Оптомеханика

Lecturers:
Михаил Петров
Александр Поддубный

Assistants:
Иван Тофтул

Language:
English

Credit points:
6 з.е.

Monitoring type:
Зачет с оценкой

Educational Program:

Нанофотоника
2 семестр

Квантовые материалы
2 семестр

Компьютерное моделирование квантовых и нанофотонных систем
2 семестр

Гибридные материалы
2 семестр

Lectures (a.h)*	Practice (a.h)	Labs (a.h)
22	10	
*1 academic hour = 45 minutes		

The course is aimed to give introduction to the concept of how it is possible to manipulate the matter with light. We will cover optical tweezers (2018 Nobel prize in Physics), go deeper into fundamentals of optical forces and torque from classical and quantum perspective (e.g. lecture about LIGO project). Lastly, we will go through the cavity optomechanics and see how it is possible to realize an interplay between phonons and photons. Each topic is supported by unique interesting problems. After this course each student will gain a nice perspective of physics behind each effect, and will be able to read and analyze related papers about novel discoveries in the field.

Course content

Plan of a course

Структура курса

№	Название раздела	Основные темы раздела, разделенные на лекции, практики, лабораторные	Формат занятия
1	Part 1. Nanoparticle optomechanics	1.1 Forces on particles. Optical tweezers	Лекция, практика
		1.2 Sophisticated effects: optical binding, optical pulling, optical torques	Лекция
		1.3 Plasmonic and metamaterials for optomechanics	Лекция, практика
2	Part 2. Cavity optomechanics	2.1 Types of optomechanical interaction for resonators	Лекция, практика
		2.2 Mandelstam-Brillouin scattering. Resonant and non-resonant.	Лекция
		2.3 Optomechanical nonlinearity-classical consideration. Bistability, heating and cooling.	Лекция, практика
		2.4 Mandelstam-Brillouin Scattering in the bulk	Лекция
3	Part 3. Quantum optomechanics	3.1 Optomechanical interferometry	Лекция, практика
		3.2 Quantum fluctuation interactions (Casimir force, Casimir-Polder potential)	Лекция
		3.3 Dynamical Casimir effect (optional)	Лекция
		3.4 Atomic optomechanics and atomic cooling (Doppler cooling, optical viscosity, magneto-optical trap, Sisyphean cooling)	Лекция

Recommended resources

Литература:

R. Loudon, J. Modern Optics 49, 821 (2002).

A. Ashkin and J. M. Dziedzic, Phys. Rev. Lett. 30, 139 (1973).

J. P. Gordon, Phys. Rev. A 8, 14 (1973).

V. Perel’ and Y. Pinskii, Sov. Phys. Solid State 15 (1973).

M. Glazov and S. Ganichev, Physics Reports 535, 101 (2014).

P. C. Chaumet and M. Nieto-Vesperinas, Opt. Lett. 25, 1065 (2000). R. N. C. Pfeifer, T. A. Nieminen, N. R. Heckenberg, and H. Rubinsztein-Dunlop, Rev. Mod. Phys. 79, 1197 (2007).

A. Zangwill, Modern electrodynamics (Cambridge University Press, 2013).

L. Landau and E. Lifshitz, Electrodynamics of Continuous Media (Pergamon, New York, 1974).

I. N. Toptygin and K. Levina, Physics-Uspekhi 59, 141 (2016).

K. Y. Bliokh, A. Y. Bekshaev, and F. Nori, New Journal of Physics 19, 123014 (2017a).

K. Y. Bliokh, A. Y. Bekshaev, and F. Nori, Phys. Rev. Lett. 119, 073901 (2017b).

A. Ashkin, J. M. Dziedzic, J. E. Bjorkholm, and S. Chu, Opt. Lett. 11, 288 (1986).

L. Novotny and B. Hecht, Principles of nano-optics (Cambridge university press, 2012).

P. C. Chaumet and A. Rahmani, Opt. Express 17, 2224 (2009).

Grading Policy

Промежуточная аттестация: решение задач, вес - 50%, минимум решить 3 задачи

Аттестация(зачет с оценкой): решение задач, вес - 50%, минимум решить 6 задач