



February 2016

News from the High Plains



Spring 2015 Graduates



Enzi STEM Facility

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Greetings Alumni & Friends,

The Enzi STEM Facility opened its doors this January (see photo). We occupy six labs on the first floor for teaching freshman and sophomore physics and astronomy labs. One of our rooms was specially designed to accommodate 56 students in a studio setting (lecture, lab, and discussion combined) and another lab forms half of a 'STEM suite' where a traditional lab setting is found on one side of a movable glass wall and a computational lab on the other. Another recent curricular experiment involved the 'flipped' classroom; Professor Paul Johnson has tried out this technique in our introductory astronomy course.

We are pleased to welcome Assistant Professor Bill Rice, a physicist who specializes in low-dimensional structures. He has added a nice jolt of energy to our program including having already picked up three graduate and two undergraduate students to work in his research group. Both his lab space and that of Assistant Professor TeYu Chien occupy some of the first floor lab areas that formerly were devoted to undergraduate teaching labs but became available thanks to the Enzi STEM Facility.

In astronomy news, thanks to Professor Kobulnicky and our observatory staff we now carry out robust remote observations at WIRO. Students have also recently contributed to fully automated observations with Red Buttes Observatory. The current RBO program follows up on Kepler exoplanet candidates.

Last year I updated you on our renovation of the UW planetarium. Business is booming, as we have tripled our annual attendance. Nearly all Friday night shows have sold out since the renovation, and word has spread among the WY school systems that a visit to the UW Planetarium is a real treat. I personally love how the new digital planetarium has attracted a large number of motivated students to become more involved in the department - we have a small army of physics and astronomy majors (and even a few high school students) who are developing and presenting excellent public shows. Lab Coordinator Travis Laurance has done a great job in leading this effort.

As usual, this newsletter includes updates from selected alumni. Please let us know about your career path (physics.uwyo.edu). We post these updates on our alumni page physics.uwyo.edu/Alumni/alumni.html. Also, please send us your email if you are interested in receiving an electronic copy of these newsletters.

All the best,
Danny Dale
Department Head





Professor Bill Rice earned his Sc.B. (with Honors) in Physics from Brown University and Ph.D. in Applied Physics from Rice University. He was a Director's-funded post-doctoral fellow at the National High Magnetic Field Laboratory at Los Alamos National Laboratory. Professor Rice is a condensed-matter physicist who investigates strong-field physics, optically induced behaviors, and exotic 1D phenomena in low-dimensional structures using magneto-optical spectroscopy, spin techniques, and conductivity. Hailing from the good and great state of Maine, Rice loves to run, enjoys biking, and is a mediocre to poor swimmer. He looks forward to roundly embarrassing himself on the Snowy Range ski slopes this winter.



Fun with liquid nitrogen ice cream

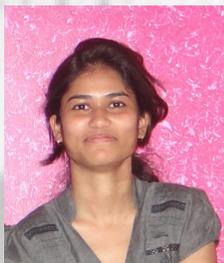


Outreach with optics and WY school groups

This year we welcomed 6 new grad students and 1 post doc from both near and far.



(pictured from left to right - top)
Shane Allison - U. Wyoming
Jessica Sutter- Whitman College
Xin Tian- Northwest U. (China)



(pictured from left to right-bottom)
Ying-Hao Chien - Tamkang U. (Taiwan)
Robert Nielsen - U. Wyoming
Jaya Maithil - Homi Bhabha (India)
Dr. Keshab Sapkota (Catholic U.)

GRADUATE STUDENT PROFILES

Vitaly Proshchenko



Diluted magnetic semiconductors have recently attracted increasing interest in various fields such as spintronics, solar cells, optics, and nanoelectronics of low dimensional materials. Photoluminescence properties become unusual if CdSe nanocrystals are doped by Mn atoms. In this case, one observes two emission lines, one fast and the other slow, depending on a CdMnSe quantum dot (QD) size. At some QD size the slow luminescence disappears. We theoretically explain the effect of the disappearance of the slow luminescence for CdMnSe quantum dots. In this effect, one line relaxes quickly and corresponds to the CdSe conduction band, whereas the second is very slow (0.1-1.0 ms). The slow luminescence line disappears for quantum dots with diameters $D > 3.3$ nm, and therefore the luminescence is tunable via QD size. We also study slow luminescence in CdS, ZnS, and ZnSe quantum dots doped by Mn impurities.

Other attractive features of manganese-doped CdSe quantum dots are the additional absorption in a gap range and the effect of gap narrowing. Thus we study optical transitions in CdMnSe quantum dots. For low manganese concentrations, the transitions are spin-forbidden. Nevertheless, strong light absorption was experimentally found. To explain this phenomenon we propose a new mechanism that includes two or more Mn atoms closely placed to each other containing the electrons with opposite spin projections. In this case there is no spin-flip. We find that the strongest absorption from the gap is for an antiferromagnetic arrangement.

Room temperature nano-ferromagnetism is very important in quantum computing and spintronics. Such an effect is induced by intrinsic defects (vacancies) and has recently attracted a great deal of attention. This class of materials does not include magnetic ions with open d or f shells and refers to d0 magnets. We theoretically study d0 magnetism in ZnS quantum dots. We explain the origin of magnetism and find that only Zn vacancies can introduce magnetic moment. The calculated total magnetization in ZnS quantum dots is in good agreement with experimental data from Professor Tang's group.

Uma Poudyal



Quantum dot-sensitized solar cells have been drawing huge attention due to their fascinating characteristics like high absorbance and tunable bandgap. There are different methods to synthesize quantum dots such as hot injection, direct adsorption, SILAR, and CBD. I work on Cadmium Selenide (CdSe) quantum dots prepared by the SILAR (Successive Ionic Layer Adsorption and Reaction) method. As its name suggests, this method involves a substrate that is successively immersed in a cation and anion source solution to deposit CdSe quantum dots. Study of the absorption spectra of these quantum dots shows that the bandgap is tunable and depends upon the size of quantum dots. Zinc-Tin-Oxide (ZTO) nanowires have been utilized as photoanodes in my research and they are coated with layers of CdSe to fabricate solar devices. I study the effect of the number of coating cycles of CdSe on the efficiency of these devices and I work with undoped and Manganese (Mn) doped CdSe Quantum dots. The comparison of doped and undoped CdSe is done using various characterizations and imaging techniques to reveal their characteristics and to quantify the effect of doping in the performance of solar devices.

Artem Pimachev



My research is focused on a theoretical exploration of the optical and magnetic properties of semiconducting materials and their light absorption, efficient electron transfer, and spin configuration in application to solar cells and nanostructure devices. I calculate photocurrents, the main link between experimental measurements and ab initio computations. I introduce the spin dimension into the system by doping the materials with transition metal impurities or vacancies.

I have modeled the optical properties of PbS and PbSe nanocrystals as a function of size. I have shown that manganese impurities tend to form an antiferromagnetic coupling and shift the bandgap towards the higher energy. I have studied hybrid lead halide perovskites with various concentration of iodine and chlorine atoms and the effect of the concentration on bandgap. I also estimated the energy barriers necessary for the rotating MA group in perovskites that are responsible for the electric dipole moment of the material.

Along with our experimental research groups at UW, I study PbS quantum dots on ZTO nanowires. We have shown that doping the quantum dots with manganese atoms boosts the measured photocurrent. To explain the experimental data I use Quantum Chemical and Solid State computational packages to estimate the electron transfer rates and molecular orbital overlaps. My goal is to explain experimental data on optical, magnetic, and photocurrent measurements using ab initio software along with a theoretical Green's functions approach developed in my research group.

ALUMNI NEWS

Daniel E. Carroll (Ph.D. 1976) I am retiring after 30 years at Sandia National Laboratory. After getting my PhD I went to work in Los Alamos for EGG and then Los Alamos National Laboratory, working with some other Wyoming graduates who had found a nice niche there. Then in 1985 I moved to Sandia. I have worked in Reactor Safety, High Performance Computing, Sensor systems for satellite detection of Nuclear Detonations and some other areas. I have mostly stayed in the Modeling and Simulation area I worked in at UW with David Hoffman and Jim Rosen -- stratospheric aerosols. A long time ago in a world far, far away.

Michael Mayo (BS 2002) I earned a PhD in Physics from U. Missouri in 2009. My research there focused on using mathematical modeling to understand the anti-fouling characteristics of heterogeneous catalysis over fractal surfaces, which could equivalently describe the ability of the human lungs to provide oxygen to the blood despite experiencing damage (e.g., cigarette smoking, disease). I joined the Environmental Genomics and Systems Biology team at the US Army Engineer Research and Development Center, a Department of Defense-funded government laboratory. I have contributed to projects ranging from signal characteristics of transcriptional-regulatory networks in the presence of noise to biological pathways involved

in toxicity response at the molecular level. These activities involve close collaborations with experimentalists in cell biology, toxicology, microbiology, immunology, and engineering. In recognition of these and other works, I was awarded the prestigious US Army Modeling and Simulation Award in 2013, and the Commanders Award for Civilian Service in 2015.

Sabrina Savage (MS 2005) I studied gamma ray bursts at UW and went on to receive my Ph.D. in Physics from Montana State University. My Ph.D. thesis focused on observational signatures of magnetic reconnection during solar eruptions. I also gained valuable satellite operation experience as a graduate student at MSU, adding to my ground-based experience from UW. I was then awarded a NASA postdoc fellowship which allowed me to continue that research at Goddard Space Flight Center and led into my current civil service position as an astrophysicist at NASA Marshall Space Flight Center in Huntsville, AL. I am currently serving as the Project Scientist for the Hinode satellite, involved with several sounding rocket projects developing new technologies for solar observations, and continuing my research into the fundamental physics behind energy release from magnetic reconnection.

Thank you to our recent donors! Dr. and Mrs. David Barnaby, Burnett Family Charitable Fund, Dr. Lowell Burnett, Dr. & Mrs. Terrence and Margaret Flower, Ms. Leslie W. Fung, Dr. Paul K. Henry, Mr. Lowell W. Hill, Mr. and Mrs. Gary & Betty Jo Horton, Mr. Michael E. Johnson, Dr. Roland Lamberson, Mr. and Mrs. David & Lois Larmouth, Captain William L. Roberts, Mr. Roy C. Sarver, Mr. Samuel R. Schrinar Jr., Dr. Terry A. Scott, Ms. Jean M. Meyer-Scott, Mr. Jerry D. Tastad, Dr. and Mrs. Ronald Wilson. If you would like to donate please visit uwyo.edu/foundation.

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