Is random lasing possible with a cold atom cloud?

May 18 2009, By Miranda Marquit

(PhysOrg.com) -- Random lasing, Robin Kaiser tells *PhysOrg.com*, is like standard lasing, with a little bit of a twist: "You don't know the direction the photons will go, as you do with a more standard laser. This is because the feedback normally produced by a cavity, which sets a propagation axis, is now provided by multiple scattering in all directions. Light is randomly scattered throughout the structure of the laser, exciting further light-emitting processes. Light in a random laser does not come out in a precise direction; it comes out in all directions."

"When you work with random lasing," Kaiser, a scientist at the National Center for Scientific Research (CNRS) and University of Nice Sophia-Antipolis, in France, continues, "you normally have two different physical entities. One is for providing gain and one is for scattering. Most random lasers are also based on condensed matter systems. We wondered whether we could combine gain and scattering in cold atoms, and thus achieve random lasing using a completely different system."

Along with his colleague William Guerin in Nice, Kaiser worked with Luis Foufe-Pérez at the Institute for Materials Science in Madrid, Spain and Rémi Carminati at the Optical Physics Laboratory in Paris, France. They believe that they have shown that it is possible to build a random laser using a cloud of cold atoms. Their work appears in *Physical Review Letters*: "Threshold of a Random Laser with Cold Atoms."

"There is broad interest in the topic of random lasing, following initial ideas of what Letokhov called a photonic bomb" Kaiser says. (Vladilen

Letokhov, a Russian scientist, made a number of contributions to the field of random lasers, as well as laser cooling. He died earlier this year.) “There are a number of possible applications for random lasing, and the fundamental implications are interesting as well.” Some of these applications include low-cost lasers, display, identification, and even medical applications. “Fundamentally,” he continues, “random lasers could lead to a better understanding of multi-mode lasers as well as helping to better understand Anderson localization.”

The system proposed by Kaiser and his peers is one that could potentially simplify the process of random lasing to a certain degree. Right now, the gain - or amplification of the light - is separate from the scattering of the light. “Until now, gain and scattering have been produced by different components and properties.” Kaiser and his colleagues theorize that a cloud of laser-cooled atoms could produce a random lasing effect without needing to use different components for gain and scattering. “Light confinement due to multiple scattering and lasing have both been demonstrated using cold atomic vapor in magneto-optical traps,” Kaiser says. It should be possible to take it a step further and engage in random lasing, with the gain and scattering features combined to come from the same atoms.

So far, this type of random lasing exists only as a model. The next step is to take the model worked on by the team and set up experiments. “Our equations, which are shown in the *Physical Review Letters* paper, not only show that it is possible to achieve random lasing in this manner,” Kaiser insists. “Also, the size of the cold atom cloud needed to achieve this effect is within reach of today’s experiments. So we are trying to get experiments set up to test our system.”

More information: Froufe-Pérez, Guerin, Carminati and Kaiser, “Threshold of a Random Laser with Cold Atoms.” Physical Review Letters (2009). Available online:

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