



Applied Research and
Technology Program of
Distinction

Western Kentucky University

ARTP

Leading Edge

Issue 8, 2nd Quarter

October 2005 thru December 2005

Inside this issue:

Physics and
Astronomy
Symposium 1

WATERS lab
DNA Research 2 3

ICSET Workshop 4

MCC: Lab
researches
cancer drug 5

Hoffman graduate
discovers new
species 6

Biotech hosts
KBRIN/INBRE
Meeting 7

Center Directory 8

API and IASS Students Attend Argonne National Laboratory Symposium

Six students from the Applied Physics Institute (API) and the Institute for Astrophysics and Space Sciences (IASS) attended the sixteenth annual Argonne National Laboratory Symposium in Argonne, IL. The symposium was a two-day event that began November 4, 2005.

Argonne National Laboratory is the nation's first laboratory and is the U.S. Department of Energy's largest research center. The symposium provides an opportunity for undergraduate students in science, engineering and mathematics to present their latest research projects. This year, Argonne had more than 350 students from across the nation attend.

The API student representatives included Jonathan Craft, Sarah McMurray, Ryan Moore and Ian Rice. The IASS members that presented were Shelly Smith and Richard Walters. Dr. Phillip Womble, associate physics professor and Director of the Applied Physics Institute, was the faculty mentor that accompanied the students.

Ian Rice, a junior physics major from Fort Campbell, KY, and the President of WKU's Society of Physics Students, plans to attend Argonne's next symposium this fall. "Argonne gave me a sense of accomplishment when seeing my research with other science

students from across America," Rice said. "I also picked up on presentation techniques that will help me with research presentations in the future."

For more than ten consecutive years, students and faculty members have attended the symposium. This year marked Dr. Womble's second trip to Argonne. Dr. Womble said he has enjoyed taking students because of the diverse research topics and experiment discussions.

"One of the best ways for our students to learn new ideas is by attending research conferences," Dr. Womble said. "Argonne is one of the best and we will continue to offer it as an annual trip for students."

While presenting, students are not in competition with one another, but are there to demonstrate their knowledge and enlighten one another about various fields. The symposium creates a positive atmosphere for all presenters.

Western Kentucky University's Society of Physics Students co-sponsored the trip along with the Department of Physics and Astronomy. Student presenters and project titles are listed below.

Jonathan Craft: "Investigation of Ranges for Proton Recoil Reaction Products in Gas Mixtures of Position Sensitive Neutron Detectors"

Sarah McMurray: "Design and Construction of the WKU Ion Beam Materials Analysis Laboratory"

Ryan Moore: "Threat Level Determination through Elemental Analysis"

Ian Rice: "Harmonic Prime Mover Development for Thermo-Acoustic Agglomeration"

Shelly Smith: "Revealing Pulsations of WR123 Using MOST"

Richard Walters: "Structure Function Analysis of Blazar PKS 0716+714"

~Submitted by
Dara Hardin

Public Relations Coordinator
Applied Physics Institute

Approved by
Phil Womble, Director
Applied Physics Institute



Shelly Smith, member of the Institute of Astrophysics and Space Science was the first WKU presenter at the Argonne Symposium.

Figure 1a

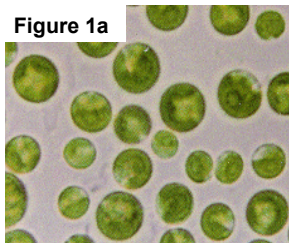


Figure 1b

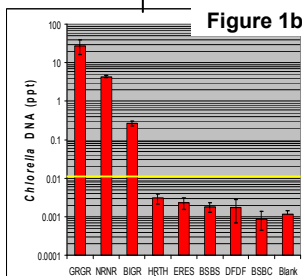


Figure 1c

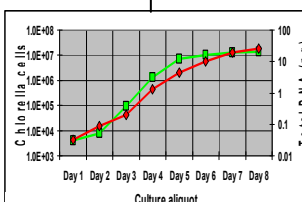
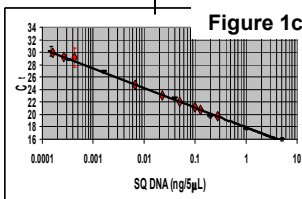


Figure 1d

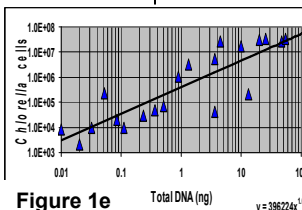


Figure 1e

Figure 1a-e: Mammoth Cave National Park (MACA) is monitoring phytoplankton in surface waters using a test developed at WATERS for specific quantification of *Chlorella* DNA. *Chlorella* species make up 95% of the phytoplankton community in the Green and Nolin Rivers making it an ideal indicator of green algae populations which sustain higher aquatic organisms, including some endangered species, in the environment.

WATERS Laboratory Finds Applications for Environmental DNA Research

Environmental Biotechnology can be defined as the application of modern DNA and genetic engineering techniques to the study and monitoring of microbiological processes relevant to the environment. Environmental Biotechnology techniques have proven particularly successful in the WATERS Laboratory for measuring the concentrations of DNA from bacteria, fungi, algae, amoebae, and other protozoa in water, and sediment samples in environmental monitoring programs for three agencies of the National Park Service, and in drinking water monitoring and re-

search underway at the Louisville Water Company.

Mammoth Cave National Park (MACA) provided seed funding and now contracts WATERS to carry out monthly monitoring of phytoplankton, at the photosynthetic base of the surface aquatic food web.

Previous studies showed that *Chlorella* sp. make up 95% of the phytoplankton population year-round in the Green River and its tributary, the Nolin River in MACA. WATERS collaborated with a Japanese researcher who developed specific DNA probes for *Chlorella* DNA and with

those primers we developed a quantitative Real-Time PCR (qRT-PCR) assay to specifically measure *Chlorella* DNA concentrations accurately in the parts per trillion range. *Chlorella* DNA concentration was shown to correlate with the number of *Chlorella* cells in culture. The number of cells represented by a given DNA concentration is more subjective than qRT-PCR (which is based on a spectrophotometric standard curve), but cell numbers can be estimated by data accumulated by performing the assay on samples in which cells had been counted under the micro-

Figure 2a



Figure 2b

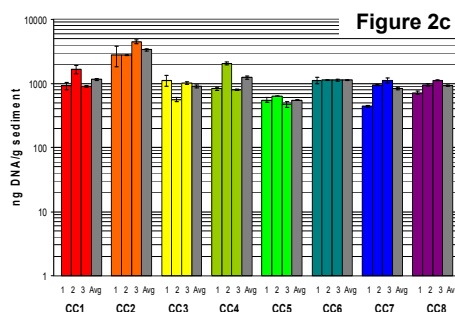


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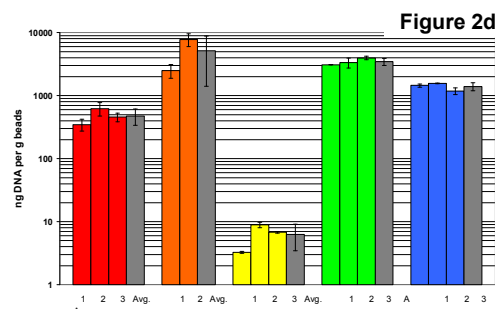


Figure 2d

Figure 2a-d: WATERS is monitoring bacterial communities in sediments and on artificial substrates at study sites in Mammoth Cave selected for their importance to long term monitoring of cave microbial ecology. Artificial substrates are placed and retrieved after one year in the cave aquifers (Photographs by Rick Olson and Gary Berdeaux.)

Also at Mammoth Cave, concentrations of bacterial DNA in cave sediments and in biofilms on artificial substrates in cave aquifers are being recorded as part of the Long Term Ecological Monitoring Program with funding by a grant from the National Cave and Karst Research Institute (NCKRI). The data will be used as a parameter in which changes may be observed if the aquatic environment is perturbed (**Fig. 2a-d: bottom Page 2, Fig 2e: Right-top Page 3**). Many of the bacterial DNA sequences have given clues to the types of bacteria that inhabit cave sediments and flowing streams.

The impact of tourism on Oregon Caves National Monument (ORCA) is being monitored by quantifying and identifying bacterial and fungal species in sediments and substrates from sites both on and off the footpaths and hand-

rails constructed for tourism, and from sites not impacted by frequent visitation. DNA sequence data have been reported for almost 100 cloned cave bacteria, 13 cloned cave fungi, and six cloned cercozoans found in the cave. Concentrations of fungal DNA tended to be higher on the trails, and differences in the types of bacteria were evident (**Fig. 3: at right**).

Louisville Water Company (LWC) has contracted WATERS to measure concentrations of *Acanthamoeba* in eye wash stations at schools and laboratories served by the utility. *Acanthamoeba* is a leading cause of keratitis in contact lens wearers and thus poses a public health hazard. WATERS applied a published method using specific DNA probes in qRT-PCR to specifically detect and quantify the organisms (**Fig. 4: bottom**). *Acanthamoeba* DNA used as a

standard in our experiments was obtained by collaboration with the original author of the study in France.

Also, the Louisville Water Company is studying the dose-response effect of chlorite ions on the growth of ammonia oxidizing bacteria (AOB) in treated water distribution storage tanks. WATERS applied a published method for quantifying AOB using specific DNA probes in qRT-PCR to specifically detect and quantify AOB related to *Nitrosomonas europaea* (**Fig. 5: bottom**). The cloned gene used as a standard in our experiments was obtained by collaboration with the original authors of the study at the University of Tennessee.

~Submitted by
Rick Fowler and
approved by Jana Fattic
Assistant Director
WATERS Lab
Center for Water
Resource Studies



Fig. 2e: Charon's Cascade

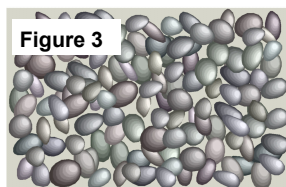


Fig. 3: bacterial and fungal species in sediments Being monitored by the WATERS Lab for ORCA.

Figure 4a HEX Acanthamoeba Probe Fluorescence

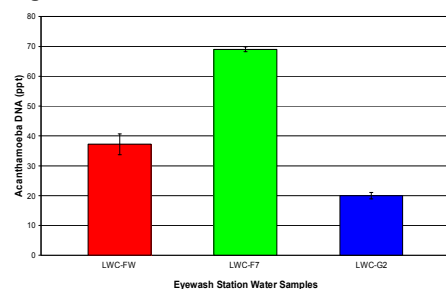


Figure 4b

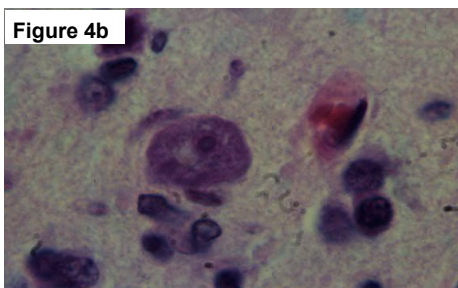


Figure 4a-b: Quantification of *Acanthamoeba* DNA in eyewash stations in the Louisville Water Company service area. Concerns about *Acanthamoeba* and its association with corneal keratitis in contact lens wearers, as well as its potential transfer of other infectious diseases, led to an opportunity for WATERS to apply qRT-PCR technology to detect and quantify potential pathogens using a specific DNA test.

Figure 5a AOB Primers SYBR Green

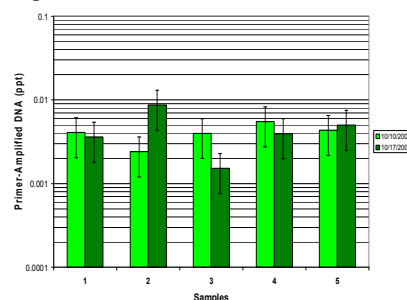


Figure 5b HEX TaqMan Probe

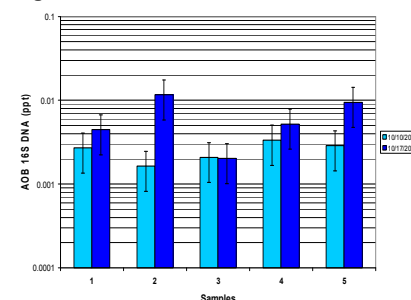


Figure 5a-b: Quantification of Ammonia Oxidizing Bacteria (AOB) to measure dose response to oxidizing treatments in drinking water storage tanks. WATERS has applied qRT-PCR using simultaneous monitoring of two fluorescent dyes to assist the Louisville Water Company in research examining the effect of chlorite ions on AOB growth.

ICSET Hosts A Hands-On Mercury Workshop

“ICSET claims that this was an excellent opportunity for anyone who wants to gain industrial and hands-on experience on several analytical instruments that are used for mercury monitoring and analyzing.”

The Institute for Combustion Science and Environmental Technology (ICSET) made preparations for the hands-on mercury workshop in conjunction with the grand opening, which was held on February 22 and 23, 2006. More information on the mercury workshop is provided at www.wku.edu/ICSET.

This workshop covered current hot topics such as compliance strategies from an industry's perspective, mercury chemistry, and overview of issues and QA/QC protocols of SCEM, Ontario Hydro Method, and Appendix K. The grand opening had a great line-up of keynote speakers who discussed baseline Hg determination, Hg control technologies and

general reference methods. This meeting created an opportunity for networking, collaboration, sharing of technical information with other participants representing coal industry, government policy makers, as well as academic scholars and researchers. ICSET claims that this is an excellent opportunity for anyone who wants to gain industrial and hands-on experience on several analytical instruments that are used for mercury monitoring and analyzing.

ICSET was the recipient of 12 funded projects through the U.S. DOE, USDA, NASA, Kentucky Office of Energy Policy and EPRI. Over 200 materials characterization services were provided in 2005. The ICSET

mercury emission team also helped more than 35 power stations in 2005 and more than 85 power stations in last three years to conduct baseline determination, evaluate different mercury control technologies, and to compare SCEM systems, appendix K and the Ontario Hydro method over the past year. The newly updated website clearly shows how ICSET has vastly expanded its services in the past year.

*~Submitted by
Dr. Wei-Ping Pan
Director, Institute
For Combustion
Science and
Environmental
Technology*



(Above Left) Undergraduate students preparing Ontario Hydro Method (OHM) solution.



(Above Right) Sampling personnel working on-site.

MCC: Dr. Williams' laboratory researches an anticancer drug.

Cisplatin is a widely used platinum-based anticancer drug. It has shown remarkable success with certain types of cancers, particularly testicular cancers. Cisplatin and related compounds can react with DNA, RNA, or proteins, the former being the key target responsible for anti-cancer activity. Reaction of platinum with proteins may be a detoxification pathway that leads to resistance to the drug's activity. Complexes that are structurally similar to cisplatin have also shown the ability to chemically cleave proteins at selected sites; while the conditions necessary for protein cleavage are probably not relevant to the anticancer activity, site-selective protein cleavage is important for a number of biochemical laboratory applications.

Thus, the reactions of platinum compounds with proteins are of significant biological interest.

Research in Dr. Williams' laboratory focuses on the effects of the size and shape of platinum compounds on the formation of DNA and protein adducts. Structural models of various adducts are determined using a computer to perform molecular mechanics calculations. These calculations are used to interpret experimental data and also to predict the results of experiments that have yet to be performed. Experimentally, selected cisplatin analogs of various shapes and sizes have been prepared (**Fig. 1: Bottom of page 5**). These compounds have been reacted with various DNA and protein building blocks, and the results have been charac-

terized by instrumentation and techniques including NMR spectroscopy, gel electrophoresis, and ICP-AES. The results from earlier studies in the Williams laboratory have shown that the presence of bulk on the platinum compound prevents certain types of adduct formation with the amino acid methionine and slows reaction with this amino acid considerably. The Williams laboratory has published two articles in scientific journals, and two more publications are being planned. These studies are currently being expanded to include small peptides and proteins.

~Submitted by
Eric Conte, Director
Materials
Characterization
Center

"It has shown remarkable success with certain types of cancers, particularly testicular cancers."

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- Williams, K.M.; Chapman, D.J.; Massey, S.R.; Haare, C. "Interaction of N-acetylmethionine with a non-C₂-symmetrical platinum diamine complex", *J. Inorg. Biochem.*, 2005, 99, 2119-2126.
- Williams, K.M.; Rowan, C.; Mitchell, J. "Effect of Amine Ligand Bulk on the Interaction of Methionine with Platinum (II) Diamine Complexes", *Inorg. Chem.*, 2004, 43, 1190-1196.

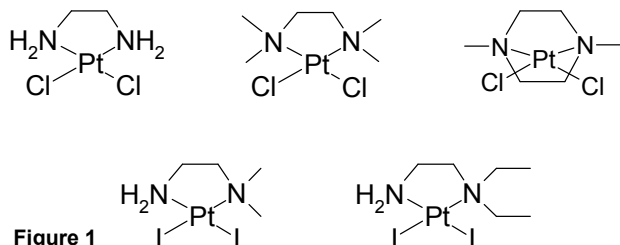


Figure 1

Figure 1: Representations of selected platinum compounds prepared and studied in the Williams laboratory.

Figure 2



Figure 2: Undergraduate student researchers, Bethany Alicia and Steven Chmley, with Dr. Kevin Williams.



Figure 1

Figure 1: Millipede found at the Sequoia National Park.

Photo taken by Joel Despain

“The high regard that Joel has earned nationally among cave scientists and federal land managers highlights the level of student that WKU’s karst science programs are able to attract,” Dr. Groves said.



Figure 2

Figure 2: Scorpion found at Sequoia National Park.

Photo taken by Jean Krejca

WKU HERI Graduate Student Helps in the Discovery of 27 New Species In California Caves

A Western Kentucky University geo-science graduate student is making national news as part of the discovery of 27 new species in California caves.

Joel Despain, a cave specialist for the National Park Service at Sequoia National Park, participated in a three-year study of subterranean life and helped explore 30 of the 238 known caves in Sequoia and Kings Canyon national parks where the previously unknown species of spiders, centipedes, scorpion-like creatures and other animals were discovered.

“Not only are these animals new to science, but they’re adapted to very specific environments -- some of them to a single room in one cave,” Despain said in an Associated Press report on the discovery. Dr. Jean Krejca, a Texas biologist who directed the research, has worked with Despain on several cave projects from California to the jungles of Malaysia.

Dr. Chris Groves, Despain’s graduate adviser and director of the Hoffman Environmental Research Institute within WKU’s Applied Research and Technology Program, isn’t surprised that Despain is earning national recognition again.

“The high regard that Joel has earned nationally among cave scientists and federal land managers highlights the level of student that WKU’s karst science programs are able to attract,” Dr. Groves said.

Despain, who lives in Three Rivers, Calif., is completing WKU graduate coursework as part of a specially designed master’s degree program for full-time scientists and land managers in the National Park Service. He will defend his thesis research and complete his degree in early March, Groves said.

Despain said he was attracted to WKU because of the program in karst hydrology and karst geology. “It is really a unique program nationwide with a good reputation and years of producing top people in world of caves and karst,” he said. “The degree has been a big help at my job as a Cave Management Specialist at Sequoia and Kings Canyon. It has changed my career by giving me the tools and skills for conducting necessary karst research and studies here at the two parks.”

In 2004, Despain published “Hidden Beneath the Mountains: Caves of Sequoia & Kings Canyon National Parks,”

a 128-page book on the history, science and management of caves within the mountainous national park in the California Sierras.

He traveled to southwest China in 2001 as part of the Hoffman Institute’s China science program and led cave science expeditions to both Indonesia and Malaysia during the time he has been a WKU student.

In 2001, Despain was awarded the Cave Research Foundation’s \$3,500 Karst Research Fellowship for his graduate thesis research, which examined interactions between karst geochemistry and atmospheric carbon dioxide in a high mountain karst area of Sequoia National Park.

~Press release by

Tommy Newton,

Jan 20, 2006

Submitted by

Chris Groves

Director,

*Hoffman Environmental
Research Institute*

BIOTECH Investigators for KBRIN/INBRE Host Statewide Meeting

On December 1st and 2nd, Western Kentucky University hosted a statewide meeting of the Kentucky INBRE program (IdeA Network of Biomedical Research Excellence). Dr. Cheryl Davis of the Department of Biology serves as WKU's Lead Faculty Representative for the program, and four other members of the Department of Biology (Drs. Rodney King, Jeffrey Marcus, Nancy Rice, and Michael Smith) are research scientists in the program. One additional faculty member from the Department of Psychology (the late Dr. Joseph Bilotta) was involved in the program as a research scientist until his untimely death on January 2.

In attendance were the Principal Investigator of the statewide grant, Dr. Nigel Cooper of the University of Louisville Health Sciences Center and other members of the Administrative Advisory Board, External Advisory Committee, and Steering Committee. Representing the External Advisory Committee for the program were Dr. David Landsman, Chief of the Computational Biology Branch National Center for Biotechnology Information at the National Institutes of Health; Dr. Daniel Goldowitz, Director of the UT Research Center of Excellence in Genomics and Bioinformatics University of Tennes-

see Health Science Center; Dr. Cynthia Gibas, Department of Computer Science, University of North Carolina, Charlotte; and Dr. Irv Kornfield, School of Marine Sciences, University of Maine.

The meeting included a tour of the Visual Neuroscience Lab in the Department of Psychology, and tours of the newly constructed Biotechnology Center and numerous research labs on the 3rd floor of the Center for Engineering and Biological Sciences building. Guests were welcomed at a reception held in the lobby of EBS in opening remarks by Dr. Richard Bowker, Department Head of Biology, and Dean Blaine Ferrell of Ogden College of Science and Engineering. Later in the evening, guests also were welcomed by President Gary Ransdell.

WKU researchers receive nearly \$500,000 annually as participants in the Kentucky IdeA Network of Biomedical Research Excellence. The goal of the KY-INBRE is to build on the successes of the KBRIN (Kentucky Biomedical Research Infrastructure Network), its infrastructure and its network of biomedical researchers, to increase the capacity for research in the state of Kentucky. Other participating institutions include the University of Louisville, University of Kentucky, Eastern

Kentucky University, Northern Kentucky University, and Morehead State University.

The program described above is supported by NIH Grant Number P20 RR-16481 from the IDEa Networks of Biomedical Research Excellence (INBRE) Program of the National Center for Research Resources

*~Submitted by
Sigrid Jacobshagen
Director,
Biotechnology Center*



Figure 1

Figure 1: External Advisory Committee Member, David Landsman (NIH) and KBRIN/INBRE Director and PI, Nigel Cooper (UL), tour research labs with Biology Department Head, Richard Bowker. Photo by Sheryl Hagan-Booth

Figure 2



Figure 2: Lead faculty representative, Cheryl Davis, addresses KBRIN participants and invited guests from WKU in the 3rd floor lobby of CEBS.

Photo by Sheryl Hagan-Booth

Figure 3

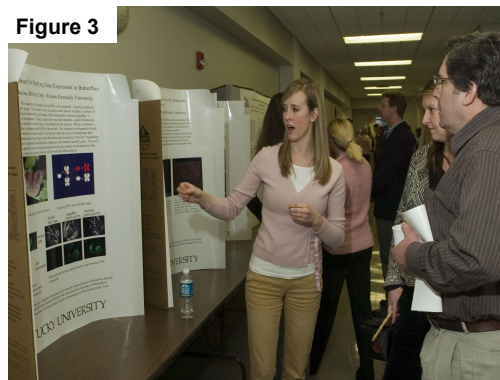


Figure 3: Junior biology major, Brooke Polen, performs research with Biotechnology Center member, Rodney King. Here, she explains her latest results to External Advisory Committee Members, Cynthia Gibas (UNC, Charlotte), and Dan Goldwitz (UT, Memphis)

Photo by Sheryl Hagan-Booth



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