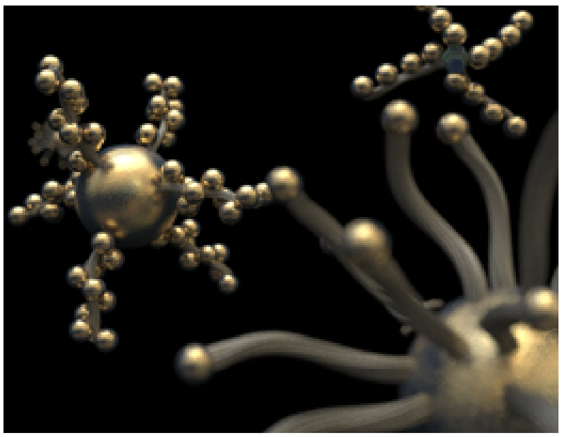
Nanoparticles and their orbital positions

December 16 2013



Physicists have developed a "planet-satellite model" to precisely connect and arrange nanoparticles in three-dimensional structures. Inspired by the photosystems of plants and algae, these artificial nanoassemblies might in the future serve to collect and convert energy.

If the scientists' nanoparticles were a million times larger, the laboratory would look like an arts and crafts room at Christmas time: gold, silver and colorful shiny spheres in different sizes and filaments in various lengths. For at the center of the nanoscale "planet-satellite model" there is a gold particle which is orbited by other nanoparticles made of silver, cadmium selenide or organic dyes.

As if by magic, cleverly designed DNA strands connect the satellites with the central planet in a very precise manner. The technique behind this, called "DNA origami", is a specialty of physics professor Tim Liedl (LMU Munich) and his team. Together with the group of Professor Jochen Feldmann (also LMU Munich) they introduced and analyzed this novel assembly scheme. Both groups are part of the cluster of excellence Nanosystems Initiative Munich (NIM).

Large or small, near or far

A distinctive feature of the new method is the modular assembly system which allows the scientists to modify all aspects of the structure very easily and in a controlled manner: the size of the central nanoparticle, the types and sizes of the "satellites" and the distance between planet and satellite particle. The approach also enables the physicists to adapt and optimize their system for other purposes.

Photonic systems

Metals, semiconductors or fluorescent organic molecules serve as satellites. Thus, like the antenna molecules in natural photosystems, such satellite elements might in future be organized to collect light energy and transfer it to a catalytic reaction center where it is converted into another form of energy. For the time being, however, the model allows the scientists to investigate basic physical effects such as the so-called quenching process, which refers to the changing fluorescence intensity of a dye molecule as a function of the distance to the central gold nanoparticle.

"The modular assembly principle and the high yield we obtained in the production of the planet-satellite systems were the crucial factors for reliably investigating this well-known effect with the new methods," explains Robert Schreiber, lead author of the study.

A whole new cosmos

In addition, the scientists succeeded in joining individual planet-satellite units together into larger arrays, while maintaining the combinatorial freedom. This way, it might be possible to develop complex and functional three-dimensional nanosystems, which could be used as Raman spectroscopy platforms, as plasmonic energy funnels or as nanoporous materials for catalytic applications.

More information: "Hierarchical assembly of metal nanoparticles, quantum dots and organic dyes using DNA origami scaffolds." Robert Schreiber, Jaekwon Do, Eva-Maria Roller, Tao Zhang, Verena J. Schüller, Philipp C. Nickels, Jochen Feldmann, Tim Liedl. *Nature Nanotechnology* (2013) DOI: 10.1038/nnano.2013.253

Provided by Ludwig Maximilian University of Munich

Citation: Nanoparticles and their orbital positions (2013, December 16) retrieved 26 April 2024 from https://phys.org/news/2013-12-nanoparticles-orbital-positions.html