# "Quantum Photonics Faculty Candidate Seminar"

## March 5th, 2015 @ 1:30pm
## BRK , ROOM 1001

## Dr. Alexey Akimov

### Title: Quantum optics in new systems: from plasmonics to cold atoms

**Bio:** Alexey graduated and then got his PhD from Moscow Institute for physics and technology in 2000 and 2003 correspondently. Starting from 1997 he joined to laboratory for active media at Lebedev Physical Institute. His research was focused on narrow optical resonances and its applications for metrology, both using hot and laser cooled atoms. In 2006 keeping part time position at Lebedev he joined to Misha Lukin group at Harvard, where he started work with plasmons, quantum dots and NV centers. Main focus of this activity was light-spin interfaces and solid state nanophotonics. In particular novel approach on using plasmon nanowires for light collection and Purcell enchantment of nano emitters was realized. In 2010 he was involved in Russian Quantum center (RQC) initiative and became its acting director for first 2 years of the Center development. Currently he is Principal Investigator at RQC, where he is conducting research in both fields of cold atoms and solid state spin systems.

**Abstract:** Among main streams of modern society development are fast developing filed of information processing and development of new materials. One of key challenges in modern information processing is enabling efficient transfer of quantum information stored in atomic like system onto photon and vice versa. Photons are almost perfect information carriers while atomic spins provide controllable system for performing operations or serve as memory. Building such an interface will find a lot of applications not only in quantum and classical information processing and related question of long distance quantum communication but also will be highly demanded for metrological and sensing applications.
On another side understanding of complicated materials require strong computational resources, often far beyond possibilities of best supercomputers. Powerful approach to address this issue developed over last year is replacing complicated numerical simulation by quantum simulation based on use of cold atom in optical lattices.
Over last few years we developed number of approaches to spin-photons interfaces. This includes use of surface plasmons to deal with nanoscale quantum emitters such as colloidal quantum dots or NV centers in diamond, photononic crystal cavities and nanoscale traps for single atoms. Recent fast development in the field of metamaterials opened a way to create new generation of light –spin interfaces out of hyperbolic metamatherial using CMOS compatible approach. Use on this material especially in combination with an optical fiber may open a way to create efficient and industry friendly interface for solid state spin systems, in our case NV centers in diamond.
We also developing a novel platform based on ultra-cold atoms for understanding and simulating complex quantum phenomena. Our focus is on ultracold thulium atoms. Thulium belongs to a group of rare-earth atoms with a hollow submerged electronic f-shell. Due to their large ground state magnetic moment, thulium atoms feature strong dipole-dipole interactions, even at distances of a few hundreds nanometers. Furthermore, due to the large orbital moment, a large number of low-field Feshbach resonances are expected enabling control over atomic iterations. Moreover, thulium atoms loaded in an optical lattice may serve as a favorable candidate for quantum simulations of magnetic interactions. This feature opens the opportunity to study long-range dipole-dipole and quadruple interactions between atoms, as well as magnetic properties like spontaneous magnetization in the quantum regime and the observation of exotic magnetic phases. Therefore thulium atoms could provide a powerful platform for quantum simulation, and potentially could contribute to our understanding of quantum magnetism and other complex quantum phenomena
In my talk I will describe our activities in both field on quantum interfaces and cold atoms