

PHYSICS OF ULTRACOLD ATOMS

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Physics of ultracold atoms in Russia: development and co-ordination

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Research on the physics of ultracold atoms in Russia has deep and rich traditions. It began almost immediately after the advent of lasers, whose light made it possible to effectively act on the translational degrees of freedom of atoms and ions through resonant light pressure. Work in this direction was begun by Petr Lebedev (light pressure experiments). The pioneering contribution made by Russian scientists to this area of physics is generally acknowledged. It is sufficient to note the world's first experiments on the laser cooling of neutral atoms carried out at the Institute of Spectroscopy (IS), USSR Academy of Sciences, by a team headed by Letokhov and Balykin. A considerable contribution to the theory of the mechanical action of light on atoms was made by Kazantsev, Minogin, Surdutovich, Yakovlev and other Russian scientists.

Unfortunately, experimental work on the physics of ultracold atoms in Russia considerably slowed down from the late 1980s to the early 2000s. This led to a significant lag behind the world's leading centres in both mastering laser cooling methods and utilising ultracold atoms and ions. In a number of research directions, such as precise optical frequency standards, quantum computation, quantum simulation, quantum phase transitions, ultralow-energy atomic collisions and the physics of degenerate gases, progress is just impossible without utilising laser-cooled atoms.

Starting in about 2000, experimental studies of ultracold atoms were activated in Moscow [P.N. Lebedev Physical Institute (LPI), Russian Academy of Sciences (RAN); IS, RAN; All-Russia Research Institute of Physical and Radio Engineering Measurements (VNIIFTRI); Joint Institute for High Temperatures, RAN], Novosibirsk and Nizhnii Novgorod, where several scientific groups differing in their research interests were formed simultaneously. For example, researchers at the Institute of Laser Physics, Siberian Branch (SB), RAN; LPI; and VNIIFTRI have focused on the development and implementation of state-of-the-art ultraprecise optical frequency standards based on ultracold atoms and ions; highly excited ultracold atoms and their applications in resolving quantum information processing issues were investigated at the Rzhanov Institute of Semiconductor Physics, SB, RAN; researchers at the Institute of Automation and Electrometry, SB, RAN, experimentally demonstrated Bose–Einstein condensation; and a two-dimensional Fermi gas based on ultracold lithium atoms was produced for the first time in Nizhnii Novgorod. The necessity of sharing experiences and co-ordinating efforts between various groups led to their close collaboration. In 2007 it was decided to held annual working sessions on the physics of ultracold atoms, which in effect were one of the reporting back events for the RAN SB's integrated projects. It was understood rather soon that the reporting back working session framework was too narrow, and it was decided to invite scientists from other Russian institutes and regions to these meetings. This undertaking took hold and the working session rather rapidly became a full-scale all-Russia conference, even though some features of working sessions were retained. At present, of the order of 50 researchers from Russian regions from Voronezh to Vladivostok and Russian-speaking leading foreign scientists participate in the conference.

This issue of Quantum Electronics presents reports selected by the Conference Organizing Committee and the corresponding parts of reports presented at the Physics of Ultracold Atoms 2016 (PUCA 2016, 19–21 December 2016) Conference. On the whole, the conference programme comprised 35 reports made by scientists from 29 different institutions (see the Conference website www.iae.nsk.su/index.php/ru/quantum16-programma). The reports were divided into several special sessions: quantum metrology, quantum gases, waves of matter, spectroscopy, quantum computation and laser cooling. The papers in this issue are presented in roughly the same order as that of the sessions.

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