Since the first research on quantum dots, i.e. semiconductor nanocrystals with diameter in the range of 2-5 nm, in 1980s much scientific attention has been driven due to possibility of the tuning of their physical properties with their size. **Therefore quantum dots have arose as one of the most important issue of present-day nanoengineering.** These are zero-dimensional objects i.e. those in which spatial movement of electrons is confined in all three spatial dimensions. Hence the allowed electronic energy levels in quantum dots do not create bands (like in bulk semiconductors), but are discrete, thus quantum dots are often called artificial atoms. The position of electronic energy levels can be tuned through the change of quantum dot size, which allows the absorption/emission of light with well-defined color. It results in many possible applications e.g. in lightning technologies, photovoltaics and bio-imaging. The latter is focused on the development of novel nontoxic materials, as opposite to the leading Cd- and Pb-based quantum dots. **The promising candidate are ternary $AgInS_2$ quantum dots**, because of their red-shifted luminescence, fitted well to the optical window of body tissues, relatively high quantum yield (ca. 20-30%) and long fluorescence lifetimes (ca. 100 ns) very useful for fluorescence lifetime imaging microscopy (FLIM). However, despite their good luminescent properties and many possible applications, the exact nature of electronic transitions in $AgInS_2$ quantum dots still need to be explained. **The essential problem connected with $AgInS_2$ quantum dots is their complex dynamics of excited states relaxation (i.e. how the systems returns to the ground state after energy absorption).** Previous research indicate, that three particle recombination via Auger processes leads to the charging for quantum dots as a result of excited electron trapping by surface defect states originating from the geometry reconstruction of the quantum dot surface, which leads to the photoluminescence bleaching.

The aim of this project is to investigate the influence of the metallic phase on the optical properties of $AgInS_2$ quantum dots. It is expected, that the negative surface related effects will be reduced and luminescence of $AgInS_2$ quantum dots enhanced by the passivation of surface defect states as well as by the coupling between exciton (excited electron in quantum dot) and plasmon (oscillation of electronic density) induced in the metallic phase, which is the main research hypothesis of this project. **The set goal will be pursued in two ways: experimental and theoretical.**

During the experimental part the synthesis of hybrid metal/$AgInS_2$ quantum dot nanostructures will be synthesized using wet chemistry methods. Two types of systems will be synthesized: metal-rich $AgInS_2$ quantum dot alloys of general formula M_xAgInS_2, where M will be copper, silver, aluminum or indium, and core/shell nanoparticles, where core will be made of gold and semiconducting AgInS2 will be shell. After the proper synthesis the influence of the metal will be investigated during the spectroscopic measurements. Theoretical part will be devoted to the quantum chemical calculations of the geometry, electronic structure and optical properties of $AgInS_2$ nanoclusters (several dozen of atoms) as representatives of larger AgInS2 quantum dots. Quantum-chemical calculation methods emerged as a very useful tool complementary to the experimental methods enable very often to predict various physical properties of nanostructures prior the synthesis and measurements. Detailed analysis of the geometry and electronic structure will allow to investigate the mechanism of surface defect states formation and the influence of metal adatoms on these states.
Proposed research will allow to deeper understand the nature of electronic transitions and complex dynamics of excited states recombination in $AgInS_2$ quantum dots.