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EDITORIAL

Spin Physics, Spin Chemistry and Spin Technology

Pavel G. Baranov[1] · Vladimir Dyakonov[2]

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As Guest editors of a special issue of Applied Magnetic Resonance, we were highly inspired by the possibility to emphasize the role of magnetic resonance techniques for the investigation in the field of spin physics, spin chemistry, and spin technology.

The goal of this special issue is to provide a snapshot to the current state of the art of the field of spin physics, spin chemistry, and spin technology. Modern technology development demands low power consumption, high sensitivity, and operating speed on one side and miniaturization on the other side. However, they are not easy to achieve at the same time. Future technology development scenarios are based on physics at the molecular or even atom scale, utilizing electron charge and spin. Semiconductor industry faces the challenge of developing a transistor, in which the number of electrons sufficient to switch and to amplify should fall to just one. Any nanoscale device inevitably displays quantum behavior, and the main task is to exploit quantum mechanics based ideas, to seek a radical technology with fully novel quantum components operating alongside existing one. The next quantum revolution is expected to transform the twenty-first century technologies.

Spin is a purely quantum object and spin properties begin to play a decisive role in the creation of nanoscale device structures and in nanotechnologies aimed at sensing of biological systems. Magnetic resonance is the most direct method for

✉ Pavel G. Baranov
pavel.baranov@mail.ioffe.ru;
http://www.ioffe.ru/labmsc/en/main.html

Vladimir Dyakonov
dyakonov@physik.uni-wuerzburg.de;
http://www.physik.uni-wuerzburg.de/EP6

[1] Ioffe Physical-Technical Institute, Polytekhnicheskaya 26, 194021 St. Petersburg, Russia

[2] Julius-Maximilians University of Würzburg, Bavarian Center for Applied Energy Research e.V. (ZAE Bayern) Am Hubland, 97074 Würzburg, Germany

studying spin processes. High sensitivity, extreme resolution, and spatial selectivity of optically and electrically detected magnetic resonance make this technique very suitable for a study of a very small number of spins down to single spin.

The ultimate object of the miniaturization of the device is based on a single spin. This fantastic scenario begins to be implemented at the present time after the discovery of the unique optical and magnetic properties of spin centers in diamond and silicon carbide. As a result, it creates a source of single photons for the first time have a real opportunity to make quantum manipulation of a single electron and nuclear spins in ambient conditions, to conduct nanoscale magnetic and temperature sensing with individual electron spin. Considering the rapid rise and successes of diamond- and silicon carbide-based spin research over the past few years, the prospect of room-temperature quantum information processors does not sound like science fiction anymore.

Electrons carry both charge (which is used in the conventional electronics) and spin. Spintronics is an advanced form of electronics that exploits the two properties simultaneously to achieve innovative capabilities.

A topical problem is also monomolecular magnets, which could be used as magnetic molecular sensors or applied for the storage or processing of information or used as qubits in quantum computers. The development of methods of controlling the state of spins of systems by external fields, the so-called methods of spin alchemistry, is of great importance as well.

As we know, scientists themselves are the driving force behind the science. We are happy that this special issue on the development of spin physics, spin chemistry, and spin technology, in general, and on the potential of magnetic resonance spectroscopy in particular, will be published in the year when our highly regarded colleague Professor Kev M. Salikhov will celebrate his 80th birthday. It is a great privilege for us to dedicate this issue to Professor Salikhov marking his outstanding contributions to magnetic resonance spectroscopy. Almost all theoretical predictions made by Prof. Kev Salikhov were confirmed in experiments in many laboratories. The characteristic feature of his creative activity is the close interaction with experimenters. Results he obtained are widely used being an important contribution to electron paramagnetic resonance spectroscopy, chemical physics, and physics of magnetic phenomena. Books in the field of electron paramagnetic resonance, theory of spin exchange during the collision of paramagnetic particles, and theory of magnetic and spin effects in elementary photo-chemical and photo-physical processes he wrote in collaboration with other scientists became textbooks for many specialists all over the world. It is remarkable that he continues to generate new ideas and develop theoretical fundamentals of spin technologies.

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