University of Missouri-Rolla
Physics Department

Matter 'n Motion

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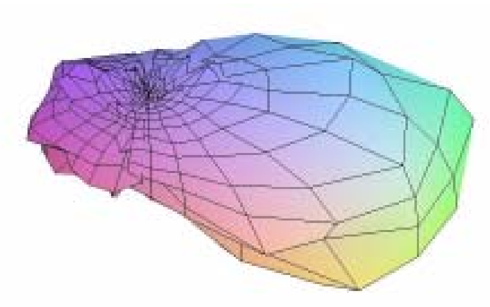
Schulz and Madison Found in Nature, Olson in Science



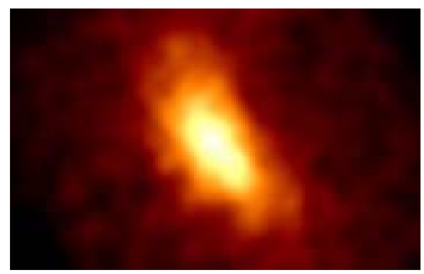
electron distribution from C^{6+} + He collisions

At the atomic level, all processes in nature are governed by the interaction between charged particles. Although many particles are usually involved, the basic interactions occur between pairs of charged particles. Using their understanding of these interactions, physicists attempt to describe the temporal and spatial evolution of many mutually interacting particles under the influence of the forces between them. This latter step, known as the few-body problem, remains one of the unsolved, fundamentally important problems in physics. In fact there is no analytical solution to the three body problem and only recently, after three decades of work, have numerical solutions been reported for some elementary cases.

Employing the most recent technology in their experiments, groups led by **Michael Schulz** at Rolla and **Joachim Ullrich** at Heidelberg, Germany, have been able to measure all the details in full 3-dimensions for the four body problem of a bare carbon nucleus colliding with a helium atom. The theoretical group led by UMR's **Don Madison** performed calculations of what the best current theoretical models would predict for the outcome of this collision and significant differences between experiment and theory were found. These differences were unexpected and they clearly indicate that the experimental results have revealed some physical effects that have not been previously seen or predicted by any published theoretical model. These results appeared in *Nature* **422**, p. 48 (March 6, 2003).

This is the first time that currently-employed UMR Physics faculty have had a paper published in *Nature*, which is the world's oldest and most-respected science journal. More details about this work appear in the article on page 5 of this newsletter.

Curators' Professor of Physics **Ron Olson** published an article in the June 6 issue of *Science* describing the origin of X-rays emitted from comets as they transit our solar system. The work was done in collaboration with colleagues from the Lawrence Livermore National Laboratory and the NASA/Goddard Space Flight Center. The paper follows from the surprise 1997 discovery of X-rays being emitted from the comet Hyakutake. Many other comets have now been shown to emit X-rays.



Olson's calculations show that the X-rays are due to collisions between the comet's surface and highly-charged ions present in the solar wind. After these collisions, ions in the solar wind are left with more internal energy than before. They then get rid of this extra energy by emitting light waves in the form of X-rays. This interpretation follows directly from Olson's experience on light emission for similar types of collisions occurring in nuclear fusion test reactors, where his calculations are used to determine their performance characteristics.

The *Science* article was preceded by one in *Physical Review Letters*, the most prestigious journal in physics, and another in *The Astrophysical Journal*, that detail how charged particle collisions of this type lead to the unexpected X-ray emission. The UMR calculations are now being used to predict the light that will be observed with a new, high-resolution spectrometer that will be aboard the 2005 launch of the ASTRO-E2 satellite.

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