Hybrid organic-inorganic lead halides are interesting group of multifunctional materials that attracts a lot of attention of researchers from all over the world for the past several years due to their interesting properties and potential application. There are three-dimensional (3D) perovskite-like architecture described by general formula ABX_3 and their layered 2D analogues described by the A_2BX_4, $A''A_{n-1}Pb_nX_{3n+1}$, and $A'A_{n-1}Pb_nX_{3n+1}$, etc. (A, A', A'' denote protonated amines and X the halogen linker). Due to relatively low production cost, optical and structural properties and their tunability, they are promising materials for solar cell application. It is noteworthy that power conversion efficiency (PCE) of perovskite solar cells (PSCs) increases rapidly. The first PSC reported in 2009 had PCE equal to few percent, which was lately increased to about 25 %.

Most of published papers concerned 3D lead halide perovskites and was focused on using small organic cations, such as methylammonium (MA^+) or formamidinium (FA^+) cations. Other cations in the most cases caused obtaining 2D or quasi-2D structures. Compounds such as $MAPbI_3$ or $FAPbI_3$, due to optimal band-gap, have a huge potential in development of PSCs, however due to their intrinsic instability against factors like moisture or UV radiation, their application potential is limited. There are some approaches to improve their properties, such as passivation of perovskite layer or modification of their compositions with an use of amines with bigger spatial hindrance.

Recently, a few studies were published focused on obtaining of two- and three-dimensional perovskite-like structures with amines larger than MA^+ or FA^+ cations, i.e. methylhydrazinium ($MeHy^+$) cation. Obtained materials exhibit interesting and unusual structural, dielectric and optical properties in comparison to traditional and well-known perovskites, such as $FAPbI_3$ or $MAPbI_3$. Last year, it was also shown that addition of the 1,1,1-trimethylhydrazinium cation to the $MAPbI_3$ system caused boosting of photo conversion efficiency.

These studies opened a new possibilities in exploration of the world of amines from the group of multimethylated hydrazines and other alkylhydrazines for the application of three- and two-dimensional perovskites and further detailed analysis of their properties changing with the increased steric hindrance.

In this proposal we are going to synthesize novel two- and three-dimensional phases and analyzed in details their structural properties, lattice vibrations as well as optical and electrical properties in the broad temperature and pressure range. Such studies will allow to answer a raising questions, i.e. how chemical modification changes the structural, phonon, electrical and optical properties. Only the full understanding of structure-properties and stability relations will allow for their broader application in the future and finally designing of modern materials with desired properties for particular applications for optoelectronics.