NEWSLETTER 2015

UNIVERSITY OF MONTANA

# CHEMISTRY & BIOCHEMISTRY

It has been my honor to serve as the department chair for just over two years as the department has enjoyed a period of change and growth. I am fortunate to work with highly dedicated faculty and students whose efforts and contributions make the department an exceptional place for learning and discovery. And it is also a pleasure to meet and work with our many dedicated alumni and friends, who provide important feedback and support to the department.

PROFESSOR & CHAIR
**CHRIS PALMER**

Our undergraduate programs are doing well, and enrollment in Chemistry and Biochemistry programs has seen a steady increase in recent years. We have made significant investments in instructional infrastructure, establishing the Chemistry and Biochemistry Learning Center and purchasing a bench-top NMR system, numerous liquid chromatographs, and a spectrofluorimeter for the instructional labs. The Learning Center, which provides a place for students to study with new computers and electronic presentation capabilities, and offers the tutelage of teaching assistants, has proven to be a very popular addition.

Research activity also continues to be strong. Professor Mike DeGrandpre and his tech-transfer company Sunburst Sensors were recently awarded both of the Wendy Schmidt Ocean Health XPRIZEs for development of instruments to measure and monitor ocean pH. Assistant Professor Orion Berryman (Organic Chemistry) has been in the department for just over three years and has established an active research program developing catalysts that make use of halogen bonding. The Department is a central participant in the new multi-campus Materials Science PhD program. Chemistry faculty continue to compete for and earn grants from national funding agencies including the NSF and the NIH, and three chemistry professors were recently awarded one of the initial grants from the new Montana Research and Economic Development Initiative. The 600 MHz NMR instrument was recently refurbished and re-energized and new single crystal X-ray diffractometer and LC-ESI-MS systems were installed in the past year.

The Department was saddened by the loss one of our most supportive community members in February of this year. Dr. R. Keith Osterheld joined the Department as a professor in the late 1950's and served for 17 years as chair of the department beginning in 1974. He and his wife Jean established the R. Keith and Jean Osterheld Scholarship fund, which continues to provide important scholarship support to Chemistry and Biochemistry graduate students. An obituary for Keith can be found further on in this newsletter.

The Department is experiencing important changes in personnel. Professor Garon Smith retired in July of 2015, signaling the loss of a great deal of teaching experience, energy and personality in the department. Professor Ed Rosenberg has also reduced his effort with the department and will retire in coming years. At the same time, we welcome the addition of Assistant Professor of Bioinorganic Chemistry, Dong Wang, who arrived in August. We are currently commencing a search for an environmental chemist to join the department in August of 2016.

While we are excited about recent progress, the department also recognizes several areas that we need to address in order to grow and be effective in both our research and teaching missions. Among the department's top priorities for continuing our tradition of excellence is continued development of our undergraduate and graduate curricula, as well as additional scholarships and research support for graduate students. We plan to improve and enhance delivery of our introductory courses, and we are working to evaluate and improve our upper-division offerings and programs. We also plan to strengthen existing research programs while also exploring opportunities in materials science and green and sustainable chemistries. The support of our alumni and friends is essential to this effort. Please consider either making a financial contribution to one of these funds or establishing a new fund.

We enjoy hearing from you about happenings and successes in your lives, as well as about your experiences with the Department. Please do not hesitate to contact me (christopher.palmer@umontana.edu) or the department (chemistry@umontana.edu) with news, updates, and feedback. Please also consider liking us on Facebook, where you can keep up with Department news.

Just prior to sending this newsletter to press we were saddened to hear that former organic chemistry professor and Department chair Ralph Fessenden passed away. We will have a tribute to Ralph in a forthcoming newsletter. Ralph's family asked that donations in his name be made to the Department to support graduate student travel.

Regards,
Chris Palmer

# THE DISCOVERY OF NUCLEAR FISSION

*by Dick Field, Emeritus Professor of Chemistry*

(l-r) Otto Hahn, Lise Meitner, and one of Max Planck's twin daughters, Emma or Grete. The other took the photo in ~ 1910. *Churchill College Archives Centre, Cambridge.*

In 1909 Ernest Rutherford suggested to his students Hans Geiger and Ernest Marsden they bombard a piece of Au foil with a beam of alpha (α) particles ($^{4}_{2}He^{2+}$) from the decay of Radon as an experimental exercise. The result was shocking! Most of the α particles passed directly through the Au-foil, but a very few were scattered backwards, some by 180°. Rutherford interpreted this as nearly all of the mass of an atom is concentrated in a very small nucleus, which turned out to be composed of positively charged protons ($^{1}p^{+}$), held together by the very short-range "Strong Force." The idea that nuclear protons must be insulated from each other was introduced with the discovery of the neutron ($^{1}n^{o}$) by Chadwick in 1932.

The transformation of one element into another had been demonstrated in 1917 by Rutherford with the reaction $^{14}_{7}N + ^{4}_{2}He^{2+} \rightarrow ^{17}_{8}O^{+} + ^{1}p^{+}$. With the discovery of $^{1}n^{o}$ and its ready production via $^{4}_{2}He^{2+} + ^{9}_{4}Be \rightarrow ^{12}_{6}C^{2+} + ^{1}n^{o}$, Enrico Fermi and colleagues in Rome began systematically bombarding the elements with $^{1}n^{o}$ and found each element absorbs a $^{1}n^{o}$ and is transmuted to the next higher atomic number element with emission of an electron. For example, $^{12}_{6}C + ^{1}n^{o} \rightarrow ^{12}_{7}O^{+} + e^{-}$. It was expected that for $^{235}_{92}U + ^{1}n^{o} \rightarrow ^{235}_{93}A + e^{-}$. Following this reasoning, Fermi et al. thought that the new elements $^{235}_{93}A$ and $^{235}_{94}H$ could be formed and named them ausonium and hesparium.

Not everyone agreed, and Otto Hahn, Lise Meitner, and Fritz Strassmann began similar experiments in Berlin. Meitner, an Austrian Jew, lost her citizenship in 1938 and fled to Sweden, where she remained in mail contact with Hahn. She learned that Strassman had added $BaCl_2$ to the water-dissolved radioactive product of the irradiation of $^{235}_{92}U$ by $^{1}n^{o}$, and then added $SO_4^{2-}$ to crystallize out the very insoluble $BaSO_4$. The radiation amazingly was found in the $BaSO_4$. One of the products of the irradiation was barium! Lise Meitner's cousin, Otto Frisch, was visiting her, and they discussed this result on a Sunday skiing trip and decided U must have broken up, presumably into two fragments and with the release of much energy. Their scheme was: $^{235}_{92}U + ^{1}n^{o} \rightarrow ^{236}_{92}U \rightarrow ^{92}_{36}Kr + ^{141}_{56}Ba + 3\,^{1}n^{o}$.

Note the multiplication of $^{1}n^{o}$ (1 to 3 above) which suggests the possibility of a nuclear chain reaction. Leo Szilard had patented the idea in 1934 of release of energy in just such a nuclear chain reaction! I wonder if he collected royalties? Why does the U nucleus not just break into many small pieces when the $^{1}n^{o}$ hits it? Niels Bohr's nuclear work had led him to the idea that a large atomic nucleus is like a water droplet. When such a nucleus absorbs a slow moving $^{1}n^{o}$, it begins to vibrate. It had been found experimentally that $^{1}n^{o}$ must be slowed to cause fission. The mathematics of this vibration is well-understood; a drop typically fissions into two drops. Bohr was immediately notified of nuclear fission just as he was leaving Europe (1939) for Princeton University. The rest is history. It has been wondered how things might have turned out if nuclear fission had not been discovered in 1939, and whether it was good or bad that it was discovered just then?

## IN MEMORY OF R. **KEITH OSTERHELD** *written by Dick Field*

Keith was born in 1925 in New York City and died from pneumonia in Arkansas at age 89 on February 4, 2015. He is survived by his wife Jean and four sons, Albert, Bob, Jim and Tom. RKO, as he signed things with a flourish, did his undergraduate work at Brooklyn Polytechnic Institute, graduating in 1945, after taking something like 29 months to do his B.S. degree; there was a war on. He then joined in WWII serving mostly in the Philippines as an air traffic controller and learning the Chinese language along the way.

After leaving military service, Keith started graduate school at the University of Illinois, completing a Ph. D. in inorganic chemistry in the early 1950s. His first position was at Cornell University, where he met and married Jean, a graduate student working with Paul Flory. Keith was uneasy at Cornell and wished to move west. At About this time, the UM Department of Chemistry had an opening for an inorganic chemist. The deal was made sight-unseen, and Keith and Jean drove cross-country one summer in the late 1950s to begin their life in Montana.

About 1974, Keith became Chair, a position he held for 17 years. He was a superb administrator and leader, and the Department then entered a long and stable period of growth and progress. With Keith's leadership, the chemistry department became known around campus as a reliable, conscientious, energetic and mature department deserving of trust and support from the central administration. Keith was the recipient of the 1992 Robert T. Pantzer Presidential Humanitarian Award.

Keith left the Chair in 1990 (at age 65) leaving the department in my care. I had always wondered why so many wonderful things happened around the department to help our faculty and students excel. When I became Chair, it was clear how these things happened; Keith made them happen. His best advice to me was that the job of the Chair is to make it possible for his/her colleagues and students to do well. That is what he did! And that is how he should be remembered.

# NEW FACULTY **HIGHLIGHTS**

ASSISTANT PROFESSOR
**ORION BERRYMAN**

**Orion Berryman** started as an assistant professor at the University of Montana in 2012. The circuitous route that brought Orion to Missoula included growing up in Homer, Alaska, undergraduate studies at the University of New Hampshire, doctoral work at the University of Oregon and postdoctoral training at the Scripps Research Institute in La Jolla, CA working with Julius Rebek Jr. His new job at the University of Montana has brought Orion closer to his outdoor origins while allowing his research program to thrive. Orion is passionate about noncovalent interactions and as a graduate student helped define the interaction between anions and electron-deficient aromatic rings. As a postdoc Orion used the concepts of molecular recognition to build light-responsive container molecules that control the release of encapsulated smaller molecules.

Orion's current research program uses noncovalent interactions to drive the assembly of ion receptors and catalysts. Orion's lab is particularly interested in developing new catalysts that activate compounds for reaction by halogen bonding to them. This new mode of catalysis will have broad implications in a number of fields including pharmaceuticals and industry. The lab uses a battery of physical organic techniques to characterize and study the behavior of the new molecules in solution, the solid state and computationally. Through an NSF-MRI award, Orion brought to Montana the only small molecule single crystal X-ray diffractometer for atomic resolution. This new state-of-the-art instrument is further highlighted below. Additionally, as a co-PI with professors Palmer and DeGrandpre on the state's first-ever large scale research initiative Orion will be developing selective sensors for arsenic. Further details of Orion's lab can be found at the following website:
http://cas.umt.edu/departments/chemistry/lab/berryman/

Orion is a competitive cyclist and XC skier and an enthusiastic hunter and fisherman. Orion is frequently chased down the trails by his three young children and supportive wife, Erin.

PROFESSOR
**AARON THOMAS**

**Aaron Thomas** joined the Department of Chemistry and Biochemistry in January of 2013 after spending 11 years on the faculty of Chemical and Materials Engineering Department at the University of Idaho. His primary reason for transferring was his desire to oversee the Native American Research Laboratory at the University of Montana. This has now been rebranded to be the Indigenous Research and STEM Education (IRSE) program where Dr. Thomas works to help undergraduate and graduate students complete their degrees in a STEM discipline as well as works with the tribal communities on Native based research activities.

IRSE also works with K-12 Native students to help them prepare for college, especially in math and science. The program has collaborated with middle schools on each of the 7 Montana reservations implementing various camps and programs with hands on activities with a goal of increasing STEM interest and math advancement. IRSE has also run summer bridge programs helping Native students transition from their senior year in high school to their freshman year of college. Dr. Thomas helps implement the Louis Stokes Alliance Minority Participation (LSAMP) program on the UM campus that seeks to provide scholarships for undergraduate Native students in STEM disciplines. Dr. Thomas is also the director of the Sloan Indigenous Graduate Partnership (SIGP) for the state of Montana that supplements graduate assistantships and implements professional development for Native graduate students. Finally, the program has worked with faculty at the tribal colleges on professional development workshops that helps build relationships between the university and the tribal colleges.

His research is in the area of mass transfer and fluid mechanics in examination of the effects of flow oscillation on the transport and separation of biological species in microchannels for lab-on-a-chip studies. Specifically, he is examining the effects of oscillating electro-osmotic flow on the transport and separation of DNA and proteins to be used in a potential point-of-care device that can be used in rural regions.

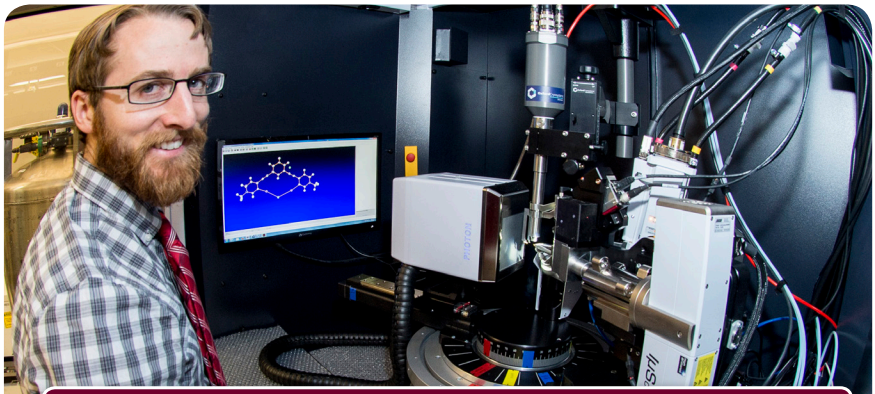

ASSISTANT PROFESSOR
**DONG WANG**

**Dong Wang** came to the University of Montana in August 2015 from Princeton University. He was trained as a bioinorganic chemist and obtained his PhD degree at the University of Minnesota under the mentoring of Prof. Larry Que. He then moved to the east coast and worked with Prof. Jay Groves at Princeton University as a postdoctoral associate on bio-inspired catalysis, particularly on artificial photosynthesis. Dong brings to the Department many years of experience in the areas of organic/inorganic synthesis, spectroscopy and catalysis.

Dong's research will address fundamental and frontier challenges at the interface of biological chemistry, inorganic chemistry and energy science. A special focus is to apply enzymatic strategies to develop biomimetic and bio-inspired catalytic systems to carry out important reactions related to metabolic transformation, the energy industry, and environmental sustainability, including the functionalization of inert aliphatic hydrocarbons in an environmentally friendly way, and the conversion of water and carbon dioxide to produce renewable fuels. Dong will investigate these catalytic systems using combined methods including a variety of spectroscopies, surface analysis techniques, electrochemistry, and computational methods. Dong's research landscape is expected also to provide excellent opportunities for establishing vigorous, interdisciplinary collaborations with research groups within and outside of the University of Montana.

Dong is also interested in cooking, reading, swimming and playing games with his wife and two little girls. He is especially good at cooking spicy Asian dishes.

# NEW RESEARCH CAPABILITY ARRIVES AT UM



Small molecules beware, your structures will be revealed! Professor Berryman next to the UM x-ray diffractometer.

In 2013 the National Science Foundation funded a state-of-the-art small molecule X-ray diffractometer for research, teaching and outreach at the University of Montana and surrounding areas. The half-million dollar instrument can handle a variety of crystalline samples thanks to the dual X-ray sources (Cu and Mo) and large CMOS detector. The instrument was funded in part by an NSF Major Research Instrumentation grant awarded to Prof. Orion Berryman and through internal support at UM including the Vice President of Research, the College of Humanities and Sciences and the departments of Chemistry and Biochemistry as well as Biomedical and Pharmaceutical Sciences. To date, over 100 crystal structures have been solved and new research has been enabled in five labs across the UM campus contributing to over 14 new publications. The instrument also operates as part of the Macromolecular X-ray Diffraction Facility as a service to researchers throughout the region including the University of Idaho, Montana State University and University of Wisconsin-Eau Claire.

## NEW DEPARTMENT FACILITIES

The Department of Chemistry and Biochemistry recently expanded its Mass Spectrometry capabilities with the addition of a liquid chromatography mass spectrometry (LC/MS) system which incorporates an Agilent 1040 binary pump LC to a Bruker Amazon SL mass spectrometer. This new addition will further enhance analytical capabilities for small molecules, medicinal chemistry as well as small biomolecular studies. The mass spectrometer addition along with the present Agilent 6890/5973N GC/MS, Bruker Maldi-TOF systems has dramatically increased the University's Mass Spectrometry capabilities.

# XPRIZE AWARD

### Sunburst Sensors

www.sunburstsensors.com

Professor DeGrandpre's company, Sunburst Sensors located in Missoula, won the Ocean Health XPRIZE competition for development of autonomous pH sensors. The company won both competitions, one for affordability and one for accuracy, against 27 other global competitors. The Ocean Health XPRIZE competition was sponsored by philanthropist Wendy Schmidt to bring attention to ocean acidification, the decrease in pH caused by absorption of anthropogenic $CO^2$ from the atmosphere.

PROFESSOR MICHAEL DEGRANDPRE

# STUDENT NEWS? WHERE ARE THEY NOW

**ERIC BERGQUIST** (B.S. 2003) Upon graduating from UM in 2003, Erik went to Dartmouth Medical School where he also completed his Orthopaedic Surgery Residency. He then pursued a Hand and Upper Extremity Fellowship at the University of Rochester. Upon return to Montana in 2013 with wife and new baby daughter, he started working at the Helena Orthopaedic Clinic where he maintains a busy practice focusing on care of the upper extremity. He continues to enjoying the outdoors spending as much time as he can hiking, fishing, biking and catching the occasional Griz game.

**KATIE HAILER** (Ph.D. 2006) After graduating in May 2006, Katie completed a one year post-doc at the Mayo Clinic in Rochester, MN and then spent 3 years teaching at Winona State University in Winona, MN. In August of 2010 she escaped the Midwest and took a job at Montana Tech in beautiful Butte, MT. Over the past 5 years, Katie has taught sophomore organic chemistry as well as biochemistry, and has grown a research program focusing on assessing metal accumulations in a human population.

**HOPE MARISKA** (B.S. 2008) is currently living in Hawaii and working as an Environmental Scientist for a global environmental consulting firm. She is also attending graduate school at the University of Hawaii at Manoa, pursuing a masters degree in Environmental Engineering. With her career in Hawaii and other offices within the company she is able to travel regularly and has been involved in several interesting projects in the Pacific region as well as the continental U.S. She takes full advantage of her new location and regularly spends her off time, as well as a portion of her working time, both on and under the water. She still makes it back home to Montana regularly to visit with family and friends.

# UM LAUNCHES NEW INTERDISCIPLINARY ENVIRONMENTAL REU PROGRAM

This summer brought back the **Research Experience for Undergraduates (REU) program** to the Department of Chemistry and Biochemistry for its first year of a three year program. The REU, co-led by Professors Aaron Thomas and Earle Adams, funded by the National Science Foundation, supports up to six students from around the country to come to the University of Montana for eight weeks in the summer to experience 'hands on' research in the areas of environmental chemistry. This year over 110 students applied to the program which brought in six students including four Native American students. The students' projects covered the gamut of environmental fields including air quality, water monitoring and green industrial chemistry. The UM Department of Journalism along with a journalism graduate student, Shanti Johnson, collaborated with the REU program in order to enhance student's science writing skills and dissemination of their research experiences via media sources such as radio, newspaper, blogging and website design.

Summer 2015 REU students with their graduate student and professor mentors. Aaron Young (lower right) is the director of the UM Indigenous Research and STEM Education program and co-leader of the REU program with Earle Adams (top center).

UNIVERSITY OF MONTANA
CHEMISTRY & BIOCHEMISTRY

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## CHEMISTRY & BIOCHEMISTRY CLASS OF 2015

Our Department graduates from 10-20 chemistry and biochemistry majors each year. Most of the students shown above were active in undergraduate research projects. This on-the-job experience makes our students very competitive for jobs, graduate programs and professional schools.