Single photon techniques for atomic system analysis

The “Single photon techniques for atomic system analysis” project aims to investigate interaction of single quanta of light with single matter particles. The set of experimental techniques, which will be used to realize this goal, is based on the ability to generate, control and detect single photons.

The quantum light is typically generated by means of the so-called spontaneous parametric down-conversion (SPDC) process, in which a photon from a laser beam, when traveling through a specially designed crystal, can be spontaneously converted into a pair of photons. These pairs can feature non-classical correlations, called entanglement. They may be subsequently used to illuminate a single atomic system, such as a nitrogen-vacancy center in a diamond, and observe the interaction effect by detecting another photon emitted by the system. The ability to observe fully quantum interaction of a single photon or a photon pair with atomic medium can lead to novel microscopy techniques, allowing for ultra-spatial and ultra-temporal resolution at the highest possible level of sensitivity. In particular, it can be used to revolutionize the two-photon absorption technique which has recently became one of the most important tools in biological imaging. By utilizing the entangled photon pairs in this technique it is possible to eliminate its biggest disadvantage which is the necessity to use potentially destructive high-energy pulses. The project aims at characterizing the absorption and emission spectra of various single-atomic-like materials and performing experiments leading to the observation of the entangled two-photon absorption effect.