DESCRIPTION FOR THE GENERAL PUBLIC

Since the ancient times, the humanity possesses immeasurable impetus towards discovering the unknown. Throughout the human history there were only a few scientific moment of scientific breakthrough. Undoubtedly, one of them is discovering the nano-scaled world, that is the physical systems which dimensions are comparable to that of an atom, where, as it was already predicted by Richard Feynmann, the basic principles of macroscopic world could no longer be in force.

Beyond a shadow of doubt, it is a fact that one of the most promising directions for research is centered around investigations of metamaterials, i.e., artificial materials possessing unique properties, unachievable for conventional media. Their exemplary feature is the effect of inverse light refraction. The particular class of metamaterials which has emerged as the most important at optical frequencies are hyperbolic metamaterials (HMMs). Such structures are composed of alternating nanolayers of a metal and a dielectric, revealing extremely variable behavior, i.e., metallic or dielectric, depending on the direction of wave propagation. Moreover, due to their unique properties they can be applied as emission enhancers.

This project is dedicated to a study of a new class of nanoscale multilayered periodic structures based on Hyperbolic Metamaterials. In contrast to “conventional” HMMs, the proposed structures comprise a layer of a material that can be tuned by an external stimulus resulting in an active control of the effective structure’s properties. We call such structures the ATHMMs – Active Tunable Hyperbolic Metamaterials. In particular, such media are especially interesting in the context of the possibility for implementing them in a new class of highly efficient laser sources.

What is noteworthy, the investigated topic is still in its infancy phase. Due to this fact, a diligent analytical study is required. Within this project, we propose such an analysis of ATHMM-based structures by means of analytical, as well as numerical methods. A special emphasis will be put on diligent and complex numerical simulations covering propagation properties in ATHMMs. The obtained results could pave the foundation for a new class of active media with controllable gain.