Project 4.3. Photonic phenomena and luminescence in spherical microdroplet resonators

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Unit: ON2.7 - Group of Optical Characterisation of Micro- and Nanoobjects

www: http://info.ifpan.edu.pl/sdvs/en/on2.7.html

Background:
The Earth's atmosphere, like the entire universe, is very dusty. However, the mechanisms of atmospheric and cosmic dust formation are different. While the cosmic dust grains are born in star atmospheres and continue to grow in the clouds of cold interstellar gas, the more complex dust grains in the Earth's atmosphere are formed by the so-called "scavenging" – ubiquitous water droplets (often also condensing on aerosol nanoparticles; in clouds, fog and rain) scavenge all they encounter in the atmosphere, creating droplets of complex suspensions. These, in turn, can further evaporate and thus drive the aggregation of suspended solid particles into regular structures – the resulting grains of complex dusts inherit, however, the spherical symmetry of the droplet. In order to understand the mechanisms determining the optical properties of the dust particles being formed, it is necessary to know the processes governing their formation. Following this lead, it can be noticed that via appropriate control of the aggregates' structure, their optical properties can be engineered and new materials can be manufactured. These are called metamaterials, since their properties are defined on a larger than molecular scale. In particular, the use of metallic particles seems to be very promising, due to the plasmonic phenomena, associated with the collective oscillations of the electron gas density, manifesting in them.

Aim:
The objective of the research is to analyse the spectral properties of evaporating microdroplets of various suspensions containing dielectric (e.g. silica or titania) or plasmonic (e.g. gold or silver) inclusions. We also plan to study the final aggregates built in this process. The research will be conducted in electrodynamic traps developed in the Group of Optical Characterisation of Micro- and Nanoobjects. Additionally, we will utilise the luminescence of nanoparticles (e.g. of gadolinium oxide doped with rare earth ions) to probe the surface and the internal structure of evaporating microdroplets and to investigate the phenomenon of luminescence in a spherical resonator. The experiments will be accompanied by modelling of the aggregation of nanoparticles in a droplet with methods similar to molecular dynamics (MD). The research aim is to study the aggregation phenomena in detail and to develop methods of tailoring optical properties of materials for potential applications.

Requirements:
- Master's degree in physics or related field.
- Skills in experimental physics (best but not obligatory – in the field of optics, nano-photonics or related), ideally – proven by publications.
- Programming skills in C++ are desirable but not obligatory.
- Ability to work in a team.
- Good spoken and written English.