

PHYSICS AND APPLICATIONS OF ULTRACOLD ATOMS https://doi.org/10.1070/QEL17377

Physics of ultracold atoms in Russia: topical research

I.I. Ryabtsev, N.N. Kolachevsky, A.V. Taichenachev

Over the last year, the world has seen significant progress in studies of ultracold atoms and their applications. Researchers have produced optical frequency standards based on forbidden transitions of atoms and ions with record high metrological parameters (better than 10^{-18} in terms of relative stability and uncertainty), made impressive advances in the spectroscopy of cold antihydrogen atoms, demonstrated laser spectroscopy of ultracold multiply charged ions, significantly improved the performance of quantum sensors (gyroscopes, accelerometers and gravimeters) based on matter waves of ultracold atoms and implemented quantum registers based on atoms and ions with a number of qubits approaching 100 and more.

Intense research along all these topical lines has been conducted in Russia as well: over the last year, our scientists have obtained new, world-level results. Prototypes of state-of-the-art ultraprecise optical frequency standards based on ultracold atoms and ions, including a transportable standard based on ytterbium ions, which can be used for improving the accuracy of the GLONASS navigation system, have been designed and implemented at the Institute of Laser Physics, Siberian Branch (SB), Russian Academy of Sciences (RAS); P.N. Lebedev Physical Institute (LPI), RAS; and the All-Russia Research Institute of Physical and Radio Engineering Measurements (VNIIFTRI). A Bose condensate of thulium atoms has been obtained for the first time at the Russian Quantum Center (RQC). Researchers at RQC and LPI are developing quantum registers based on ytterbium ions, and those at the A.V. Rzhanov Institute of Semiconductor Physics, SB, RAS, and Moscow State University are designing quantum registers based on rubidium atoms in arrays of optical dipole traps. Research effort at the Institute of Applied Physics, RAS (Nizhny Novgorod), has been concentrated on the trapping of ultracold ^{6}Li atoms in a hollow optical dipole trap, which makes it possible to prepare a quantum Fermi gas with a significant fraction of atoms retained. Researchers at the Joint Institute for High Temperatures, RAS, have begun work on the preparation of an ultracold plasma of calcium atoms excited to Rydberg states.

As a continuation of the previous special issues of Quantum Electronics [1–3], this issue presents reports selected by the Conference Organising Committee and the editorial board of the journal and the corresponding parts of reports presented at the Physics of Ultracold Atoms 2019 (PUCA 2019) Conference, which was held on 16–18 December 2019 in Akademgorodok, Novosibirsk. On the whole, the conference programme comprised 33 oral presentations and 6 posters by scientists from 22 Russian institutions (see the Conference website https://www.isp.nsc.ru/quantum19/). The reports were divided into several special sessions: optical frequency standards, laser cooling, quantum Fermi and Bose gases, quantum computation, waves of matter and nonlinear laser spectroscopy. All these directions are represented in this special issue.

References

1. Kolachevsky N.N., Taichenachev A.V. *Quantum Electron.*, **47** (5), 393 (2017) [*Kvantovaya Elektron.*, **47** (5), 393 (2017)].
2. Kolachevsky N.N., Taichenachev A.V. *Quantum Electron.*, **48** (5), 401 (2018) [*Kvantovaya Elektron.*, **48** (5), 401 (2018)].
3. Ryabtsev I.I., Kolachevsky N.N., Taichenachev A.V. *Quantum Electron.*, **49** (5), 409 (2019) [*Kvantovaya Elektron.*, **49** (5), 409 (2019)].

I.I. Ryabtsev Rzhanov Institute of Semiconductor Physics, Siberian Branch, Russian Academy of Sciences, prosp. Akad. Lavrent'eva 13, 630090 Novosibirsk, Russia; Novosibirsk State University, ul. Pirogova 1, 630090 Novosibirsk, Russia;
N.N. Kolachevsky Lebedev Physical Institute, Russian Academy of Sciences, Leninsky prosp. 53, 119991 Moscow, Russia; Moscow Institute of Physics and Technology (State University), Institutskii per. 9, 141701 Dolgoprudnyi, Moscow region, Russia;
A.V. Taichenachev Institute of Laser Physics, Siberian Branch, Russian Academy of Sciences, prosp. Akad. Lavrent'eva 15B, 630090 Novosibirsk, Russia; Novosibirsk State University, ul. Pirogova 1, 630090 Novosibirsk, Russia

Received 6 May 2020
Kvantovaya Elektronika **50** (6) 519 (2020)
Translated by O.M. Tsarev