Prof. L. (Kobus) Kuipers (Delft university of technology, The Netherlands) - «Light twists show the way»

Abstract:

Nanophotonics aims to control light flows and emission with nanostructures at deep-subwavelength length scales. Interestingly, light fields that we observe on a daily basis, e.g., the patterns at the bottom of a swimming pool, already contain optical entities -both phase and polarization singularities- that, in their size, put nanophotonics to shame as they are infinitesimally small. The singularities also exhibit intriguing topological features. In this lecture we explore the topology of light in nanostructures. In a chaotic cavity the spatial distribution of phase singularities in space reminiscent of ions in an ionic liquid. Changing a parameter of the system, e.g., the optical frequency, the singularities perform a random walk. Sometimes they are created or they annihilate, always in pairs conserving the total topological charge. We observe that two families exist: those that exhibit life-long fidelity and those that are “promiscuous”. The latter live “longer”. Lights topology also offers new ways to manipulate light-matter interactions. Strong confinement of propagating light leads to optical spin-momentum locking. We exploit this effect to create a room temperature chiral valley-photon interface, creating a 1-to-1 link between light emission from a specific valley in WS2 and a specific propagation direction along a nanowire. This opens avenues for combining spintronics and nanophotonics in novel, energy-efficient devices.

Prof. Mikhail M. Glazov (Ioffe institute, Russia) - «Exciton transport in atomically-thin crystals»

Abstract:

The two-dimensional semiconductors based on transition metal dichalcogenides are in focus of the researchers attention due to fascinating optical properties. The Coulomb interaction bound electron-hole pairs, excitons, can freely propagate in the monolayer plane demonstrating diffusion across the micrometer distances. Here we present the results of theoretical and experimental investigation of the exciton transport in atomically-thin transition metal dichalcogenides focusing on the non-linear diffusion, phonon wind and phonon drag effects. We also discuss the quantum interference effect on exciton propagation.

Prof. Nikolay Gippius (Skolkovo Institute of Science and Technology, Russia) - «Optical properties of resonant photonic structures»

Abstract:

Periodic photonic structures are one of the most important low-level components in modern photonics since they form the basis for plenty of optical elements and devices. Layered periodical structures support resonant quasi-guided modes and are widely used in modern photonics. Their optical properties are intensively investigated. Strong redistribution of the electromagnetic fields near the resonances in these systems is responsible for the rich spectra of light reflection, diffraction and transmission. The relative intensities of the resonant diffraction channels can be tuned by the design of the photonic unit cell and the surrounding layered structures. We show that based on the parameters of the resonances (energies, wave-vectors and resonant field distributions) the parameters of the resonance of combined structures can be obtained with high accuracy. We present implementation of the discrete dipole approximation (DDA) for the construction of scattering matrices of arrays of resonant nanoparticles. This approach strongly speeds up the calculations and therefore provides an opportunity for thorough consideration of various layered structures with small periodic inclusions in terms of the rigorous coupled-wave analysis. We demonstrate the performance of the proposed method by considering plasmonic lattices embedded in a homogeneous ambience and placed inside and onto an optical waveguide. We apply this approach for the analysis of several problems including control of the polarization of light emitted from photonic crystal slabs.