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SINGLE NANOPARTICLE DETECTION AND SIZING BY MODE-SPLITTING IN AN ULTRA-HIGH-Q MICRORESONATOR

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With the rapid progress in nanotechnology, a variety of nanoparticles of different materials and sizes have been synthesized and engineered as key components in various applications ranging from solar cell technologies to biomolecular detection1-3. Meanwhile, nanoparticles generated continuously by vehicles and industries have become sources of exposure posing potential threats to human health and environment4,5. The ability to detect and size individual nanoparticles with high resolution in environment and other complex media is thus crucial to understand behaviours of single particles and effectively use their strong size-dependent properties for developing innovative products.

Here, we demonstrate, for the first time, real-time and in-situ detection and sizing of single nanoparticles using the mode-splitting in a monolithic ultra-high-Q (Q>108) optical whispering-gallery microresonator. The mode-splitting mechanism provides superior noise suppression as the split modes share the same resonator, and feel the same noise and environmental perturbations. We achieved detection and accurate sizing of individual particles with radius down to 30 nm in air.

The results exhibit the smallest dielectric particles detected and characterized using optical scattering techniques6,7. Our method requires neither labelling of the particles nor apriori information on their presence in the measurement media. The approach demonstrated here will assist in the realization of on-chip nanoparticle detection and sizing systems with single particle resolution. This will lay the groundwork to investigate the properties of single particles and their dynamics which cannot be attained using ensemble measurements.