Optical spectroscopy of single molecules and gold nanoparticles

Fluorescence remains the workhorse method in single-molecule optics. Nonetheless, new techniques generalizing single-molecule optical observations have appeared recently. Photothermal microscopy opens the study of non-fluorescent absorbers, down to single-molecule sensitivity. Combining this contrast with photoluminescence, we can measure the luminescence quantum yield on a single-particle basis. The high signal-to-noise ratio of this technique enables uses of individual gold nanoparticles for local plasmonic and chemical probing. Gold nanorods generate strong field enhancements near their tips. Matching the rods' plasmon to a dye's spectra, we observe enhancements in excess of thousand-fold for the fluorescence of single molecules of Crystal Violet and other weak emitters. This method generalizes single-molecule fluorescence to a broad range of weak emitters.
We recently studied the dynamics of vapor nanobubbles created in the liquid surrounding a single immobilized gold nanosphere. We found that these nanobubbles form in an instable, explosive process before collapsing. Nanobubbles can react to reflected sound waves such as those released in the explosion.