Prof. Oleg. Misochko からの講義に関するレポート：

Report on 3-lecture course
"Coherent and squeezed states in physics"
for graduate students by Prof. O.V. Misochko

The course was designed to be a brief introduction into the physics of coherent and squeezed states. The main accent was placed on physical picture of the coherent and squeezed states, while the mathematical details were largely ignored. In the first lecture, after a brief review of uncertainties for physical observables, I considered classical and quantum-mechanical description of a harmonic oscillator. Having compared the similarities and differences, I dwelled on the concept of zero-point energy and introduced a coherent state stressing that the coherent state is the state minimizing the uncertainty product. Further I considered different definitions of the coherent state such as an eigenstate of the lowering (annihilation) operator, as well as the displacement operator consisting of a linear combination of lowering and raising operators. In the second lecture, different definitions of a squeezed state were given in a complete analogy to the coherent state considered previously. In addition, some examples of squeezed states for light and matter were considered (quadrature-, amplitude-, and phase-squeezed state, squeezed vacuum, etc.), as well as the generation and detection of squeezed states were described. In the final lecture nonclassical light and matter experiments were considered, as well as various applications of the squeezed states for metrology and fundamental physics. The lecture ended with the list of publications needed for further reading.

As far as I can judge from the questions raised by students either during the lectures or afterwards, as well as from in the student reports, the main topics of the course were understood to some extent. The main difficulties were the very concept of coherence, and in part the concept of squeezed vacuum. Also nonlinearity effects leading to squeezing were not easily understood. If I were to read the same course again, I would remodel the way to deliver the course. First, since the students understand the written English much better than the spoken English, the slides should contain the main idea of the concept introduced in the written form. New terminology also should be introduced in the written form (and repeatedly). Second, the quantum mechanics background needed to understand the topics should be provided prior the lectures (it is difficult to discuss the material based on operator formalism without a detailed knowledge of state vector and Dirac's concept of the state). Third, in addition to the time-domain, some effects, like squeezing, should be considered in the frequency domain. Last, but no the least, each lecture should be delivered at much slower speed, which, without doubt, will smooth the progress of students' understanding.

Report on 3-lecture course
“Introduction to ultrafast optics”
for undergraduate students by Prof. O.V. Misochko

The course was designed to be a primer on the ultrafast optics with a particular attention paid to the creating and measuring of ultrafast (picoseconds and femtoseconds) laser pulses. In the first lecture, after a brief description of the history of ultrafast physics, I considered the Heisenberg uncertainty principle stressing the inevitable limitations imposed by the principle on measurement process. Then on the base of a generic ultrafast-pulse laser, the generation of ultrashort pulses was considered and the importance of bandwidth for making shorter and shorter laser pulses was stressed. The second lecture was devoted to mathematical description of laser pulses: intensity and phase, the instantaneous frequency and group delay, the linearly and quadratically chirped pulses. Special attention was paid to higher order nonlinearities resulting in second and third harmonic generation, induced grating and phase conjugation, as well as continuum generation. The final lecture concentrated on measuring ultrafast pulses as well as on pulse shaping and coherent control techniques. Some details of ultrafast laser spectroscopy based on the consideration of a generic ultrafast experiment and of other applications of ultrafast pulses were also provided.

Based on the questions raised by students either during the lectures or in their reports I conclude that the main topics of the course were understood (the main difficulties were the concepts of coherence and correlation). However, if I were to read the same course again, I would remodel the presentation of the course. First, since the students understand the written English much better than the spoken English, the slides should contain the main idea of the concept introduced in the written form. New terminology also should be introduced in the written form (and repeatedly). Second, the linear optics background should be provided prior the lectures (it is difficult to discuss non-linear matters, and the ultrafast optics is essentially non-linear physics, without a solid knowledge of geometrical and wave optics). Last, but no the least, each lecture should be delivered at much slower speed, which without doubt, facilitate students’ understanding.

Report on the lecture

"Swinging atoms - ultrashort flash of light creates and images atomic motions"

for freshmen by Prof. O.V. Misochko

In this popular physics lecture I told the students that scientists have always strived to see smaller and smaller things and faster and faster events. Atoms from which all material world is composed of are minuscule objects with proportionately tiny masses. They can only be observed individually using special instruments such as the scanning tunneling microscope since the typical size of an atom does not exceed one angstrom, that is 100pm. But how can we catch the motion of an atom? The easiest way is to freeze the motion by stopping the time. A simple camera can do this. However, we all know that one cannot record the flapping wings of a bird in flight with a camera with a slow shutter speed. The same principle holds for scientific experiments. A mechanical shutter is limited in the time-resolution to millisecond range, an electronic shutter – to nanoseconds, while an optical shutter allows us enter femtosecond range. To record the progress of a dynamic process requires that the detector, that is our shutter, be faster than the process; otherwise, the "picture" is fuzzy. Many of the processes of interest to those at the frontiers of research take place on a time scale of molecular vibrations, typically around 100 femtoseconds (100 quadrillionth of a second). However, no one had, until recently, been able to observe what actually happens to the atom in a crystal lattice as the state of the crystal change. This remained a misty no-man's land. The story how to visualize the atomic motion on the example of a solid was the main topics for the lecture.

Based on the questions raised by students either after the lecture or in their reports I conclude that the main topics of the lecture were essentially understood. However, if I were to read the same lecture again, I would in part remodel the presentation. First, since the students understand the written English much better than the spoken English, each slide should contain the main idea of the concept introduced in the written form. Second, the lecture should be delivered at much slower speed, which without doubt, facilitates students' understanding.