Klaus Ruedenberg of Ames Lab and Iowa State University.

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DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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Research Highlights . . .

Gene therapy reduces drinking in "alcoholic" rats

A preliminary study at DOE's Brookhaven Lab shows that it's possible to turn "alcoholic" rats into light drinkers, and those that can take or leave the sauce into near teetotalers. The findings may have implications for the prevention and treatment of alcoholism in humans. The scientists used a viral vector to deliver the gene for dopamine receptors directly to the brain's pleasure center in rats that had been trained to prefer alcohol to water. The inserted gene upped the number of receptors—and presumably the brain's ability to respond to pleasurable stimuli—and cut the rats' drinking dramatically.

[Karen McNulty Walsh, 631/344-8350, kmcnulty@bnl.gov]

Neutrino measurement surprises Fermilab physicists

Scientists at the DOE's Fermilab have found a discrepancy between predictions for neutrino behavior and experimental results. Although the difference is tiny, it is the kind of inconsistency that gets physicists' attention because of its potential implications. Experimenters at the NuTeV experiment measured the ratio of neutrinos and muons emerging from high-energy collisions. Generations of experiments have yielded precise predictions for the value of this ratio. The predicted value was 0.2227; but the observed value was 0.2277. In particle physics, such "misfit" results are often harbingers of new particles and new forces. Experimenters believe the discrepancy may foreshadow upcoming discoveries at accelerator laboratories.

[Judy Jackson, 630/840-3351, jjackson@fnal.gov]

'Surfing' for particles

For particle physicists, getting "more bang for the buck," means colliding particles at higher energies for lower cost. Researchers at DOE's Argonne National Laboratory have demonstrated a technique—called wakefield acceleration—that can power a linear, high-energy particle accelerator by using a low-energy particle accelerator like a booster in a multistage rocket. The wakefield approach accelerates groups of electrons using the electromagnetic field generated by another high-current electron beam. These wakefields—so-called because they rely on the wake created by the high-current electron beam—would accelerate the trailing electron bunches much like an ocean wave accelerates surfboards.

[Catherine Foster, 630/252-5580, cfoster@anl.gov]

System rapidly separates complex chemicals

Absorption Detection System in Multiple Capillaries—developed by Edward S. Yeung, director of the Chemical and Biological Sciences Program at DOE's Ames Lab, makes it possible to rapidly separate samples of complex chemical or biochemical mixtures. Minute capillaries disperse heat very well and so can withstand an electrical charge of up to 20,000 volts, resulting in fast separations. Using absorbance detection to identify the molecules means it can handle 95 percent of all known chemical and biochemical compounds and uses 1,000 times less solvent than high-performance liquid chromatography. It recently received an R&D magazine most promising technology award.

[Mary Jo Glanville, 515/294-5635, mglanvil@iastate.edu]

DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions. ***DOE Pulse*** (www.ornl.gov/news/pulse/) is distributed every two weeks. For more information, please contact Jeff Sherwood (jeff.sherwood@hq.doe.gov, 202-586-5806).

Matter, antimatter and the price of bread

Humans weren't present from the beginning of time and so cannot see how everything got started. So physicists conduct their own studies, hoping to tease clues from Nature's tiniest creations, subatomic building blocks known as quarks. Scientists at the DOE's Jefferson Lab have concluded an experiment designed to look at some of the rarest subatomic particles known to exist: K-mesons, or kaons, and a kind of hybrid known as a hyperon.

"We are studying how matter and antimatter are produced and distributed spatially," says scientist Pete Markowitz, assistant professor of physics at Florida International University. "We produce these particles, these pairs of strange quarks and strange antiquarks, and then sift through the pieces. We're interested in one particle in a billion—and it's hard to find. We're ultimately thinking backwards: How do such particles fit together? How were they created in the first place?"

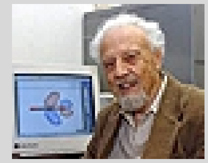
Mesons are a class of particle containing equal numbers of quarks and antiquarks (although not necessarily of the same type). When matter and identical antimatter meet, annihilation is instant and complete, with virtually complete conversion to energy. Conversely, examination of how K mesons, or kaons, are formed from energy—that is, are created—as a result of the internal interplay between their constituent quarks and antiquarks and should give invaluable insight into how quarks interact with each other.

Once a kaon is created, the remnants of its creation—particles known as hyperons, and in particular a hyperon variant called a "lambda"—are composed of one strange, one up and one down quark. Examining the structure of these particles, and the behavior of electrons emitted during multiple interactions, physicists take another step on the way to understanding how matter came to be in the macroscopic world in the first place.

"This fundamental research takes a long time to affect the price of bread in a grocery store," Markowitz contends. "But in the long run it will. It leads to a better understanding of Nature, which ultimately leads to practical benefits."

Submitted by DOE's Jefferson Lab

A GIANT AMONG US



Klaus Ruedenberg

"Among the professional options available to us, we choose those that fascinate us and pose problems we feel we will be able to help solve," says Klaus Ruedenberg, an Ames Laboratory senior associate and an Iowa State University Distinguished Professor *Emeritus*.

Ruedenberg chose well in the mid 1950s when he combined his abilities in physics and chemistry to work on molecular theory, then a newly developing area of study. Today he is one of the few quantum chemists in the world to be recognized as a leader in establishing the field of theoretical chemistry and ensuring its viability during the last 50 years. Honoring his innovative research in the field, the American Chemical Society has named Ruedenberg the recipient of its prestigious Award in Theoretical Chemistry for 2002.

His work has been characterized as seminally advancing many different, important facets of quantum chemistry, encompassing fundamental theory, formal mathematical developments, computational methods and software implementations, as well as conceptual interpretations.

His elucidation of the energetic realignments that cause molecule formation has led to profound insights into the basic origin and the physical nature of the chemical bond. Related are his methods that create a rigorous quantum theoretical foundation for the 200-year-old empirical model of molecules being built from atoms, revealing the modifications of atoms by their interactions with molecular environments.

Ruedenberg's recent work addresses the problem of electron correlation, a major bottleneck in the quest for accurate quantitative predictions of the properties, in particular energies, of ground and excited electronic states of large molecules—a fundamental as well as practical goal of theoretical chemistry.

Submitted by DOE's Ames Laboratory