K-State physics lab becoming a frontrunner in ultrafast laser research

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For decades, the J.R. Macdonald Laboratory at Kansas State University has been known worldwide as a center for atomic collision physics using particle accelerators. Now, researchers at the lab are working toward making it known for ultrafast laser science.

The Macdonald Lab is the main part of the K-State atomic, molecular and optical physics program, which has ranked in the top 20 in the nation out of all such university programs, according to U.S. News and World Report. In recent years the lab has shifted its research focus to ultrafast laser science. This change in emphasis was marked with the installation of the Kansas Light Source, an intense ultrafast laser, a few years ago.

"There are advantages to both ultrafast laser research and accelerator research," said Itzik Ben-Itzhak, Macdonald Lab director and K-State professor of physics. "But the laser gives you the ability to control a reaction occurring within a molecule and not just to observe that phenomenon. Just imagine what opportunities such control could lead to in molecular engineering."

In a nutshell, he said, this is the key advantage for probing matter with lasers rather than collisions, which are nearly impossible to control.

The basic physics research at K-State's Macdonald Lab could one day enable researchers to tailor molecules to improve health care, energy and security. Ben-Itzhak said that the Macdonald Lab's work to investigate

these fundamental processes and find out the optimal laser characteristics -- such as intensity, pulse duration and spectrum -- is the first step on a long road.

"We're not trying to be solely a laser technology lab," Ben-Itzhak said. "Rather, we are interested in studying laser-matter interactions on the atomic and molecular scale. However, in order to be in the forefront of this rapidly evolving field, we have to have the right balance between developing our laser technology, i.e. instrumental capabilities, and immediately interrogating matter with them."

The Macdonald Lab includes nine K-State faculty experts and brings in $2.5 million of U.S. Department of Energy support annually.

"If you exclude national laboratories, we have the biggest support within our program area in the Department of Energy," Ben-Itzhak said.

Along with Ben-Itzhak, the department of physics faculty include: Zenghu Chang, professor; Lew Cocke, distinguished professor; Brett DePaola, professor; Brett Esry, professor; Vinod Kumarappan, assistant professor; Chii-Dong Lin, distinguished professor; Igor Litvinyuk, assistant professor; and Uwe Thumm, professor. Research faculty include: Kevin Carnes, associate research professor; Charles Fehrenbach, research assistant professor; and An Thu Le, research assistant professor. Also included are atomic, molecular and optical physics program faculty Kristan Corwin, associate professor, and Brian Washburn, assistant professor.

These researchers leverage the DOE funding and the infrastructure it provides to bring in additional funding from the National Science Foundation, the Army Research Office and the Air Force Office of Scientific Research, among other sources. All together, the atomic, molecular and optical physics group brings in more than $4.7 million per

year in grants.

In addition to the Macdonald Lab members, the Kansas Light Source also is used by others at K-State. For example, Shuting Lei, associate professor of industrial and manufacturing systems engineering, and his group members from the department use the lasers to drill holes because they are much cooler, temperature-wise, than using a drill press.

"Our goal is to be one of the top ultrafast labs for atomic, molecular and optical physics in the world. We want to draw people from around the world," Ben-Itzhak said. "What can we provide that will bring them here? We need to be an environment that is welcoming and friendly to other researchers. But they wouldn't be coming here unless there's also strong research and advanced laser technology."

Ben-Itzhak said the lab is currently suffering a bit from its own success. The switch to ultrafast laser science has generated such a demand for laser time that the laser resources available are no longer sufficient. In fact, the productivity of the lab is now limited primarily by laser time, he said. That's why the lab is working to acquire another laser that can provide new research opportunities in addition to relieving the logjam on laser time.

The atomic, molecular and optical physics group is also working to elevate the Macdonald Lab's profile in ultrafast laser science, which includes serving as host to an international conference in summer 2009 that will draw scientists from around the world.

"People from all over the world came to do atomic collision research at Kansas State University in the past," Ben-Itzhak said. "Now the question is, can we attract them to come for ultrafast laser science?"

Source: Kansas State University