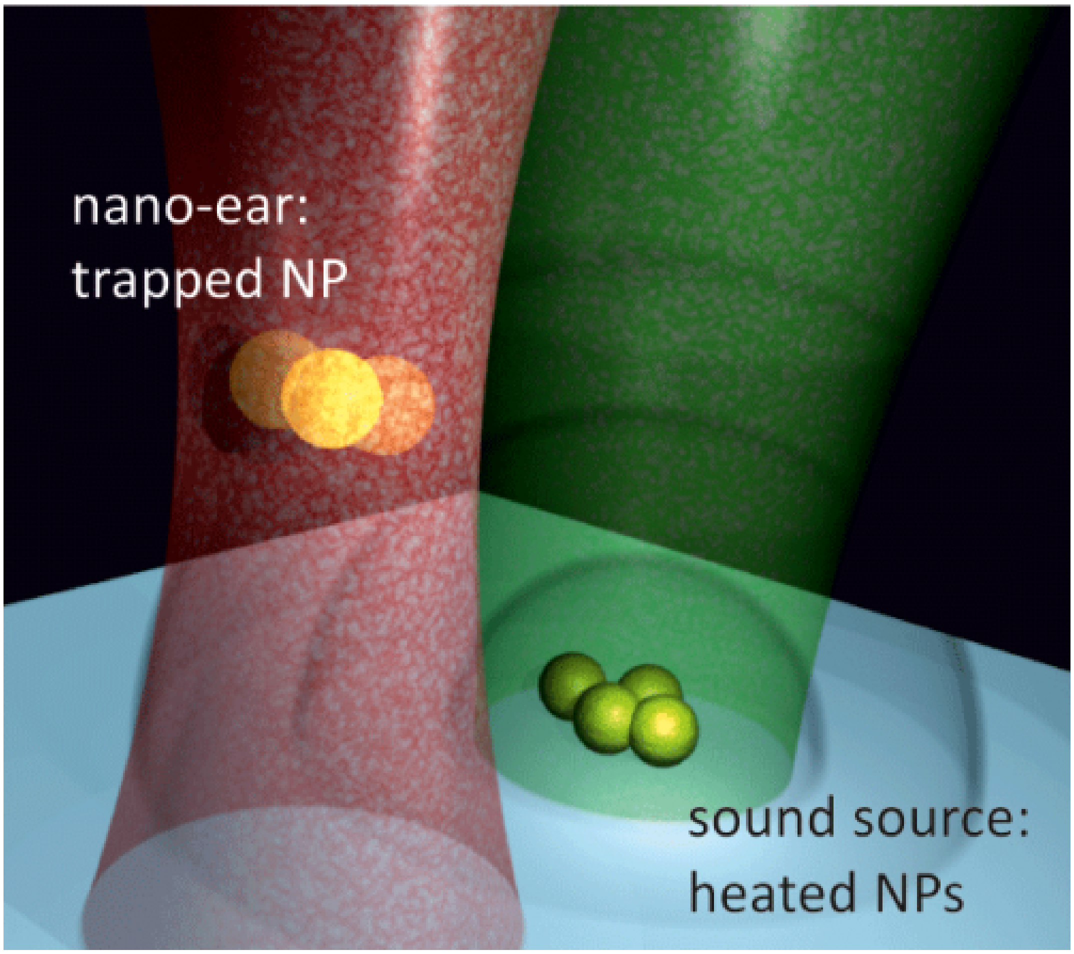
Physicists develop nano-level sound detector

January 12 2012, by Bob Yirka



An optically trapped nanoparticle can act as an ultrasensitive detector of sound. Pressure waves from a nearby sound source are detected by tracking the small displacements of a trapped gold nanoparticle from its equilibrium position in the neck of a focused laser beam (red region). The sound waves are produced by an aggregate of nanoparticles that vibrate when heated by a laser (green region). Image: A. Ohlinger et al., Phys. Rev. Lett. (2012)

(PhysOrg.com) -- For a couple of decades now, physicists have known that if a very small laser beam is pointed at a microscopic particle, it could be held in place due to the very small electrical field that is generated. Because of that, the technique has been used to hold objects in place for close examination, sort of like using a pair of tweezers to hold a grain of sand for study under a magnifying glass. One truly nice feature of the technique is that it's very gentle, thus no harm comes to the particle being examined.

Now, a team of German physicists has found that the same technique can be used to measure minute amounts of vibration of objects near the particle held by the quasi nano-tweezers, allowing sound to be measured. The team, as they describe in their paper published in *Physical Review Letters*, has found that they can measure sound that is far below what the average person can hear.

Using lasers to hold objects still for study using a laser was first discovered back in the 1980's and since that time, researchers have tried using smaller and smaller beams to allow for holding smaller and smaller particles. Recently, progress has led to the point where nanoparticles can be held steady while under review, and it's these advances that have made the sound detector created by the German team possible.

To make their sound detector, the team set up two sound sources, both of which were placed in water. For the first, a tungsten needle was affixed to a speaker that generated vibrations at 300Hz. The second was a very tiny cluster of gold nanoparticles that were heated periodically by a laser to create vibrations at a frequency of 20Hz. Next a laser beam with 808 nm wavelength was fixed onto a 60 nm particle of gold, to hold it in place very near to the sound sources.

Once everything was set up, the researchers then measured the impact of the vibrations on the fixed nanoparticle. They found that they could very accurately measure the sound created by the sources by measuring how much the "fixed" nanoparticle was displaced by their vibrations.

The team writes that they believe their acoustical measuring technique could be used to record and measure sound created by bacteria or viruses, or in micro-electronics applications, all of which could lead to the field of so-called acoustic microscopy.

More information: Optically Trapped Gold Nanoparticle Enables Listening at the Microscale, *Phys. Rev. Lett.* 108, 018101 (2012) DOI:10.1103/PhysRevLett.108.018101

Abstract
We explore a new application of optical tweezers for ultrasensitive detection of sound waves in liquid media. Position tracking of a single gold nanoparticle confined in a three-dimensional optical trap is used to readout acoustic vibrations at a sound power level down to -60 dB, causing a ~90 μeV increase in kinetic energy of the nanoparticle. The unprecedented sensitivity of such a nanoear is achieved by processing the nanoparticle's motion in the frequency domain. The concept developed here will enable us to access the interior of biological microorganisms and micromechanical machines not accessible by other microscopy types.

via Physics Viewpoint: A Trapped Nanoparticle Listens In

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