# Tailoring the optical dipole force for use on molecules

October 29 2009, Miranda Marquit

(PhysOrg.com) -- "Scientists have been working with dipole fields for quite some time," Peter Barker tells *PhysOrg.com*. "However, most of the work is focused on very small particles, like atoms, or on larger particles, such as for use as optical tweezers. There is an interim region between atoms and large particles, and that is what we are looking at. We want to be able to control molecules a little differently."

Barker is a professor at University College London, and has been working on a process by which an optical field can be used to align molecules. Along with Simon Purcell, Barker has found a way to not only align molecules through the tailoring of the optical dipole force, but to also move them around. “This is, we believe, the first time that alignment and the ability to move molecules around have been brought together using the dipole force,” Barker says. Barker and Purcell report their work in Physical Review Letters: “Tailoring the Optical Dipole Force for Molecules by Field-Induced Alignment.”

“In order to do this, we have a gas sitting at a relatively high pressure in a chamber. Using strong optics, we send a beam through the chamber, forming a hole of sorts. The optical field acts as a tractor beam, grabbing the molecules present in the gas and bringing them to rest. This makes them ultra cold,” Barker explains.

Laser cooling in a similar fashion has been done with atoms for quite some time. It is standard practice for many experiments. However, Barker says that it is harder to produce ultra-cold molecules than it is to

bring atoms to a state of rest. “This could provide a way to cool molecules to just above absolute zero, which is of interest for a number of research applications.”

The process introduced by Barker and Purcell could also have use as a way to separate rotational states. “In some cases, scientists want to be able to separate out different states. Unfortunately, there is a whole range of molecules that can’t really be singled out in this way. With our dipole tailoring process, though, it is possible to separate out these states. We could also separate molecules of different types.”

Another use for this process could conceivably be the use of light to focus molecules onto a particular surface. “We haven’t done this yet, but it should be possible get molecules to act as a lens, and then rotate the polarization to change the focus. We think that it should be possible to get features down to the nanometer size by focusing molecules in this manner.”

“Being able to tailor the optical dipole force in this way is a big step,” Barker says. “In our experiment, we were able to both align molecules and move them around by tailoring the optical dipole force. Being able to align and position molecules simultaneously is something that hasn’t been done before with this force, and it has a great potential, both for fundamental research, and for possible practical applications.”

More Information: S.M. Purcell and P.F. Barker, “Tailoring the Optical Dipole Force for Molecules by Field-Induced Alignment,” *Physical Review Letters* (2009). Available online: link.aps.org/doi/10.1103/PhysRevLett.103.153001