Tiny laser light show illuminates quantum computing (w/ Video)

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A new laser-beam steering system that aims and focuses bursts of light onto single atoms for use in quantum computers has been demonstrated by collaborating researchers from Duke University and the University of Wisconsin-Madison.

Described in the journal Applied Physics Letters, published by the American Institute of Physics, the new system is somewhat like the laser-light-show projectors used at rock concerts and planetariums. But it's much smaller, faster, atom-scale accurate and aimed at the future of computing, not entertainment.

In theory, quantum computers will be able to solve very complex and important problems if their basic elements, called qubits, remain in a special "quantum entangled" state for a long enough time for the calculations to be carried out before information is lost to natural fluctuations. One of several promising approaches to quantum computing uses arrays of individual atoms suspended by electromagnetic forces. Pulses of laser light manipulate the internal states of the atoms that represent the qubits, to carry out the calculation. However the lasers must also be focused and aimed so accurately that light meant for one atom doesn't affect its neighbors.

The new system did just that. Tiny micromirrors, each only twice the diameter of a human hair, pointed to each target atom in as little as 5 microseconds, which is about 1,000 times faster than sophisticated beam-steering mirrors developed for optical communications switching, not to

mention the still slower units used in light shows. The researchers saw that the laser pulses also correctly manipulated the quantum properties of each target atom – in this case a line of five rubidium-87 atoms -- without disturbing any neighboring atoms, which were separated by just 8.7 microns, about one-tenth the diameter of a human hair.

"Our experiments demonstrated the crucial requirement that our micromirror system maintain the laser-beam quality necessary to manipulate the internal states of the individual atoms," said Jungsang Kim, leader of the Duke researchers who designed the micromirror system. The atomic physics experiments were performed in Mark Saffman's group at University of Wisconsin-Madison.

The groups plan to continue their collaboration, with future experiments targeting two-qubit gates, which are expected to be the basic building block of quantum logic, and atoms confined in larger two-dimensional arrays.

Provided by American Institute of Physics