Guiding an Atom Laser

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One of the biggest differences between photons and atoms is that the latter are massive particles, making gravity is a huge factor. It can be seen as an advantage when designing new high accuracy atom interferometers based inertial sensors, but can be a major drawback when controlling atom laser beams. “Gravity makes for higher velocity,” William Guerin explains to *PhysOrg.com*, “and that means wavelengths become small.”

According to Guerin, a scientist at the Institute d'Optique Graduate School in Palaiseau (south of Paris), in order for an atom laser to be practicable for many applications, a method for creating longer wavelengths needs to be found. And, with his colleagues from Aspect's Atom Optics Group of the Laboratoire Charles Fabry, he has. An article published in *Physical Review Letters* by Guerin and his coworkers Riou and Gaebler from the team led by Josse and Bouyer, is titled “Guided Quasicontinuous Atom Laser”; it demonstrates how this longer wavelength can be achieved.

“By making our atom laser into a wave carrier, we can get rid of the acceleration of gravity,” says Guerin. “We can create an atom laser with a constant.” The French team’s Letter describes how such a laser works with trapped Bose-Einstein condensate (BEC):

“The BEC, in a state sensitive to both trapping potentials, is submitted to a rf outcoupler yielding atoms in a state sensitive only to the optical potential, resulting in an atom laser propagating along the weak confining axis of the optical trap.”

“By using quasicontinuous outcoupling,” Guerin further explains, “we can get a beam with much less interaction.” A guided quasicontinuous atom laser, such the one described, would allow for better atomic motion control during propagation. Better atomic control would pave the way for more coherent atom sources for use in atom interferometry. Additionally, this set-up for a guided atom laser has the potential to provide a variety of other useful future applications. Quantum transport is another field that could benefit from the work performed by the team led by Josse and Bouyer.

The members of the team, though, are especially interested in the interferometry aspects illuminated by this new type of atom laser: “We could use this scheme not only to guide atom laser beams, but also to separate and then recombine them to get an interferometer, which can be used to measure rotations or accelerations.” Guerin also points out that such interferometer could also be realized on atom chips.

Designs that can produce atom-wave interferometry can yield progress in sensor technology. One of these technologies, says Guerin, includes “Creating a gyroscope with coherent atomic beams.” The applications and information that could come from the work by the team in France are varied and many.

But rather than getting too carried away with the future, Guerin sticks with the basics. “There are two main points that we have realized because of this work,” he says. “First, we have a well-defined and large wavelength. This is new.” He continues his explanation: “And, second, we can control the amounts of interaction. It is great that we can control the flux of the atom laser, by controlling the flux, we control the density inside the beam.” And it is great for the world of atomic science as well.