, because he was a former English Professor, I learned to write concisely and clearly.

1952

Graham Gutsche (M.S. 1952, Advisor: J. Williams) I got my B.S. at U of Colorado in 1950. I went on to do my Ph.D. in 1960 at Catholic University of America. After graduation I worked at U.S. Naval Academy. I am now retired. My favorite thing about the School was the close-knit nature of the graduate students. I also enjoyed my association with Dr. Harry Johnson (research associate) which was personal, social and professional. My favorite course was E. L. Hill's Introduction to Mathematical Physics. John Williams was a very supportive advisor.

1953

Kaworu C. Nomura (B.S. 1948, M.S. 1949, Ph.D. 1953, Advisor: E. L. Hill) After graduation, I worked at Honeywell. I became a writer after retiring in 1987 and published three books and one translation "Sleeping on Potatoes," Business Success with less Stress," and "How to Solve Difficult Sudoku Puzzles." I received the Outstanding Achievement Award from the University of Minnesota and Honeywell's highest award, the CEV Award. Hill's Mathematical Physics was my favorite course.

1956

Arthur F. Hayes (B.S. 1956, Advisor: M. Blair, M.S. 1960, Advisor: G. Freier) After graduation, I started my 34-year career at Honeywell as an Evaluation Engineer. I worked on navigation, fire control, marine and space systems. I was the co-inventor of the "Hot Line Gun Sight" for fighter aircraft, for which I received the Honeywell Sweat Award in 1970. I also worked on the development of Honeywell systems for the Space Defense System Initiative, or "Star Wars." I retired in 1990 as a Project Engineer. I then became a Church Business Administrator at the First Presbyterian Church in Bellevue, WA. I refer to this second career as moving from near space to outer space. I retired again in 2000 and moved to Florida with my wife of 60 years, Jacqueline. My favorite memories were the times I spent dating Jacquie; going to football games, watching Paul Giel; going to hockey games and watching Ken Yackel; and studying in the Engineering Library. We lived on the Saint Paul campus

and sometimes had the pleasure of sitting next to Dr. Nier as we traveled on the intercampus trolley. My favorite physics courses were A. Nier and G. Freier's Modern Physics, E. Hill's Mathematical Physics f and M. Blair's Electronics.

1957

Morton K. Brussel (Ph.D. 1957 Advisor: J. H. Williams) I am a retired Professor Emeritus from the U of Illinois. I have just moved to a retirement community. I am still active with interest in politics, sustainability, human rights, and inequality. I remember fondly my fellow Ph.D. students and physics staff. My favorite courses were Hill's Mathematical Physics and Hintz's Nuclear Physics.

Sedley C. Davis (M.S. 1967, B.S. 1957, Advisor: E. P. Ney) I worked 21 years as Air Force Electronic Warfare Officer and 32 years full- and part-time as computer system manager/analyst/programmer. My favorite professor was Dr. J. Morris Blair. I am now retired in Austin, TX.

1959

Roger Agard (B.S. 1957, M.S. 1959) After graduation I worked for thirty years at Honeywell Corporation in R & D plus eight years with Butler Instruments in Chaska, MN. I have been retired for 16 years, spending the winters in Florida and the summers in Minnesota. My favorite memory is the balloon flights to get data for my Master's. My favorite professors were G. Freier, E.P. Ney, A.O.C. Nier, and J.R. Winckler.

1961

Stan Brodsky (B.S. 1961) I got my Ph.D. in 1969 under Donald Yennie, followed by a postdoc at Columbia, then Stanford. I am a professor at SLAC National Accelerator Laboratory, Stanford University. I recall a physics honor class with Professor Ed Ney. He was in Africa for an astronomy observation. His Jeep overturned, and he broke his clavicle. However, he told our class that he declined medical attention since the physics mission was too important!

Donald Vierimaa (B.S. 1960) After graduation, I worked at North American Aviation. I am retired. My favorite course was Thermodynamics.

Earle Kyle (B.S. Physics 1961) I have fond memories of a bunch of us brainstorming in our American Institute of Physics student chapter club room (when I was president) trying to create a block diagram of the human brain so we could design an artificial intelligence computer system. (Boy, were we naive trying to crack this tough nut!) But one of us, the late John Leslie Pollock, (B.S. CCE 1961) did go on to become an accomplished expert in the field. I'm single and a great grandfather. I love photography, working out with my son, reading and writing, discussing cosmology with my son who is finishing his Ph.D. at Columbia and visiting my daughter. In April 2014 I was one of the Minnesota Go Boldly Challenge Honorees for extraordinary achievement in aerospace, where I got to meet Buzz Aldrin, who visited the moon in the spaceship I helped design. For over 12 years I have been working with NASA's Solar Sy. I am now Executive Director at TCC Systems, LLC, a consultancy to increase minority and female participation in Science, Technology, Engineering, and Math (STEM). I remember

CLASS NOTES

Edward Ney who was funny, humble, and so accomplished. He inspired me to join the team in the cosmic ray research lab to help design instruments on the OSO-I Orbiting Solar Observatory.

1962

Stuart F. Goldstein (B.A. 1962, Advisor: O. Schmidt) After graduation, I got my Ph.D. in physics in 1968 at Caltech. I am a Professor Emeritus of Genetics, Cell Biology and Development at the U of MN, TC. I retired last year after 42 years. I am married with children, living in Minneapolis. As an undergrad, I worked in Otto Schmitt's biophysics lab. I not only learned electronics, but I got to see research being done, meet researchers and confirmed that I wanted to get a Ph.D. and do research. Blair's electronics course was a terrific one-year introduction to circuits. I still have my course notes after 50 years! Lawrence Johnston was one of the best teachers I ever had, for any subject.

Roger I. Johnson (B.S. 1962, Advisor: J. Winckler) I taught physics and engineering at North Hennepin Community College from 1996 to 2000 and set up its engineering program. I retired from MnSCU Teaching of Physics and Engineering. I lobby and volunteer advocating for education funding. Among my favorite memories were arranging speakers for our AIP Student Section; working with lab equipment to make measurements of all kinds; and working on John Winckler's projects searching for cosmic rays. My favorite professor was George Freier, in Physics 7, 8, and 9.

Richard E. Pontinen (Ph.D. 1962, Advisor: T. M. Sanders) I have been at Hamline University as a Professor for 32 years, and Department Chair for 22 years. I am married with two children (both physics majors), and two grandchildren. My favorite memory was the discovery of a "new" resonance in 86 doped GE (good for a Ph.D.). Tim Sanders was my favorite professor.

1963

John Kronholm (B.S. 1963) I am retired. I was formerly chair of the math/physics/astronomy/engineering/comp sci. department at Minneapolis College. My wife and I enjoy backpacking and canoeing. I enjoyed Bolsterli's informal, no or very few notes, approach to lecturing. I was impressed by Nier's bringing out the U235/238 separation tube. Nier's Classical Mechanics was at 8:00 or 9:00 a.m. after my 4:00 a.m. job, in the old steam radiator heated room in Folwell. I would usually fall asleep and my roommate would poke me if I snored. I graded for freshman physics one summer which only paid minimum wage. I recall Werutz having us turn in double our actual times to compensate.

1965

Carol H. Kern (M.S. 1965, Advisor: W. J. Luyten) After graduation, I raised a family and started a community library. I am now the director at the Western Pocono Community Library in Pennsylvania. I have been married to my husband, Peter for 52 years. We have three children and four grandchildren. I received numerous awards for work with the library. I founded Western Pocono Community Library in 1974, which expanded in 2000 to a new building, serving a

community of 35,000. My favorite memories are driving to class each morning with friends in the School of Law, parking under a bridge near University Avenue and walking a mile and a half to class at 30 below and having my eyelids freeze shut! I also remember experiencing the joy of ice skating on the Mississippi at Lyndale and 65th Avenue North. W.J. Luyten was a superb teacher and a wonderful mentor during my two-and-a-half years as a graduate assistant in the Astronomy department. My "Proper Motion" work was exciting!

1966

Paul Nyhuis (M.S. 1966, Advisor: Freier) After grad school, I went to Inver Hills Community College. From 1970 to 2000, I taught physics and math at Concordia College, St. Paul and physics, astronomy, and engineering at Inver Hills Community College. I have been doing pastoral care and jail ministry since 2001. I use my physics and astronomy background to build conversations with inmates. I am also a Care Pastor at the Gallery Covenant Church, St. Paul. My wife Gayle and I will celebrate our 50th wedding anniversary this year. My favorite favorite courses were R. Hobbie's Modern Physics and W. Zimmermann's Thermodynamics and Quantum Mechanics.

Larry M. Peterson (B.S. 1966) After graduation, I went to Penn State University. I am now a semi-retired after 40+ years as a research physicist in laser applications at Ann Arbor, MI. I still enjoy playing pond hockey in winter. I am married with three children and three grandchildren. My favorite memories are teaching courses in electrical engineering; and working in the Senior Physics Lab with liquid helium, measuring second sound and building a simple mass spectrometer. I remember Engineering Day, when graduate students would set up demonstrations of the research work. My favorite course was C. J. Waddington's Mechanics.

1967

Robert A. Breun (B.S. 1967) After graduation I went to the University of Wisconsin-Madison where I was a Senior Scientist in Engineering Physics for 22 years. I am currently retired. I married my wife, Jane in 1971 and we have two children: Laura (lawyer) and Karen (adjunct assistant professor at UCLA). My favorite memories of the School are working as a student lab assistant for the fledgling high energy physics group and flying in a Turboprop to Argonne to analyze bubble chamber pictures - what a hoot! It was a great way to spend a weekend and it was the only time equipment was available to the UM group. My favorite course was Waddington's Introductory Physics. He was an extremely good and articulate lecturer. The class was early in the morning though!

Steve Gustafson (B.S. 1967) After graduation, I went to graduate school at Duke University. I retired after 23 years as a physicist at the University of Dayton and 17 years at Air Force Institute of Technology. I have been married for 44 years with two sons and one grandkid. My favorite part of the School was working as an undergrad research assistant in Dr. Earl's cosmic ray lab, including two summer trips to the magnetic north pole. My favorite course was Ney's Cosmology.

CLASS NOTES

Frank T. Mabley (B.S. 1967) After graduation, I worked for NASA at the Manned Spacecraft Center for four years, first with landing and recovery with Apollo program and then for lunar surface experiments. After NASA, I returned to MN for law school. I have been an attorney since 1974. I proposed to my wife in the math/physics library. I met her in a cave in southern Minnesota when we were both on a spelunking trip with the Minnesota Rovers. I was widowed after 43 years. I have two daughters who are U of M grads and one grandchild born 37 hours before my wife's death.

1968

George R. Alexander (B.S. 1968) My favorite memories from my undergraduate career at the University come from my position as the Vice President of the student YMCA/YWCA club. After graduating I fought in the Vietnam War. Today my favorite hobby is writing letters to editors, politicians, and corporate executives.

William A. Bardeen (Ph.D. 1968, Advisor: S. Gasiorowicz) After graduation, I was a postdoc at SUNY – Stony Brook, and at the Institute for Advanced Study at Princeton. I was faculty member at Stanford University. In 1975 I joined the staff at Fermilab and I worked there for thirty-five years, serving as Head of the Theoretical Physics Department. I also worked as Head of Theoretical Physics at the SSC Laboratory during 1993-94 until its termination. In 2010 I retired as a Scientist Emeritus of FermiLab. I live in Warrenville, IL with my wife, Marge. We have two grown children, Chuck, an atmospheric scientist, and Karen, a high school chemistry teacher. (Please see alumni highlight: <http://www.physics.umn.edu/alumni/Newsletter10-3-6-09.pdf>)

Alan Kiecker (B.S. 1968) I did an undergraduate experiment in second sound in the low temperature physics lab at the School. After graduation I worked six years as civilian in US Navy R&D Lab. I went to work as a software engineer for Sperry-Univac, now Unisys. I retired after 38 years with them. I have been married for 42 years, with four children, and four grandchildren. I am a very active amateur photographer.

Horst L. Truestedt (B.S. 1968) My advisor was Dr. Poppe. I worked in physics at 3M while finishing my degree and then worked for IBM for 30 years before retiring in 1997. I started a consulting company for computer storage, high-speed interfaces, and data centers called TrueFocus, Inc. I am married with two daughters and five grandchildren.

1969

Rufino H. Ibarra (B.S. 1963, Ph.D. 1969, Advisor: B. Bayman) I am now retired. My wife and I love travelling to European countries. I have fond memories of my time in Minnesota. It was a great school and a great city. My favorite courses were Zimmermann's Quantum Mechanics and Bayman's Nuclear Physics.

James Kish (B.S. 1969 Advisor: William R. Webber) I had had an interesting career in astro-physics at the U of Minnesota and the U of New Hampshire. I also had a computer business in NH for many years. Working for Dr. Webber for many years allowed me to travel to remote parts of the world, flying large balloons for research in cosmic ray astronomy. I am now retired and living in Las Vegas, NV. I have two children, a daughter (Santa Rosa, CA)

and a son (Austin, TX). I have two wonderful grandchildren.

Charles Reinert (B.S. 1961, Advisor: Ney, M.S. 1963 and Ph.D. 1969, Advisor: W.R. Weber) After graduation, I worked in education at Southwest MN State University. I am the founder and lead therapist at Helping to Heal Clinic in Tracy, MN. I am a grandfather, a father, and a husband. As a student, I was a member of Edward Ney's Solar Eclipse Expedition to West Africa in 1958. My favorite courses: P. Kellogg's Plasma Physics; Ed Ney's second year Honors Physics course, and M. Blair's electronics class.

Stephen Snyder (B.S. 1969) After graduation, I attended Harvard Law School. I am now an attorney at Snyder & Brandt, P.A. I am married with two sons and two grandsons. I have practiced law for 40+ years as a trial lawyer. My physics degree has given me an advantage over opponents in working with statistical, economics, and other technical experts. I remember that tuition at that time was a flat rate for each quarter regardless of credits, so I would regularly take an extra course each quarter. At that time there were no non-technical requirement, so I filled my schedule with courses like Asian History, Composition, Public Speaking, Accounting, English History, World and Political History, which was a great pre-law preparation.

1970

David G. Madland (Ph.D. 1970, M.S. 1969, Advisor: Norton Hintz) After graduation, I was a postdoc at Indiana University. I worked over 30 years in the Theoretical Division at LANL with seven years as Deputy Group Leader of the Nuclear Physics Group. I am now retired. I married a pianist, and we have a daughter and two sons, and six grandchildren. We hiked to the bottom of the Grand Canyon 11 times on different back-country trails. My favorite memory is my Ph.D. thesis defense and the celebratory party at my thesis advisor's home, N.M. Hintz. It was a blast. My favorite and most respected professor was Ben Bayman who taught Theoretical Nuclear Physics. I took his course once for credit and it was so good that I audited a second time.

1971

Ronald M. Krell (M.S. 1971) After graduation I earned a master's degree from Indiana University in public affairs. I worked at U.S. Naval Undersea Warfare Center, Division Keyport. I retired from Keyport in 1997 where I as a major DoD program Manager and Department Head. My wife and I have visited 46 of the 50 state capitols and Russia, China, Peru, Israel, Egypt, Turkey, France, England, Scotland, Ireland, Italy, Croatia, Switzerland, Austria, Hungary, and a few other countries.

1972

John Christoffel (B.S. 1972, Advisor: A. Goldman) I enjoyed many of the classes and mostly meeting new friends at the School. The Vietnam War was in full swing during my undergraduate education, so a lot of the usual college fun felt more subdued. I worked at Honeywell for thirty years, with five years as a senior scientist, taking various management positions for the next twenty-five years. My physics background always helped, since I could get a good fundamental understanding regardless of discipline. I am married with four kids and two

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grandkids. I volunteer for the Special Olympics and for Feed My Starving Children. In my free time I like to hunt, golf, fish, bike, and cross-country ski.

Frank R. Harder (B.S. 1972) After graduation I joined the military at USAF working in electronic systems. I also managed a precision measurement equipment repair facility. Now I am the President of The Tioga Group, Inc. in Philadelphia, PA. I am married with two grown children. I am a committed Christian.

1973

Jacqueline Aguilera (née Korent) (B.S. 1973, Advisor: S. Gasiorowicz) After graduation I worked at 3M Corporation. I retired from 3M as Research Specialist in 2009 and returned to work part-time at 3M in my former lab as a Technical Specialist in 2013. After a few years in R&D using optical physics, I transferred to the Corporate Research Analytical Lab using transmission electron microscopy. I retired in 2009, after 35+ years. My favorite memories are working on my senior project in the student machine shop, thankful for the staff members who guided me. I also enjoyed my job in the High Energy Physics lab doing manual image analysis measuring particle interactions on film, and the friendships formed in that lab. I remember Clayton Giese fondly for his patience with the length of time it took me to complete my senior project.

Bob Akaki (B.S. 1973, Advisor: G. Freier) I am retired after 30 years with telephone company, Northwestern Bell, US West, Qwest, and two years with IBM. For the last 25 years I have been a programmer/analyst with 18 years as systems programmer. I am divorced with two children, and have been a single parent since 1989. My favorite memories are Dr. Freier's many demonstrations during General Physics and the "Star of Bethlehem" Lecture, by Dr. Kaufmanis. My favorite courses were General Physics and later Cloud Mechanics taught by Dr. Freier. I did not have a job where my physics degree was directly applicable, but the skills and thought processes and scientific methods I learned helped make me successful.

Donald W. Hillger (B.S. 1973) After graduation I attended Colorado State University and received a M.S. and Ph.D. in Atmospheric Science. I am currently at National Oceanic and Atmospheric Administration (NOAA) Regional and Mesoscale Meteorology Branch in Fort Collins, CO. I am currently the Acting Branch Chief for a group of NOAA meteorologists stationed at Colorado State University. I am an avid postage stamp collector and have published numerous articles on the topic. I remember fondly two years where I was in charge of the weather map facsimile machine, which displayed the weather maps in Tate Lab. I particularly enjoyed the astrophysics courses that I took at the U of M.

1974

Gary Bickel (Ph.D. 1974, Advisor: S.A. Collins) After graduation I worked at ITT Electric in the Optical Products Division. I worked 30 years in fiber optics communication technology, optical fiber characterization, standards, coupling and connector technology, fiber manufacturing process, ISS F.O. components and launch facility communications. I retired in 2004 and now do freelance paleoclimatology. I have been married 50 years with six grandchildren, one great-grand-daughter and three children. I enjoyed being a lab TA for a class that was predominantly pre-

med. Ben Bayman made classical mechanics understandable. My favorite course was L. H. Nasanow's Solid-State Physics.

James McLinn (Ph.D. 1974, Advisor: W. Zimmermann) After graduating I worked at Control Data doing mainly electrical and failure analysis. Physics was good background for this. I am a widower with two children and two grandchildren. My favorite memories were teaching Astro classes as a TA and using the 10" telescope on the roof. We opened the telescope to the public for one lunar eclipse in February. People showed up at 2 am. My favorite professor was Paul Kellogg.

1975

Kristine Black (B.S. 1975) After graduation, I received a M.S. in Cell Biology in 1981 and an M.S. in Materials Science in 1983. I worked for thirty years in microelectronics and medical devices and retired in 2008. I am married with two step-children and four grandchildren. I use my creative skill to make handmade gift cards and organize craft drawers. So many great teachers - Kaufmanis, Broadhurst, Hammermesh and they spent time with us. Hammermesh used to take us to lunch and tell us about the Manhattan project! I enjoyed Broadhurst's measurement class which taught us how to apply the theory to real-life applications.

Tim Bornemann (B.S. 1975) After graduation, I got my masters in Engineering at the U of Illinois, then my Finance Cm.B.A at the U of Michigan. I began my professional life as an engineer designing machines, working my way up to run the day-to-day operations of a \$250m/year manufacturing company. I am the president/owner of Lean Training and Coaching. I also serve on the Board of Directors for two other firms. I have three daughters and currently five grandchildren. I enjoyed people watching around the campus in the spring. My favorite course was Quantum Mechanics. It radically effected how I thought not only about science but about everything else, teaching me that things are not always as they seem.

Steve E. Kahm (B.S. 1975) After graduation, I went to Hamline University Law School. I became a patent attorney and am now retired. I worked on Aerospace patents for NASA, DOE and DOD contractors and for law firms. I worked on patents in many different technologies. I met a lot of great scientists who became cherished friends.

Richard Robinett (B.S. 1975) After graduation, I did a postdoc at UW Madison, then at UMass. I am a faculty member at Penn State, currently Associate Department Head. I have been married for 30 years with two grown children. There were excellent teaching and abundant research experiences at the U of MN. All faculty (save one) throughout my undergraduate career were excellent instructors. We had a very collegial atmosphere among the undergrads. My entire career was based on the great start I had at UM. Does anyone know of a LinkedIn U of MN Physics alumni group?

1976

Allen Olson (B.S. 1976) After graduation, I worked in movie sales. Now I am the Master of Properties of the Texas Ballet Theatre. I performed at Renaissance Festival for 30 years before getting into the technical side of theatre. I am married with two stepdaughters, one daughter, and two grand-daughters.

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My favorite memory is the first day of Modern Physics when the instructor spent the entire hour writing down everything we had learned to that point and quizzing us on it. Then he ended the hour by erasing it all, saying "just kidding - tomorrow we start Modern Physics." Steven Gasiorowicz was fun.

1977

Louis A. Rose (Ph.D. 1977, Advisor: E. Ney) After graduation, I did a postdoc at Goddard Space Flight Center. In 1981 I joined the Naval Research Laboratory (NRL) as a research physicist for 25 years. I retired from NRL in 2006. I then taught at the U.S. Naval Academy and Lipscomb University. My wife, Emmanuel, and I have been married for 47 years and have three children. When Dr. Ney gave a colloquia at Goddard, Dr. Frank McDonald (Ph.D. Physics, 1955), one of Dr. Ney's first PhD students, introduced him by saying "It is sometimes said that there is a Minnesota Mafia at work in NASA. If that be true, then our speaker today is surely the Godfather." Dr. Ney then gave one of the most entertaining lectures I had ever heard. Afterwards one of my fellow postdocs said to me, "Wow, working for him must have been a lot of fun." Dr. Ney was one of my heroes and working with him was one of the highlights of my professional life. The training in radiometry I received from P. Roll and E. Ney helped prepare me for the work I did later at NRL.

1978

Hardayal S. Gill (Ph.D. 1978, Advisor: W. V. Weyhmann) After graduation, I worked at the National Semiconductor Corporation. I am a technologist in San Jose, CA. I have been very active in magnetic data storage, currently holding 320 granted U.S. Patents. I was elected IEEE Fellow in 1995. In 1997, I was named an IBM Distinguished Engineer. My wife, Seema Dhillon and I have a son, Kavi. Ben Bayman was always available to answer any questions and help students. I fondly remember his practice Ph.D. written exams. My favorite professors were W. Weyhmann, A. Goldman P. Ellis, B. Bayman, W. Halley and C. Campbell.

1979

Tom Christensen (B.S. 1979) After graduation, I got my Ph.D. at Cornell. I am a professor of physics at the University of Colorado, Colorado Springs. I am a former department chair and dean. I currently co-direct a science teacher certification program working with SPS chapter and starting the π chapter. I am married with two daughters. I play string bass in the community orchestra. My favorite course was Huang's Statistical Mechanics.

1980

Thierry Copie (B.S. 1980) I am a Senior Member of Tech Staff at the MIT Lincoln Laboratory. I joined MIT Lincoln Lab after completing my Ph.D. in physics at Cornell and have been there ever since. I am married with one daughter and one cat. My favorite memory is doing an internship in Heller's group at FermiLab in 1978. I was hooked on experimental particle physics after that. K. Heller was my favorite professor. He introduced me to the great field of experimental particle physics. My favorite course was Peterson's Electricity and Magnetism.

1984

James Povlis (Ph.D. 1984, Advisor: K. Heller) After graduation, I worked at Hughes (now Raytheon) where I wrote software. I am

now retired and doing fine. I enjoyed my time at Fermilab and the course in particle physics.

1986

Brian P. Beecken (Ph.D. 1986, M.S. 1984, Advisor: W. Zimmermann) After graduation, I worked at Texas Instruments. I am now Professor and Chair of the Physics Department at Bethel University.

Gerald C. Blazey (Ph.D. 1986, Advisor: E. Peterson) After graduation, I went to Northern Illinois University and then to the White House, Office of Science and Technology Policy. I am now a Professor of Physics at Northern Illinois University. My favorite memory is chasing bats in the Soudan mine!

James DePuydt

(Ph.D. 1986, B.S. 1981 Advisor: D. Dahlberg) After graduation, I started as a postdoctoral temp in 3M Corporate laboratory, and was hired as full-time scientist one year later. I am now an executive director at Imitation Corp. I also do consulting. I am the co-inventor of blue-green laser diode. I am married with six daughters. My hobbies include biking, fishing, camping and fitness. I enjoyed the comradery in graduate school, forming great friendships with Scott Fricke (Ph.D. Physics, 1985), Jim Davidson (Ph.D. Physics, 1985), and Brad Orr (Ph.D. Physics, 1985), and Anne Mason (Masters. Physics, 1984). I remember trips to the Soudan mine and canoeing down the St. Croix. A memorable course was M. Marshak's Freshman Physics. He always seemed to have trouble with the demonstrations. Once he used a bike wheel and sat on a rotating chair to demonstrate conservation of angular momentum. The chair started spinning and he became dizzy and fell from the chair.

1987

Rebecca (Becca) Emmons (M.S. Physics 1987, Advisor: R. S. Jones) After graduation I taught at community colleges. I got a Masters in Library and Information Sciences (1996) and worked as a librarian at an engineering firm. I am married to a scientist (Ph.D. in Optics). I am currently a homemaker and volunteer. We have no children. I remember one Halloween Professor Kapusta arrived in class in a white lab coat and an Einstein mask. He gave the entire lecture in the mask with several absent-minded moments. I worked in the lecture-demo area with the Physics Force and on the first computerized Demonstration Handbook, helping create the first set of graphic illustrations. I am glad I had a chance to know and work with Phil Johnson. My favorite professor was Bob Lysak with his plaid shirt, hiking boots, and once-a-year haircut. I was fortunate to have him five/six terms. He was an excellent teacher from whom I learned a lot.

1989

Janet Hoskin (B.A. 1989) Graduation was my ticket out of poverty. I began college as a single mother living below the poverty level. After graduation, I worked at Hawkins Chemical. Leveraging my degree, I gained experience and professionalism and I now earn more than \$100K/year. I work as a supplier development engineer with Chassis Component Suppliers for Polaris ATV's, R&R's, Rangers, Slingshot, Victory and Indian Motorcycles. I extensively use Lean and Six Sigma tools as well as statistics every day. I am married with two kids. My son graduated from U of M (B.S. Mechanical Engineering) and my daughter just came out of the Army. I have one grandchild. We spend time at our cabin up north, gardening and being with our cat and dog. In my undergraduate education, I truly learned the most in the physics labs.

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1991

Faith Abney (B.S. Astrophysics/Physics) After graduation, I worked at Space Telescope Science Institute. Now I am a Data Processing and Archive Services Branch Manager in Baltimore, MD.

Mark Berg (B.S. Physics) After graduation, I attended the U of MN Medical School. Now I am a partner in Parkview Medical Clinic in New Prague, MN. I married Julia Berg ('95 B.S.N., U of M) and we have three children: James, a senior in high school; Mariah, a junior in high school; and Cate, a sixth grader.

1992

Lisa Umhoefer (Siskind), (B.S. Physics, M.S. Biophysical Sciences, 1993, Ph.D. Medical Physics, 2005) After graduation I went into the medical field and was self-employed. Now I am a Locum Tenens Medical Physicist based in Portland, OR. My favorite memory was Greenlees' Modern Physics. He could be a little crabby - but very funny! And he had the best tennis shoes.

1993

Martha Anderson (Ph.D., Astrophysics, Advisor: L. Rudnick) After graduation I did a postdoc at UW Madison in the Soil Science Department. Currently I am a Research Physical Scientist, working in satellite remote sensing of drought and crop water use at the USDA Agricultural Research Service, Beltsville MD. I am married to a groundwater hydrogeologist in the U.S. Forest Service, with an 8-year old son Niklas.

Rodney Olson (B.S., Astrophysics) I teach astronomy and physics at Crespi Carmelite High School in Encino, CA and also serve as the Science Department Chair. I was selected by the National Science Teachers Association to become a Next Generation Science Standards Curator. Both of my children will be in high school this year. I have very fond memories of my time in the astronomy department. I spent a lot of great days and nights at O'Brien and Mt. Lemmon. We had great, accessible professors who served as wonderful mentors. I taught the introductory astronomy lab course for three years which helped me realize that I wanted to become a teacher. I am still friends with a number of classmates, Brooks Rownd (B.S. Physics/Astrophysics, 1993) and Bill Ketzeback (B.S. Physics, 1994).

Brooks Rownd (B.S. Astrophysics) After graduation, I attended the U of Massachusetts, U of Colorado, and Harvard-Smithsonian. I am currently an Electronics Technician at Harvard-Smithsonian Submillimeter Array in Mauna Kea, HI. My hobbies are doing bird surveys and locating rare plants in the native wilderness here in East Hawaii. I remember early mornings in the Astronomy reading room, trips to spooky O'Brien Observatory, and very late nights in the basement electronics laboratory. My favorite courses were the advanced electronics lab using the excellent old Horowitz & Hill text, and Woodward's Computational Methods course.

1994

Christian P. Minor (B.S. Physics) I got my Ph.D. in astrophysics at UC-Riverside and then worked as a scientific contractor at the U.S. Naval Research Laboratory where I currently work as a Senior Staff Scientist. My research is in multi sensor system design, data fusion, and machine learning. I am married to Amy Pemble. We have a son, Miles, and daughter, Maisie, under the age of two.

We are very much involved in parenting, but we try and get back to Minnesota to see family as often as we can. My favorite memories were working on the Soudan 2 project; and the time and patience all the professors had with my endless questions about physics. All of my professors at U of MN physics and math were favorites and I learned a tremendous amount from them all.

George A. Rosevear (B.S. physics) My favorite memories are looking at Saturn through the telescope on the roof and getting locked in for one of the experiments at the Particle Accelerator on the River Flats. My favorite course was Gasiorowicz's "Introduction to Quantum Mechanics."

1995

Jeff Stehr (Ph.D. Advisor: Mauersberger) After graduation I did a postdoc at the University of Maryland. Now I am an associate at Booz Allen Hamilton, on-site at NASA Headquarters. I am married with one child, perform improv comedy on weekends at the Comedy Spot, and teach weather and climate classes to local Master Naturalist groups. I support the director of Applied Sciences at NASA Headquarters in the Earth Science Division, using technical and communication skills I learned along the way. My favorite memories have to do with the people I met there and the things I did with them. Founding the Physics Grad Student organization, playing hockey with the Astropucks, and going rock climbing in St. Paul on Tuesday nights were all great. At the end, it was a great honor to graduate on the same stage, in the same robe as my father and grandfather did decades before me! I am terribly biased, but my advisor, Konrad Mauersberger, taught me about the science, the important of focusing on getting it right, and publishing good papers instead of just flooding the world with more of the same junk. And I will never forget the kind, humble brilliance of Ben Bayman or the Motown phonon from Jim Kakalios. Thanks!

1996

William (Bill) Ketzeback (B.S. 1994, Astrophysics, Advisor: T. Jones) I am currently Chief Telescope Engineer at Apache Point Observatory, Sunspot, NM. I have been married for ten years to my wife Lisa. We have three children, Ben (25), Keegan (22) and Maggie (8). I enjoy spending time with the family. My hobbies include reading and researching my family history. I have fond memories of several of the professors Drs. Skillman, Humphrey, Gehrz, T.Jones and T.J. Jones were my favorites. I have several favorite memories from school. Many involve spending time working in Dr Roberta Humphrey's Automated Plate Scanner lab, the IR lab, and the O'Brien Observatory.

Robert Zubeck (B.S. Physics) After graduation, I got my Ph.D. in Applied Physics at Stanford University. I am now retired from my job as Director of Technology at Miasole Soler. I am currently travelling. My favorite memory is Dr. Ney giving a lecture in a gorilla suit. Dr. Ney's Honors Physics course got me trapped (hooked) on physics stuff.

1998

Heather L. Grebe (M.S. Astrophysics, 1998, B.S. 1996, Advisor: T. Jones) I worked as an actuary for 12 years and I became a fellow in the Society of Actuaries. I went to night school to get my teaching license. I became a high school physics teacher in 2010. I am currently a science teacher at South Education Center Alternative, Richfield, MN. I am married with a son and daughter. Although I have always been interested in astrophysics, I have never been one for telescopes. I was shown how to use the telescope on top of the

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physics building in order to lead the viewing nights. When I aimed and looked through it, I exclaimed "Hey! You can see Saturn's rings!" My other good memories of the School include Kakalios's jokes in Modern Physics, my summer internship, and Courant's stories about his time in Los Alamos.

Bradford Hill (B.S. Physics) After graduation, I got my M.S. in Physics from the University of Maryland, and an M.A. in Science Education from UC Berkley. I am a high school physics teacher in Beaverton, OR. In 2014 I was awarded the AAPT Paul W. Zitzewitz Excellence in Pre-College Teaching Award, the Outstanding Classroom Teacher Award by the Oregon Science Teachers Association, and became a finalist for the Presidential Award for Excellence in Science and Math Teaching. In fall 2014 I will be President of the Oregon Science Teachers Association. My time at the University was filled with great intellectual growth, lasting friendships, and a lot of ultimate frisbee (where I met my wife). I remember an evening study session for an E&M final exam. A group of us were crunching out problem after problem when it began to rain. The mall flooded and we ran outside to do lay out catches with a frisbee, sliding twenty feet on the flooded grass, shooting streams of water along the way. Afterwards we went back to studying and all did well on the exam. Being a research assistant in Dahlberg's group was some of the best education I have ever experienced. I learned what science is really about.

1999

Jon Huber (B.S. Physics) I got my Master's in Science Education in 2010. I teach high school physics and mentor the robotics team in Burnsville, MN. My favorite memory was working as a junior scientist trainee for the undergraduate labs under Kurt Wick, where I tested out new labs and worked with the professors.

Usman Suriono (Ph.D. Physics, 1999 M.S. Physics 1997, B.S. Physics, 1993 , Advisor: D. Polla) After graduation, I worked at Pratt & Whitney, Polar Semiconductor, and as adjunct faculty at ITT Tech. I am currently a Principal Device Development Engineer. I love the variety and flexibility of my job. My physics background is essential for tackling novel tasks. I have a wife and three daughters. I enjoy home improvement projects and gardening. I also play guitar in a church band. My hobbies are microcontrollers and robotics.

2000

Andrew Ferstl (Ph.D. Physics, Advisor: K. Olive) What I remember most from the School is conversations about physics and other topics of the day with my peers and professors. The seminars and colloquiums were also memorable. I graduated the same year as my wife, Kerri Ferstl (Ph.D. Psychology). We have two children. I enjoy volleyball, mountain and road biking, hiking, and attending my son's soccer matches. I currently serve as Chair and Professor of the Physics Department at Winona State University. I also lead workshops for K-12 teachers throughout the year and organize Science Fun Nights (science shows) for local elementary schools. I have the pleasure of working with Nathan Moore (Ph.D. Physics 2006) and Jennifer Anderson (B.S. Physics 1998).

2001

Paul Way (M.S. Physics, Advisor: J. Wygant) After graduation, I worked as a physicist for the Environmental Protection Agency. I

returned to MN to work in R & D for Donaldson Company, where I currently work as Director, Global Computational and Test Systems. My favorite course was Bayman's classical mechanics. His teaching style was fantastic. I also enjoyed working with J. Wygant and his group. I remember cookies on Wednesdays at symposium, Bayman's bus stop problems from classical mechanics, working on observational data/physics on the fourth floor. I am married to Sarah (Alfano) Way (M.S. Physics 2002), with two children, Evan and Cathryn.

2002

Luis Hernandez (Ph.D. Physics, Advisor: Goldman) I am the lead on an advanced program for BAE Systems in Fridley, MN. I completed my MSMOT degree from the University of Minnesota's Technology Leadership Institute in 2012. I have been married for ten years and I have four daughters.

2003

Andrew Cady (Ph.D. Physics, Advisor: C. C. Huang) After graduation, I did a postdoc at Argonne. Now I am a Senior Display Engineer at Microsoft, developing displays for Microsoft surface products. I work on the products from concept to production. I travel to Asia a lot, and I enjoy working with many different people in varying roles from all over the world. I am married to my wife Melissa and we have a son, James. My favorite courses were Bayman's Classical Physics, Kakalios' Condensed Matter physics. My favorite professors were C.C. Huang, P. Crowell, W. Halley, B. Shklovskii, O. T. Valls and L. Glazman.

Ricky Egeland (B.S. Astrophysics) I was recently awarded a Newkirk Fellowship to study the solar dynamo at the High Altitude Observatory.

Jim Lyke (Ph.D. Astrophysics, Advisor: R. Gehrz; B.S. 1997) After graduation, I worked at W.M. Keck Observatory. Currently I am a Support Astronomer II in Hawaii where I am responsible for keeping a subset of Keck's astronomical instruments in top shape for use every night. I have worked with teams discovering planets outside our solar system, new planets in our solar system (which led to Pluto's demotion--sorry about that), stars, the supermassive black hole at the Galactic Center, and galaxies. I get to work on nearly all fields in optical/IR astronomy. Minnesota really prepared me for where I am today. My favorite courses were Halley's Freshman Physics and grad level Quantum, Gehrz's Intro to Astrophysics, P. Ellis' Classical and Quantum, YC Tang's E&M, B. Bayman's grad level classical, Tom Jones' high-energy astro, Terry Jones for all things astro, and Hans Courant for stimulating discussions. My wife, Didi, and I were married in 2008 and we have twins, Kate and Henrik. They are fun and full of energy! I mostly remember the people and how helpful they were: Terry Thibeault, Ginny Olson, Al Knutson and all my classmates.

2004

Andrew Jensen (B.S. Physics) After graduation I got my M.S. from Wisconsin in Medical Physics. I am currently a Medical Physicist at Minnesota Oncology. My favorite memory is Marshak rolling on the table to demonstrate particle spin in Honors Introduction to Physics.

2005

Jacob Haqq-Mizra (B.S. Astrophysics) I completed my M.S in Meteorology in 2007 and my Ph.D. in Meteorology & Astrobiology in 2010 from Penn State University. I then did a postdoc at the Rock Ethics Institute. I am currently a research scientist with the Blue Marble Space Institute of Science in Seattle. My wife, Gina Riggio, and I were married in 2012. We enjoy our friendship, gourmet cooking, and

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performing music together with our band. We live in Newark, DE with our two cats. I remember public observation nights. One evening we observed all the planets from Mercury to Uranus. Skillman's Galaxies class was by far my favorite undergraduate course, particularly the informal discussion-based format, which taught me a lot about the role of teaching style in effective communication.

2006

Vanessa Krake (B.S. Physics) After graduation, I worked in the tech industry at various contract/temp jobs. Now I am a Carestream Health R&D SEM Technician in Oakdale, MN. My favorite course was MXP and it has been the most useful in my niche field of analytical work.

2007

Taylor Childers (Ph.D. Physics, Advisor: M. Duvernois) After graduation I did a postdoc at Heidelberg University in Germany and at CERN working on the ATLAS experiment. I was heavily involved in the startup of CERN's Large Hadron Collider including being on shift in the ATLAS Control Room when first beams circulated in September 2008. During our six years at CERN, we met many amazing people and had many adventures, including having our two boys born there. We cherish our time in Europe and we are also glad to be back in the U.S. I am now an Assistant Physicist at Argonne National Laboratory. My wife and I will soon celebrate our tenth anniversary. One of my favorite memories was weekend mornings and afternoons spent with fellow classmates doing homework at Dinkytown coffee shops. Our class was particularly social. S. Rudaz was my favorite professor, who made Quantum Field Theory seem so easy and straightforward.

Bradley Froehle (B.S. Physics) I finished a Ph.D. in Mathematics at the UC, Berkeley. Since graduating I have been working as a Software Engineer for Google on YouTube's related videos feature.

Clayton Hogen-Chin (M.S. 2007, B.S. 1999 Astrophysics and Physics, Advisor: S. Hanany) After graduation, I joined Frontier Technology, Inc.. Now I am a Senior Scientist for a company based in MA. I am married with two children.

Patrick McLoughlin (B.S. Physics) After graduation, I joined the U.S. Navy as an Instructor in Nuclear Power Training Command. Now I am an auxiliary operator at the Brunswick Nuclear Plant. I have been married for just over a year to my wife, Kristin. We share a home with Jowels, a French bulldog. My classmates included some brilliant people who have gone on to achieve hugely impressive things. I remember feeling like the dumbest person in the room, but having more fun learning than any other time in life. I remember an all-nighter in Walter Library before the 4002 (E+M) final with classmate and future Navy colleague Cory Szczepanok (B.S. Physics 2008) which paid off well on the test. My favorite courses were Peloso's Introductory Quantum Physics and Kubota's Quantum Mechanics. I have since read Kakalios's "Amazing Story of Quantum Mechanics" - these topics are as fascinating now to a layman as then to a student.

2008

Ian Behor (B.S. Physics) Currently I am a manager of sales at Bridgestone in Maplewood, MN. I married after graduation and we have two kids. A great memory for me is when Maxwell's equations all came together to describe light! I also enjoyed Huang's Waves, Optics and Relativity; and Janssen and Marshak's History of Physics.

Patrick Foley (B.S. Astrophysics) I work in Technical Services at Epic, a medical records firm. I am happily living in Wisconsin. I would characterize my job like the NASA team on the movie Apollo 13. Remember the scene where the techs need to devise an air filter to fit a square peg into a round hole with only a box of stuff only in the LEM? That's a lot like what I do. I was fortunate to T.A. the Introduction to Astronomy lab as an undergrad. One of my duties was to host the telescope public viewing nights. My first-ever gig, I got there an hour early to try and set up telescopes. The other, more-experienced T.A. was late. I scrambled to set things up while a troop of Boy Scouts patiently waited. A group of ten students poured in. Followed by ten more. And another ten. And another. There was a line out the door wrapping down to the stairs. Why all the crowds? Turns out, the MN Daily had done a column for the top-ten cheap dates. We had a record showing of around 100 people when an average night was maybe ten. Nevertheless, the sky was clear, the night was warm, the moon was out, and Saturn was beautiful. Everyone had a great time while listening to Dark Side of the Moon. My favorite course by far was Introduction to Cosmology. I also liked the lab portion of Introduction to Astronomy. The moon-phase project incorporated many scientific principles of observation, data analysis, and prediction.

Tyler LaGrave (B.S. Physics) After graduation I got my M.S. from Central Baptist Theological Seminary. I am currently an assistant pastor in Stillwater. I also teach ESL online to students in Korea. In addition, I have taught science classes for homeschool co-ops. In 2013, I married my best friend, Olga, got my masters, and became an assistant pastor in Stillwater, MN. It was a busy year! We now have a son, Jonathan. By far, my two favorite classes were D. Cronin-Hennessy's Introduction to Nuclear and Particle Physics and J. Wygant's Introduction to Space Physics. My favorite memory was researching and presenting the heliospheric radio emissions detected by the Voyager Plasma Wave Instrument in Introduction to Space Physics.

Marie Lopez del Puerto (Ph.D. 2008, M.S. 2004, Advisor: J. Chelikowsky) I am currently an Assistant Professor in Education at St. Thomas.

Andy Schofield (B.S. Physics) After graduation, I got my J.D. from William Mitchell College of Law. Now I am a Patent Attorney in Minneapolis. I prosecute patents at a mid-sized Minneapolis-based patent law firm. Great stuff - always seeing new technology keeps one from growing bored or complacent. I fondly remember late night MXP labs. I had the pleasure of doing UROP and CURA grants with Woods Halley. He's brilliant and awesome. Chuck Campbell's courses were great as were Kris Davidson's cosmology lectures.

2009

Christina Cowman-Eggert (B.S. Physics and Chemistry) After graduation, I got my Ph.D. in 2014 in Chemistry at Cornell. I am now a graduate research fellow. I joined 3M in St. Paul in 2014. My favorite memory was switching roles with my MSP lab partner in Crowell's MXP course. She built the instrument and I wrote the programming. The

CLASS NOTES

experience brought both of us out of our shells as scientists and out of our comfort zones. My favorite course was Rudaz's Honors Physics I - III, which inspired my love of physics. It was challenging, fun, and where I met my husband, Nicholas Eggert (B.S. Physics 2009). He started at Seagate after finishing his Ph.D. in experimental particle physics and a post-doc at Cornell.

2010

Caitlin Nolby (B.S. Astrophysics) While working on my masters in Space Studies at the University of North Dakota (UND), I completed an internship at NASA Marshall Space Flight Center studying outbursting comets and active asteroids. I now work as a coordinator for the NASA Space Grant Program. Continuing to work full time, I am also in the Ph.D. program in Teaching and Learning at UND. I loved being a TA for Introductory Astronomy. I learned how much I loved teaching and helping those who didn't necessarily have a strong interest in science. My favorite course was K. Davidson's Intro to Astrophysics, where I wrote down humorous things he said along with my actual notes. L. Williams was also amazing in AST 4001, working out the problems with us and helping us to understand what the math was telling us. P. Haines' Intro to Cosmology was also a fantastic course. He has a way of simplifying seemingly abstract ideas into basic principles.

2011

James Geddes (B.S. Physics) I am a Systems Integration Engineer in SSD at Seagate Technology in Shakopee, MN.

Molly Krogstad (B.S. 2011) I am currently in the Physics Ph.D. program at the University of Colorado, Boulder. My favorite courses were Crowell's Honors Physics sequence and Heger's Physical Optics.

Brian Skinner (Ph.D. Physics, Advisor: B. Shklovskii) After graduation, I took a postdoc in condensed matter theory at Argonne. I am married and living in the suburbs of Chicago. I have great memories of sitting on the front steps of Tate in the summer and eating lunch with classmates. The School also hosted some great workshops and speakers. My favorite courses were Y. Qian's Quantum Mechanics and Kamenev's Solid State Physics.

2012

Erik Aver (Ph.D. Physics, advisors: K. Olive and E. Skillman) I am an Assistant Professor at Gonzaga University in Spokane, WA.

Cameron Nicholas (M.S. Physics, Advisor: J. Kakalios) Since graduation, I have visited Europe, and spent last summer looking for work in the San Francisco Bay Area to no avail. Currently, I am tutoring math and physics in Tucson, AZ while I learn additional skills and address some mental health issues.

Grant Remmen (B.S. Physics) I am enjoying graduate school in Theoretical Physics in sunny Pasadena, CA at the California Institute of Technology. I am a Hertz Graduate Fellow and an NSF Graduate Research Fellow. I am working on research with Sean Carroll and Cliff Cheung. My favorite memories are the fun I had doing undergraduate research and getting to know the fantastic faculty at the School. I had so many favorite professors and classes! R. Gehrz inspired an interest in astrophysics in Introduction to Astrophysics; D. Cronin-Hennessy's Classical

Mechanics was great because he was always so helpful with questions; I enjoyed Tom Walsh because he had lunch with his Freshman Honors Physics students every Tuesday; and L. Williams' Cosmology was very engaging as well.

Mike Sullivan (B.S. Physics) After graduation I began a summer internship at an event software startup called Social Point. I was the third employee. At the end of the summer they offered me a full-time job and I had to decide between that and graduate school. I decided that being a part of a startup was a good opportunity. We now have eleven employees and business is growing. I live in Minneapolis and enjoy the great running trails. I have run a full marathon and two half marathons. My favorite memory was my involvement in the Society of Physics Students (SPS). It was great to see the growth we had in membership. P. Haines' Physics 3022 was an enjoyable class because he was approachable and willing to explain new concepts. S. Hanany (Physics 2201) had a great teaching process. His lectures were really valuable and his grading system incentivized hard work. His office hours were by far the best of any class I took. Not only did he teach us thermodynamics, he also taught us how to learn physics in general.

2013

Steven (Susan) Dorsher (M.Sc. Physics) I recently started the Physics Ph.D. program at LSU. Summer 2014 I was outreach coordinator for the LSU Center for Computational Technology REU, RET, and REHSS programs. I am getting involved in the board gaming community, the Unitarian Church, and the GLBT community. One moment that sticks out from my time at the U is discussing with Adam Schreckenburger (Ph.D. Physics 2013) how to modify quantum mechanics so that there is no need for time. I liked all my advanced courses, especially learning about the in-depth aspects of modern theories of physics. M. Shifman taught us about supersymmetry in Quantum Field Theory 2. I still do not really understand it, but it was very beautiful.

Deano Farinella (B.S. Physics) I am a Graduate Student at UC – Irvine. I am currently working with lasers and plasmas to study fundamental physics. I enjoy hiking and backpacking when I can. My favorite memories come from staying up all night working on homework and studying with my classmates in SPS. The courses I enjoyed most were Gehrz's Introduction to Astrophysics, Mans' MXPII, L. Williams' Galactic Dynamics and D. Cronin-Hennessy's Introduction to Particle Physics.

Ian Young (B.S. Physics) After graduation, I worked at Dayton Die Cushions. Now I am a Mechanical Design engineer in Eden Prairie at a small engineering firm making industrial machinery for metal stamping processes. I am a rock climber, Olympic-style weightlifter and an avid reader. My favorite memories are working on my MSPII experiment with liquid helium. My favorite courses were J. Kakalios' MSPII, Quantum I and D. Cronin-Hennessy's Quantum II.

CORRECTION: Thomas Dombeck, received his Masters in 2002 from the School, not a PH.D as stated.

NOTE: The response to our survey was such that we were forced to reduce the size of many of the notes. To see the full class notes, please visit our website: www.physics.umn.edu/alumni/news/

FRUSTRATED MAGNETISM

Natalia Perkins is a condensed matter theorist working in the area of strongly interacting systems. Electrons and atoms in these systems experience a tremendously large force between each other. She is particularly interested in phenomena observed in magnetic materials, especially in frustrated magnetic systems where atomic orbital degrees of freedom play a crucial role as well as in systems where strong relativistic effects, known as spin-orbit coupling, are at the origin of new phenomena.

Although magnetism is one of the oldest fields of science, it remains one of the fastest developing branches of condensed matter physics due to its direct connection to experiment and discoveries of new materials with intriguingly novel behavior with, perhaps, new paradigms for technological applications.

In everyday life, we encounter a wide variety frustrated systems from proteins to ice. The cores of neutron stars, are frustrated systems and the phenomenon occurs whenever it is not possible to simultaneously satisfy all of the competing pairwise interactions between the particles constituting the system. As a result of this “dissatisfaction,” a large number of states end up having the same energy, in other words, a large degeneracy. The system will fluctuate between these states and, even at low temperature, will have large residual entropy - the hallmark of frustration. “From a human perspective, we are quite familiar with that phenomenon: when nobody can agree on what to do because all disagree, nothing gets done or happens!”

The simplest magnetic frustrated system is one triangle with magnetic moments (or spins) that interact with the antiferromagnetic coupling. There, a conflict arises between the geometry and the local correlations favored by the spin-spin. If one puts three spins (arrows) at the corner of triangle. We point the arrow at the left corner of triangle up, then we point the arrow at the left corner down. These two spins are satisfied by being antiferromagnetically aligned or what's called “anti-parallel” to each other. The problem arises when one tries to



orientate the third spin at the upper corner of the triangle. If it points up, it will satisfy one of the first two spins, but it will be facing the wrong direction for the other one and the whole ensemble is considered to be frustrated.

Frustrated materials with competing charge, spin, and orbital degrees of freedom, both found in nature and artificially synthesized, are repeatedly reported to exhibit a variety of novel properties such as a metal-to-insulating transition, unconventional magnetic order and, in some cases, spin liquid ground state in which the magnetic degrees of freedom continue to fluctuate down to absolute zero temperature. These properties may hold significant promise for useful applications. Some frustrated magnetic compounds are already in use in memory devices, the computer industry, and cell phones and other electronic devices. However, many important fundamental properties of frustrated materials that may hold the key for truly revolutionary applications still need to be understood. Therefore, Perkins thinks that her research on developing and analyzing microscopic models of frustrated electronic is not only fundamentally important to understand the broad principle of physical systems with strongly competing interactions, but also constitute an essential stepping stone for harnessing the potential of novel materials towards technological applications.

MARGARET HANSON



Margaret Hanson is a Professor of Physics and Associate Dean of the Graduate School at the University of Cincinnati.

www.physics.uc.edu/~hanson/

Why did you pick Minnesota? I was pursuing a nursing degree at smaller colleges. I liked my math and science courses enough to drop out of nursing and pursue first chemistry then physics. It was clear that if I wanted to be successful in physics, I would need to attend the best program I could afford because I paid my own tuition/living expenses. The School provided the rigorous instruction and serious research experience to be successful in graduate school.

Who were your favorite professors? I enjoyed all of the courses I took at the School. I must thank my research advisor, J. Dickey and academic advisor, R. Kennicutt, for their individual attention and support that put me on a graduate school path. My classmates and I were in awe of Serge Rudaz. He was young, fun, and showed great enthusiasm. I recall one QM lecture, the board was thick with long equations and complex derivations he had done entirely from his head (and he never made mistakes). He stepped back, looking for open board space, and then said "That's a nice looking board!" We ALL aspired to be like Serge! I was also very fond of Earl Peterson and Bob Lysak. Russ Hobbie showed me great kindness during a difficult situation. Hans Courant introduced me to my first husband, David Hanson (**Physics BS '83, PhD '88**).

Favorite Memories? Doing homework with my cohort in the Astronomy Reading Room at off and sometimes long hours. We all took the GRE's, applied to grad programs, and shared the excitement of getting offers and heading off to graduate school. That core six of us (**Toby Smith**, B.S. Physics 1988; **Scott Demars**, B.S.

Physics 1988, **Rob Szalapski**, B.S. Physics, 1988, **Bill Bottke**, B.S. Physics/Astrophysics, 1988, **Darryl Busch**, B.S. Physics 1988 and I) all completed our Ph.D.s. Years later, I learned how important this comraderie was to our success. When I was director of our undergrad program, I strived to create the same level of community amongst our majors.

What was/are your favorite parts of your job? I love working with and helping students. All students. The amazingly gifted ones, and the troubled, doubting ones. At some time in our lives, we have all been both. I was asked to join the Graduate School because of my reputation for supporting physics students. It was hard to leave physics, but there was a desperate need to better support University of Cincinnati's 10,000 graduate students.

What got you interested in physics? I took physics after I became a chemistry major, and things clicked. I had completed a year of calculus before I even took my first physics course. This makes a huge difference and it's something I always pushed with our students: GET THE MATH if you want to be successful in physics. Everyone thought physics was so hard. I thought well, gee, if physics is so hard, maybe being good at it will mean I can get a job. I was always very pragmatic.

Tell us about your family. I remarried 12 years ago. Brian (a UM alumnus) is a professor of biology with two daughters from his previous marriage. They are now college graduates and have started careers. We fostered and then adopted two daughters (biological sisters) 10 years ago and are presently working through the tumultuous teen years with them.

What are your hobbies? We all like to travel. My family has been able to accompany me for some of my work travel. The girls' passports are well used. We even like simple weekend road trips. I took up running during the summer I was finishing my dissertation to help reduce stress. I hope I never have to stop, as it continues to keep me mentally and physically well. I put a lot of time and energy into my work, so I spend the rest of my time with my family and friends.



CARL PFITZER

Carl Pfitzer retired in 2004 after more than four decades in the aerospace industry, working on projects from the Apollo missions to the Space Shuttle.

Where did you grow up? What was the best part of growing up there? I was born in 1939 in Salzburg Austria just as World War II was starting. My parents divorced in 1940. My mother moved to Germany and I lived with my father and grandmother. Although I was only a few years old, I remember the bombings. I was a happy go lucky kid getting C- in school. All that changed just before my 12th birthday. My Mom, who had emigrated to America as a war bride, got papers to have me join her. She had trouble dealing with Immigration in Duluth. She requested help from Senator Hubert Humphrey. Within a few weeks I was on an airplane for the trip to Duluth. At age 13 I started caddying six days a week at the Northland Country Club.

Why did you pick Minnesota? I did not want to live at home or go to UMD. I worked to get good grades and received the Evans Scholarship (it was given to caddies) which paid for tuition and a place to live.

Who were your favorite professors? George Freier steered me in the direction of the physics degree. I was a chemical engineering major and learned to hate organic chemistry. Every rule had a dozen exceptions. To ace the tests I had to memorize dozens of facts. In Freier's physics class everything made sense and if I forgot a formula I could derive it. So at the end of my sophomore year I changed major from chemistry to physics.

How did your physics help you in your career? I joined McDonnell Douglas in 1969. Aerospace had many ups and downs. My skill in being able to do almost any job kept me employed during lean times. My skill as a physicist was used to solve problems that the engineering community could not solve. I designed a lower cost lightning protection system for the Delta IV

launch pad at Cape Canaveral by re-writing the lightning protection handbook for large structures using relativistic equations instead of the simple classical equations in the standard handbook. It resulted in a factor of four cost savings. I became the person in charge of designing electromagnetic shielding for various satellite programs. My original Ph.D. subject was used to design the astronaut radiation protection for both the space station and the space shuttle. I became the company's go-to troubleshooter, solving problems as diverse as chilled water refrigeration problems on SpaceLab and vibration problems on the new laser gyro guidance system for the Delta rockets. As a physicist my skills reach across many disciplines. My skills and contributions to the company (Boeing had now purchased McDonnell Douglas) were recognized in 1998 when I was made a Boeing Senior Technical Fellow, the highest technical honor at the Boeing.

Tell us about your family? My wife Marjorie and I were married in 1964, about half way through my Ph.D. studies. She was a stay at home Mom until our children were all in school. She complements me, I am the technologist and she is the people person. We have now been a team for 50 years. We recently renewed our marriage vows (see photo). We have six very successful children all independent of us.

Anything else? I attended college at an absolute magical time. Sputnik had just happened and I was asked to be a part of the space program. In my undergraduate studies I learned about vacuum tubes, for the satellite program I needed to use transistors. I was able to work with the engineers to design and test those new circuits. Computers were just coming on line. I needed to analyze the data from 1000 magnetic tapes. I became a very skilled programmer and because I could only use the U of M computers at night and they were always failing, I learned how to fix the computers. I became that jack-of-all-trades, the person who could put a fresh eye on virtually any problem. I have this uncanny ability to see what others cannot. I consider it a gift, one that I have treasured over the years, a gift that was honed by my extra ordinary Ph.D. program at the University of Minnesota.

See full story at: www.physics.umn.edu/alumni/newnewsletter.html

CHARITABLE INVESTMENT IN THE SCHOOL OF PHYSICS AND ASTRONOMY:



Shannon Weiher

Within each issue of the School of Physics and Astronomy's news magazine we are excited to highlight the accomplishments of our amazing students. We are ever grateful to the many

who give of your time, talent and resources to help make their accomplishments possible.

Now through December 31st, alumni and friends have a unique opportunity to support students with the University's *Fast Start 4 Impact* initiative. *Fast Start 4 Impact* is designed to get more scholarships and fellowships in the hands of deserving students now when they need it the most. For each new endowment gift or four-year pledge of \$50,000 or greater, the *Fast Start 4 Impact* initiative will pay the first four years of annual scholarship or fellowship awards to students, while the earnings on the new endowment fund are reinvested for growth.

Benefactors immediately see the impact of their gift to students while their endowed fund accumulates earnings in its early years. Moreover, the endowed fund becomes a permanent source of income for the department to recruit and retain the best students now and in the future.

I look forward to visiting with many of you as I travel for the school or when you are on campus. In the meantime, please contact me if you are interested in learning more about *Fast Start 4 Impact* or additional ways to support the School of Physics and Astronomy, the College and our students.

Shannon Weiher
Senior External Relations Officer
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Contributions Make a Difference

Why We Give: Thesis Fellowship

Chao Yun Bao is a graduate student in Shaul Hanany's observational cosmology laboratory. She received the Doctoral Dissertation Fellowship from the graduate school for 2014. Bao works on EBEX, a NASA-funded balloon-borne experiment targeting the B-mode polarization in the Cosmic Microwave Background (CMB). "Currently I am working on a component separation algorithm to properly remove the contamination signal from the thermal dust in the Milky Way Galaxy, so we get the proper level of the B-mode signal we are after."



The fellowship will fund her final year of thesis research, allowing her to devote herself full-time to research. The Fellowship also includes a travel grant which will help her present her results at conferences and meetings.

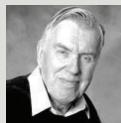
Bao says she got interested in astrophysics when "I saw the pretty pictures from the Hubble Space Telescope when I first got on a computer with internet access. Always fascinated by the beauty of the vast Universe, I eventually decided to pursue a Bachelor's degree in Astrophysics and now my Ph.D." Bao has not completely decided between an academic career or an industry career yet. "I definitely want to get involved in public outreach and promoting women in STEM field at some level."

IN MEMORIAM



Lyman T. Aldrich (Ph.D. Physics, 1948) 1919-May 1, 2014, who worked as a geophysicist and geochemist at the Carnegie Institution for Science's Department of Terrestrial Magnetism (DTM) died in Mitchellville, MD. His advisor was Al Nier, with whom he studied radiogenic Argon in potassium-bearing minerals, as well as making some of the first measurements on the elements Strontium and Helium. He was known for his work pioneering the development of methods and instruments for determining the ages of rocks through dating their constituent minerals. Aldrich served as DTM's Assistant Director from 1965-1966, and as Associate Director from 1966-1974. He retired in 1984.

Sam Brinda (B. S. Physics, 1959) August 13, 1924-December 28, 2013, passed away in Duluth, MN. He served in the U.S. Navy during WWII and was in the Battle of Guam. He did research for NASA while at the U of MN.



Robert Featherstone, 1921-2014, died in Minneapolis, MN. He served as a captain in the Army Signal Corps in World War II, receiving a Bronze Star for his conduct. He worked for the School, supervising the construction, operation and upgrading of the Minnesota 68Mev proton linear accelerator from the early 1950s-1970. This was an onerous task for, as this was the world's first proton linear accelerator of this energy, it was designed, fabricated and assembled from raw materials using the facilities of the physics and the accelerator mechanical and electrical workshops.

John P. Grund, 1932-2014, died in Edina, MN. He worked as a drafting engineer for the School for 38 years as well as running his own patent-drawing business until 2000. Grund served in the Korean war.



Craig R. Holt (B.S. Physics, 1975) August 14, 1953 - April 9, 2014 died Weaverville, CA. He earned a Ph.D. degree in physics from the University of Colorado, Boulder in 1981. He developed the "Holt Hamiltonian," an equation that can be found in graduate level math textbooks. His 20-year research career included a post-doc at Fermilab, signal processing at TRW Inc., ocean physics at Arete Associates and remote sensing at Air Education and Training Command.



Richard Huberty (B.S. Physics, 1964) 1937-2013, of Spring Lake Park, MN. He was a retired Quality Assurance Engineer.



Keith B. Jochum (B.S. Physics, 1980) August 8, 1953 - June 1, 2013, died in Springfield, OH. He received a bachelor and masters of aeronautical engineering from the Air Force Institute of Technology, and an M.B.A. from Wright State University. He retired from the Air Force in 1998, after which he worked as a program manager at Wright Patterson AFB.



Ian A. MacFarlane (M.S. Physics, 1960) July 4, 1931 - January 24, 2014, died in Cedar Rapids, IA. He received a Bachelor's degree in philosophy from Butler University, a Masters in philosophy from Yale and a Ph.D. in Physics from Bryn Mawr. He did research at the Lawrence Berkeley Laboratory and was a member of the faculty at Wilson College in Chambersburg, PA, the College of Wooster, OH, Cottey College in Nevada, MO, Mount Mercy College in Cedar Rapids and Hawkeye Community College in Waterloo, IA.

Elwood "Woody" Nestvold (M.S., 1959, Ph.D. Physics, 1962) March 19, 1932 -January, 2014. He served in the US Air Force and attended Augsburg College as well as the U of MN. He pioneered many of the modern theories, processes and techniques used today in the field of geophysics.



George B. Richter, (B.S. Physics, 1950) 1927 - June 10, 2013 died in Grand Rapids, MN. He served in the U.S. Navy from 1945-1946. He received a BA in Physics from St. John's University and a Masters and Ph.D. from the U of MN in Education. He taught engineering at the University of Minnesota and St. Thomas. He also directed the Adult Technical Education Division at St. Paul Technical College. In 1999 he received the "Distinguished Engineer" award from the Minnesota Federation of Engineering Societies.



Ralph D. Sorum (B.S. Physics, 1962), July 1, 1937 - Oct. 16, 2013 died in Burnsville, MN. He was a longtime employee of Control Data and also a veteran of the U.S. Marine Corps.

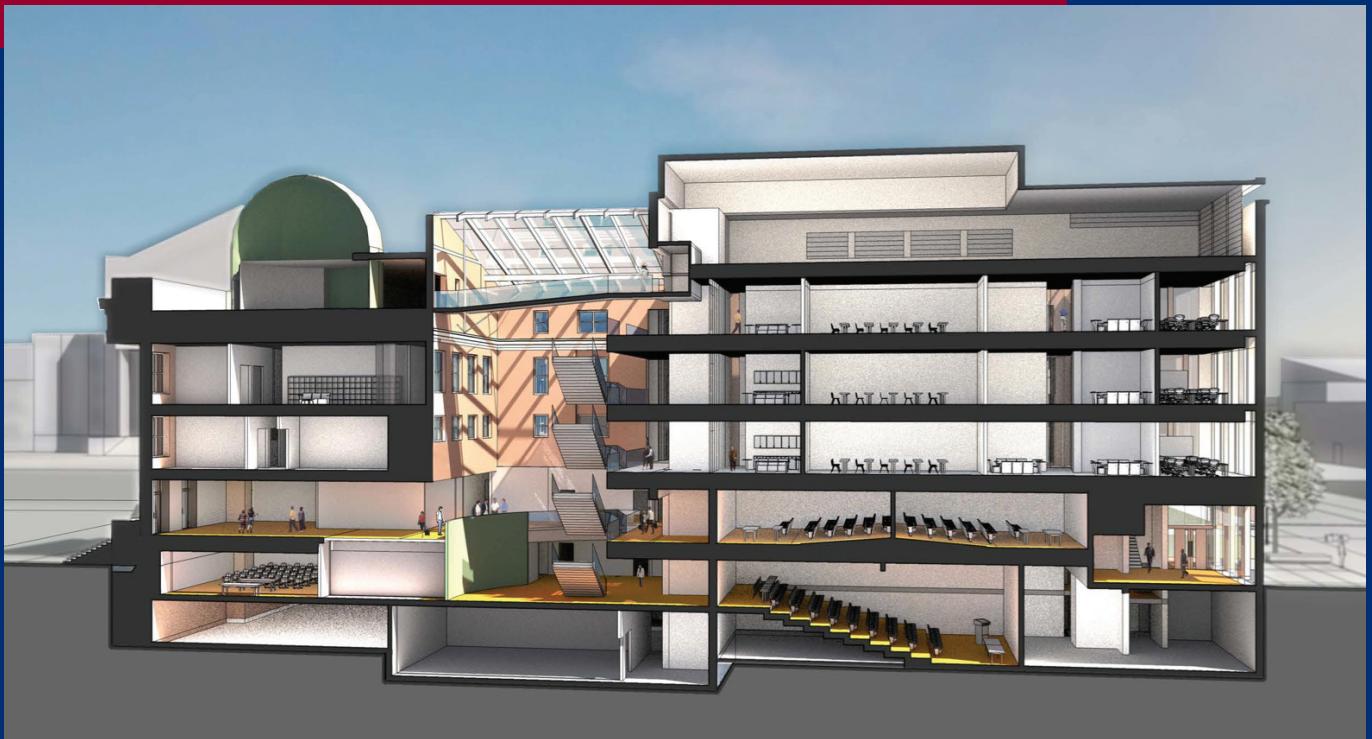
William (Bill) R. Stratton (Ph.D. Physics, 1951) May 15, 1922 - Oct. 3, 2013. He died in Los Alamos, NM. He served as a naval aviator during WWII. He worked at Los Alamos National Lab. After retiring, he started a consulting business that focused on nuclear energy and safety.

Dennis W. Whitson (M.S. Physics 1964) November 1939 - May 3, 2014 died in Indiana, PA. He received his Ph.D. in Physics from the Univ. of Pittsburgh. In 1969, he joined the physics department in Indiana University of PA, where he taught for 34 years. He was instrumental in the development of the electro-optics course, and served as department chairman for several years.



Judy Young (Ph.D. Physics, 1979) September 15, 1952 - May 23, 2014. She received a B.A. in astronomy at Harvard University. She was the recipient of the American Astronomical Society, Annie J. Cannon Prize (1982), the inaugural Maria Goeppert-Mayer Award (1986), a Sloan Research Fellowship (1986), a James Clerk Maxwell Telescope Fellowship at the University of Hawaii (1991). She received a Distinguished Academic Outreach Award from the University of Massachusetts, Amherst, where she was a professor of Astronomy from 1993 to 2013.

Coming in 2015 Tate Lab Remodel



In 2014, Gov. Dayton signed a bonding bill that includes funding to renovate, furnish, and equip the Tate Laboratory of Physics building on the Minneapolis campus. The \$56.7 million in funding will provide two-thirds of a total \$85 million construction budget include modern lecture halls and classrooms, instructional labs, study spaces, and conference rooms, along with dedicated space for the Fine Theoretical Physics Institute and the Minnesota Institute for

Astrophysics. More than half of the School's faculty will have offices in the remodeled Tate, with the remainder in the new Physics and Nanotechnology Building. Tate will also be the home for the teaching and research programs of the Department of Earth Sciences.

At right: rendering of the remodeled Tate Lab which will feature a Church Street entrance where the old van de graaph accelerator tank currently resides.



1990's Alumni Reunion: May 29-31, 2015

A 20-year reunion is being planned for graduate students and other affiliated individuals who were in the Physics and Astronomy program ~20 years ago (mid-1990s). The reunion dates will be just prior to the closing of Tate for remodeling. People interested in attending or helping to plan the reunion should contact us at MNPhysicsReunion@gmail.com and/or join the "UMN Physics Reunion 2015" Facebook group. -Milena Higgins, Jeff Stehr and Barbara Thompson.