Draft of Bachelor / Master Project

Project title: **Broadband metasurface photodetectors**

Proposed by: Vladimir Zenin

Possible supervior(s): Vladimir Zenin, Torgom Yezekyan, Sergey I. Bozhevonlyi

Project Description:

Photodetectors are devices which convert light into electric signal. Everyday examples of photodetectors are camera sensors, illumination sensors in smartphones, position sensors in a computer mouse, sensors in smoke detectors, etc. The most efficient way of photodetection is to use semiconductors, where absorbed photons generate electron–hole pairs, which are then electrically detected.

Photodetector performance can be optimized in several way: increasing the photocurrent, decreasing the response time, decreasing the dark current, decreasing the noise, etc. All from above can benefit from reduction of both the lateral semiconductor size and its thickness. However, reducing the thickness results in a reduced absorption and, consequently, in an unwanted decrease of the photocurrent. **And here comes the main idea of the project: keep the photodetecting layer thin but enhance light absorption inside it by y covering it with non-absorbing nanoantennas.** For simplicity of fabrication, the photodetecting material will be germanium (Ge), the wavelength range is near-infrared (1000-1600 nm), and material for nanoantennas is silicon (Si). One part of the project will be dedicated to the optimization with a fixed shape of nanoantennas (namely, cylinders), simply by sweeping its parameters. Another part will be the optimization of the geometry with genetic algorithms. Both above will be conducted in COMSOL. Finally, if results will look promising, and if the time will allow, the photodetector fabrication and experimental verification of the efficiency enhancement will be conducted.