ed one of his algorithms and confirmed Grover's idea," Bucksbaum said.

"It is important to keep this study in perspective," he said. "Quantum phase data storage is a new concept. Most researchers are using the spin of a quantum particle as a storage medium. Our work may turn out to be a step on the pathway to a viable quantum computer system or it could be a complete deadend. The field is still too new to know which approach will succeed."

John Reffner Receives 2000 Williams-Wright Award

John A. Reffner, technical director of SensIR Technologies, has been named recipient of the 2000 Williams-Wright Award from the 2000 Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy held in March in New Orleans, Louisiana. He is being honored for his work toward the development of infrared microspectroscopy (IMS).

In collaboration with colleagues, Reffner raised the standards for Fourier transform infrared spectroscopy (FTIR) microscopes and expanded the applications of IMS, which led to the development of new infrared microscopes and rapid advances in infrared microanalysis, spectral mapping, and quantitative microspectroscopy.

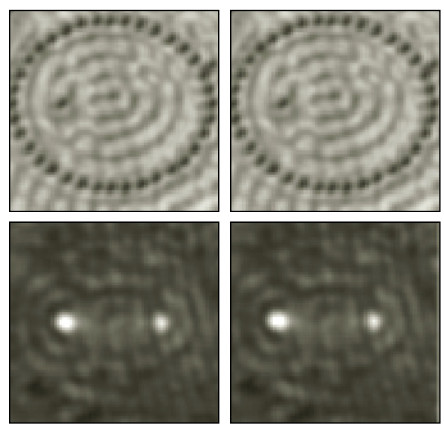
Reffner received his PhD degree from the University of Connecticut, where he was assistant director of the Institute of Materials Science and a member of the chemistry faculty. He has held research and scientist positions at B.F. Goodrich, W.C. McCrone Associates, American Cyanamid, and Spectra-Tech. He joined SensIR Technologies in 1998. Since 1974, Reffner has served as forensic consultant to the Connecticut State Police. He is a Fellow of the Academy of Forensic Science and serves on the editorial board of the *Journal of Forensic Science*. He is a member of several scientific and professional associations, including the Coblentz Society and the Society of Applied Spectroscopy.

This award has been presented by the Coblentz Society since 1978.

"Quantum Mirage" May Enable Atom-Scale Circuits

As computer-circuit features shrink toward atomic dimensions, the behavior of electrons changes from being like particles described by classical physics to being like waves described by quantum mechanics. For example, on such small scales, tiny wires do not conduct electrons as well as classical theory predicts. Therefore, quantum analogues for many traditional functions must be available if nanocircuits are to achieve the desired performance advantages of their small size. Researchers at IBM Almaden Research Center have discovered a way to transport information on the atomic scale that uses the wave nature of electrons instead of conventional wiring. They call this phenomenon the "quantum mirage" effect.

Physicists Hari C. Manoharan and Christopher P. Lutz and IBM Fellow Donald M. Eigler, lead researcher on this project, describe their research in the February 3 issue of *Nature*. Using a low-temperature scanning tunneling microscope (STM), they created the quantum mirage by first moving several dozen cobalt atoms on a copper surface into an ellipse-shaped ring. The ring atoms acted



This four-part composite image shows the "quantum mirage" effect in action. When a magnetic cobalt atom is placed at a focus point of an elliptical corral (upper left), some of its properties also appear at the other focus (lower left), where no atoms exist. In this case, a change in the surface electrons due to the cobalt's magnetism—the Kondo resonance—appears as a bright spot at each focus. When the cobalt atom is placed elsewhere within the ellipse but not at a focus point (upper right), the mirage disappears (lower right), and the Kondo effect is detected only at the cobalt atom itself. The corral is made of 36 cobalt atoms positioned on a copper [111] surface.

as a "quantum corral," reflecting the copper's surface electrons within the ring into a wave pattern predicted by quantum mechanics.

The size and shape of the elliptical corral determine its quantum states—the energy and spatial distribution of the confined electrons. The scientists used a quantum state that concentrated large electron densities at each focus point of the elliptical corral. When the scientists placed an atom of magnetic cobalt at one focus, a mirage appeared at the other focus: the same electronic states in the surface electrons surrounding the cobalt atom were detected even though no magnetic atom was actually there. The intensity of the mirage is about one-third of the intensity around the cobalt atom. See Figure.

"We have become quantum mechanics, engineering and exploring the properties of quantum states," Eigler said. "We're paving the way for the future nanotechnicians." The operation of the quantum mirage is similar to how light or sound waves can be focused to a single spot by optical lenses, mirrors, parabolic reflectors, or "whisper spots" in buildings.

"The quantum mirage technique permits us to do some very interesting scientific experiments such as remotely probing atoms and molecules, studying the origins of magnetism at the atomic level, and ultimately manipulating individual electron or nuclear spins," said Manoharan." But we must make significant improvements before this method becomes useful in actual circuits. Making each ellipse with the STM is currently impracticably slow. They would have to be easily and rapidly produced, connections to other components would also have to be devised, and a rapid and power-efficient way to modulate the available quantum states would need to be developed."

The researchers have built and tested elliptical corrals up to 20 nm long with the width as little as half that. The electron density and intensity of the mirage depends on the quantum state, not the distance between the foci.

APS Division of Materials Physics Names 2000 Award Recipients and Fellows

The American Physical Society's (APS) Division of Materials Physics (DMP) has awarded the 2000 James C. McGroddy Prize to **M. Brian Maple**, the Bernd T. Matthias Professor of Physics at the University of California—San Diego, for the synthesis of novel *d* and *f* electron materials and for the study of their physics. This prize recognizes and encourages outstanding achievement in the science and application of new materials. Maple received an AB degree in mathematics and a BS degree in physics from San Diego State University (SDSU) in 1963, and a PhD degree in physics from UCSD in 1969. His research interests include superconductivity, magnetism, strongly correlated electron phenomena, high-pressure physics, and surface science. Maple is a Fellow of APS and the American Association for the Advancement of Science and served as chair of the APS Division of Condensed Matter Physics in 1987. He has served on advisory committees for seven national laboratories and has served on review committees for the Department of Energy, the National Science Foundation, and numerous universities. He has received many honors and awards.

Bertram Batlogg of Bell Labs, Lucent Technologies, received the 2000 David