Physicists slow and control supersonic helium beam

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The speed of a beam of helium atoms can be controlled and slowed using an "atomic paddle" much as a tennis player uses a racquet to control tennis balls, physicists at The University of Texas at Austin have discovered.

The slow helium beam technique—a breakthrough in the field of atom optics—could someday be used to better probe microscopic surfaces or create advanced navigation systems.

"The slow beam is an enabling technology," said Dr. Mark Raizen, the Sid W. Richardson Foundation Regents Chair in Physics. "The next step is to do science with the beams."

Raizen and his colleagues at the Center for Nonlinear Dynamics created the slow helium beams using a yard-long, rapidly spinning titanium blade tipped with silicon wafers that Raizen calls an atomic paddle.

He and his colleagues pumped puffs of super-cooled helium gas into a vacuum chamber containing the paddle using supersonic beam technology developed by Professor Uzi Even of Tel-Aviv University. The paddle's silicon wafers reflected the helium atoms much like a glass mirror reflects a beam of light.

Just as the energy of a tennis ball is absorbed by the motion of a tennis racquet, the motion of the paddle absorbed the energy from the helium beam. The beam was slowed to 560 miles per hour, less than one-eighth

the normal velocity of helium.

Raizen's slow beam work is important to understanding the interaction between an atom and a surface, a fundamental aspect of physics that has been investigated since the pioneering work of Otto Stern in 1930. Scientists can bounce atoms off a surface and observe the scattered atoms to learn about the properties of the atoms and the surface.

To date, the main disadvantage of using helium to probe surfaces has been that it typically moves very quickly, nearly 4,500 miles per hour at room temperature. When helium hits a surface at a very high velocity, it tends to scatter in many directions, making it more difficult to observe the atoms after impact and limiting its practical use as a probe.

Slow beams could someday be used in advanced navigation systems with gyroscopes, like those found in airplanes, submarines, space probes and the International Space Station. Gyroscopes allow an object to maintain its orientation or balance, even in outer space.

A gyroscope system based on atoms would have a much higher sensitivity than gyroscope systems that use lasers, said Raizen.

He said that the atomic paddle method could be used in the future to produce even slower helium atoms and ultimately to stop and trap them.

Source: University of Texas at Austin