Scilight

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Optically levitated microsphere can act as a non-ionizing pressure gauge

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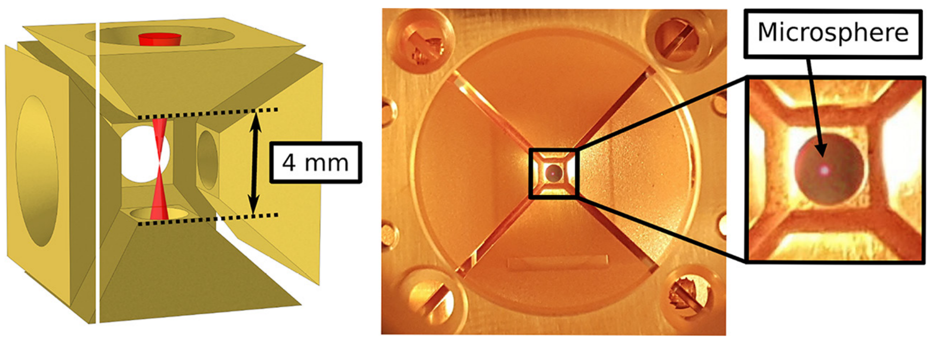
The relationship between a dielectric particle's dynamics and the gas pressure surrounding it determines vacuum properties.



The ability to perform absolute vacuum pressure measurements without ionizing residual gas is an important experimental challenge, since ionization can have detrimental effects on the experiment and can increase measurement uncertainties. In a recent paper, Blakemore et al. demonstrated the applicability of an optically levitated silica microsphere as a non-ionizing vacuum gauge.

Using a single-beam optical tweezer, the researchers levitated a microsphere and induced it to rotate within a shielding electrode box.

“An effective way to think about it is that a focused laser beam creates optical springs connected to a trapped dielectric particle,” said author Charles Blakemore. “Displacements away from an equilibrium point result in restoring forces that pull the particle back to the equilibrium, just like a standard spring-mass system.”

After removing an initial driving field that fixed the microsphere rotation within its optical trap, they measured the time constant of the microsphere's angular momentum decay to determine its torsional drag coefficient, which relates to the absolute pressure of the gas. To check their results, the authors monitored the phase lag between the driving field and the microsphere's dipole moment, another parameter that depends on the gas pressure.

The device's current setup is specifically designed to fit the group's vacuum chamber system in order to better understand background effects in their experiments. However, the authors note its key components are readily adaptable.

“The primary in-vacuum apparatus is some type of trapping optics to create an optical tweezer, which in turn needs a compatible electrode structure to apply rotating electric fields. Both could easily be made much more compact,” Blakemore said. “These methods, although subject to practical limitations of our specific apparatus, could be made exceptionally sensitive.”

Source: “Absolute pressure and gas species identification with an optically levitated rotor,” by Charles P. Blakemore, Denzal Martin, Alexander Fieguth, Akio Kawasaki, Nadav Priel, Alexander D. Rider, and Giorgio Gratta, *Journal of Vacuum Science and Technology B* (2020). The article can be accessed at https://doi.org/10.1116/1.5139638.