ITMO

Level of education: **Master**
Field of study: **16.04.01 Technical Physics**

Advanced Quantum and Nanophotonic Systems

NANOPLASMONICS

Credits: 6 ECTS		
Semester		Assessment
2nd semester	6 ECTS	Exam

Course developers: **Mihail Petrov**

Nanoplasmonics studies the physical phenomena that occur when light interacts with metal or highly doped semiconductor structures. Oscillations of free charge carriers in such structures (plasmons) can interact with an external electromagnetic field. This leads to the appearance of plasmon polaritons – waves, whose energy is made up of the plasmon energy and the photon energy. Unlike conventional electromagnetic waves, plasmon-polaritons possess a strong spatial localization at optical frequencies, which potentially allows the creation of optoelectronic devices, sensors and subwavelength lasers. In the framework of the course, the fundamental principles of the light interaction with material's plasma oscillations will be considered, and methods for describing the plasmon properties of single metal nanoparticles and their arrays will be discussed.

Requirements

Course prerequisites: Electrodynamics, Photonics, Mathematical Methods in Physics.

Course structure

1. OPTICAL PROPERTIES OF METALS
   1.1. Maxwell's equations.
   1.2. Drude Model.
   1.3. Interaction of electromagnetic waves with metals.

2. SURFACE PLASMON-POLARITONS
   2.1. Surface plasmon-polaritons.
   2.2. Losses in surface plasmon polaritons propagation.
   2.3. Excitation of surface plasmon-polaritons.
   2.4. Plasmonic waveguides. Bulk plasmon-polaritons.

3. LOCALIZED SURFACE PLASMON RESONANCE

3.1. Resonances in small metal nanoparticles: quasistatic approximation
3.2. Fabrication and optical characterization of plasmonic structures
3.3. Resonances in small metal nanoparticles: complex shapes and structures
3.4. Light scattering on metal nanoparticles: beyond quasistatic approximation

4. PLASMONICS APPLICATIONS

4.1. Nanoparticle ensembles for light localization and guiding
4.2. Plasmonics applications for light emission enhancement
4.3. Photoluminescence and Raman enhancement
4.4. Forster resonance energy transfer
4.5. Plasmonics for sensing, nonlinear optics, and optomechanics applications

Assessment

- There is a set of home tasks aiming to help students in mastering the course (about 40 problems of different level).
- During classes the students are supposed to solve problems in class.

Grading policy:

Final exam 50 %
Homeworks 50 %

100 on 5 points projection:

<60 points — failed
60-74 points — satisfactory
75-89 points — good
90-100 points — excellent

Faculty: **Faculty of Physics**

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Tags: **Maxwell's equations; Drude model; Interaction of electromagnetic waves with metals; Surface plasmon polaritons; Losses in surface plasmon polaritons propagation; Excitation of surface plasmon polaritons; Plasmonic waveguides & Bulk plasmon polaritons; Resonances in Small Metal Nanoparticles; Fabrication and Optical Characterization of Plasmonic Structures; Light; Scattering on Metal Nanoparticles; Metal nanoparticle ensembles; Plasmonic arrays; Quantum emitters interaction with plasmons; Photoluminescence and Raman enhancement; Forster resonant energy transfer; Plasmonics for sensing applications**