epr newsletter

2022
volume 32 number 2

The Publication of the International
EPR (ESR) Society

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The official publication of the International EPR (ESR) Society is supported by the Society, by corporate and other donors, and the Zavoisky Physical-Technical Institute of the Russian Academy of Sciences, Kazan, Russian Federation.

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The *EPR newsletter* is published quarterly by the International EPR (ESR) Society and is available in electronic and printed form to all members of the Society. The deadlines for submission of news for upcoming issues: Spring March, 15; Summer June, 15; Fall September, 15; Winter December, 15.

ISSN 1094-5571

TECHNION | PRINTING UNIT

The cover picture illustrates aspects of the research carried out by Graham Smith, recipient of the Bruker Prize 2022. It shows the HIPER system – a high power, wideband, AWG-controlled, W-band (94 GHz) spectrometer.

epr newsletter

The Publication of the International EPR (ESR) Society

volume 32 number 2 2022

Editorial

Dear colleagues,

We succeeded in minimizing the time interval between publication of *EPR newsletter* issues 32/1 and 32/2 in order to facilitate reading the article on the “History of EPR in Poland” by Czesław Rudowicz and Piotr Pietrzyk (Part 1 was published in 32/1, pp. 8, 9, 12, 13; Part 2 is published in this issue, pp. 7, 8, 11, 12). In combination with the article on the 10th anniversary of the Polish EMR Group by the same authors (31/2, pp. 6–8), the current article presents a comprehensive story about the genesis of the EPR research and achievements of EPR researchers in Poland from the very beginning until today. It is our pleasure to thank Czeslaw for his long-term collaboration with our publication, particularly as the Founder President (since 1997) and Immediate Past President (2004–2008) of the Asia-Pacific EPR/ESR Society and more recently as the Chairman of the Polish EMR Group (since May 2010), and also thank Piotr who started his collaboration with the *EPR newsletter* only recently as the Chairman-Elect of the Polish EMR Group in 2018.

The Awards column demonstrates a good balance between older and younger researchers, and shows our geographic and gender diversity. In fact, the thoughtful decisions of the IES Awards Selection Committees are of a great help in this respect. The same considerations are reflected in the policy of the *EPR newsletter* concerning the researchers we feature in our publication.

In this issue, the Awards column is a meeting point for researchers who have already contributed to the *EPR newsletter* and it was a special pleasure for me to interact with them.

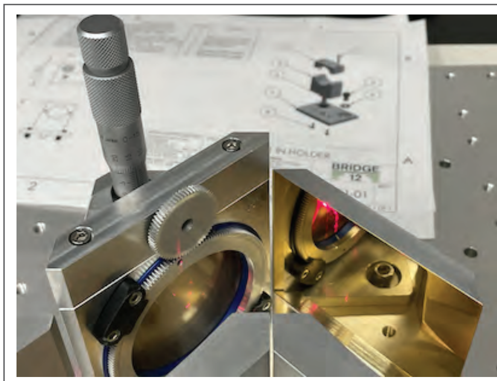
The success story of Bernard Gallez, IES Silver Medal for Biology/Medicine 2022, presents the milestones of his research career (pp. 3, 4). At its beginning, he and his friend Karsten Mäder were distinguished with the IES Young Investigator Award (2000) for their contribution to the development of EPR applications in the field of Pharmacy and Pharmacology, and they were featured in the “IES Young Investigator Award Revisited” column (22/2, pp. 4–7).

The ESR Spectroscopy Group of the Royal Society of Chemistry announced that the 2022 Bruker Prize will be awarded to Graham Smith. We are grateful to Graham for giving us the interview prior to the delivery of his award lecture. Graham’s article on the occasion of his IES Silver Medal 2011 for Instrumentation (21/3, pp. 8, 9) gives a good insight into the genesis of his research.

A success story of Daphné Lubert-Perquel on the occasion of her Inaugural IES Best Paper Award 2019 and her write-up by Chris Kay (29/3, p. 4) could serve as a nice preamble to her interview on the occasion of her Bruker Thesis Prize 2021 (p. 6).

We will keep in our grateful memory Massimo Martinelli’s sunny smile (pp. 13, 14) and the smiling face of Richard Quine (pp. 15, 16). We join Giuseppe Annino and the Eatons in grieving on their loss and send heartfelt condolences to families, collaborators and friends of Massimo and Richard.

Laila Mosina



IES Silver Medal for Biology/Medicine 2022

Playing with Oxygen (and others)

Bernard Gallez

I am very honored to receive this prestigious international award. I am grateful for the nomination and for the selection made by the award committee of the International EPR (ESR) Society. At the request of the EPR Newsletter, I am presenting what I consider as the most important milestones of my research career. I am Pharmacist, Radiopharmacist and Industry Pharmacist from the University of Louvain (UCLouvain) in Belgium. I realize that my background is not common in the EPR community as the interest for EPR in drug research is shared by only a few people worldwide (including my friend Karsten Mäder in Germany).

My first contact with EPR spectroscopy started during my PhD thesis (1988–1993) under the supervision of Prof. Pierre Dumont (Laboratory of Medicinal Chemistry, UCLouvain). I was synthesizing new nitroxides with the objective to target them to receptors/transporters expressed by hepatocytes. The aim was to use these nitroxides as liver selective MRI contrast agents thanks to their paramagnetic properties. Because the NMR relaxivity (reflecting how the relaxation rates change as a function of contrast agent concentration) depends on their molecular dynamics, I started my training in EPR with the help of Prof. René Debuyst and Dr Fernand Dejehet as mentors. I was rapidly convinced by the complementarity offered by NMR/MRI and EPR to solve biological problems. The publications linked to my PhD thesis actually included a mix of organic synthesis, pharmacological characterization of the interactions between nitroxides and their target, metabolism of nitroxides, molecular dynamics characterization by EPR and MRI evaluation.

After my PhD thesis defense in 1993, I joined the group of Prof. Harold M. Swartz in Dartmouth (Hanover, New Hampshire) to get trained in "*In vivo* EPR". I joined his group at a time of the early development of EPR oximetry with particulate sensors (i.e. lithium phthalocyanine and India ink). My main interest during my post-doc was to evaluate *in vivo* the ability of different nitroxides to report on tissue oxygenation, redox status, tissue perfusion and cell viability using both EPR and MRI. During my stay in Dartmouth, I also demonstrated with Goran Bacic that manganese-based MRI contrast agents were unstable in biological media. The evidence for this instability was proven by combining EPR, ^{31}P-NMR spectroscopy and NMR relaxometry. This research was pursued later in Belgium with the demonstration that the manganese released by the contrast agents actually accumulated in the brain of subjects having received these compounds. In Dartmouth, I had also the opportunity to collaborate with Karsten Mäder to evaluate by EPR drug-induced changes in pH in the stomach (using pH-sensitive nitroxides) and pH in drug delivery systems. I also collaborated with Fuminori Goda and Julia O'Hara on the changes in tumor oxygenation (measured by EPR) and perfusion (measured by MRI) after irradiation.

Back in Belgium in late 1994 as researcher of the Belgian National Fund for Scientific Research (FNRS), I started to develop and characterize new oxygen sensors to optimize their properties for EPR oximetry. Very large screening of charcoals and carbon black materials collected in different countries allowed us to identify materials with optimal features, namely high spin density and high oxygen sensitivity. We are still using these materials in our laboratory thirty years after their identification. At that period, I also started a new research area to render biocompatible EPR oxygen sensors with the hope to use these materials in the clinic. Strategies were based on the development of biocompatible inks (suspensions made with paramagnetic charcoals or carbon blacks dispersed in biocompatible polymers) and inclusion of paramagnetic sensors in biocompatible oxygen-permeable films. At that time, I did not have access to a low frequency EPR spectrometer in Brussels. Therefore, all developments and *in vitro* characterization were done in Belgium during the academic year and I travelled (with my fiancée Muriel who becomes later my wife) to Dartmouth in the summer for *in vivo* evaluation of the performances of the sensors. This research activity has been continuously developed over the years in collaboration with Hal Swartz with the support of NIH PPG/PO1 grants. I am quite happy of the achievements as these biocompatible inks developed in my laboratory have been used later in the pioneer clinical trials of EPR oximetry that were carried out in Dartmouth and Emory.

In 1996, I started my academic career in UCLouvain climbing the steps, first as assistant professor, then professor and finally full professor since 2010. It was also in 1996 that we succeeded in getting the funds to purchase a L-Band spectrometer for *in vivo* EPR studies. Our academic authorities were also convinced by my project to combine technologies and expertise in EPR and experimental MRI on a same site, and the "Laboratory of Biomedical Magnetic Resonance" was created in UCLouvain. This opportunity offered the capability to develop my main research orientation, namely using cutting-edge magnetic resonance technologies (EPR and MRI) for the guidance of pharmacological interventions. Since that time, I have directed or co-directed 27 PhD theses either on development of new EPR and/or MRI approaches to characterize the tumor microenvironment (oxygenation, perfusion, angiogenesis, oxygen consumption, metabolism) and/or the application the innovative tools developed to define novel therapeutic approaches to fight cancer. To analyze these parameters intrinsically related in tumors, combining magnetic resonance technologies was for me an evidence. EPR oximetry is unique to provide noninvasive longitudinal measurements of oxygen from the same site over long periods of time. EPR is also the method of choice to identify subtle changes in oxygen consumption. Dynamic Contrast Enhanced MRI was unique to characterize perfusion and permeability of tumor vasculature. BOLD-MRI was the cornerstone to develop the first noninvasive imaging method to characterize tumor acute hypoxia (also called cycling hypoxia). Initially focused on tumor hypoxia, our research evolved on the characterization of tumor metabolism with a development of expertise in fluxomics using ^{13}C-NMR spectroscopy. Of note, my first PhD student was Bénédicte Jordan. During her thesis, she characterized nitric oxide dependent treatments to modulate tumor hemodynamics and metabolism. She became later co-director of the laboratory where she developed expertise in hyperpolarization that reinforced our armamentarium to characterize dynamic changes in tumor metabolism. From all our achievements on tumor oxygenation, I believe that our main contribution has been the identification of several innovative pharmacological treatments that modulate the oxygen consumption by tumor cells, thereby alleviating tumor hypoxia and rendering tumors more sensitive to treatment by radiation therapy. The success of these approaches was possible only because *in vivo* EPR oximetry provided us the opportunity to identify the exact timing of reoxygenation and ability to predict when irradiation should be applied. These successes would not have been possible without the collaboration with other faculty members in UCLouvain, Prof. Vincent Grégoire, Prof. Olivier Feron and Prof. Pierre Sonveaux. Our interest in modulating the tumor cell respiration by inhibiting the mitochondrial electron transport chain (ETC) prompted us to investigate by EPR the production of superoxide anion radical coming from the electron leak in the ETC. We recently developed an EPR toolbox to measure simultaneously the oxygen consumption and the superoxide production by mitochondria and cells. This is now used in the laboratory to characterize the effect of anti-cancer treatments but also to study mitochondrial dysfunction induced by toxic agents on normal cells. While EPR oximetry has unique capability in providing quantitative measurements of oxygen in tissues, we need to admit this area is still a niche in clinical practice. This observation stimulated us to use *in vivo* EPR to qualify (or disqualify) other oxygen biomarkers developed in MRI or Positron Emission Tomography (PET), imaging modalities fully accessible in clinical practice. Our ability to measure tissue oxygenation longitudinally has been also exploited in other fields than oncology. This was done at the initiative of our laboratory to stimulate wound healing in diabetic models or upon request of other collaborating laboratories to study factors promoting graft take (i.e. pancreas islets grafts and ovarian grafts).

Besides our interest in tissue oxygenation, we are also using EPR to characterize melanin (a naturally-occurring free radical pigment) in melanomas. We published several papers on the use of EPR imaging to provide images of melanin distribution that was superimposable on histological images. We also succeeded for the first time in measuring noninvasively with EPR this endogenous free radical in melanoma models in small animals. We are now conducting a large scaled clinical trial (100 patients enrolled) where clinical low frequency EPR is used to characterize melanin in suspicious skin lesions. The ambition is to help in the diagnostic (benign naevus versus melanoma) and the characterization of the skin invasion (Breslow depth of lesion) to accelerate the process in cancer lesion management. Finally, among our realizations, I would like to highlight our development in EPR retrospective dosimetry in teeth and bones with a focus on gradient of dose as evidenced by EPR imaging, our combined EPR/MRI approach to monitor/quantify iron oxide particles in tissues with applications in tumor cell tracking (metastatic process) and biodistribution of new drug delivery systems (in collaboration with Prof. Véronique Préat) and our contribution to characterize free radicals in dental restorations (with Profs. G. Leloup and J. Leprince).

During my career, in addition to excellent collaborations already mentioned, I have worked with many brilliant PhD students and post-docs who all have been key players for the progress in this field: R. Ansiaux, C. Baudelet, C. Buyse, T. Cao-Pham, N. Charlier, F. Colliez, J. Conq, N. Crokart, G. Cron, P. Danhier, C. Desmet, G. De Preter, D. d'Hose, C. Diepart, B. Driesschaert, A. C. Fruytier, Q. Godechal, J. He, D. Jacobs, B. Jordan, N. Joudiou, M. Lan, J. Magat, B. Mathieu, L. Karmani, O. Karroum, P. Leveque, J. Nel, M. A. Neveu, K. Radermacher, S. Scheinok, N. Schleich, C. Schoonjans, L. B. A. Tran, M. Wehbi. They are all acknowledged for their outstanding contribution. This award is also yours!

Interview with Professor Graham Smith on the Occasion of His Bruker Prize 2022

EPR newsletter: *Dear Professor Smith, on behalf of the readers of the EPR newsletter we congratulate you on your Bruker Prize 2022. We are most appreciative that you agreed to answer the questions of this interview. Why did you start towards your career in science?*

My initial interest in science was undoubtedly inspired by my late father who was a mechanical engineer at Newcastle University. I studied Theoretical Physics at York University, before starting a Masters degree in Lasers and Optoelectronics at St Andrews University. The latter, I still regard as one of the best academic decisions I ever made. St Andrews was simply a wonderful place to live, and study, as a student, and the course was terrific. Graduates from that particular MSc, over many years, have gone on to populate much of the UK's optoelectronic industry. At the end of the course, I was very kindly invited to stay, and start a PhD with any supervisor I wished. Much to everyone's surprise, rather than join one of the major laser groups, I chose a PhD with the newly established mm-wave group headed by Dr Jim Lesurf. At the time mm-wave technology was very much a new area, but with obvious potential in radar, radiometry, comms, nuclear fusion, and metrology. I also thought there was far more scope for a young researcher to be innovative, by adapting ideas both from the microwave and optics fields. I still think that's true today. At the time, one small downside was the group really started off with no equipment and no funding. Thus we had to design and build everything ourselves – but that was also a great training, and ultimately a very scientifically rewarding experience.

Who introduced you into magnetic resonance?

The first person to introduce me to magnetic resonance was Prof Peter Riedi from St Andrews around 30 years ago. At the time I was a PDRA in the mm-wave group and Peter was a pioneer of wideband zero-field NMR.

I remember Peter introducing some key papers discussing mm-wave EPR, and then spending the next weeks researching through all the high frequency EPR instrumentation literature I could find. I remember being particularly inspired by the research groups of Klaus Möbius, Jan Schmidt, Yakov Lebedev and Jack Freed.

That interest subsequently turned into a joint research proposal that turned into a UK high field EPR facility. Key ideas formed during that time, then became part of a successful collaborative submission that funded the HiPER instrumentation program, and established the UK's first modern commercial pulse EPR/PELDOR program at St Andrews/Dundee.

What part of your research is most dear to your heart and why?

I think this has to be the HiPER spectrometer at 94 GHz. It was developed in the belief that major increases in pulsed EPR concentration sensitivity were possible at high frequencies (above X-band), which I think, would be fair to say, were not widely accepted at the time. That funding success made a huge difference to a young lecturer, and to everyone who worked on that program. It allowed us to build on existing mm-wave component and sub-system development at St Andrews, and combine it with a number of EPR system ideas that I think have stood the test of time. The current AWG based system allows broadband excitation with full amplitude and phase control over GHz instantaneous bandwidths at kW power levels. It has exceptional pulsed EPR sensitivity for a broad range of paramagnetic systems. The gains being particularly large for broad-line transition metals. Dr Richard Wylde from Thomas Keating Ltd was (and still is) a key collaborator – and many of the techniques and components developed in that grant – now appear in multiple high frequency EPR and DNP sub-systems across the world provided by his firm. Many of the innovations have also fed into the design of a number of mm-wave security, drone, terrain, cloud and space radar instruments.

What is your message to the young generation of magnetic resonance researchers?

Well first of all, whilst recognizing the challenges faced by all young researchers, I do think the younger EPR generation are fortunate to work in a growing research field that continues to have a highly supportive senior research community.

I do believe that EPR will open up many new research career opportunities. There is definitely scope for further growth within the broader University system, led by demand for EPR expertise in molecular biology, catalysis, materials science and DNP that goes to the heart of many of the technological demands of modern society. In the UK, those Universities with modern pulsed EPR systems are currently swamped with demand.

In my view, there is also considerable scope for major innovation. In high field pulsed EPR, it is likely that ongoing advances in ultra-wideband gyro-amplifiers, wideband AWG's and digitisers, and improvements in mm/sub-mm-wave components will all lead to further advances in EPR and DNP capability. Methodologies currently deemed impractical today will suddenly become possible. Equally, it is possible to point to many other ongoing technical, methodological and sample-based innovations for applications at lower frequencies.

I would thus strongly encourage PhD students and PDRAs working in EPR (or DNP) to be ambitious, outward looking, and collaborative in their vision, to ensure they are in position to take full advantage of these opportunities.

Interview with Dr. Daphné Lubert-Perquel on the Occasion of Her Bruker Thesis Prize 2021

EPR newsletter: *Dear Dr. Lubert-Perquel, on behalf of the readers of the EPR newsletter we congratulate you on your Bruker Thesis Prize 2021. We are most appreciative that you agreed to answer the questions of this interview. Why did you start towards your career in science?*

Before starting university, I volunteered for several months in South America. I soon realised that many issues that impoverished communities were facing could be resolved with cheaper, more accessible and more sustainable technology. This could be in the form of energy, water treatment, building materials, access to educational resources and many more. I was teaching kids from slums that would have the latest iPhone to feel "normal" even though they had no running water. This discrepancy really unnerved me and I therefore decided to pursue science, starting with an undergraduate course in Physics, followed by a PhD in Materials Science.

Who introduced you into magnetic resonance?

I was first introduced to magnetic resonance during a summer project at the University of Sydney in Professor David Reilly's group. EPR spectroscopy was then an integral part of my PhD supervised by Professors Sandrine Heutz and Chris Kay. In that time I primarily worked with Dr. Enrico Salvadori at UCL.

What are you main interests of work in magnetic resonance?

My research investigates functional molecular materials using magnetic resonance techniques for optoelectronic or quantum technologies. During my PhD, I focused on the interactions between light and matter to find more efficient solar energy solutions, specifically the effect of molecular geometry on photophysical mechanisms such as singlet fission. I also have an on-going collaboration working on the development of a multifunctional photocatalysts for solar fuels. Now, my research has turned to molecular nanomagnets using high-field EPR spectroscopy, including measurements under external stimuli such as pressure. The aim is to identify suitable alternative systems for a two-qubit gate.

Relocation is common, even expected for academics. What are some of the challenges you faced, and how do you think the research community facilitates these transitions?

Relocation for anyone is difficult. As a postdoc, however, it presents particular challenges. Unlike a semester abroad where the infrastructure is in place to receive us, this is a semi-permanent displacement which, for some, includes relocating their family. As positions are temporary, this presents significant challenges in terms of immigration, travel, housing and their financial implications. There is also little consideration and appreciation for the mental health consequences associated with uprooting every few years. Although most institutions provide international offices that help with administration and many try to have postdoc societies, I feel the recent complications from COVID have exposed some cracks in the system. Personally, I relied on individual mentors to facilitate my transition, but this is not available to all, an issue often overlooked.

What is your message to your colleagues – the young generation of magnetic resonance researchers?

Many research fields use magnetic resonance, it is an opportunity to branch out. As I was investigating the photophysics of thin films, I was invited to collaborate on a project studying multifunctional photocatalysts for solar fuels. Similarly, EPR is a versatile technique with a lot of potential in research fields that do not yet make use of it. Explore the possibilities and push the development and applications of magnetic resonance.

History of Electron Paramagnetic Resonance in Poland. Part 2*

EDITORIAL INTRODUCTION

Editorial Introduction to Part 1* outlined the origin of the ideas behind this article and provided key information concerning the Polish EMR Group (see: www.pgemr.org), which has reached maturity at the 10th Anniversary in 2020 (C. Rudowicz, P. Pietrzyk, *EPR newsletter*, 31/2 (2021) p. 6), and the next Forum EMR-PL (see, www.emr6.zut.edu.pl). Further to Part 1*, which covered the history of EPR/EMR research in Poznań and Kraków centers, Part 2 presents Wrocław, Warsaw, Szczecin, and Rzeszów centers.

Our sincere thanks go to Laila Mosina, the *EPR newsletter* Editor and John Pilbrow, the ex-President, the International EPR/ESR Society, without whom this article would not come to fruition.

Czesław Rudowicz, Chairman, Polish EMR Group
Piotr Pietrzyk, Chairman-Elect, Polish EMR Group

WROCŁAW CENTRE: Wrocław University of Science and Technology (WrUST) (Małgorzata Komorowska); **University of Wrocław (UWr)** (Julia Jezierska); **Polish Academy of Sciences (PAS)** (Henryk Drulis)

Department of Microwave Theory and Technique, WrUST

It was at the Wrocław Centre that the first EPR spectrometers in Poland were developed. Marian Suski, the then head of the Department of Microwave Theory and Technique (WrUST) pioneered this work starting in 1956. His research team succeeded in building a prototype EPR spectrometer modeled on the Soviet EE 1301 instrument manufactured by the Automation Department in Smolensk. Team members and later students of Suski were engineers: Marian Kloza (later a long-time Bruker employee), Ryszard Czoch, Andrzej Francik, Jan Duchiewicz, Włodzimierz Wolski, Andrzej Ludwik Dobrucki, Janusz Kościelniak. J. Duchiewicz played the leading role in introducing modern electronics to their spectrometers. That enabled digital control of, e.g. the magnetic field stabilizer, modulator-receiver with digital synchronous detection, magnetic field sweep module, and thus digital recording of EPR signals. Several programs for servicing spectrometers and EPR signal processing [28] were also developed. After 2012, the team focused on constructing compact EPR spectrometers, i.e. EPR sensors. This research concluded with the death of J. Duchniewicz in 2015 and the retirements of other team members.

In parallel, Włodzimierz Trzebiatowski introduced the EPR technique to researchers in Wrocław back in the early 1960s by initiating the purchase of the quality Russian-made X-band EPR spectrometer (the first in Poland) for WrUST. The first measurements were made in 1964/65 in Bohdan Staliński's group (Henryk Drulis, Janusz Pyter, Ryszard Fatla). His Laboratory was incorporated in the early 1970s into the structure of the newly established ILTSR PAS in Wrocław. The Laboratory was equipped with a new Russian-made X-band EPR spectrometer, supplemented by cryogenic facilities in order to extend the areas of research. An independent EPR laboratory was established at FC UWr in 1970. Since the mid-1970s, ILTSR PAS extensively cooperated with the Physico-Technical Institute (PTI) of the USSR Academy of Sciences in Kazan. In the late 1980s, another spectrometer constructed in WrUST was installed. Its unique capabilities, e.g. digital control panel and computer acquisition of EPR spectra, the transmission resonance cavity, and its size, enabled measurements using a metal-quartz cryostat with a quartz finger diameter of 20 mm. This spectrometer was constantly modernized, especially its software, electronics, and temperature range (adding cryostat accessory for 4 to 300 K). This quality spectrometer was available to other Polish research groups from Katowice, Częstochowa, Toruń, and Kraków.

Faculty of Chemistry, University of Wrocław (FC UWr), https://chem.uni.wroc.pl/pl/jednostka-organizacyjna/18

The launch of the EPR Laboratory at FC UWr in 1970 (see above) was the result of previous studies of the magnetic and spectroscopic properties of metal compounds. Over the next 50 years, five CW EPR spectrometers were acquired: JEOL JES-ME-3X, X- and K-band, 4–295 K, (1970–1990); RADIOPAN SE, X-band, 100–500 K (1986–2008); Bruker ESP 300E, X-band, 100–500 K (1993–2012); from 2012: Bruker ELEXSYS E500 CW (X- and Q-band, 4–295 K) and Bruker EMX (X-band, 100–500 K).

As an application unit, the EPR laboratory of FC UWr also provides external services. Along with the growing experience of employees, a Research Group "Structural Applications of EPR Spectroscopy" was established and led by Adam Jezierski (1991–2020). This EPR research, also conducted in cooperation with other Polish and foreign research centres, resulted in over 400 publications. The EPR research at FC UWr focused on key contemporary topics in chemistry. The analysis of changes in diagonal components of g and A tensors was the basis for the assessment of the molecular and electronic structure of Cu(II), Mn(II), and V(IV) complexes with biological and catalytic activities [29]. Magnetic anisotropy (referred to as ZFS) of mono- and polynuclear metal complexes with $S > 1/2$ (catalysts and potential magnetic materials) were additionally examined using HFEPR in the NHMFL in Tallahassee, Fl., USA [30]. EPR was also used for the identification of radical processes in natural materials (humic acids) under the influence of pH [31], metal ions [32], and pesticides [33]. For more than 20 years this experimental research has been supplemented with quantum chemical modelling of the molecular and electronic structure of radicals and their complexes with metal ions [31, 34], radical reactions [33]

* Part 1 was published in the *EPR newsletter* 32/1 (2022) pp. 8–13.

and comparative analysis of EPR and DFT parameters [30–34].

Institute of Low Temperature and Structure Research, PAS

Initially, EPR research at ILTRS focused on the diamagnetic hydride phases of Y-, Th-, and La-doped with paramagnetic Gd^{3+} ions. In the early 1970s, using a specially constructed metal-quartz helium cryostat, studies of rare-earth ions Nd^{3+}- and Er^{3+}-additives in non-magnetic hydrides, were undertaken. Analysis of EPR data confirmed the anionic nature of the hydrogen atoms in Y, Th, and La dihydrides. The cooperation with Zavoisky Physical-Technical Institute in Kazan resulted in common projects, which concerned alloys and intermetallic compounds, especially those exhibiting superconductivity, and EPR studies of Gd^{3+} ions in low-temperature superconducting palladium hydrides.

In the 1990s, the EPR group (H. Drulis, A. Shengelaya, L. Folcik) focused on the electronic and magnetic properties of the high-temperature superconductors [35]. A noteworthy achievement was the study of the magnetic flux distribution around the superconducting Bi2212 single crystal using EPR tomography [36]. This method was also used to study the distribution of the magnetic field in the EPR resonator loaded with an Nb superconducting ring. The EPR laboratory in ILTSR PAS concluded its long and fruitful activity in 2016.

WARSAW CENTRE: Institute of Nuclear Research (INR) – since 1966 till 1983, later **Institute of Nuclear Chemistry and Technology (INCT)** (Jacek Michalik, Grażyna Przybytniak), http://www.ichtj.waw.pl

EPR experiments at INR began in 1964 when an EPR spectrometer constructed at Wrocław Polytechnic was installed. From 1970 till 1990 the EPR studies utilized mainly JEOL JES-3X spectrometer and later a Bruker ESP-300, since replaced by a Bruker ELEXSYS in 2007. At present, three EPR spectrometers are in use at INCT: Bruker EMX X-band, Bruker ELEXSYS Q-band, and MINISCOPE MS-5000 dedicated to radiation dosimetry measurements. The EPR group in INCT has organized two conferences of the Polish EPR Society: in Zakopane in 1993 and Warsaw in 1996, with the participation of many scientists from all over the world.

EPR Laboratory

In the 1960s and 1970s, the research led by W. Stachowicz focused on the structure and reactivity of radicals generated by γ-radiation in glassy hydrocarbons at 77 K, and bone grafts sterilized by an electron beam from an accelerator. In mineralized tissues, two types of paramagnetic products are formed – collagen radicals which decay quickly at RT and stable $^{\bullet}CO^{2-}$ centres localized in bone mineral – carbonate hydroxyapatite. In cooperation with The Warsaw Medical School, the $^{\bullet}CO^{2-}$ signal has been extensively utilized as a label to study various mineralization processes in living tissues [37]. In the 1980s and 1990s, the focus was on atom agglomeration processes induced by γ-radiation in zeolites. The studies involved the electronic structure and dynamics of trimeric and hexameric silver clusters in AgNa-A zeolite and the formation and reactivity of the Ag_4^{3+} tetramer in AgCs-rho [38]. The Conduction Electron Spin Resonance (CESR) spectra of Ag, Pd, and Pt metal nanoparticles stabilized in molecular sieves were analyzed to characterize their size and location [39]. More recent studies concern the reactivity and dynamics of small radicals produced radiolytically in confined spaces. In γ-irradiated ZMS-5 exposed to ^{13}CO, the analysis of EPR spectra of $^{\bullet+}CO$ radical cation made it possible to characterize the adsorption sites in zeolite framework [40].

Laboratory of Polymer Modification

The EPR group was led by H. Ambroż till 1980s, and later by G. Przybytniak. Initially, the projects concerned the triplet ground state of aryl cations generated by decomposition of diazonium salts and radicals formed by single and double DNA strand breaks. Since the late 1990s, the studies have focused on free radical reactions induced in various polymers by ionizing radiation, aiming at medical and technical applications [41].

SZCZECIN CENTRE: Szczecin University of Technology (SUT), since 2009 **West Pomeranian University of Technology in Szczecin (WPUT)**, **Institute of Physics (IP)** (Niko Guskos, Czesław Rudowicz, Danuta Piwowarska, Grzegorz Leniec, Tomasz Bodziony), http://www.kft.zut.edu.pl/katedra-fizyki-technicznej.html; **University of Szczecin (US)**, **Institute of Physics (IP)** (Ryhor Fedaruk), http://www.kft.zut.edu.pl/index.php?id=22876

The history of EPR in Szczecin dates back to the late 1960s when the EPR laboratory was established at IP, then SUT, under the supervision of IP Director, Tadeusz Rewaj, in cooperation with IMP, PAS, in Poznań. The first EPR spectrometer (Russian made) was installed at IP, SUT in 1967, the more modern ones were bought in 1976, 1988 (RADIOPAN), and 2000 (Bruker). Given several reorganizations of various Laboratories and/or Groups within IP, SUT, and later WPUT, the most recent unit names are utilized below.

Solid State Physics Laboratory, IP, SUT/WPUT

Initially, the EPR technique was applied to dielectric crystals doped with the iron group and rare earth group ions and later metal fluorides MeF_2 (Me = Ca, Sr, Ba) doped with Eu^{2+} and Gd^{3+} ions at cubic sites. The first EPR spectra, measured by T. Rewaj, as a function of temperature, to study the cubic zero-field splitting (ZFS) parameter b(4) were published in Fiz. Tverd. Tela in 1969. After hiring Jerzy Kuriata, and in cooperation with IP, PAS in Warsaw, a uniaxial pressure system was built to study pressure dependence of ZFS parameters and spin-lattice coefficients for Eu^{2+} and Gd^{3+} in MeF_2.

Cooperative studies were carried in the 1990s with: (a) FP, University of Athens, and National Research Centre Demokritos (NRCD), Athens, Greece – EPR studies of high-temperature superconductor materials, resulting in over ninety publications, e.g. [42]; (b) Faculty of Chemical Technology at SUT (FCT, SUT) – EPR studies of magnetic and organometallic compounds with iron group ions, resulting in dozens of publications in renowned journals; (c) Institute of Biochemistry, PAS in Poznań – EPR studies on organic copper complexes [43].

More recently we studied [44] (in brackets collaborating institutions): magnetic and electronic properties of multiwall carbon nanotubes (FP, University of Athens; FP, Temple University, USA); spin frustration processes in vanadium oxides (FCT, SUT; IP, PAS in Warsaw; Centre for Nuclear Research in Dubna, Russia); EPR studies of TiC and TiN ceramics (Faculty of Materials Engineering (FME), SUT); magnetic resonance studies of $M_3Fe_4V_6O_{24}$ (M = Mg, Zn, Mn, Cu, Co) compounds (FCT, SUT); the matrix freezing effect on the magnetic properties of γ-Fe_2O_3 nanoparticles dispersed in multiblock copolymers (FME, SUT; FP, University of Athens; IP, PAS, Warsaw; NRCD).

Other EPR/FMR studies of magnetic materials include [45], e.g. vanadium oxides (FCT, SUT), extended free radical networks (FME, SUT; NRCD); micro-silica/cement matrices with carbon-coated cobalt nanoparticles (Faculty of Civil Engineering, SUT);

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EPR200-Plus
1D magnetic field scanning
2D magnetic field-microwave power scanning
2D magnetic field-modulation amplitude sweep
2D magnetic field-time scanning
Variable temperature experiment
Irradiation experiment

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Product Parameter

Parameter	Value
Frequency Range	9.2-9.9GHz
Modulation Field Amplitude	10 Gauss
Magnetic Field Range	6500 Gauss (Max)
Uniformity of magnetic field in sample area	Better than 50mG
Detection SN ratio in continuous wave mode	Better than 600:1
Absolute spin number sensitivity	5×10^{9} spins/(G√Hz)

Applications

Environment Science | Chemistry | Physics & Material | Biomedical | Food Science | Industry

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C_{60}2F-ferrocene (Belarusian Acad. of Sci., Minsk); magnetization dynamics in Landau-Lifshitz-Gilbert formulation (IP, University of Zielona Góra); 2-D and 3-D covalent networks derived from triazine central cores and bridging aromatic diamines (NRCD); nanocrystalline $ZnFe_2O_4$ (FCT, SUT); the relationship between oxygen defects and the photoluminescence property of ZnO nanoparticles (Nanophosphor Application Centre, University of Allahabad, India); phases in the $FeVO_4$–$Co_3V_2O_8$ system (FCT, SUT); and photocatalytic properties of modified TiO_2 (FCT, SUT; Catalysis Research Centre, Hokkaido University).

Optoelectronics Laboratory, IP, SUT/WPUT

This EPR group was headed by Sławomir M. Kaczmarek since 2003 until his retirement in Sep. 2019. Single crystals obtained by the Czochralski method in cooperation with Marek Berkowski, IP PAS in Warsaw, and materials obtained from foreign institutions collaborating with IP SUT/WPUT were investigated. The focus was on laser host materials, scintillators and luminescent diodes, e.g. single crystals – pure and doped with transition metal ions, e.g. Co^{2+}: $Li_2B_4O_7$, $PbMoO_4$ [46], rare-earth ions, e.g. Yb, Er, Pr, Tm: $LiNbO_3$, $BaWO_4$, $KGd(WO_4)_2$ [47], as well as magnetic nanopowders [48] and phosphors [49], investigated with RADIOPAN and ELEXSYS E500 X-band spectrometers. Currently, the team is leading the EPR studies at WPUT of magnetic and structural properties of various luminescent and paramagnetic materials for different applications, e.g. as magnetic polymers, photocatalysts, battery electrodes, in cooperation with research centres in China (Chinese Academy of Sciences, Ningbo), Taiwan (National Taiwan University), as well as Australia, Russia, Spain, Italy, and Poland.

Solid State Physics Laboratory, IP, US, http://fiz.usz.edu.pl/instytut/pracownicy/ryhor-fedaruk

Since 2002 EPR studies at IP US were performed by R. Fedaruk. Using Rabi oscillations in the pulsed EPR, the dynamics of multiphoton quantum transitions in solid-state spin two-level systems (qubits) was studied under their bichromatic (microwave and radiofrequency) excitation. Such dynamics was investigated particularly under the so-called Rabi resonance and for multiphoton Raman transitions in the optically detected EPR of the nitrogen-vacancy centre in diamond [50]. The method for suppression of electron spin decoherence was proposed [51]. Dissipative dynamics of qubits was investigated under ultra-strong off-resonant conditions [52]. EPR experiments were usually carried out in diluted spin systems when the number of microwave photons n in the cavity is much larger than the number of spins N. In materials with high spin density and a narrow line, where $n << N$, a quantum phenomenon known as the vacuum Rabi splitting was revealed in the cw-EPR signal of anthracite [53]. The cw and pulsed EPR were applied to study graphene oxide and reduced graphene oxide [10, Part 1].

Modelling in Spectroscopy Group, IP, SUT/WPUT (C. Rudowicz: 2005–2015, from 2015 at FC, AMU), http://www.chemia.amu.edu.pl/en/faculty-members/czeslaw-rudowicz

After working for 27 years overseas I returned to Poland in Feb. 2005 and resumed theoretical EMR studies heading the newly established group at SUT/WPUT. Since 2015 these studies have continued at FC, AMU. Major topics concern foundations of EMR (EPR/ESR) and optical spectroscopy of transition ions, microscopic spin Hamiltonian theory of $3d^N$ ions, superposition model of ZFS and ligand/crystal field parameters, low symmetry effects in EMR, see, the reviews [54–56] and references therein.

RZESZÓW CENTRE: University of Rzeszów (URz), Institute of Materials Engineering, College of Natural Sciences (Ireneusz Stefaniuk), https://www.ur.edu.pl/kolegia/kolegium-nauk-przyrodniczych/jednostki-naukowe/instytut-inzynierii-materialowej; **Institute of Food Technology and Nutrition** (Izabela Sadowska-Bartosz), https://www.ur.edu.pl/kolegia/kolegium-nauk-przyrodniczych/jednostki-naukowe/inst-techno-zywnosci-i-zywienia/struktura-structure/zaklad-biochemii-analitycznej

The development of the EPR group in Rzeszów originates from I. Stefaniuk's PhD thesis at then SUT in Szczecin in 1996. Here research has been focused on various oxide crystals and application of the superposition model in analysis and interpretation of EPR data and was carried out in cooperation with several centres: IP, TUS; IMP, PAS, Poznań; IP, PAS, Warsaw; Faculty of Chemistry (FC), Jagiellonian University (JU), Kraków. EPR studies were aimed at characterization of the paramagnetic centres in technologically important materials in terms of spin Hamiltonian parameters, e.g. $YAlO_3$ crystals doped with Co^{2+} and unintentional Cr^{3+} and Fe^{3+} admixtures [57]. Due to this cooperation, a used X-band spectrometer (SE/X), made by Wrocław University of Technology, was purchased from FC, JU in 2006. This enabled EPR studies of semiconductor materials, e.g. ZnO, CdTe with various admixtures, and free radicals in cooperation with The Warsaw University of Life Sciences [58].

As part of the EU-funded project, I. Stefaniuk designed and launched, in 2012 an EPR laboratory equipped with Bruker FT-EPR ELEXSYS E580 X- and Q-band spectrometer enabling pulse EPR as well as measurements at liquid helium and nitrogen temperatures. The studies were extended to include, e.g. nanoparticles in various materials: NiMnIn-type Heusler alloys, defects, and contaminants in materials used for cores and ceramic forms in the aviation industry and oxygen crystals; for references see the review [58].

Cooperative studies of free radicals started in 2015, concerning detection and quantification of free radicals in model biological systems, e.g. two-step oxidation process [59], estimation of membrane fluidity and rigidification using the spin-labelled fatty acids; studies of transport of, e.g. nitroxides and nanoparticles through a cellular model of the blood-brain barrier, and TEMPO-phosphate analogue into human erythrocytes [60].

CONCLUSION

In this account (Part 1 and Part 2) we have presented historical roots of EPR (EMR) studies in major active research centres in Poland, major scientific achievements, and whenever applicable links with industry and impact of research. Current status of EPR (EMR) research in Poland may be briefly summarized as follows. Over the years the EPR (EMR) research moved from physics departments, where reduction in the number of students has occurred, more to chemistry departments. In spite of adversities, EPR (EMR) research in Poland is still thriving and looking into new vistas both in topics and applications. Currently, research using the EPR method includes both the chemistry of materials and molecular systems, the chemistry of radicals, biochemical applications, the use of theoretical methods and molecular modeling. Traditional CW, pulsed and EPR imaging techniques are used. To supplement this account, we provide a link to an interactive map of Poland with all centres indicated: http://pgemr.org/osrodki.php. Those centres not described here, i.e. Częstochowa, Opole, and Zielona Góra have recently vanned due to staff retirements.

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Massimo Martinelli (1943–2021)

At the end of my studies of Physics at the University of Pisa, in 1995, I asked the professors of some university courses about the availability of a thesis work. The choice fell on a work concerning the development of a laser system for the generation of millimeter waves. The person in charge for this thesis told me that the work would be carried out as a part of the project for a novel high-field EPR apparatus, under the development at the Istituto di Fisica Atomica e Molecolare (IFAM) of the Italian National Research Council (CNR), in Pisa. He invited me to contact the IFAM coordinator of this project, Massimo Martinelli, to better focus the activity of the thesis. The meeting with Massimo was revealing for me. I was fascinated by his personality, given by a balanced combination of brilliance, respect, and humanity, so different from the ones commonly exhibited at that time with the undergraduate students. The meeting with Massimo represented one of the turning points of my professional and personal life.

In 1995, Massimo was already at the peak of his professional career. He was the director of IFAM and had been funded a project to build what would be the first and (so far) the only very high-field EPR apparatus in Italy, based on a 14 T large bore superconducting magnet (later reduced to 12 T due to production problems with the magnet). At that time, and for several years to come, there were no commercial EPR spectrometers available at such high magnetic fields, mainly due to the lack of well established (sub)millimeter wave sources and accessory components. For this reason, a large part of the spectrometer had to be developed and the research groups involved in this challenge were looking for possible solutions. Massimo was oriented to follow a rather innovative approach, counting on the strong experience both in microwaves and in the development of lasers available at IFAM and at the University of Pisa. Initially, Massimo focused on a system of lasers – a CO_2 laser optically pumping a methyl iodide and trioxane laser emitting at 240 and 316 GHz, respectively – as millimeter and submillimeter wave source, and on mechanically tuned dielectric resonators operating on the so-called Whispering Gallery Modes (WGM).

Massimo was the right person to lead the development of the high-field EPR spectrometer, both from the human and professional point of view. He was capable to establish profitable relationships almost independently of the personality of the interlocutor – a rather rare and precious talent, related to his empathy and sensibility. From the scientific point of view, Massimo could count on a rich experience in the field of magnetic resonances, including a strong experimental and theoretical background, the latter covering both fundamental and methodological aspects.

His first scientific work, concerned with an experimental study partially based on EPR measurements on OH-divalent cation complexes in NaF, was published in 1969, shortly after his degree in Physics at the University of Pisa. In 1970, he participated in a publication concerning the response to double irradiation of a nuclear spin system, which posed the theoretical bases for an interpretation of multiple-quantum transitions phenomena based on the second quantization formalism, in which both absorption and emission lines appear. Initially developed for NMR, the general formalism presented in this publication was then applied to EPR. This work represented the first of a long series of publications related to the theoretical and experimental development of magnetic resonance techniques. In 1973, Massimo published a paper on the behaviour of the longitudinal magnetization under double irradiation, soon followed by the proposal of the longitudinal detection of electron spin resonance (LODESR) technique, which was demonstrated by means of an *ad hoc* spectrometer. A good review of Massimo's most relevant publications in the EPR field up to the 1980s can be found in the book 'Electron Spin Resonance: A Comprehensive Treatise on Experimental Techniques' by C. P. Poole, Jr., a well-recognized reference text for the EPR community.

Along the years, Massimo always kept intense his passion for the magnetic resonance phenomena, at the same time starting to explore other research fields, concerning, for instance, dielectric spectroscopy and gas spectroscopy.

At the beginning of the nineties, he started to investigate the use of WGM dielectric resonators in EPR spectroscopy, thought as possible approach for high-field applications. He was also involved in the development of long-wavelength laser sources.

The first demonstration of the excitation of high-frequency WGM resonators by means of a millimeter-wave source based on a laser system was published in 1997. This work preluded the first EPR spectra obtained with the high-field spectrometer in Pisa, employing mechanically tunable WGM resonators excited by a molecular gas laser emitting at 240 and 316 GHz.

1999 was a key year for the high-field EPR laboratory led by Massimo. The first EPR spectra were obtained and the 'Specialized Colloque Ampere, EPR, NMR and NQR in Solid State Physics: Recent Trends' conference, promoted by Massimo, was held in Pisa, giving the possibility to meet many of the protagonists of EPR and NMR and to establish durable friendships, as that with Laila Mosina, who helped in the preparation of the special issue of *Applied Magnetic Resonance* dedicated to the conference (volume 19, n. 3–4, 2000).

The 'Specialized Colloque Ampere, EPR, NMR and NQR in Solid State Physics: Recent Trends' conference surely represented one of the magic moments for the scientific carrier of Massimo, in which many success stories crossed each other, including those of the undergraduate and graduate students working at the high-field EPR laboratory at that time, as Gabriele Bolognini, now at the Institute for Microelectronics and Microsystems of CNR, Stefano Faralli, now at the Sant'Anna School of Advanced Studies of Pisa, Maria Fittipaldi, now at the University of Firenze, Lorenzo Lenci now at the University of Uruguay, Carlo Andrea Massa, now at the IPCF-CNR, Luca Pardi, now at the IPCF-CNR, Enrico Prati, now at the Institute for Photonics and Nanotechnologies of CNR, and Giacomo Scalari, now at the ETH Zurich.

In the early 2000s, Massimo was involved in the birth of a new CNR Institute, on the wave of the simplification of the CNR scientific network. The new Institute (Istituto per i Processi Chimico Fisici – IPCF), into which IFAM merged, was conceived and strongly promoted by Massimo. At the time of its foundation, IPCF was composed of over 100 researchers. Massimo became the first IPCF director in 2002, a position that he held until his retirement in 2008. The great engagement necessary first to promote and then to lead this new Institute, as well as other national and international commitments (such as the coordination of the 'Infrastructure Cooperation Network EC Service Enhancement through Infrastructure Networking for Electron Paramagnetic Resonance Spectroscopy with Large Fields' (SENTINEL), in the period of 2001–2005), progressively distanced Massimo from laboratory researches. The decline of the practical involvement in the research activity represented a great regret for him. Moreover, in the last years of his carrier the symptoms of a disease that will accompany him until his death, which took place on January 12, 2021, began to be manifested. Also in the last hours of his life, his thoughts came to the old colleagues and to 'his' Institute.

From the scientific point of view, the activity of Massimo after the 2000s mainly focused on the high-field EPR with particular attention to the dynamics of polymers studied by spin probes. He also participated in studies on optical spectroscopy, microwave dielectric characterization, and on the development of electromagnetic resonant devices.

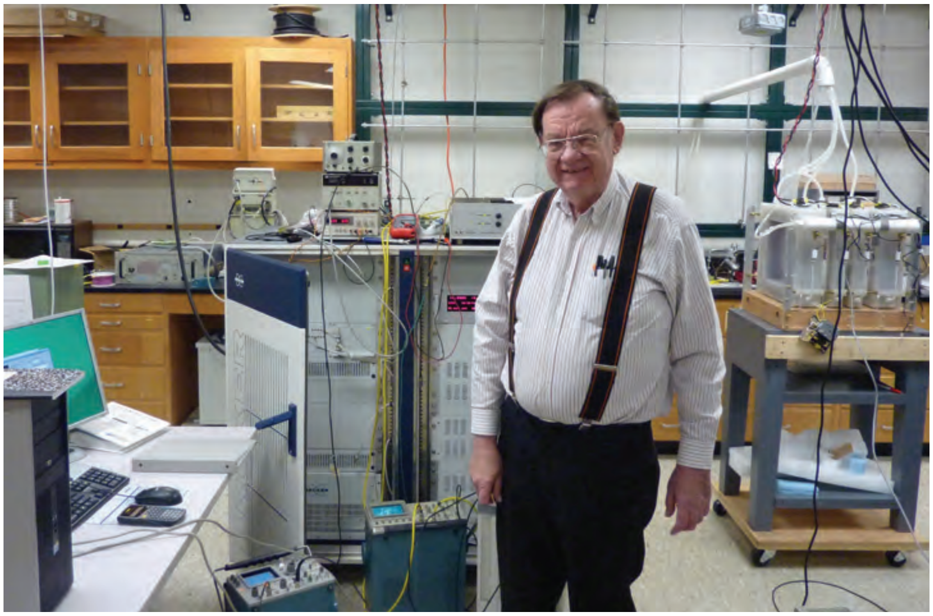
Massimo's passion and commitment to his work were very intense. Among the anecdotes that the family loves to tell, that of when he remained two full days in his office, night included, to correct the thesis of a graduating student. Or the many times he forgot to inform the family about a late arrival, fully taken by the research activity. Massimo's great passion for his work did not limit other passions, numerous in his life. In addition to the study of history and philosophy, Massimo alternated over the years passions for sports such as rowing and arm wrestling, for olive harvest and production of olive oil, for walks in the mountains – especially in the Dolomites. More recently, he developed a passion for marathons, of which he run several editions, including the 100 Km ultramarathon from Florence to Faenza, called 'Maratona del Passatore', run in 2004 at the age of 61. He also loved science fiction stories and had promised himself to write stories of this type once retired, a desire that his illness prevented him from fulfilling.

When our mutual friend Laila Mosina proposed me to organize a tribute for Massimo in the In Memoriam column of the *EPR newsletter*, I instinctively offered to write it in person. It seemed to me the most natural choice, justified by the many years of fruitful collaboration and deep friendship. I soon realized that I had underestimated the emotional burden of this task, which emerged forcefully in recalling the many challenges and experiences we shared. Therefore, I preferred to take time to try reaching a reasonably correct perspective on who Massimo was and what he represented for all those who met him, avoiding that the emotional aspects could obscure the story of the person. In this period, I had the opportunity to talk about him with several colleagues who knew him well, with people who spontaneously offered to provide their contribution to the tributes that Massimo has received in these months, and with his family members.

From these talks emerged always the same person, whose human stature is not less than the scientific one. A person of great scientific and managerial skills combined with extraordinary human qualities; a person who achieved a very relevant success in his work, still keeping intact these qualities, such as empathy, respect for people, generosity. These characteristics led to a remarkable lightness in human relationships, helped by a brilliant and at the same time delicate sense of humour, which allowed him to look at things and face problems while maintaining the right distance from them. Qualities that have guaranteed him a deep esteem and appreciation of those who have had the privilege of sharing with him a part of their life journey. I believe that Massimo's most engaging legacy is precisely the sense of gratitude expressed by many of the people who knew him.

Grazie ancora Massimo! Che la terra ti sia lieve. Sit tibi terra levis...

Giuseppe Annino



Richard W. Quine (1943–2021)

Richard Quine was known world-wide for his expertise in EPR instrumentation. He is the co-author of many scientific papers. The EPR community lost a valued colleague in 2021 when he succumbed to complications of polycystic kidney disease. He lived with a kidney transplant for many years.

Richard W. Quine has enriched EPR with the design and construction of innovative pulsed and CW spectrometers and imaging systems. He designed very strong, linear magnetic field gradient systems for the early development of EPR imaging before we were aware of EPR imaging in two other labs. His patented programmable timing unit provides great flexibility in pulse sequences for spin echo and saturation recovery with less than 1 nanosecond resolution. He designed and constructed several EPR spectrometers: an X-band spin echo spectrometer, an X-band saturation recovery spectrometer, a multifrequency (L-, S-, C-band) spectrometer that incorporates CW, spin echo, and saturation recovery capabilities all in one bridge, and 250 MHz, 700 MHz and 1 GHz CW, rapid scan and pulsed EPR spectrometers. These spectrometers incorporate multiple functions for the testing of new resonators and new experimental methodologies. Richard Quine served the EPR community as a resource for the maintenance and upgrading of EPR spectrometers. During the transition to modern EPR spectrometers he provided over fifty interfaces for computer control of magnetic fields in older spectrometers.

Richard Quine took pride in being able to create a circuit that would convert specified inputs to desired outputs. When GRE sought his help in 1980 to design a pulsed EPR spectrometer with 1 ns resolution, Richard looked at the timing diagrams for a while and said "these are microseconds aren't they." When told no, nanoseconds, he replied "that will take a little longer." Chips were not available to provide 1 nanosecond delay steps. An engineer at the manufacturer taught us that the only real specification was on the overall delay, not on the individual steps. Richard then designed and built an instrument to measure every step delay in each chip, and then find paths through two chips that would compensate for the errors in each. The result was a digital delay generator with a peak-to-peak timing error of no greater than 0.29 ns.

Richard Quine designed and constructed the magnetic field gradient coils and control systems for our very early EPR imaging experiments, and, characteristically, provided full details to the EPR community.

Richard Quine transferred useful engineering tools to the operation of EPR spectrometers. For example, the Smith chart display of impedance vs. frequency, commonly used on the test bench, becomes a valuable tool for critically coupling a resonator when used in conjunction with the usual "dip" display in a spectrometer.

Beyond his special expertise in timing, he quickly grasped the concepts of the full EPR spectrometer system and was an international resource for maintaining and improving spectrometers. Although he insistently described himself only as a circuit designer, he understood the entire EPR spectrometer, from magnet to data collection, in both overall scope and in detail. He shared the Silver Medal of the International EPR/ESR Society, for contributions to EPR instrumentation, 2002, with another member of the research team, Dr. George Rinard, who designs magnets and resonators. Richard not only designed innovative equipment, he worked alongside students to carry out the initial experiments on a series of investigations, explaining to them how the equipment functioned.

Richard Quine's formal education included a BSEE in Electrical Engineering from the University of Colorado, Boulder Colorado in 1969. He also took some graduate courses in electrical engineering, at Iowa State University, Ames Iowa in 1970 to 1972. The range of his interests is described by continuing education at the University of Denver in Anthropology, Audiology, Philosophy, Clarinet, Linguistics, and German (1978 to 1997). He taught microprocessors and circuits part-time 1980–1986 at the Community College of Denver, and at the University of Denver. During the early days of excitement about Mandelbrot sets, he taught young students to program the diagrams to stimulate interest in engineering and math.

Richard Quine pointed to early employment in a TV repair shop and then at Collins Radio Division, Rockwell International, and Honeywell, Inc. as the practical background for his 40 years at the University of Denver (DU).

In addition to his EPR work, Richard's skills contributed to a wide range of fields. About 22 years ago he created a tactile fMRI device for research in the department of psychology. He created the circuits required for the aircraft-mounted condensation nucleus counters developed by Prof. J. C. Wilson at DU that contributed to understanding the ozone hole. Since these instruments must perform under harsh conditions without human intervention and must be designed to stringent size and weight limits, the fact that Professor Wilson could always be assured that the systems Quine created would work as designed is a great testimony to his consummate design skill. Richard also designed the circuits used for remote roadside monitoring of automobile exhaust known at the FEAT (fuel efficiency atmospheric testing) system developed by Prof. Donald Stedman at DU.

Before joining the EPR team, Richard Quine designed vital signs monitors for the early astronauts. The NASA quality control standards and his earlier work on airplane controls shaped his approach to building EPR spectrometers.

Music was also an important part of Richard's life. He played the clarinet in local groups and for the research group when we gathered for Thanksgiving dinner. The major vacations he took were to enjoy music with a long-time friend.

Richard and his brother, Thomas, wrote a book about their family history titled Wolf Creek Pioneers (2018). Their father was one of the highway workers who was responsible in the mid-1930s for keeping Colorado mountain roads passable year-round. He plowed the snow accumulations averaging 39 feet on a critical corridor of travel over Wolf Creek Pass on the Continental Divide. Richard was born near this pass.

In summary, Richard W. Quine designed, built and tested several EPR spectrometers and magnet field control systems. He had expertise in detailed circuit designs, bridge construction, acquisition of pulsed, CW, and rapid scan spectra, and the overall engineering system view of EPR systems. He also calculated and measured absolute EPR signal amplitudes for several spectrometers and did the quality control and testing of all of the resonators. Richard Quine's contributions to EPR spectroscopy are immeasurable and have led to the development of many innovative new procedures.

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ICONS-4: Hyperpolarization and Magnetic Resonance

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ICONS-4, organized during February 09–11, 2022, was the fourth edition of the on-line magnetic resonance conference series called Konstantin Ivanov **I**nter**CON**tinental Magnetic Resonance **S**eminar [1–3], named after our untimely deceased colleague and friend, Konstantin Ivanov. The ICONS conferences are an off-shoot of the weekly Intercontinental NMR Seminar Series that started on April 8, 2020. This seminar series has enabled the communication and dissemination of research ideas among the magnetic research community in the times of the COVID-19 pandemic and will continue to do so beyond. In the framework of the ICONS series, until now, more than 130 scientists from five different continents have presented their latest results. Contrary to what "NMR" in the title suggests, both the ICONS seminars and the ICONS conference series cover all aspects of magnetic resonance, including both EPR and NMR, with the goal to foster new developments in magnetic resonance and to enable communication and dissemination of research ideas among the magnetic resonance community. While the speakers at the semi-annual conferences are chosen among experienced scientists in the field, the weekly seminar series tries to give a balanced mixture between early-stage researchers and experienced scientists. The ICONS-4 conference attracted registrations from nearly 200 people from 30 countries (in the spirit of the meeting, covering 6 continents, Europe, North America, South America, Africa, Australia, and Asia) and spanned 17 time zones from Japan over Europe to the West Coast. The meeting talks were broadcasted across the Zoom and YouTube platforms. The average combined attendance was around 100.

While the summer ICONS-conferences are broad in scope, the winter conferences are focused on a special topics area. This year we decided to put an emphasis on hyperpolarization techniques and invited a number of cutting-edge speakers in order to highlight recent developments in the fields of Chemically Induced Nuclear Polarization (CIDNP), Dynamic Nuclear Polarization (DNP), Nitrogen Vacancies (NV-centers), Noble Gases (SEOP), Parahydrogen Induced Polarization (PHIP, SABRE). The twelve invited speakers were in chronological order **Jan Henrik Ardenkjær-Larsen**, Denmark, **Pierre-Jean Nacher**, France, **Eleonora Cavallari**, Italy, **Thomas Meersmann**, UK, **Eriks Kupče, Bruker**, UK, **Lucio Frydman**, Israel, **Philip Kuchel**, Australia, **Silvia Cavagnero**, USA, **Christian Degen**, Switzerland, **Michal Leskes**, Israel, **Simon Duckett**, UK, and **Gaël de Paëpe**, France. The presentations spanned a broad range of topics, going from basic spin-physics and experimental technology over applications in chemistry and biochemistry, medical imaging, and investigation of physiological processes. For details of the contents of the talks see the upcoming report in APMR [4].

The conference and seminar series were sponsored by the Alexander von Humboldt Foundation, Wiley, Springer, HyperSpin, and Adani. Following the scheme of a general MR conference in summer alternating with a specialized conference on cutting-edge topics in winter, there are already plans for a general ICONS-5 in summer of 2022. For updates and the schedule of upcoming talks see the home page of the meeting ICONS-Seminar: https://sites.google.com/view/nmr-seminar-series/home.

1. Abergel, D.; Buntkowsky, G.; Ivanov, K. L.; Madhu, P. K., Editorial: Introducing the Intercontinental NMR Seminar ICONS2020. Appl. Magn. Reson. 2021, 52, 1–4.
2. Abergel, D.; Buntkowsky, G.; Ivanov, K. L.; Madhu, P. K., Editorial: The Second Intercontinental NMR Conference ICONS2021. Appl. Magn. Reson. 2021, 52, 565–569.
3. Buntkowsky, G.; Abergel, D.; Madhu, P. K., Editorial: The Third Konstantin Ivanov Intercontinental Magnetic Resonance Conference on Methods and Applications ICONS-3. Appl. Magn. Reson. 2021, 52, 1–4.
4. Buntkowsky, G.; Abergel, D.; Madhu, P. K., Editorial: The Fourth Konstantin Ivanov Intercontinental Magnetic Resonance Conference on Methods and Applications ICONS-4, Appl. Magn. Reson. 2022, in print, DOI: 10.1007/s00723-022-01468-w.

Postdoctoral position: Protein disorder in RNA-protein interactions: from dynamic structures to pathology
Jeschke group (EPR Spectroscopy). ETH Zurich, Zurich, Switzerland.

Project description: In a Sinergia project funded by Swiss National Science Foundation, we address structure and functional relevance of intrinsically disordered protein domains (IDDs) of RNA- binding proteins.

Our part of the project uses continuous-wave EPR, Overhauser DNP measurements of water accessibility, and distance distribution measurements by double electron electron resonance (DEER) for obtaining information on structure and dynamics of (IDDs) in the dispersed and condensed state at ambient temperature and after fast freezing. We generate ensemble models by integrating information from EPR, NMR, small-angle scattering techniques and, potentially, FRET.

The successful candidate will design and develop spectroscopically orthogonal spin labelling methodology, use DEER and NMR paramagnetic relaxation enhancement (PRE) measurements to gather restraints for integrative structure modelling, and will be involved in further development of our modelling approach.

Profile: The candidate is either an NMR spectroscopist with experience in biochemistry and biophysics, who is interested in EPR spectroscopy or an EPR spectroscopist with interest in biological applications and in NMR. Candidates should have a PhD in chemistry, biochemistry, or biophysics.

Interested candidates should send a C.V., motivation letter and the names of two referees to gjeschke@ethz.ch. **Deadline:** 15th May 2022. https://epr.ethz.ch/

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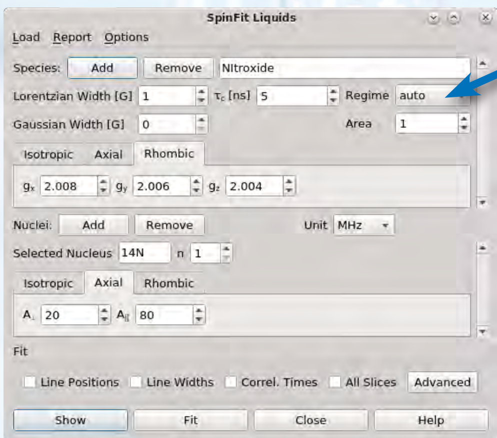

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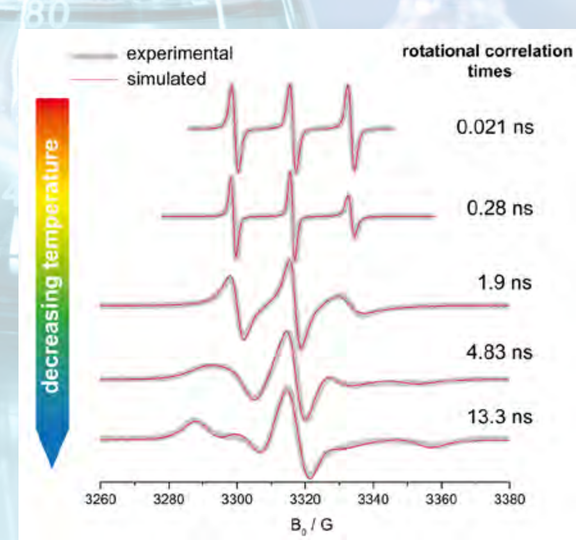

Rotational correlation times of nitroxide spectra in water/ glycerol mixture obtained from SpinFit Liquids

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