STAYING CONNECTED TO ADVANCE THE FIELD

Staying connected to the global scientific community is integral to life at Cornell's Wilson Synchrotron Lab. The CHESS Journal Club, the Frontier Applications in Synchrotron Radiation (FASR) lecture series, and the summer 2006 ERL x-ray science workshops are some of Cornell's programs that encourage researchers to come together to discuss new scientific developments in accelerator-based sciences at Cornell and around the world.

The CHESS Journal Club

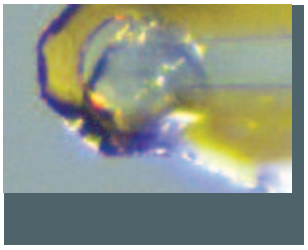
Since the mid-1980s, the CHESS Journal Club has brought x-ray scientists within the Cornell community together to learn about and discuss current published research in the field. In this informal setting, researchers talk about the work they are doing, what others have done, their rationale for doing it, and how they chose their methods.

SINCE THE MID-1980s, THE CHESS JOURNAL CLUB HAS BROUGHT X-RAY SCIENTISTS WITHIN THE CORNELL COMMUNITY TOGETHER TO LEARN ABOUT AND DISCUSS CURRENT PUBLISHED RESEARCH IN THE FIELD.

One important function of the journal club is to showcase the published or soon-to-be published work of Cornell graduate students. Journal club participants discuss, analyze, and critically evaluate the work. The gatherings are an excellent opportunity for graduate students to learn how to give presentations to their fellow physicists in a friendly, informal setting. They experiment with a variety of presentation styles and engage the group in discussion about how best to conduct the research at hand. Students and faculty benefit from advice and assistance from on-campus experts.

The journal club also invites guest speakers who are making strides in their fields from other universities and research facilities. Two recent speakers were Christina Biscula, a graduate student in the field of art conservation science at the University of Delaware, and Paul Fenter, a physicist and group leader for Interfacial Processes at Argonne National Lab (ANL).

Biscula works with confocal x-ray fluorescence spectroscopy, a new nondestructive technique developed at CHESS by staff



scientist Arthur Woll for compositional depth profiling used to analyze oil paintings. The technology potentially allows x-ray scientists and art conservationists to analyze sublayers of paint without taking physical samples from historic works. It has future applications in the authentication, dating, and understanding of historical artistic techniques.

Fenter discussed how toxic waste substances interact with clay and mineral surfaces. When substances are released into the environment, some chemicals bond with the surfaces of minerals in the ground, while others are not attracted to the particle surfaces, instead seeping into groundwater. Fenter uses x-ray scattering capabilities to image atomic- and molecular-scale phenomena, the liquid-solid interface, in which liquid chemicals interact with the solid surface of minerals. These molecular processes have significant future applications for chemical and environmental science.

As part of the yearlong lecture series, CHESS invited experts ... to lecture on their research in the biological, environmental, or materials sciences and how synchrotron radiation will serve as a frontier scientific tool.

Each CHESS Journal Club event is advertised on campus and is open to the public. The events usually attract CHESS staff and Cornell faculty, undergraduates, and graduate students involved in physics, applied physics, and chemistry. The frequent meetings help keep researchers from across campus abreast of new discoveries in x-ray science, as well as the happenings in science at national facilities and other universities.

ONE IMPORTANT FUNCTION OF THE JOURNAL CLUB IS TO SHOWCASE THE PUBLISHED OR SOON-TO-BE PUBLISHED WORK OF CORNELL GRADUATE STUDENTS.

CHESS

Philip Anfinrud, National Institutes of Health

Frontier Applications in Synchrotron Radiation (FASR)

In a technological field such as x-ray physics, it is imperative that scientists at CHESS prepare for the advancement of science far into the future. It is especially necessary for the researchers at CHESS to ask far-reaching questions: What will the field be like in the coming years? What will scientists be capable of doing? What will the expectations of the technology be? What tools will scientists need to develop? To encourage the synchrotron community to think in this way, CHESS created the 2005–6 Frontier Applications in Synchrotron Radiation (FASR) lecture series, with support from Cornell's provost office. Speakers for the lecture series were chosen to address diverse audiences on campus with a range of topics outside the campus' usual research.

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Philip Anfinrud Lecture

As part of the yearlong lecture series, CHESS invited experts Gordon E. Brown, Stanford University; Barbara Illman, U.S. Department of Agriculture Forest Products Laboratory; Philip Anfinrud, National Institutes of Health; John Spence, Arizona State University; and Chris Jacobsen, State University of New York at Stony Brook, to lecture on their research in the biological, environmental, or materials sciences and how synchrotron radiation will serve as a frontier scientific tool. The scientists use x-ray spectrometry and crystallography to study a wide variety of fields, ranging from environmental contamination to real-time protein structure.

The visiting scientists were hosted for weeklong stays by departments related to their fields. During their visits, they served as scientists-in-residence, lecturing and attending informal meals and meetings with students and faculty to exchange ideas firsthand.

CHESS Journal Club Speakers

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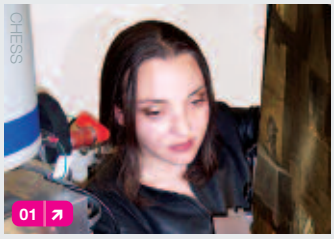

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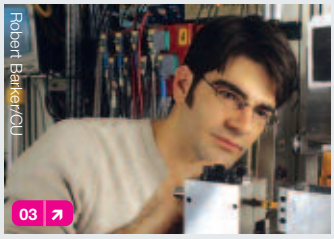
Robert Barker/CU



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CHESS

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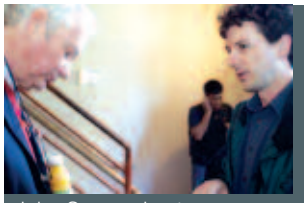
01. Christina Biscula, a graduate student in the field of art conservation science at the University of Delaware, works with confocal x-ray fluorescence spectroscopy, a new nondestructive technique developed at CHESS by staff scientist Arthur Woll for compositional depth profiling used to analyze oil paintings.

02. Paul Fenter, a physicist and group leader for Interfacial Processes at Argonne National Lab (ANL), discussed how toxic waste substances interact with clay and mineral surfaces. These molecular processes have significant future applications for chemical and environmental science.

03. Joel Bernier, former Cornell mechanical engineering graduate student now a postdoc at Advanced Photo Source, Argonne National Lab, addressed the CHESS Journal Club on "Quantitative Stress Analysis Using Area Detectors."

04. Anthony Ingraffea, Civil and Environmental Engineering, spoke on "Simulation of Fatigue Crack Nucleation and Propagation in Aluminum Alloys Using Realistic Microstructures."

CHESS



John Spence Lecture

Each scientist gave three formal lectures, geared to the different needs of the Cornell community: one with highly technical information specifically for x-ray scientists, another for nonspecialists on campus, and a third for the host department covering a subject of topical interest to that department. These lectures provided a unique opportunity for the experts to promote the field of x-ray science, particularly among nonspecialists, and to demonstrate capabilities for continued advancement. The lectures also encouraged researchers to look into the literature and advance their own research.

2006 Summer Workshops for ERL Preparation

By 2013 CHESS seeks the permission to proceed with the building of a revolutionary x-ray source, the Energy Recovery Linac (ERL). To obtain funding for this new machine, CHESS will submit a detailed proposal to the National Science Foundation. In preparation for this proposal, CHESS invited external experts to the Cornell campus to discuss the scientific need for the ERL in a series of workshops held in the summer of 2006.

FOR TWELVE DAYS IN JUNE, SCIENTISTS MET FOR SIX SEPARATE WORKSHOPS ON CAMPUS. THE EVENT ALLOWED SCIENTISTS FROM ALL OVER THE WORLD TO COLLABORATE IN THE DEVELOPMENT OF THE WORLD'S FIRST ERL X-RAY SOURCE.

For twelve days in June, scientists met for six separate workshops on campus. The event allowed scientists from all over the world to collaborate in the development of the world's first ERL x-ray source. As part of the early drafting stages of a multistep proposal and review process, scientists attending the workshops set initial goals for the new machine and discussed initial plans, techniques, and designs for building the new facility.

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Barbara Illman, U.S. Department of Agriculture Forest Products Laboratory

The scientists discussed the future needs of x-ray physics and determined what the ERL can do to meet them. The six two-day workshops covered topics in high-pressure science, high repetition–rate and ultrashort pulse x-ray sources, materials science, soft materials and nanoscience, biology, and nanometer-sized x-ray beams. The materials science workshop, for example, entitled "Almost Impossible Materials Science: Pushing the Frontier with ERL X-ray Beams" opened with presentations from 12 scientists. Then the scientists broke into three working groups to discuss the needs of scientists studying in three areas: imaging nonperiodic materials, fluctuations and dynamics, and in situ growth and characterization. These are broad areas of science in which CHESS's new ERL source could provide much better experimental data than scientists can presently collect from existing x-ray sources around the world.

The ERL science workshops are critical for helping to define new scientific opportunities made possible by an ERL source located on the Cornell campus.

Gillian Sarah Paul '08

Gordon E. Brown Lecture

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Top left: Gordon E. Brown, Stanford University

ERL WORKSHOPS YIELD EXCITEMENT

Frank DiMeo

DURING THEIR VISITS, THEY SERVED AS SCIENTISTS-IN-RESIDENCE, LECTURING AND ATTENDING INFORMAL MEALS AND MEETINGS WITH STUDENTS AND FACULTY TO EXCHANGE IDEAS FIRSTHAND.

Materials science, soft matter, high-pressure, biology, the ultrafast, and nanobeams were topics of discussion for 96 invited speakers and 420 participants from around the world over a two-week period of six ERL workshops held this past summer. Sol Gruner, Physics/director of CHESS and x-ray science, set the agenda: Give us "one good idea" for an experiment needing the ERL. Neil Ashcroft, Physics, opened the first workshop with an invitation for participants to boldly put forth "adventurous ideas." And so it was.

During the high-pressure workshop, Paul Loubeyre (Université Paris) answered with "hydrogen," the lightest of all elements and one of the hardest to study. "The ultimate goal is to determine the structure of metallic hydrogen. That should certainly require a significant jump in the x-ray brightness and source size. Such a beam could be obtained by an ERL." Scientists currently study the dynamics of liquid oxygen and water under pressure, but going to higher pressures will require much smaller specimens and a single spectrum would take more than one hour to collect. Faster data collection and much higher resolution are needed to advance our knowledge of these ubiquitous materials, which will have a huge impact on our understanding of geology and earth and planetary sciences.

At the materials workshop Eric Isaacs, director of the Center for Nanoscale Materials at Argonne National Laboratory, surveyed the field of nanofabricated materials and pointed out that scientists need to learn much more about mesoscale systems, melting and solidification processes, dynamics of domain walls, and magnetic phenomena on the nanoscale. With the ERL as a tool, an entirely new regime of faster measurements on smaller systems should lead to new materials and ultimately new technologies. Faster electronics, including quantum computing, higher density magnetic storage, more efficient alternative fuel generators are all on the horizon.

Exciting questions came forth. Can an x-ray beam focus down to the size of an atom? Will we be able to record very fast physical and chemical reactions, such as molecules vibrating or the all-important process of photosynthesis? Will high x-ray dose damage prevent the imaging of a living biological cell? Will we be able to detect fluorescent light given off by a single atom? If so, will environmental scientists be able to track heavy metal contamination inside bacteria, plants, and cells from higher organisms?

The excitement of the participants made clear that a full-scale ERL machine will keep Cornell at the forefront of x-ray science in many areas of physics, chemistry, biology, and materials research for decades to come.

Ernest Fontes, Assistant Director, CHESS

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