

CONFERENCES AND SYMPOSIA

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Scientific session of the Division of General Physics and Astronomy of the Russian Academy of Sciences (25 April 2001)

A scientific session of the Division of General Physics and Astronomy of the Russian Academy of Sciences (RAS) was held on 25 April 2001 at the P L Kapitza Institute for Physical Problems, RAS. The following reports were presented.

(1) **Aleksandrov E B** (S I Vavilov State Optical Institute, A F Ioffe Physico-Technical Institute, St. Petersburg) "Contemporary state of the techniques for measurements of the moduli of weak magnetic fields, from zero to ten oersted";

(2) **Sokolov I V** (St. Petersburg State University, V A Fok Institute of Physics, St. Petersburg), **Gatti A** (INFM, Dipartimento di Scienze CC FF MM, Università dell' Insubria, Como, Italy), **Kolobov M I** (Laboratoire PhLAM Université de Lille, Villeneuve d'Ascq, France), **Lugiato L A** (INFM, Dipartimento di Scienze CC FF MM, Università dell' Insubria, Como, Italy) "Quantum teleportation and holography";

(3) **Vartanyan T A** (S I Vavilov State Optical Institute, St. Petersburg) "Action of optical radiation on the boundary of a rarefied resonant medium. New possibilities and problems".

The reports presented are given below in brief.

PACS numbers: **06.20.–f**, 07.55.Ge
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Contemporary state of the techniques for measurements of the moduli of weak magnetic fields, from zero to ten oersted

E B Aleksandrov

Measurements of weak magnetic fields have many scientific and practical applications. Precision measurements of very weak fields (on the order of 1 μT) are of decisive importance in arranging certain fundamental experiments looking for violations of symmetry. For example, search for a constant neutron dipole moment currently calls for long-term (for 1000 s or so) stabilization of a weak magnetic field to an accuracy of no worse than 10 fT. The most relevant is the geomagnetic field range (20 – 80 μT), which is the domain of various geophysical studies, as well as diverse magnetic reconnaissance activities: ore exploration, archaeological research, military intelligence tasks, such as the detection of submarines and buried ammunition, search for sunken ships, installation of security perimeters, etc.

Today the best characteristics in the measurements of weak magnetic fields are achieved using so-called quantum magnetometers with the optical pumping of paramagnetic atoms or nuclei. Out of the many existing types we select those devices that possess a high sensitivity and absolute accuracy, as well as a quick response. These three characteristics are, to a certain extent, incompatible, and are best implemented in devices of different types. Special attention is paid to the recently developed M_x-potassium magnetometer with a narrow resonance line. This instrument is capable of covering the entire geomagnetic range, ensuring an exceptionally high sensitivity (on the order of 10 fT $Hz^{-1/2}$ in the band from 0.001 Hz and higher), with a reproducibility of readings as good as to 10 pT. Importantly, this device is of a quick-response type, allowing at least 10 readings per second. The absolute accuracy of measurements is formally determined by the accuracy of measurement of the gyromagnetic ratio and is of the order of 100 pT. An even better reproducibility of measurements is achieved in so-called tandems, which are combinations of a fast M_x magnetometer and a slow M_z magnetometer. The reproducibility of readings of a tandem is expected to be as good as 1 pT, and is apparently limited by the magnetic susceptibility of the structural materials. Today's methods of measurement of magnetic fields give a relative accuracy of 10^{-9} to 10^{-10}, which wins it the second place in metrology after frequency measurements.

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Quantum teleportation and holography

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Quantum teleportation allows the transfer of the quantum state of some system (for example, an electromagnetic field) from one point to another using the exchange of classical information in combination with a quantum channel that employs the quantum entangled states of auxiliary fields. One of the first phenomena of quantum information realized with optical methods was the quantum teleportation of spatially single-mode light beams. We demonstrate that the extension of the teleportation scheme to spatially multimode light beams makes it possible to teleport the quantum state of fields distributed in space and time — for example, fields carrying optical images. Such a form of teleportation (quantum holographic teleportation) may be regarded as the

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