The main purpose of this project is experimental and theoretical determination of the conditions for occurrence the cascade photon emission process followed by energy transfer between Pr^{3+}, Mn^{2+} and Yb^{3+} ions embedded in nanosized alkaline earth fluoride matrices of SrF_2.

Cascade photon emission (PCE), sometimes called a quantum cutting process, consist of two stages: absorption of the one photon with the high energy (for example from the UV range) and emission two or more photons, each with lower energy (for example from the NIR range). As a result of interaction of the light with the proper material, the number of photons can be at least doubled but the total energy of the system will be conserved.

Many conditions have to be fulfilled by material to show PCE. First, it needs to be doped with ion with well-define electronic level structure. Second, the excitation energy cannot be dispersed by transitions to another configuration states. Next, there has to be any kind of intermediate electronic level, to allow for "splitting" the absorbed photon. More practically: material should be cheap, easy to synthesize, useful also in other applications. Hence bulk alkaline earth fluorides (AEF) doped with Pr^{3+} ion were investigated for many years as a promising candidates. These crystalline lattices, due to their unique properties, are widely studied in optical science. Unfortunately, the PCE was not observed and also theoretical calculations showed that this process cannot take place in a bulk AEF, due to overlapping the Pr^{3+} states from different configurations. However, contrary to previous results, recently the first step of PCE has been experimentally observed in nanosized CaF_2:Pr^{3+}, which belongs to the family of AEF. The explanation of that phenomenon and the impact of the crystalline size by experimental methods and theoretical calculations is one of the goals of that project.

Therefore, the planned tests include the measurement of PCE in the nanocrystals SrF_2 doped with Pr^{3+} ions by excitation with high energy radiation from the vacuum UV range. Presence or absence of the process will be explained by theoretical calculations on the basis of crystal field theory and ab initio methods. Second stage of the project will be focused on the shifting the wavelength of emitted photons (from UV to red and near infrared range) by co-doping the studied materials with Mn^{2+} and Yb^{3+} ions. The Mn^{2+} belongs to family of transition metal ions, so its luminescence properties are strongly dependent on the host lattice. In that project the possibility of the energy transfer between Pr^{3+}, Mn^{2+} and Yb^{3+} ions will be investigated as in the first stage: experimentally and by its modeling using computational methods. Especially, the position of the ground level of Mn^{2+} ion relative to band gap of nanosized SrF_2 will be determined. The impact of crystalline size as well as dopants concentration will be also investigated.

The expected result of that research is better understanding previous results of other researcher and in consequence describing and explaining the conditions for occurrence the PCE process and energy transfer from Pr^{3+} to Mn^{2+} in nanocrystalline SrF_2. Extending the state of the knowledge in the topic of adjusting of the optical properties of nanomaterials to required needs is also foreseen.