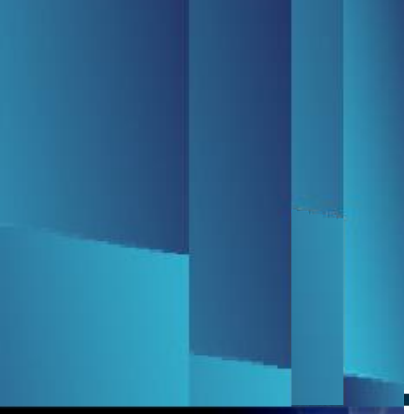

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THE AIR FORCE RESEARCH LABORATORY

Optically Levitated Nanoparticle Accelerometer

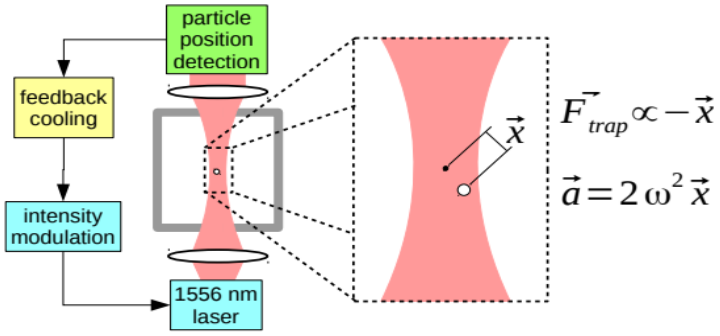
Inventors: Maxwell Gregoire, Brian Kasch

Background

There is limited research for optically levitated nanoparticles as force sensors since the research has mainly focused on mechanical resonators to measure amplitude of oscillating forces. The core of an accelerometer is an optical dipole trap that contains a sub-wavelength-sized particle. The particle is held in space by the laser, causing it to scatter light in the form of spherical waves. The particle can gain motional energy from vibrational motion of the laser, fluctuations in the beam intensity, particle and background gas collision, momentum fluctuations caused by particle absorption or photon re-emissions. Due to these unpredictable effects, the levitated nanoparticle must constantly be subjected to motional cooling. This technology explores innovation methods to conduct the motional cooling in order to use optically levitated nanoparticles for inertial sensing.

Technology Summary

Researchers at the Air Force Research Laboratory (AFRL) have developed a process for using optically levitated nanoparticles to continuously and directly measure inertial and gravitational forces. Applicable for next-generation, portable, high-precision accelerometers.



Simplified diagram of an optically levitated nanoparticle accelerometer.

Market Applications

- Detect gravitational attraction to the Earth using gravity gradiometer
- Monitoring the motion of Earth's tectonic plates
- Prospecting for oil and minerals
- Detecting tunnels underground
- Monitoring motion of people or objects behind barriers

Key Advantages

- Acceleration can be computed using real time measurements
- Lower oscillation frequencies result in better acceleration sensitivities
- Sensitivity and dynamic range can be tuned in real time
- Levitated nanoparticles have smaller wavelength and do not need to be spherical