

Trapping atoms, not space ships, with tractor beams

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University of Adelaide researchers have delved into the realm of *Star Trek* and created a powerful tractor beam – or light-driven energy trap – for atoms.

Rather than sucking space-ships into a space-station, this [tractor beam](#) pulls atoms into a microscopic hole at the centre of a special optical fibre. It is opening the way for new quantum experiments that may lead to new secure communications or advanced sensing technologies.

Published in the journal *Physical Review Applied*, the researchers from the University's Institute for Photonics and Advanced Sensing (IPAS) say this is the first time that scientists have been able to demonstrate a highly efficient 'waveguide trap'.

The Ph.D. student who developed the technology, Ashby Hilton, says: "Although [tractor](#) beams are green or blue in the movies, in this case the trap is made of invisible infra-red [light](#). The beam grabs hold of atoms that are floating in a chamber that is almost completely emptied of gas – a little sample of outer space on Earth.

"Every atom that enters the tractor beam is pulled into the fibre – there is no escape. And once sucked into the interior of the optical fibre the atoms can be held for long periods of time. Our experiments show that we can very precisely control light to produce exactly the right conditions to control atoms."

The tractor beam works by the infra-red light interacting with the atoms to create a change in energy which drives the atoms to the most intense part of the [light beam](#).

Lead researcher Dr. Philip Light says: "What is really exciting is that now we have the possibility to do quantum experiments on these trapped atoms. Our first experiments intend to use these stored atoms as elements of a quantum memory. We hope that our work may eventually form part of absolutely [secure communications](#) channel that is of obvious high interest to defence, intelligence and industry."

The researchers are now moving onto the next stage in which the tractor beam is formed from a hollow cone of light rather than a solid [beam](#) of light. In this new configuration the atoms will be held at the centre of the light cone where it is perfectly dark.

"This is an extremely powerful idea – we can move and manipulate the atoms, but are able to shield the atoms from the disruptive effect of intense light," says Dr. Light. The researchers have essentially created a quantum funnel which allows them to guide and trap atoms for longer without disrupting their delicate quantum state.

IPAS Director Professor Andre Luiten says: "Our researchers are manipulating and measuring individual [atoms](#) and molecules to sense the world around us. This new era of [quantum](#) sensing is opening up diverse new possibilities from attempting to detect disease through finding

particular molecules in the breath, to assisting miners and defence by detecting anomalous magnetic fields associated with mineral deposits or covert submarine activity."

A video demonstrating the waveguide trap can be seen [here](#).

More information: A.P. Hilton et al. High-efficiency cold-atom transport into a waveguide trap, *Physical Review Applied* (2018). [DOI: 10.1103/PhysRevApplied.10.044034](#)

Provided by University of Adelaide

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