Journal of Magnetic Resonance 306 (2019) 1–2

Contents lists available at ScienceDirect

Journal of Magnetic Resonance

journal homepage: www.elsevier.com/locate/jmr

Editorial

The Journal of Magnetic Resonance Golden Jubilee: Looking forward to our next 50 years

The *Journal of Magnetic Resonance* (*JMR*) was launched in 1969, thanks to the efforts of a group of visionaries that realized the need for a new journal. This need was initially driven by the growing presence of NMR in organic chemistry laboratories, and it was in response to such demands that Academic Press approached Wallace S. Brey for launching *JMR*. Reeling from the now famous incident where Anderson and Ernst's 1965 paper demonstrating the advantages of FT-based NMR had been rejected, twice, by the *Journal of Chemical Physics*, Brey understood that the magnetic resonance community needed a much wider forum than organic NMR. The field required a venue whereby experts in *all* the branches of Science that involve magnetic resonance, could exchange their findings and their progress without being accused of "too technical", "too specialized" or "scientifically shallow". The pioneers that helped to launch JMR understood the unique synergies that would arise if intellectual barriers that are often created by short-term conveniences are brought down; if related disciplines are bridged for creating a sum that is bigger than its parts. This clairvoyant appreciation was reflected in the first issues of the journal, which encompassed NMR, EPR and NQR; solids and liquids; biochemistry, chemistry, physics and materials; calculations and hardware; diamagnetic and paramagnetic molecules. These beliefs –as well as their natural corollary, whereby all good magnetic resonance science will be welcomed regardless of its focus and/or its "impact factor"– has remained the editorial creed of the Journal over its 50 years of service to the magnetic resonance community, and to Science at large.

During the course of these 50 years, JMR has published over 13,250 papers. It has seen the deepest concepts explained, and served as crucible where original ideas, novel concepts, and sometimes altogether new fields, were forged. Celebrations on these ground-breaking scientific contributions have appeared twice in the past. The first time occurred on occasion of JMR's 25th Anniversary, when W.S. Brey compiled ≈700 pages worth of JMR articles in the volume **Magnetic Resonance in Perspective: Highlights of a Quarter Century** (Academic Press, New York 1996). Fifteen years later, as JMR was approaching 40, I opted out of another comprehensive publication, and compiled instead a Special Issue that would not just highlight some of JMR's classical papers but, more importantly perhaps, would glimpse into the people and contexts that gave origin to these inspirational discoveries. The result is an issue that, if you haven't visited it yet, I can assure you will enjoy; a story with both written (https://www.sciencedirect.com/journal/journal-of-magnetic-resonance/vol/213/issue/2) and videotaped (https://www.youtube.com/playlist?list=PL1D790E241B661706) accounts containing, among other jewels, R.R. Ernst's original notebooks, the origins of the DANTE pulse, Sir Mansfield enjoying while reminiscing on the early days of MRI, the winding road that lead to the first cryoprobe, and many more magical "Magnetic Moments" that we are delighted to reproduce again with this 50th Anniversary issue.

Since compilations have been made and historical videos released, the question naturally arises on how will JMR celebrate its Golden Jubilee: What could be done, that has not been done before? The result is the present Special Issue, which I believe represents yet another treasure that you will hopefully enjoy. The Issue is composed of three interconnected sections, starting with short historical accounts relating to the three vendors that have traditionally been associated with the history of NMR and EPR: Bruker, Jeol and Varian. We thought that this was fair and natural, as progress in our field has always been intimately interconnected with hardware developments –and vice versa. Following these often-moving pieces by Drs. Keller, Keiji and Morris, are outlooks from our Associate Editors concerning developments in protein NMR, solids bioNMR, *in vivo* imaging and spectroscopy, EPR, and low-field MR studies. With characteristic insight and knowledge, Profs. L. Kay, C. Jaroniec, P. Van Zijl, G. Jeschke and B. Bluemich, use these sections to share with us their perspectives about the status of contemporary magnetic resonance.

After reading these expert summaries one might naively think that magnetic resonance is a thoroughly mature technique, whose main harvest has already been collected. But wait! As third *pièce de résistance* in this celebration, we approached 26 topmost experts in all fields of magnetic resonance, and asked them for a feat of bravery: to look into the crystal ball, and tell us what they see in the future of magnetic resonance. This request came with the specific directive to be opinionated, visionary, bold; to throw conventions aside and not worry about credits: just to tell us what it is that these experts see lying beyond the horizon, from the special vintage of their own scientific summits. The response was overwhelmingly positive, and the outcome can simply by described as inspirational: I am convinced that as you go through each of these twenty-five essays you will find –as you would expect considering their authors– that each one is a masterpiece in its own. At the fundamentals basis of MR's future, M. Levitt and D. Budker reflect on how new states and new sensors will change in the way we use physics for doing NMR and EPR, while I. Kuprov explains how complex experiments and models will be numeri-

https://doi.org/10.1016/j.jmr.2019.07.041

cally analyzed by "defeating the matrix". A miniaturization of the NMR and EPR worlds is also on the making, as witnessed by the accounts of J. Korvink and J. Anders. Size, however, will not necessarily come at the expense of field strength, thanks to the advent of new superconducting magnets of the kind described by H. Maedasan. A perspective by Z. Gan tells us why these high fields will play an increasingly important role in opening the NMR Periodic Table; with the advent of ever more agile microwave pulses and shapes, T. Prisner also shows how these fields will open new kinds of radical centers to EPR investigations. Ultrahigh fields and convergent progress from other areas also forecast a revolution in the NMR-based characterization of disordered materials, as deftly described by B. Chmelka. At the same time a growing number of applications will continue to develop at the low end of the B_o scale, as explained and illustrated by Y.Q. Song's and D. Goldfarb's NMR and EPR essays. Whether at high or low fields, sensitivity will be a much less pressing problem than it has been in the past, as methods of nuclear hyperpolarization of the kind described by R.G. Griffin, J.H. Ardenkjaer-Larsen et al., become widespread for both solids and *in vivo* NMR. The simplification of *in vivo* MR hardware will end up playing important societal roles, as predicted by A. Webb et al. in their account of what is needed for bringing MRI "to the rest of us". This MRI-of-the-future vision is backed and furthered by L. Wald, in a view that calls for artificial intelligence elements to make up for the physical and biological shortcomings of both scanner and scannee. Machine learning will also transform the way in which conventional NMR will be done and used, as discussed in J. Hoch's thought-provoking "Who needs scientists?" essay. This learning process will also call for ever larger repositories of metabolic data, which according to D. Wishart's and E. Vinogradov's forecasts will be forthcoming both for *in vitro* and *in vivo* settings. Reliance on other rapidly progressing spectroscopic tools will also help bioNMR's elucidations of ever larger structures, as described by H. Arthanari, A. Gronenborn, C. Luchinat et al. in their accounts of solids and solution state measurements on diamagnetic and paramagnetic biological systems. BioNMR solution and solid state themselves are also seen converging, thanks to the >200 kHz ^{1}H MAS experiments envisioned by A. Samoson. With all these developments, a unique niche for unprecedented growth is also foreseen for NMR-based studies of biophysical dynamics, as new methods and analyses of the kind described in essays by A. Bax, M. Clore and P. Schanda, emerge to tackle ever more complex molecular machines. Furthermore, these developments will not be restricted to *in vitro* investigations but will leverage NMR's unique ability to monitor structure, dynamics, metabolism and morphology under functioning *in cellulo* and *in vivo* conditions, as described by P. Selenko, G. Siegal and D. Topgaard in their insightful accounts.

Preparing this Special Issue, I could not but compare the situation of magnetic resonance when JMR was established, against the one in which the field stands today. The field was naturally much less developed then, and hence ready for giving up boundless treasures that have since been revealed. In this regard it sometimes seems that advances in magnetic resonance may have plateaued, and that the treasures of the future lie elsewhere today; perhaps in mass-spec-based metabonomics, in cryoEM, in ultrasound. Yet the truth is that news of MR's demise has been greatly exaggerated before –including in the late 1960s. At that time it appeared that with fundamental concepts such as the fine structure of the NMR spectrum, the sources of line broadening and relaxation, and pulsed spin echo phenomena discovered and explained, all that was left were Sisyphean tasks associated to spectral recordings and interpretations. More than one scientist said then that "NMR is dead", and switched fields for apparently greener pastures. Yet now we know that in those days, the "real" MR party had not yet even begun. The advent of superconducting magnets, the access that these fields plus computerized FT gave to non-proton nuclides in liquids and solids, the invention and growth of multidimensional NMR and EPR, the ability to image non-invasively metabolism and morphology on living tissues, the study and use of paramagnetic agents *in vitro* and *in vivo*, real-time measurements of relaxation time changes for reading out the thoughts going on in our brains –these and other amazing discoveries, where then slightly beyond the horizon. To some they were invisible; but to those that stayed and saw them coming, they were the seeds of scientific revolutions. Likewise I believe that, as you browse through this issue's "Crystal Ball" and Associate Editor essays, you will end up agreeing that in many instances the best is yet to come. It is still not clear whether this will involve compact HTS-based magnets operating at $\geq$30 T, optically-detected experiments elucidating the MR of single molecules, studies on solutions that routinely possess 10s% polarization, bench-top MR spectrometers, hand-held cryogen-free MR scanners, biological and man-made materials spun at 100s kHz, machine learning algorithms that rapidly recreate structures and images from optimized acquisitions while coping with technical shortcomings, or other convergent developments that we still do not see. What appears certain is that sweet rewards await the students and practitioners that remain and invest in magnetic resonance. I am eagerly looking forward to be a witness of at least part of that future; and I am hopeful that JMR will be there to help serve the needs of these future generations of experts, with the same faithfulness as it has done so in the past.

Enjoy the read!

Lucio Frydman
Editor in Chief, The Journal of Magnetic Resonance
Rehovot, Israel

Received 25 June 2019
Accepted 10 July 2019

Available online 12 July 2019