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EDITORIAL

Magnetic Resonance in Molecular Biology, Biophysics and Biochemistry

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Prof. Gertz Likhtenshtein

Since the first observation of nuclear magnetic resonance in a molecular beam of lithium chloride by Rabi and coworkers back in 1938, magnetic resonance evolved from a peculiar physical experiment into an indispensable spectroscopic tool of physics, chemistry, molecular biology, and medicine as well as several other fields. Today, both electron paramagnetic resonance (EPR) and nuclear magnetic resonance (NMR) continue to advance in both new methods and the applications with many of

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these new developments addressing the most demanding biophysical and biochemical problems. The progress in these fields has been well-documented in a number of books published starting from the late fifties [1–6] and also a book series Biological Magnetic Resonance now published by Springer and having 34 volumes to this date. Other notable reviews and original articles are exemplified by refs. [1–3, 6–12].

Unfortunately, many of the magnetic resonance pioneers who contributed greatly to developing EPR and NMR in applications in chemistry, biology, medical and material sciences from the early sixties already passed away but a few are continuing to advance magnetic resonance methods. One of such distinguished researchers is Prof. Dr. Gertz I. Likhtenshtein, who is currently 88 years old. We are honored to dedicate this special issue of Applied Magnetic Resonance to the landmark contributions of Prof. Likhtenshtein to the field.

Prof. Dr. Gertz I. Likhtenshtein received his Ph.D. (1963) and D.Sc. (Doctor of Science) degree in Chemistry (1972) from the Semenov Institute of Chemical Physics of the Russian Academy of Science in Moscow where he was later appointed as the Head of Laboratory of Chemical Physics of Enzyme Catalysis. In 1992, he moved to the Ben-Gurion University of the Negev, Israel, as a full Professor in the Department of Chemistry and the Head of the Laboratory of Chemical Biophysics. He continues productive work at the Ben-Gurion University of the Negev as Professor Emeritus since 2003. In 2015, Prof. Likhtenshtein was appointed as an Adviser to the Director of the Institute of Problem of Chemical Physics of the Russian Academy of Science in Chernogolovka, Moscow region.

Prof. Likhtenshtein's record as a scientist is truly amazing! Prof. Likhtenshtein's main scientific interests were initially focuses on structural properties and dynamics of proteins, nucleic acids, membranes, and their models as well as spin relaxation in such complex supramolecular systems. Later in his career, he was primarily involved in investigations of mechanisms of light energy conversion and developing novel immunoassays based on nitroxides and also antioxidant analysis. In recognition of his outstanding scientific contributions, Prof. Likhtenshtein received many national and international awards including the highly prestigious USSR State Prize for pioneering spin labeling research in molecular biology (1977). Over his long and exceptionally productive career, Prof. Likhtenshtein published twelve books and coauthored over 490 peer-reviewed papers. Here we would like to emphasize that several of his books [13–16] became the desk copies for students and more established scientists from all over the world. Up to this date these books serve as indispensable references for everyone applying EPR and spin labels/probes techniques in their research. We wish Gertz Likhtenstein a good health for years to come so he would continue his record of scientific innovation.

The Special issue starts with a review "High-field/High-frequency EPR Spectroscopy in Protein Research: Principles and Examples" by Klaus Möbius and Anton Savitsky. The authors describe uniques capabilities of high-field EPR methodology, in conjunction with site-specific isotope and spin-labelling strategies, to provide new insights into fundamental biological processes. Specifically, the authors reviewed theoretical and instrumental backgrounds of continuous-wave and pulse high-field EPR and the multiple-resonance extensions including EDNMR, ENDOR, TRIPLE, ESEEM, PELDOR and RIDME.

In another review entitled “Research into Dinitrosyl Iron Complexes in Living Organisms Through EPR as an Example of Applying this Method in Biology: A Review”, the author Anatoly F. Vanin discusses a successful application of the EPR method to study dinitrosyl iron complexes (DNICs) with thiol-containing ligands. These complexes are currently considered as a “working form” of nitrogen monoxide (NO). By combining the EPR method with other experimental techniques, a catalytic mechanism of these complexes was put forward. It has been shown that DNICs with thiol-containing ligands can serve as donors of both nitrogen monoxide and nitrosonium cations (NO^+) in living organisms.

Yusuke Sato and coauthors contributed a research paper entitled “The Optimal Echo Time Setting on Heavily T_2-Weighted Fluid Attenuated Inversion Recovery Images for Detecting Very Low Concentrations of Gadolinium-based Contrast Agent in the Brain: A Phantom Study”. The authors employed phantoms made of a diluted gadobutrol (Gd-BTDO3A) and purified water (4–128 μM) to simulate cerebrospinal fluid (CSF), gray matter, and white matter.

Another original research paper “A Study on the Effect of Contrast Concentration on Fatty Liver Quantitative Analysis of 9.4 T STEM and PRESS MRS: A Virtual Fatty Liver Phantom Study” by Seung-Man Yu, described a virtual fatty liver phantom with 10% fat deposited, under an assumption that the contrast medium was absorbed at two concentrations in the liver. Such a phantom was then employed to investigate effects of the contrast medium on T_2* of each lipid proton by PRESS (Point Resolved Spectroscopy) and STEAM (Stimulated Echo Acquisition Mode) pulse sequence. The STEAM pulse sequence has an advantage of being able to accurately quantify each lipid proton because the j–j coupling effect between the lipid protons is small.

The main objective of the paper “Differences of Lipid Proton Compositions and Fatty Acids between Alcoholic Fatty Liver and High-fat Diet Fatty Liver Animal Models: 9.4 T Magnetic Resonance Spectroscopy Study” by Yeong-Hyeon Cho and Seung-Man Yu was to determine differences in chemical compositions according to fat deposition in the liver using the alcoholic (NIAAA model) and high-fat diet induced fatty liver animal models. The authors found some differences in the total lipid and polyunsaturated bonds between NIAAA experimental and control groups. Specifically, methylene protons were deposited at lower concentrations whereas diallylic protons were found at higher concentrations in the NIAAA experimental group than in the control group.

Tatiana S. Yankova and Natalia A. Chumakova reported on “pH of Water Intercalated into Graphite Oxide as Determined by EPR Spectroscopy”. The authors explored two pH-sensitive spin probes 4-(methylamino)-2-ethyl-5,5-dimethyl-4-pyridine-2-yl-2,5-dihydro-1H-imidazol-1-oxyl (DPI, also known as MEP) and 2,2,3,5,5-pentamethyl-2,5-dihydro-1H-imidazol-1-oxyl (MTI) to measure pH of water intercalated in Brodie graphite oxide. pH value was found to be 2.25 ± 0.05 immediately after adding of water to graphite oxide and decreased to 1.75 ± 0.05 after ca. 30 h.

In conclusion, the Editors of this Special Issue of Applied Magnetic Resonance would like to thank all the contributors of both original research and review articles, as well as the reviewers, for their efforts. The Editors believe that this Special Issue would be of interest to a broader magnetic resonance community and the growing field of bio-EPR. It would be also informative for magnetic resonance practitioners who are interested in merging EPR with other spectroscopic methods such as NMR and imaging techniques.

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