CFEL SCIENCE

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September 23rd, 2010, 11.30 a.m. – DESY Bldg. 28c, Seminar Room

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Trapping, manipulation, and transport of particles in air with optical vortices

One of the new challenges in the rapidly developing field of nanotechnology is to create new measurement techniques to meet the needs of next-generation advanced manufacturing and promote technological growth, which will rely on nanometer scale materials and technologies. To put succinctly, if a nano-product cannot be measured and characterised, it cannot be manufactured. Additionally, if we are unaware of its physical and chemical properties, that nano-product cannot be manufactured in a safe way.

We address this challenge by developing a touch-free optical trapping of particles suspended in air, and applying nanonewton (1 nN = 10^{-9} N) to piconewton (1pN = 10^{-12} N), and below, radiometric forces to manipulate particles and their aggregates in natural conditions. Our ability to apply such forces is based upon a new concept of optical vortex trapping of particles in air [1-3]. The technique has already demonstrated its capacity as an effective, robust, and long lasting trapping tool which can hold and manipulate nanoparticles in air, so as to enable study of the size, morphology, elemental composition, which all contribute to uncover physical and chemical properties of the nano-aggregates. It will provide very good integration with analysis of the nanoparticle physical properties without any detrimental influence from the background.

The ability to capture light-absorbing particles suspended in gases by optical means opens up rich and diverse practical opportunities. Our immediate challenges include developing photonic shielding/fencing for environmental protection in nanotechnology industry, and new methods of touch-free air transport of particles and small containers, which may hold dangerous substances, or viruses and living cells.

1. V. Shvedov, et. al., Optics Express 17, 5743- 5757 (2009).
2. A. S. Desyatnikov, et. al., Optics Express, 17, 8201-8211(2009).
3. V. G. Shvedov, et. al., Optics Express, 18, 3137-3142 (2010).

Host: Henry Chapman, CFEL Coherent Imaging Group