Physicists devise new technique to detect single molecule in single nanoparticle-based optical tweezer

ANJALI MARAR
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PHYSICISTS HAVE devised a technique that could be useful in future clinical diagnostics involving viruses, bacteria or for trapping microplastics that get mixed in food or water.

Scientists at the Indian Institute of Science Education and Research, Pune (IISER) have demonstrated a single-molecule detection and spectroscopy using a single gold nanoparticle-based optical Raman tweezer. They simultaneously trap nanoparticles and molecules and the detection was done using the Raman scattering effect.

CV Raman had discovered this effect in the late 1920s for which he received the Nobel Prize in Physics.

While conventional physics and biophysics labs use optical tweezers with very high power to trap, isolate and study particles at micro and nano-scales (less than hundred times smaller than a single human hair strand), this new technique requires very few micro-watts of laser power, the scientists said.

The group, led by G V Pavan Kumar, has been working on nanophotonic tweezers that are used to trap molecules, nano and micro-particles and further study their spectral dynamics and statistical mechanics. Their innovation includes Raman optical tweezers using plasmonic metal nanostructures and recently, an experiment was also attempted using silver nanowires to optically pull colloids in a fluid.

For this experiment, researchers placed a 150 nanometer-diameter gold nanoparticle surrounded by aqueous solution on a glass substrate. Its function, as an anchor trap particle, was used to create an opto-thermal assembly of plasmonic colloids that would further provide electromagnetic enhancement for Raman scattering. This setup was subject to heat using a single, low-power-density laser, which causes minimum damage to the trapped object.

"With the optical property of the light combined with the heating property of the gold when exposed to the laser at low power, we could achieve single-molecule detection sensitivity in a trap within a few milliseconds," said Sunny Tiwari, final-year PhD student of the programme and lead author of the study.

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