Novel photonic mechanisms for optical manipulation, switching, and light-harvesting in nanostructured molecular systems

David L. Andrews

Recent progress in the theory of photon interactions reveals a catalogue of new mechanisms for the interactions of light with molecules and nanoparticles. Non-resonant light can operate in an almost catalytic fashion, producing movements of energy and matter without itself suffering change. The principles are most readily understood from a clear perspective on the nature of photons, whose fundamental nature and properties come under fresh scrutiny. Some nanoscale applications such as optical binding, extensively demonstrated in experiment, allow the ordering and patterning of particles in arrays and rings, along with the application of distinctive torques. Other possible effects include a means for non-resonant laser light to promote, inhibit or switch the transfer of electronic energy between molecules, based on precisely the same photonic coupling mechanism. In addition to light-harvesting and frequency conversion, a variety of possibilities exist to effectively channel excitation between nanoscale components, and attention is now being given to optical switching applications. Still more exotic effects arise with optical vortices. This survey concludes with a few clues to some of the latest puzzles that need to be solved.

David Andrews is Professor of Chemical Physics at the University of East Anglia, where his group conducts research on fundamental photonics, optomechanical forces, optical vortices, nonlinear optics, energy harvesting and molecular energy transport. He has more than 15 books and over 350 research papers to his name. David Andrews is a Fellow of the Institute of Physics, the Royal Society of Chemistry, the Optical Society of America, and SPIE - the international optics and photonics society in which he is an elected member of the Board of Directors.