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HOW WOBBLY WAS MY LASER?

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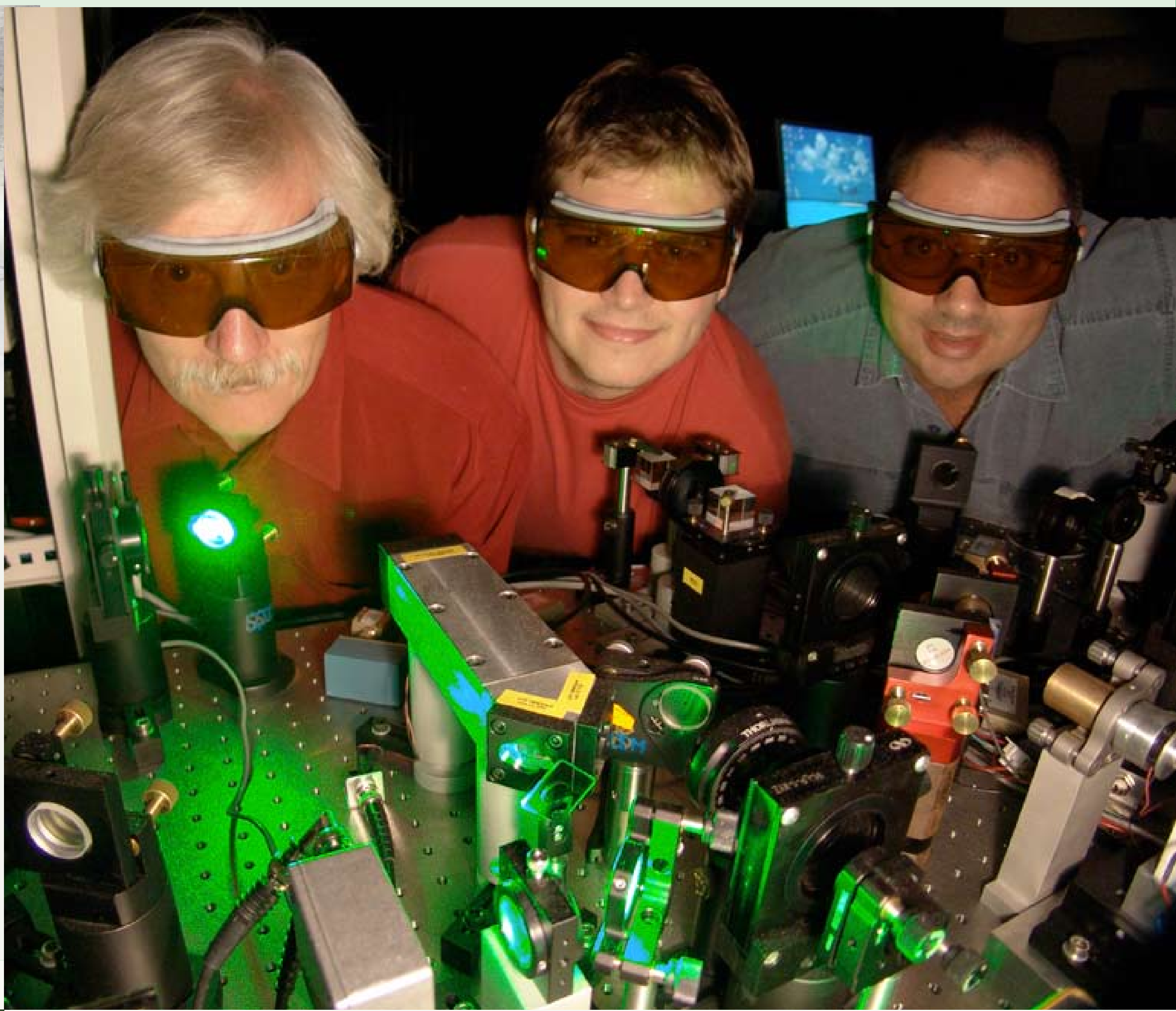
If you've ever watched sunlight bouncing up off a cup of coffee and hitting the ceiling, you would know how a tiny movement of the liquid translates into a huge displacement of the light. Engineers use this principle in a variety of instruments ranging from the old galvanometers of school labs to state of the art atomic force microscopes which can detect individual atoms by their tiny pull on a sensor tip. In principle, by bouncing a laser off a reflective sensor and collecting the light after a vast distance, it would be possible to detect fantastically small forces such as the tap of an ant's feet on a table. But of course, in the real world things are never that simple.

Because a laser beam is made up of individual photons and photons are governed by quantum statistics, it's actually impossible to determine the exact centre of the beam using conventional methods. However, scientists at ANU are currently exploring the idea of applying their quantum squeezing technology to overcome this limit. The idea is that the signal beam is mixed with quantum "anti noise" in the form of a specially generated second beam. The principle is similar to active headphones which reduce ambient noise by adding the exact opposite signal to the disturbing sound. But because the laser anti noise acts on a photon by photon basis we have to follow strange quantum rules and the technology required is a whole lot more sophisticated.




The optical mixer at the heart of the quantum noise supression system

At the heart of the system is the optical mixer where the squeezed antinoise and the main energy carrying light are intermingled to create the super quiet and highly symmetrical output beam. Initially, the scientists were able to quieten the beam in a single dimension, then in 2 dimensions, that is x - y, and in more recent work, they have been able to achieve multidimensional quietness extending over several modes within the one beam. The practical upshot of which is that this will enable fantastically accurate measurements of not only beam position in the x-y plane but also of beam direction, divergence and size.

There are many potential applications of the squeezed superbeam technology. For example, by making super accurate measurements of a laser beam as it is deflected by the tiny mirageing effect of small quantities of pollutants in air, it is possible to have a very sensitive measurement of air quality. Simply tune the laser to the wavelength of the pollutant and measure the defelction of the light. Alternatively this technique can give us ways for detecting deatures which are too small to see in an optical microscope, smaller than the wavelength of light.

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