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# epr news letter



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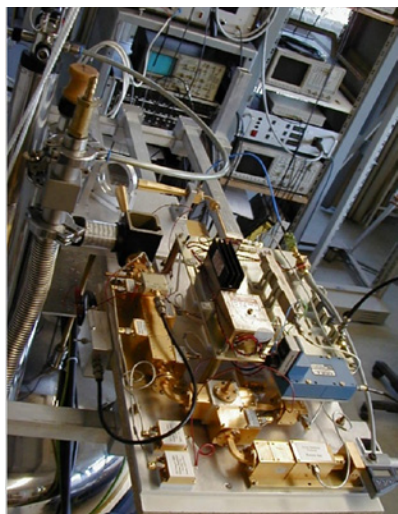
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Please feel free to contact us with items (news, notices, technical notes, and comments) or ideas for the *EPR newsletter*.

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**WESTPORT**  
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The cover picture illustrates aspects of research carried out by Thomas F. Prisner, recipient of the 2026 IES Gold Medal. It shows G-band (180 GHz) pulse EPR setup constructed by Vasyil Denysenko mainly used to obtain orientation selective PELDOR angular restraints on DNA and RNA molecules using rigid spin labels synthesized by Snorri Sigurdsson.

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## Editorial

Dear colleagues,

You might have heard about the problem known as Buridan's Ass. It refers to a hypothetical situation wherein an ass is placed precisely midway between two identical piles of hay. The poor creature, unable to choose between the two, dies of hunger. I remembered this situation, when we had to decide about the cover for this issue of the *EPR newsletter*. Two perfect variants illustrating the research of Thomas Prisner, recipient of the 2026 IES Gold Medal, were under consideration: Thomas' drawing "Heidelberg at the Neckar river on a foggy spring morning" dating back to 1983, when Thomas studied physics at the University of Heidelberg (see p. 8), and a snapshot of the 180 GHz homebuilt instrumental setup Thomas used in his experiments (see this cover).

Both variants were equally attractive. Fortunately, Jean Buridan also prompted the solution: "Should two courses be judged equal, then

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the will cannot break the deadlock, all it can do is to suspend judgement until the circumstances change, and the right course of action is clear". Both variants of the cover were sent to Thomas, and he made his choice, which allowed us to proceed.

This situation gives me a chance to attract your attention to the Another Passion column of our publication, the content of which proves that a talented person is talented in everything. In 2010, Thomas Prisner shared with us his passion for painting in his essay "Curve sketching and line etching" (issue 20/1). If you browse back issues of the *EPR newsletter*, you may find George Feher playing poker, take a flight to Alaska with Marion Thurnauer and Alex Trifunac, explore cello playing with Brian Hoffman, practise sports with Gunnar Jeschke, or enjoy sailing with Dave Britt, and more...

You are very welcome to share your own stories about passions beyond science.

Laila Mosina

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Innovation with Integrity



# Letter of the IES President

travel award of 750 \$ and two poster prizes. Application procedures are explained on our website. We are particularly excited that we are able to support the Inaugural International EPR Conference in Bangalore, India, at which the upcoming Annual General Meeting (AGM) of the IES will take place. Further details are available at <https://icesr-conf.iisc.ac.in/>.

Recently we called for nominations again for three IES Awards 2026. I'm particularly honored to announce the following winners:

- Professor Thomas Prisner receives the IES Gold Medal 2026 for his outstanding contributions to magnetic resonance. His work has been very successful not only in EPR but also at the interface to NMR, where he was one of the founders of the hyperpolarization community. He was also very engaged in IES as previous president. I will be honored to personally hand him the medal at the International Hyperpolarization Conference HYP26 in Göttingen.

- The John Weil Young Investigator Award 2026 is awarded to Dr. Alberto Privitera for his contributions to light-induced EPR spectroscopy and its application to key fields such as renewable energy and quantum information science. Alberto will receive the award at the EF-EPR 2026 meeting in Brno.

- The IES Fellowship 2026 honors Professor Periannan Kuppusamy for his pioneering work in EPR, which has shaped the fields of EPR spectroscopy, biomedical imaging, cardiovascular research and translational technology development via oxygen measurements. He will receive the award at the Rocky Mountain Conference 2026.

Please join me and the IES Board in congratulating these winners!

The next award call will be the IES Best Paper 2026, with nomination deadline of April 30th 2026. The first author, either a PhD student or a young postdoctoral researcher, is recognized with a monetary award. Please see the nomination rules on our website and help us identify excellent young scientists. As a new feature, for this award as well the IES Board is going to nominate an independent decision panel in a manner similar to that for the IES medals.

Concerning IES on-line activities, we have been collaborating more closely with the IVEM team of Joseph McPeak, Tomas Orlando, Thomas Schmidt, Yujie Zhao, and Alexey Bogdanov, who deserve a particular thank for their exemplary engagement. The

scope is to broaden the audience, diversifying speakers including those beyond IES, as well as including more speakers and IVEM board members especially from Asia. Costs for the IVEM website maintenance are now supported by IES. IVEM seminars are now announced also by our secretary, Janet Lovett, to our members. There will be a separate column on IVEM seminars by Tomas Orlando in one of the upcoming Newsletters. Please have a look at the upcoming talks and news under <https://www.eprseminars.org/> and try to engage in shaping this activity in the future. All IVEM speakers receive the opportunity to submit a synopsis and a photo to the EPR Newsletters.

Some time ago, our previous president Thomas Prisner started the initiative to create a depository for EPR data, particularly PELDOR data, that should be freely accessible to our and other communities as well as to new search engines such as AI. I'm happy to announce that last year, at IES Annual General Meeting in London and subsequent individual meetings, we were able to reach an agreement between Bruker and IES to generate a first test website for uploading the data. Bela Bode from St. Andrews, was nominated by the IES Board as IES representative to work with Thorsten Maly from Bruker, as well as with a few groups in the community, to draft the database according to the needs of our community and the rules of best scientific practice. The database should be administered in future by IES. EPR data will be uploaded in raw format to ensure transparency. Further discussion on this topic will take place at the upcoming Annual General Meeting in Bangalore.

Finally, I would like to mention the invaluable work of Janet Lovett, Laila Mosina, Christos Pliotas, and Peter Qin, who constitute an exceptional team in serving our community. All four are continuously engaging with our community and industry to support the society and keep us informed about the most exciting news from science, prize winners, conferences and events. I'm also very thankful to the IES vice presidents Sun Hee Kim, John Morton, and Sunil Saxena, as well as all panel members of the awards for their continuous contributions and advices in advancing the mission of IES. I'm deeply grateful to work alongside all of you.

I look forward to a successful and impactful year, and to connecting with many of you in person!

Marina Bennati

Dear Friends and Colleagues, it is my great pleasure to open the IES Newsletters of 2026 with several updates and news from our community. The past year has witnessed many scientific events across the world, at which EPR was well represented as a fundamental pillar of magnetic resonance. Alongside, the scientific community has celebrated a historic milestone, the centenary of quantum mechanics and the discovery of spin, which provided profound inspiration and impulse for future developments, also in our field. Yet, we have been also facing several global challenges in politics, climate, energy resources. Moreover, the advent of artificial intelligence is transforming the way of handling science and our everyday life. In this time of rapid progress and changes, we, scientists, remain a competent and reliable source of information, dialog and responsibility. This mission is also at the core of the International EPR Society. Through our activities, we foster scientific dialogue and exchange, raise the next generation of researchers, and overcome barriers by supporting a diverse community across geography, ethnicity and gender. I hope that we can continue this mission in 2026 and I'm grateful for any advice and collaboration on how to achieve and further advance!

IES is supported by your membership and several sponsors. Thanks to this generous and continuous sponsorship, the society is in a favorable situation that will allow us to support once more several international conferences in 2026. You will find a detailed list of IES sponsored conferences on our website. Particularly, for RSC ESR 2026 (Colchester, UK), EUROMAR 2026 (Gothenburg, Sweden), Rocky Mountain Conference 2026 (Utah, US), EF-EPR (Brno, Czech Republic), APEERS 2026 (Saitama City, Japan) and SCM 2026 (Padua, Italy), we are providing one student

# Report on the Activities and Evolution of the International Virtual EPR Meetings (IVEMs)

Tomas Orlando, Yujie Zhao, Joseph McPeak

The International Virtual EPR Meeting (IVEM) was established in 2020 as a response to the global pandemic, which halted in-person scientific exchange. Initiated by a group of motivated young researchers, the series sought to mitigate the isolation imposed by the pandemic by leveraging digital platforms to maintain the momentum of the EPR community while fostering exchange between established researchers and newcomers to the field.

Over the past six years, IVEM has evolved from a crisis-management tool into a permanent, biweekly seminar series that usually runs from October to June, complementing the traditional in-person meetings.

In this report, we detail IVEM's evolution, its expanding scope into fields like material science and hyperpolarization, and its efforts toward global representation.

## Scope

A core mission of the IVEM series is to provide a platform for the EPR community to interact regularly and stay updated on new developments in magnetic resonance. In many established conference formats, speaking opportunities are naturally weighted toward senior investigators. IVEM intentionally shifts this balance by inviting graduate students and early career postdoctoral researchers to present their work to an international audience.

This exposure is critical for professional development, especially in a time when financial, environmental, and organizational concerns provide increasingly effective barriers to national and international travel.

Through IVEMs, young researchers are offered a stage to present their data and engage in high-level discussion with both peers and senior PIs in a non-intimidating way. In fact, within the IVEM series, presentations of advanced research are accompanied by open discussions where even the most naive of questions may be asked without the elevated atmosphere of a prestigious conference.

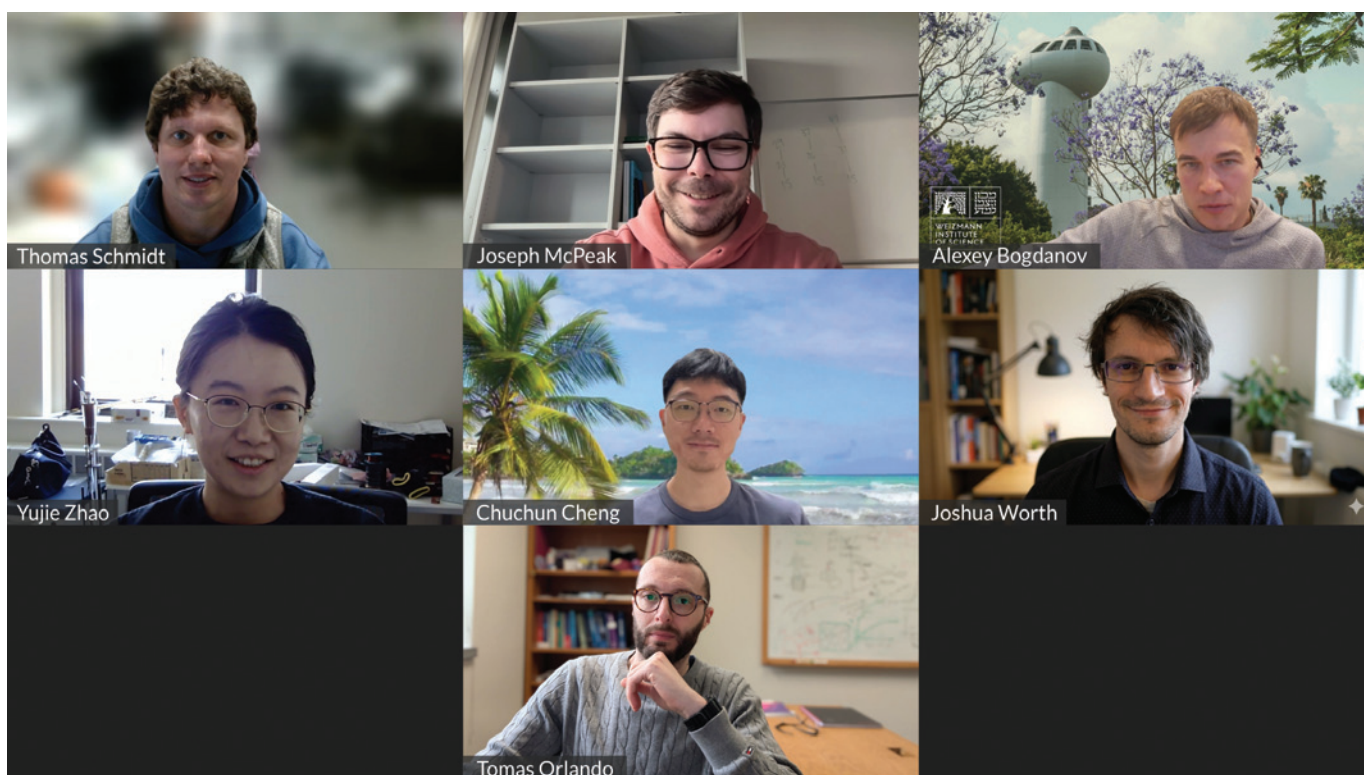
While the series prioritizes young scientists, the involvement and engagement of PIs remains a cornerstone of the program. PIs contribute not only through the presentation of current research but also through structured tutorials and career overviews.

Among those, we recall tutorial sessions which delve into the nuances of instrumentation, such as resonator design or the implementation of specific pulse sequences, providing a level of detail that is often omitted in condensed conference talks.

Furthermore, we had the pleasure of hosting career overviews that provide the historical context of EPR research, allowing younger members to understand the evolution of the field over the past few decades. In this respect, Thomas Prisner eloquently summarized pulsed EPR method development and Daniella Goldfarb gave an excellent talk on Gd-F ENDOR. Both those video recordings are now available in our archive at [eprseminars.org](http://eprseminars.org) and on our YouTube channel @eprseminars.

## Expansion

In recent years, the IVEM committee has implemented a strategy to expand the series' boundaries. While initially focused on EPR spectroscopy applied to biochemistry, more recently we have expanded into more diverse applications in material science, spin physics, and hyperpolarization.



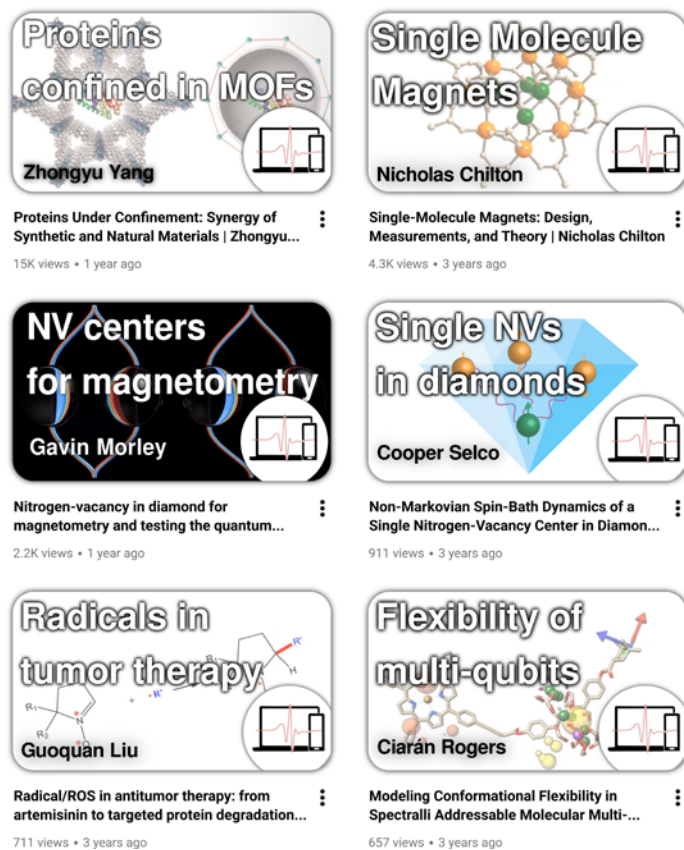


Figure 1. Thumbnails of some of the most popular seminars on the IVEM YouTube channel (@eprseminars).

The inclusion of material science has brought sessions focused on quantum information processing, the characterization of defects in wide-bandgap semiconductors, and the study of catalysts. These discussions cover the characterization of battery cathodes (Euan Bassey, Bingwen Hu), spintronic polymers (Michael Kern), and catalytic surfaces (Paolo Bruzzese), as well as the study of molecular confinement in MOFs and other porous frameworks (Zhongyu Yang). Collectively, they illustrate how EPR serves as a critical tool for understanding spin physics, electronic structure, and molecular orientation in complex material systems.

Similarly, the series has increasingly featured talks on hyperpolarization, specifically Dynamic Nuclear Polarization (DNP), by hosting experts who operate at the interface of EPR and NMR.

These seminars, featuring speakers such as Asif Equbal, Shebha Anandhi Jegadeesan, Song-I Han, Venkata SubbaRao Redrouthu,

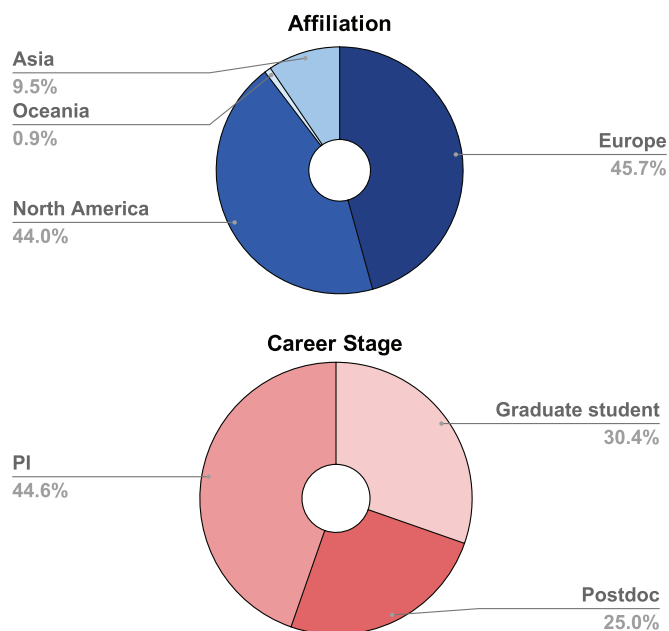



Figure 2: Affiliation and career stage of the IVEM speakers from the beginning of the series in 2020 to our last scheduled season in Spring 2026. Further statistics on the IVEM demographics are available on our website [eprseminars.org](http://eprseminars.org).

Yifan Quan, and Ilia Kaminker, collectively explore the frontier of DNP and EPR spectroscopy. The discussions range from the mathematical simulation of pulsed DNP and the physics of multi-electron coupling to the development of specialized high-field instrumentation and chirped pulse sequences designed to overcome current sensitivity limitations in structural biology and interface chemistry.


### Global Representation and the Challenge of Geographic Diversity

IVEM is fundamentally an international endeavor, with participants and speakers representing a wide array of global institutions. An analysis of our speaker demographics reveals that, while the western institutions are well represented and the distribution reflects the landscape of EPR labs across the world, researchers in Asia remain underrepresented in our current scheduling.

The committee is aware of this imbalance and is actively working to compensate for it. These efforts include occasionally adjusting the seminar times to better accommodate researchers in Far East time zones and targeted outreach to regional societies, such as the Asia-Pacific EPR/ESR Society. Our goal is to ensure that the IVEM platform reflects the global distribution of EPR expertise without geographic biases.

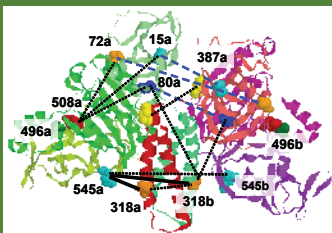


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### Digital Infrastructure and Educational Archives

The series continues to operate via [eprseminars.org](http://eprseminars.org), which undergoes constant updates regarding upcoming sessions. It also serves as a hub to navigate through the extensive IVEM archive, which now includes more than 70 seminar recordings.

Beyond the live sessions, the IVEM YouTube channel has matured into an essential archive for the IES. It serves as a comprehensive educational tool, allowing students and seasoned researchers alike to revisit complex tutorials or catch up on missed research seminars. The committee encourages all members of the society to treat this channel as a primary resource for lab training and pedagogical support.

Transparency and consistent communication are maintained through multiple mailing lists. In addition to our internal database of subscribers, IVEM announcements are distributed via the IES mailing list and the CNRS NMR mailing list (<https://listes.services.cnrs.fr/www/info/nmr>) as well as the solid-state NMR and DNP mailing list hosted by the Griffin group (<https://griffingroup.mit.edu/ssnmrdnp-zoominar/>). This multi-channel approach ensures that we reach not only dedicated EPR specialists but also the wider magnetic resonance community, encouraging the cross-pollination of ideas between different spectroscopic disciplines.

### Organizing Committee

The continuity of IVEM is maintained by a dedicated committee that organizes the program according to the academic semesters. This administrative structure ensures that the series remains well-structured and that announcements are distributed in advance.

The current committee consists of Thomas Schmidt (National Institute of Health / National Institute of Standards and Technology, USA), Joseph McPeak (Hamburg University of Technology, Germany), and

Yujie Zhao (Massachusetts Institute of Technology, USA), Tomas Orlando (Nat. High Magnetic Field Laboratory, USA) – who is stepping down – and, more recently, Joshua Worth (University of Manchester, UK), Alexey Bogdanov (Weizmann Institute of Science, Israel), and Chu-chun Cheng (National Tsing Hua University, Taiwan). Together, the committee reflects a balance of expertise across pulsed EPR instrumentation, biomedical EPR, high-field spectroscopy, and DNP methodology, as well as representation across Europe, Asia, and the United States.

Speaker selection follows a rolling nomination process. Suggestions are collected from committee members, prior speakers, and members of the broader EPR community. Nominations are first evaluated informally based on scientific novelty, technical rigor, and relevance to the evolving scope of the series. Following preliminary discussion, the committee actively monitors diversity metrics, including gender balance, geographical distribution, and career stage representation. These statistics are transparently summarized on the IVEM website ([eprseminars.org/our-numbers](http://eprseminars.org/our-numbers)), where the geographical distribution of speakers and related data are publicly available. The committee regularly reviews these metrics when planning upcoming programs to ensure that the series remains internationally representative and reflective of the global EPR community.

### Conclusion

The IVEM series remains a vital component of the International EPR Society’s mission to foster scientific excellence and sense of community. We invite the IES membership to continue their engagement with the series, whether as speakers, attendees, or users of our digital archives. Our seminars are usually scheduled on Wednesdays at 9 AM Eastern US time. We hope to see you there!

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2026 IES Gold Medal to Prof. Thomas Prisner

The IES Gold Medal for 2026 is awarded to Professor Thomas Prisner in recognition of his pioneering contributions to the methodology, instrumentation and application of EPR and spectroscopy at high fields and with pulse techniques, as well as his achievements in combining the development of EPR and DNP. Prof. Prisner's contributions to spectrometer technology, particularly for high-field ENDOR, pulse shaping by arbitrary waveform generators, and pulse liquid-state DNP, enabled new experimental techniques. He also developed such techniques, particularly for multi-frequency pulse dipole spectroscopy. Prof. Prisner demonstrated how these new techniques can provide new information about biological systems in vitro and in cellulo, thereby making an important contribution to the understanding of the structure and dynamics of nucleic acids. He served as an ambassador for EPR spectroscopy in the broader magnetic resonance community and trained a new generation of EPR spectroscopists. The International EPR (ESR) Society is proud to award Professor Thomas Prisner the Gold Medal for 2026 in recognition of his many impactful achievements at the frontier of our field. ●



2026 IES Fellow to Dr. Periannan Kuppusamy

Dr. Kuppusamy is an internationally acclaimed scientist, educator, and innovator whose pioneering work has profoundly shaped the fields of EPR spectroscopy, biomedical imaging, cardiovascular research, and translational technology development for oxygen measurements. He is a globally recognized pioneer in in vivo EPR oximetry and imaging, technologies that have transformed the ability to measure physiological parameters in living systems.

Dr. Kuppusamy's visionary leadership established comprehensive imaging resources that are still in use today. He spearheaded the creation and advancement of the Small Animal Imaging Shared Resource for the OSU Comprehensive Cancer Center, consolidating imaging capabilities across multiple colleges and catalyzing new research collaborations. He demonstrated exceptional commitment to mentorship, community-building, infrastructure development, and educational programming.

IES is honored to award Dr. Periannan Kuppusamy, a scientist of extraordinary accomplishment and influence, the distinguished recognition of IES Fellow. His career stands as a model of excellence, innovation, and service. ●



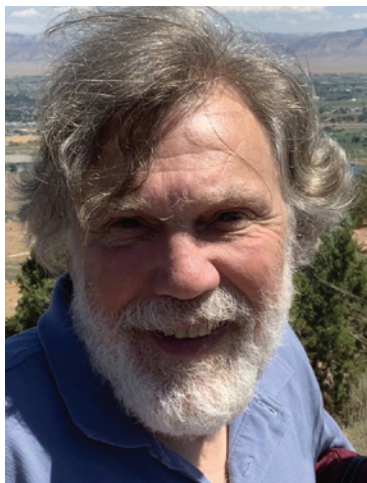
2026 John Weil Young Investigator Award to Dr. Alberto Privitera

Alberto Privitera has applied EPR to investigate the photophysics of diverse systems, including organic molecules, photovoltaic thin-film materials, and molecular qubit systems. His latest achievements include experiments to detect chirality-induced spin selectivity (CISS) in donor-acceptor compounds containing a chiral donor using time-resolved EPR and work on room-temperature optical spin polarization in a vanadyl spin qubit. These studies open new pathways for understanding spin-polarization mechanisms in chirality and transition-metal-based qubits. Alberto has made great progress on two directions. First, he investigated a trimeric porphyrin in which the photoexcited central free-base porphyrin serves as a controllable coupler to spin couple the two vanadyl qubits of the outboard porphyrins. This technique may result in a method to entangle two spins using the agency of the triplet excited state of a porphyrin. Second, Alberto contributed to research on the photogeneration of strongly spin-coupled radical pairs separated by a chiral bridge molecule. In this case, the molecules are designed to eliminate radical pair intersystem crossing leaving only CISS to produce triplet character in the radical pair. This work will have a significant impact on understanding the CISS mechanism. Alberto has established himself as an emerging leader in light-induced EPR spectroscopies and their application to key fields such as renewable energy and quantum information science. ●



Are you interested to become a member of the International EPR (ESR) Society? Please find the registration/information form for new/continuing members of the IES for individual members on this Web site: <https://ieprs.org>.

# Heidelberg – Where Love and Magnetic Resonance Found Me



Laila asked me to send “something about any magnetic-resonance-related subject I might like to talk about” from my side regarding the honorable prizes I recently received (the Richard Ernst Award in 2025 and the IES Gold Medal in 2026). As always, I gladly agreed. Instead of an interview, I would like to share a very early memory from the beginning of my scientific career.

I studied physics at the University of Heidelberg. I chose Heidelberg because of my strong interest in astrophysics and cosmology. I love the city – its old castle ruins, the mountains rising on both sides of the Neckar River, the historic Physics Institute on the Philosophenweg and, most importantly, it is the place where I met my wife Mirjam! After attending a seminar organized by Ulrich Haebleren and Klaus-Peter Dinse on “Coherent

Molecular Spectroscopy,” I decided to join the Molecular Physics group at the Max Planck Institute for Medical Research, headed by Karl Hausser, for my diploma thesis.

During my first three months at the institute, several distinguished scientists visited and delivered seminar talks: Bill Mims (Bell Laboratories, USA), Anatole Abragam (Commissariat à l’Énergie Atomique, France), Jan Schmidt (Leiden University, The Netherlands), and Robert Blinc (Jožef Stefan Institute, Slovenia). Their lectures left a profound impression on me. After listening to such eminent pioneers in various areas of magnetic resonance spectroscopy, I knew without doubt that I wanted to pursue my PhD in this field.

This was more than 40 years ago, and much has changed in science since then. I still remember Anatole Abragam giving an outstanding physics colloquium on the concept of spin temperature using only a single transparency. Today, especially after the COVID-19 pandemic, online meetings have replaced many in-person visits. Concerns about the CO<sub>2</sub> footprint of travel also encourage further reductions. Yet when I think back to how

inspiring those direct interactions were for me – and how much they shaped my career at such an early stage – I would not have wanted to miss them. Perhaps we should keep in mind this important aspect of personal visits: the opportunity to engage directly with young students, to inspire them, and to encourage them to pursue science.

I am also deeply grateful to the PhD students, postdocs and collaborators I had the privilege to work with, whose contributions were instrumental to the success of our research. It was so much fun to work together with all of you!

Thomas Prisner



Heidelberg at the Neckar river on a foggy spring morning.



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# Interview with Alberto Privitera on the Occasion of His John Weil Young Investigator Award 2026



**EPR newsletter:** *Dear Alberto, on behalf of the readers of the EPR newsletter we congratulate you on your John Weil Young Investigator Award 2026. We are most appreciative that you agreed to answer the questions of this interview. Why did you start towards your career in science?*

I was born in Bassano del Grappa, a beautiful small town in northern Italy, into a family with no direct connection to science – my father was a court clerk and my mother a homemaker – yet they always encouraged my curiosity about the world around me. I still remember one of the first gifts I received as a child: a small “magic chemistry” kit. That’s probably where my fascination for science really started. Around the same time, I picked up another passion – playing the drums – which my parents, and especially my neighbors, appreciated a bit less! Looking back, I think having both science and music in my life was important. In a way, they complement each other: science taught me to think systematically, while music kept the creative side alive.

Since elementary school, I’ve been lucky to have very good teachers who sparked my interest in mathematics and chemistry, along with constant support from my family. After graduating from a Liceo Scientifico, I decided to enroll in the Materials Science program at the University of Padua, following the advice of a friend who had just taken the same path. Since it was a relatively new program, it felt a bit like a gamble, but it turned out to be the right choice. The interdisciplinary training across physics, chemistry, and engineering gave me a broad view of science and played an important role in shaping my decision to become a scientist.

*Who introduced you into magnetic resonance?*

I was first introduced to magnetic resonance during a Magnetochemistry course taught by Marco Ruzzi and Marina Brustolon. Until then, magnetism hadn’t really been part of our training, and that course opened up a completely new perspective for me. Through it, I got to know the EPR group in Padua, where I discovered the magic of combining EPR spectroscopy with light excitation and found a really stimulating environment to learn the magnetic resonance fundamentals in depth.

At the start of my master’s degree, I had the opportunity to attend the EFEP school in Rehovot, which was a real turning point. It was my first scientific experience abroad, and being surrounded by many of the leading scientists in the EPR community made a strong impression on me.

After that, I decided to stay in Padua also for my PhD, working with Lorenzo Franco. I then moved to Oxford for three years, where I experienced the outstanding research environment of the CAESR laboratories. Over the following years, I spent time in other EPR

groups, including the University of Turin and the Northwestern University, before eventually joining the Laboratory of Molecular Magnetism in Florence, where I’m now happily putting down roots.

*What is your current research topic?*

At the moment, I’m working on two main projects, both centered on the interplay between spin and light. In the first, I study photoinduced spin interactions in organic molecules and materials, with applications in organic optoelectronics. A key technological aspect for the efficiency of devices like organic solar cells and light-emitting diodes is controlling the electron spin, which I approach using chiral molecules through the Chirality-Induced Spin Selectivity (CISS) effect. In this context, time-resolved EPR gives us a unique way to directly probe spin-selective pathways following photoexcitation.

The second project focuses on how light can help address some of the open challenges in molecular spin qubits. Light can be used to initialize qubits, generate light-activated qubits, and even switch on interactions between otherwise independent qubits on demand. Combining pulsed EPR with light really opens up new possibilities for quantum technologies.

In both cases, interfacing EPR with electrical detection could further extend its impact toward future device applications, something I plan to develop in the coming years.

*What is your opinion about the future of EPR and the development of its applications and methods?*

Year after year, EPR spectroscopy continues to prove itself as a powerful characterization technique, providing insight into processes with a level of detail and precision that is highly valuable across many fields. At the same time,

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## Awards

EPR is also becoming a method at the heart of technological development. A clear example is in Quantum Information Science, where controlling spin interactions with microwaves in qubits has direct applications.

The versatility of EPR, especially when combined with complementary approaches like optically or electrically detected magnetic resonance (ODMR and EDMR) or electric–spin effects,

further broadens its technological potential. Overall, I believe EPR is extending its scope beyond being a characterization technique, evolving into a functional technique that can help shape the future of advanced devices and quantum technologies.

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

Recent research is showing how central spin interactions are across many fields, from biology and chemistry to materials science and physics. It feels like a particularly exciting moment for young scientists to explore new phenomena and applications in magnetic resonance. I believe the key is to enjoy our work; this naturally leads to creativity, which is what ultimately drives us toward a deeper understanding of the world.

# Interview with Professor Stephen Hill on the Occasion of His Bruker Prize 2025



**EPR newsletter:** *Dear Professor Hill, on behalf of the readers of the EPR newsletter we congratulate you on your Bruker Prize 2025. We are most appreciative that you agreed to answer the questions of this interview. Why did you start towards your career in science?*

Physics, chemistry and mathematics were subjects I enjoyed immensely at school, and I was fortunate to have fantastic teachers for these subjects during my secondary education in England. My father had a PhD in chemistry and taught the subject at both the Open University and a vocational college in Oxford. Indeed, both my parents were educators, so it is perhaps not so surprising that I would also end up in the teaching profession. When you factor in a grandfather who was an engineer, science came very naturally to me. For these reasons, I have to say that there was never really a “choice” in the pursuit of a career in science. Even the decision to study physics at university was straightforward, as it was by far my favorite subject. Again, I was extremely fortunate to have exceptional undergraduate physics tutors in Kem Woodgate and John

Singleton, and I would go on to conduct my PhD research under the supervision of Singleton. Perhaps the one big moment was the decision to accept a postdoctoral position at the Magnet Lab in Florida under the guidance of Jim Brooks. The lab had only just moved from MIT to Florida State University when I arrived there. For me, this was like locking a kid in a candy store. In those early days at the lab, I was able to get as much high-field magnet time as I wanted, resulting a very significant number of publications, opening the door to a career as a professor of physics that would eventually bring me back to Florida State University and the MagLab.

*Who introduced you into magnetic resonance?*

It was John Singleton who first introduced me to magnetic resonance, though not the kind corresponding to the ‘E’ in IES. Rather, my PhD research focused primarily on using electron cyclotron resonance to measure effective masses of charge carriers in low-dimensional metals and semiconductors. I spent over a year modifying a dilution refrigerator so that I could simultaneously perform cyclotron resonance and magneto-transport measurements below 100 mK to probe the effects of electron correlations in high-mobility GaAs heterostructures. This was a hot topic at the time due to the recent discovery of the fractional quantum Hall effect. In parallel, I became interested in chemically inspired organic conductors and superconductors through a collaboration with Bill Hayes and Peter Day, where we were again interested in probing electron correlations through measurements of cyclotron masses. In these cases, the high conductivity associated with the metallic state necessitated the use of cavities to enhance sensitivity. Here, I would be fortunate enough to obtain advice from Brebis Bleaney on cavity design. Bleaney

was already retired but was a regular at coffee breaks at the Clarendon lab in Oxford. Around the same time, we acquired a vector network analyzer from Philippe Goy at l’École Normale Supérieure in Paris. Way ahead of its time and also affectionately known as the French Radio, this device would allow me to develop instrumentation for measuring conductivity in the 50 to 350 GHz range in high magnetic fields. A lot of this work was performed at the Nijmegen high-field lab in the Netherlands, where I learned a lot from Jos Perenboom, Olek Witlin and Jan van Bentum, themselves experts in magnetic resonance. Eventually, I would bring this expertise to the Florida magnet lab where I bumped into Florida State University chemist Naresh Dalal somewhat by accident. When he learned what I was doing, he asked me why I did not use my instrumentation to perform high-field EPR measurements. Naresh had an interest in the recently discovered  $Mn_{12}$ -acetate single-molecule magnet, which happens to have a zero-field splitting gap within its spin  $S = 10$  ground state of around 300 GHz. The rest, as they say, is history. Without knowing, I had developed a remarkable setup for performing ultra-wideband EPR measurements using over-moded cavities. During the next few years as I embarked on an independent career, my research would switch almost completely from the study of conductivity in metals with strong correlations, to the use of high-field EPR for investigating quantum phenomena in molecular magnets.

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

While I am extraordinarily proud and excited about the research output from my own group over the years, I think the aspect of my work that is most dear to my heart has come through the Electron Magnetic Resonance

User Program at the MagLab. In this role, I have had the opportunity to interact with so many outstanding and wonderful scientists from around the globe, and it gives so much satisfaction knowing that my colleagues and I have impacted the work of so many. Not just the PIs, but also the many students and postdocs who have visited the facility. Here, I must give a shout-out to Jurek Krzystek, Andrew Ozarowski, Hans van Tol and, more recently, Mike Ozerov and Tomas Orlando. It is a fantastic EMR team we have at the MagLab, and these individuals approach their work with the same philosophy as myself. We do so much more than simply providing access to the facility. In many cases, we seek out new users, and we work with them all the way from early conceptualization of a project through to eventual publication. Along the way, we provide training and education, particularly to early career researchers. Meanwhile, we do our best to address the needs and wishes of our users wherever funding allows, through development of new instrumental capabilities. All these activities are tremendously fulfilling.

*What is your idea of a team work in science?*

Throughout my career, interdisciplinary collaboration and teamwork have played a pivotal role. On the instrumentation side, I have been fortunate to work closely with the likes of Philippe Goy, Richard Wylde from Thomas Keating, Graham Smith at St. Andrews and my NMR colleagues in Tallahassee. Meanwhile, on the scientific side, almost all of my work has involved collaboration with chemists – far too many to mention here. To me, the most important aspect of these collaborations is the sharing of knowledge. I have benefitted tremendously by learning from my collaborators and I like to think they have learned some things from me. It is no good simply providing your own skills as a service to others or expecting a collaborator to solve a problem for you. Good teamwork requires a deep appreciation and understanding of what everyone in the team is doing so that you work together on all aspects of a problem. Without this cohesion, there is a risk that you fail to make the insightful decisions that lead to scientific breakthroughs. Of course, it helps if you have a genuine interest in learning outside of your area of expertise. Indeed, I would say this is essential to any collaboration. Early in my career, I was very fortunate to be part of an exceptionally talented interdisciplinary research team where we made tremendous efforts to develop a common language so that the physicists could understand the chemists and vice versa. We did so through weeklong

retreats focused simply on dialog, without any set agenda. Those interactions shaped my subsequent career, and I think they characterize the collaborations I am involved in nowadays. Not only does this move science forward, it is also becoming critical in terms of obtaining research funding where, more and more, there is a premium on collaboration and interdisciplinarity.

*What is your opinion about the future of EPR and the development of its applications and methods?*

I strongly believe that the future of EPR is exceptionally bright. We can all see how things have turned out for NMR, due in large part to the more mature technologies available at radio frequencies. We are now in an era where microwave electronics is advancing dramatically year-by-year, right in front of our eyes. This is driven largely by modern communications industries, and to such an extent that the most advanced EPR spectrometers require continual updating to remain state-of-the-art. The upside to this is that one can perform measurements today that were only a dream just ten years ago, and one can do so at ever increasing magnetic fields and frequencies. Meanwhile, EPR has the potential to impact so many different areas of modern research; electrons are everywhere and play a crucial role in so many fundamental aspects of nature and modern technology. Perhaps the only remaining barriers are cost and technical training: the cost associated with acquisition or development of modern EPR spectrometers is too high; and the required technical skills do not always overlap with the scientific areas of application. These are issues that I sincerely hope the EPR community will push hard on in the coming years. If the field is to continue growing, we need to educate the next generation of EPR “users” in disciplines such as chemistry and biology, and we need to make the technique more accessible.

*What are some of your frustrations in connection to EPR?*

Following on from the previous question, there is a flip side. I worry that EPR still flies somewhat under the radar. Within the wider scientific community, and even in the hard sciences, EPR is underappreciated and not widely understood, particularly compared to NMR, X-ray diffraction, thermal measurements and infrared/visible/UV scattering techniques. This presents some challenges. I find that I write rather long descriptions of experimental results in journal articles in order to assist the reader in understanding the EPR measurements. Meanwhile, reviewers sometimes do

not fully understand the importance of EPR in the context of a wider experimental investigation. For example, I recently had a referee question the assignment of an unusual oxidation state of a metal, when the EPR spectrum provided unambiguous, “slam dunk” proof. I am also often told by non-scientists that they understand NMR, but that EPR is a complete mystery. Unfortunately, I do not fully understand the reasons why. These are issues that I feel our community has to try to address, because it may impose some barriers to entry into the field. NMR has applications that most people can relate to. I am starting to see that the impact of EPR to quantum science catches people’s imagination and excitement.

*If you could make one wish to benefit EPR, what would it be?*

My wish would be to defeat the terahertz gap! EPR continues to be limited by microwave technology and not the available magnetic fields. Consequently, sensitivity does not improve with field and frequency in the same way as NMR does. It makes our job of developing high-frequency EPR spectrometers extremely challenging. Of course, this is not an easy nut to crack; there are many fundamental reasons why the terahertz gap exists. However, just imagine what we could do if someone could magically solve this problem and manufacture sources and detectors that performed optimally all the way from the radio frequency band to the infrared?

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

I know that it sounds awfully clichéd, but I have always lived by the phrase *carpe diem*. Time passes so quickly, especially in your early career. You may only have a year or two to make an impact at a given point in your career. Seizing these opportunities has a multiplicative effect in so many different ways: you build your own knowledge on top of knowledge, leading to exponential intellectual growth; you make the very most of the unique environment you find yourself at a given point in time; and, the more scientific breakthroughs you make, the more hungry you become. Of course, you need to be passionate about science, and you need to eat, sleep and breathe your work as well. But I firmly believe these things are interconnected. Seizing every opportunity also implies soaking up as much knowledge as you possibly can. Be curious about everything. In the context of magnetic resonance, this includes the hardware, the methodology, the underlying theory and the science associated

with your research project. If you do not understand the hardware, you will not be able to optimize the methodology. If you do not understand the methodology, you will not

know how a given measurement can answer a research question in your research. A final piece of advice that I feel is really important is not to go it alone. Share your experiences and

collaborate. You learn by discussing your work with others. Meanwhile, strong teamwork will always result in outcomes that far exceed the combined individual contributions.

## Interview with Mikhail Kolokolov on the Occasion of His IES Best Paper Award 2024-2025



**EPR newsletter:** *Dear Mikhail, on behalf of the readers of the EPR newsletter we congratulate you on your IES Best Paper Award 2024-2025. We are most appreciative that you agreed to answer the questions of this interview. Why did you start towards your career in science?*

I am actually a second-generation researcher, and my path into science feels like a natural continuation of my family's legacy. Both of my parents, as well as my older brother, graduated from Novosibirsk State University, making our entire family a family of physicists. From a young age, I was driven by a curiosity about how the physical world works and a strong desire to develop new, useful technologies. When it came time for my own studies, choosing Novosibirsk State University was an easy decision. It is situated in Akademgorodok, an "academic town within a town" in the middle of the Siberian forests. This unique environment hosts dozens of research institutes from all scientific disciplines, physically and intellectually united by the central university. I was deeply attracted to this ecosystem because it allows students to get involved in active, hands-on laboratory research very early. Akademgorodok is also famous for unique and highly productive collaborations across different institutes. When it comes to research, it's hard to find a better-suited place in Russia to start.

*Who introduced you to magnetic resonance?*

At the beginning of my university studies, my growing interest in biology led me to decide to specialize in biophysics, so I joined the Chair of Chemical and Biological Physics. Halfway through 2020, during my third year, I was looking for a lab for my bachelor's diploma. Following the strong recommendations of senior peers, including my brother who works in NMR, I joined Dr. Olesya Krumkacheva's group at the EPR Laboratory of the International Tomography Center. Even then, it was known as one of the top biological EPR groups in Russia. As you can guess, I enjoyed working there, and I am still there for my PhD. From the start, I was included in important projects. I loved the friendly and supportive atmosphere created by the many young, motivated researchers in our lab. I felt truly involved in the research, obtaining original results and sharing responsibility, which helped me become more independent over time.

*Your IES Best Paper 2024-2025 is a result of a brilliant team work by Mikhail I. Kolokolov, Natalya Sannikova, Sergei A. Dementev, Roman Podarov, Kseniya A. Zhdanova, Natalya Bragina, Alexey Chubarov, Matvey Fedin, and Olesya A Krumkacheva, in which everybody made his/her part of the road to the success. What part of it was within your expertise and interests in magnetic resonance?*

Our work identifying binding sites was, well, quite challenging! To start with, the investigation of photo-activated triplet systems, such as porphyrins, in a biological context has been a key direction for our group since long before I joined. This extensive investigation of porphyrins binding to albumin was a logical continuation of that research. However, this article took time to produce. In fact, some of the initial experiments were performed back in 2022 by Natalya Sannikova (who, by the way, very recently earned her PhD!). However, due to unexpected disruptions the project was temporarily sidelined. It was

revived some time later when I was tasked with interpreting the data for my Master's degree. We were curious to pinpoint exactly where the porphyrins bound to the albumin. At the time, molecular modeling was new to me, but I was happy to expand my skill set. I quickly familiarized myself with various computational tools and approaches for binding site detection. Yet, when I applied standard workflows to our specific data, I realized that they, to put it mildly, did not perform well... Traditional docking workflows simply provided results that were inconsistent with our experimental EPR data, such as predicted sites that contradicted DEER data or a disregard for the different chemical nature of porphyrins. This pushed me to develop a new computational workflow described in the paper. It took a lot of trial and error, trying different tools and ways of interpreting data, but conversations with my supervisor and colleagues helped me greatly. Along the way, I also had to learn how to perform light-induced EPR spectroscopy to conduct several crucial missing experiments. In the end, this project was a deeply collaborative effort, and I am incredibly grateful to be part of such a helpful research environment. I should also note that we are currently finishing up our next paper that iterates on this methodology with the application to more complex systems.

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

Since I am still a young researcher myself (at least I hope so), my advice might seem a bit unexpected: learn fields outside of EPR! In my opinion, biological EPR exists in an interesting niche, as it is mostly a complementary method. It doesn't give you complete, ready-to-publish structures through routine, established workflows. Instead, it provides very specific, unique information about structure and dynamics that other methods simply cannot access. Because of this, you can't just apply EPR to every biological system and expect an easy answer. Every project becomes unique and re-

quires a tailored approach. Because EPR gives us such specific data rather than the whole picture, there is no point in using it on simple problems. However, this limitation is actually its biggest strength, as it forces us to choose the most challenging systems where other methods fail, and where EPR data becomes truly necessary. That naturally pushes us to work on complex targets right at the edge of modern biology, which I find very inspiring. But working at this edge means you have to

learn other fields. You need to understand real, complex biology, not just textbook examples, because the systems you study aren't fully understood yet. You also have to learn complementary methods, like molecular modeling or other types of spectroscopy, to put the whole picture together. So, my primary advice is to look for new challenges and expand your skills beyond magnetic resonance. Also, these quirks of the field mean you almost always need to collaborate with other research groups. These

connections have to be forged somehow, so use conferences to actually make new friends and collaborators. Oh, and remember to step away from the news every now and then! Finally, I would like to thank my supervisor, Dr. Olesya Krumkacheva, and my colleagues for making it possible to work in such a great environment, as well as the IES for giving us this honorable award!

## Interview with Daniele Panariti on the Occasion of His IES Best Paper Award 2024-2025



**EPR newsletter:** *Dear Daniele, on behalf of the readers of the EPR newsletter we congratulate you on your IES Best Paper Award 2024-2025. We are most appreciative that you agreed to answer the questions of this interview. Why did you start towards your career in science?*

My path towards science was driven by a deep curiosity about how things work at a fundamental level, a curiosity that only grew stronger as my studies progressed. What truly drew me in was realizing that science offers a wonderful combination of rigor, creativity, and problem-solving. The idea that careful experiments and thoughtful analysis can reveal something new about the world was, and still is, incredibly motivating for me.

*Who introduced you into magnetic resonance?*

I was first introduced to magnetic resonance by Prof. Marilena Di Valentin, who went on to mentor me during my Bachelor's, Master's, and PhD studies. Her inspiring Physical Chemistry lectures at the University of Padova sparked my

interest so strongly that magnetic resonance was at the core of my academic path for many years. I still remember a particular moment in one of her undergraduate classes, when she mentioned that triplet states can exhibit non-degenerate spin sublevels even in the absence of an applied magnetic field, and that EPR is one of the tools used to investigate this effect. The full explanation would come in a later lecture, but that brief remark was enough to spark a curiosity that I believe was one of the earliest seeds of interest in the field.

I would like to thank her once again for the many opportunities she gave me and for being such an important guide throughout those years.

*Your IES Best Paper 2024-2025 is a result of a brilliant team work by Daniele Panariti, Sarah M. Conron, Jinyuan Zhang, Michael R. Wasielewski, Marilena Di Valentin, and Claudia E. Tait, in which everybody made his/her part of the road to the success. What part of it was within your expertise and interests in magnetic resonance?*

My contribution to this work sits at the intersection of two things I find genuinely fascinating: spin-correlated radical pairs and the precise manipulation of spins using microwave pulses.

Radical pairs of this kind, generated by photoinduced electron transfer in donor-acceptor systems exhibit distinctive spin polarization and unique behavior in EPR spectroscopy. The out-of-phase echo signal in these systems is modulated by electron spin-spin couplings, which can be probed through out-of-phase Electron Spin Echo Envelope Modulation (ESEEM) experiments to extract both exchange and dipolar interactions between the

coupled radicals. While the dipolar interaction reveals inter-spin distances and geometries, the exchange interaction offers insights into the electronic structure of the radical pair; information that is invaluable for designing optimized donor-acceptor systems for artificial photosynthesis and quantum sensing.

Advancing our understanding of spin-correlated radical pairs in biological systems, optoelectronic devices, and quantum information science relies on the ability to accurately manipulate and control spins with microwave pulses. To address this challenge, we focused on two model donor-bridge-acceptor triads at the heart of this study, BDX-ANI-NDI and TTF-ANI-PI, originally designed and synthesized by Dr. Sarah Conron, Dr. Jinyuan Zhang, and Prof. Michael R. Wasielewski. Building on their work, Dr. Claudia E. Tait and I focused on developing pulse EPR experiments with improved spin control using shaped pulses dedicated to spin-correlated radical pairs. Narrowband-selective excitation with near-rectangular excitation profiles was achieved using BURP (Band-selective, Uniform Response, Pure phase) pulses, while frequency-swept chirp pulses enabled broadband excitation of both radical pair spins.

More specifically, my role involved implementing the shaped microwave pulse sequences, carrying out the out-of-phase ESEEM experiments, and developing simulations to model the behavior of the spin-correlated radical pairs. The process of building and refining the simulation program, a Matlab routine based on the EasySpin implementation of spidyan, was particularly stimulating as these measurements are otherwise genuinely challenging to interpret and the simulations significantly deepened our understanding of what we were

## Awards

observing. Working with Claudia has been an invaluable experience, and I am deeply grateful to her for welcoming me into her group.

Overall, our approach led to enhanced modulation depths in out-of-phase ESEEM experiments and enabled the correlation of dipolar frequencies with the EPR spectrum, thus providing further insights into donor-acceptor geometries. Taken together, this collaborative work demonstrated how improving control over excitation of spins in spin-correlated radi-

cal pairs provides advantages not only for the characterization of these species in biological systems and materials for optoelectronics and energy, but also for the potential use of spin-correlated radical pairs for quantum sensing.

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

My advice to early-career researchers, whether in magnetic resonance or any other field, is

to stay curious and to keep questioning what you think you already know. Take the time to truly master the fundamentals but also dare to pursue unconventional ideas or methods; they may be more demanding, yet they are often the most stimulating and rewarding. Above all, remember that science advances through collaboration, so be open and generous with your knowledge.

## IES Poster Prize at the 10th EFEP Summer School



### Sudipta Khamrui:

To begin with, I would like to express my sincere gratitude to the EUROMAR organisers for the opportunity to engage with the magnetic resonance community. This conference became especially memorable for me. Despite initial uncertainties and challenges that made me unsure whether I could attend, I not only made it but was also honoured with the best Poster Award, thanks to the International EPR Society. This recognition made every effort truly worthwhile.

I joined the high-field DNP/EPR group at Tel Aviv University, led by Prof. Ilia Kaminker, in July 2024 as a postdoctoral fellow, following my PhD at the Indian Institute of Technology, Kharagpur. During my doctoral research, I investigated charge transport and spin dynamics of paramagnetic defects in semiconductors using X-band pulsed EPR spectroscopy. Building on this foundation in static pulse-EPR techniques, I have expanded my research interests to Dynamic Nuclear Polarization (DNP) and high-field EPR spectroscopy at 7/14 T.

DNP addresses the inherent low sensitivity of conventional NMR spectroscopy. When performed under magic-angle spinning (MAS), it offers remarkable gains in sensitivity. In DNP, mm-Wave irradiation at or near the electron Larmor frequency transfers polarization from unpaired electrons to nuclear spins, enhancing NMR signal intensities by several orders of magnitude. Because of this, it is essential to understand electron spin dynamics, which is possible with pulsed EPR measurements. While static pulse-EPR can shed light on electron spin dynamics relevant to static DNP, the electron spin dynamics under the conditions of modern high-field MAS-DNP are very different.

With advances in NMR technology, particularly the development of high-field superconducting magnets, DNP experiments have evolved too and are nowadays performed at increasingly high magnetic fields reaching 21.15 T. It is well known that the DNP performance is field dependent. So, the knowledge of electron spin dynamics measured under typical EPR conditions: static and at low fields, is of limited relevance to understanding high-field MAS-DNP. This has highlighted the need for high-field MAS-EPR experiments, of which only two early reports exist in the literature – from the group of H. W. Spiess in 1997 and 2000 at 0.3 T, aiming at improving the spectral resolution [1, 2]. Afterwards, they never executed MAS-EPR at higher fields, and this remained unattempted for more than 20 years. Implementing MAS-EPR at high fields remains challenging, especially when coupling low-power mm-Wave radiation effectively to a spinning sample.

Recently, our group achieved a significant milestone by reporting the first MAS-EPR experiment at 6.9 T with spinning speeds up to 4 kHz using a spherical rotor [3]. Although

this allowed us to observe electron spin dynamics over a few microseconds, it did not yet reach the longer timescales relevant for understanding MAS-DNP, which require both higher spinning rates and new experimental methodologies.

In my EUROMAR 2025 poster, I presented my postdoctoral work in the DNP/EPR laboratory at Tel Aviv University, where I am currently developing the methodologies to probe electron spin dynamics on the MAS-DNP-relevant timescales. Using P1 defect-enriched diamond powders, chosen for their efficient room-temperature hyperpolarization of  $^{13}\text{C}$  nuclei, we now perform rotor-synchronized MAS-EPR experiments at spinning speeds up to 37 kHz. This improvement allows us to observe electron spin dynamics over  $\sim 400 \mu\text{s}$ , a two-order-of-magnitude extension compared to our previous work.

I am deeply grateful to my postdoctoral advisor, Prof. Ilia Kaminker, for the opportunity to contribute to this flagship project, recently funded by an ERC Consolidator Grant. I also extend my acknowledgement to my lab colleagues and to Frederic Mentink-Vigier of the National High Magnetic Field Laboratory, Tallahassee, USA, for their invaluable support.

1. Hubrich, M.; Bauer, C.; Spiess, H. W. Magic-angle spinning electron paramagnetic resonance spectroscopy. *Chemical physics letters* 1997, 273, 259–264.
2. Hessinger, D.; Bauer, C.; Hubrich, M.; Jeschke, G.; Spiess, H.-W. Magic-angle sample spinning electron paramagnetic resonance – Instrumentation, performance, and limitations. *Journal of Magnetic Resonance* 2000, 147, 217–225.
3. Nir-Arad, O.; Fialkov, A. B.; Shlomi, D. H.; Manukovsky, N.; Mentink-Vigier, F.; Kaminker, I. High-field pulsed EPR spectroscopy under magic angle spinning. *Science Advances* 2024, 10, eadq6073.

# IES Poster Prize at the 10th EFEPR Summer School



## Maria Chiara Pagliero:

I am very thankful to the International EPR Society (IES) for awarding me a Poster Prize at the 10th EFEPR Summer School in Manchester and for giving me the opportunity to discuss my current research in the *EPR newsletter*.

My PhD project lies at the interface between Electron Paramagnetic Resonance (EPR) and Magnetic Resonance Imaging (MRI). MRI is a powerful diagnostic technique whose success largely depends on contrast agents that enhance image quality by shortening water proton relaxation times [1]. Currently, all clinically approved agents are gadolinium-based ( $Gd^{3+}$ ) chelates, owing to their high spin state ( $S = 7/2$ ) and long electronic relaxation times. However, concerns regarding  $Gd^{3+}$  toxicity and environmental persistence have motivated the search for safer, earth-abundant alternatives based on first-row transition metal ion (TMI) complexes.

For  $Gd^{3+}$  complexes, a wealth of experimental and computational data accumulated over more than 35 years and spanning hundreds of individual complexes, has led to well-established procedures for assessing the value of several key parameters determining relaxivity. Such comprehensive knowledge is still lacking for TMI-based systems. In this context, EPR plays a crucial role in elucidating the structure-function relationships that determine proton relaxivity, providing deep insight into electronic structure, spin dynamics, and local environments [2].

My poster presents a detailed EPR analysis of two Cu(II) complexes,  $[Cu(TACN)]^{2+}$  and  $[Cu(TREN)]^{2+}$ , which differ in ligand denticity, geometry, and hydration state, all

parameters that critically influence their relaxometric properties. The cornerstone of my PhD project is the accurate determination of key parameters such as the rotational correlation time ( $\tau_R$ ), the proton-metal distance, and the electron spin density distribution, all of which significantly affect relaxivity.

The electronic structure and site symmetry are evaluated from CW-EPR measurements on frozen solutions, while room-temperature CW-EPR enables the determination of  $\tau_R$ . Additionally, hyperfine spectroscopies such as ENDOR and HYSCORE are employed to probe the electron spin distribution over the ligands and coordinated water molecules.

The frozen-solution X-band CW-EPR spectrum of  $[Cu(TACN)]^{2+}$  revealed an axial g-tensor ( $g_{\parallel} > g_{\perp} > g_e$ ) and an axial hyperfine tensor ( $A_x = A_y \ll A_z$ ), consistent with a square-pyramidal Cu(II) site and diagnostic of a  $dx^2-y^2$  ground state. Simulation of the spectral linewidth at room temperature yielded a rotational correlation time  $\tau_R$  of 8 ps at 298 K. In contrast,  $[Cu(TREN)]^{2+}$  displayed EPR features typical of a trigonal-bipyramidal Cu(II) environment, with g- and A-tensor orders of  $g_x > g_y > g_z \approx 2$  and  $A_x > A_y > A_z$ , respectively, indicative of a  $dz^2$ -based ground state and a longer  $\tau_R$  of 12.6 ps.

To elucidate the magnetic interactions between the Cu(II) center and surrounding protons, orientation-selective  $^1H$  Davies ENDOR spectra were recorded at Q-band frequency. Both complexes exhibited intricate spectral patterns, which were simulated using DFT calculations as guidance. For  $[Cu(TACN)]^{2+}$ , two water molecules were identified by their  $^1H$  isotropic hyperfine couplings ( $a_{iso} = -0.85$  MHz and  $+0.3$  MHz).  $[Cu(TREN)]^{2+}$ , on the other hand, showed only one coordinated water molecule with  $a_{iso} = -3.8$  MHz, indicating strong spin polarization consistent with shorter Cu-H distances.

The development of MRI contrast agents based on first-row TMIs represents a promising strategy to address the safety, environmental, and supply-chain limitations associated with gadolinium-based agents. Recent studies have shown that  $S = 1/2$  TMIs, despite their lower magnetic moments, exhibit intriguing and potentially useful properties [3]. The largely untapped potential of  $S = 1/2$  systems such as Cu(II) and VO(IV) – particularly as redox-responsive “smart” probes – warrants further systematic exploration, which is the direction I am pursuing in my PhD research.

1. J. Wahsner et al., *Chem. Rev.*, **2019**, 119, 957–1057
2. E. Salvadori et al., *Chem. Sci.*, **2025**, 16, 20631–20646
3. V. Lagostina et al., *Inorg. Chem. Front.*, **2023**, 10, 1999–2013; A. Shah et al., *Proc. Natl. Acad. Sci. U.S.A.*, **2023**, 120, (27) e2219036120

## Mario Chiesa:

Maria Chiara joined our group for her final-year project of the Master's degree in Chemistry at the University of Torino in 2023. She worked on the characterization of Cu(II) complexes, exploring both their relaxation properties and ligand structures using pulse EPR techniques. Her work became the seed of a completely new research direction in our lab, dedicated to elucidating structure-activity relationships in paramagnetic molecular coordination compounds of first-row transition metal ions, with potential applications as MRI contrast agents.

We were fortunate that Maria Chiara decided to remain in the group and continue her research as a PhD student, deepening our understanding of the intricate and complex interplay between the morphological and chemical structure of transition metal complexes on magnetic relaxivity.

To this end, Maria Chiara is applying the full arsenal of CW- and pulse EPR techniques – including ENDOR, ESEEM, HYSCORE, and EDNMR – along with measurements of electron relaxation and rotational correlation times. Her goal is to bridge the intrinsic paramagnetic properties of different transition metal ion complexes with their Nuclear Magnetic Relaxation Dispersion (NMRD) profiles, thereby advancing our understanding of first-row transition metal ions as potential future MRI contrast agents.

This is a highly challenging project, and Maria Chiara's dedication and enthusiasm are yielding outstanding results. We are all immensely proud that her hard work has been recognized with the IES Poster Award at the 10th EFEPR Summer School in Manchester. Well deserved, Maria Chiara!



# IES Poster Prize at RSC EPR 2025



## Jennifer Naughton:

Firstly, I would like to thank the International EPR (ESR) Society for awarding me an IES poster prize at the RSC ESR 2025 conference held in Bloomsbury, London, as well as this opportunity to present some of my research in the *EPR newsletter*. The current interest of the Harmer lab is focused towards furthering the versatility of double electron-electron resonance (DEER) spectroscopy (also known as PELDOR, pulsed electron double resonance) through the creation and testing of novel spin label methodology that can be performed in the presence of cysteine-rich proteins. DEER is a versatile technique for protein structure elucidation, as well as protein dynamics and function investigation. It utilises site-specific spin labelling to measure long-range distance data (up to ca. 80 Å) through the space dipolar coupling between two electron spins. Spin labels to enable these measurements are typically attached to proteins of interest via prior site-directed mutagenesis to incorporate, almost exclusively, cysteine residues for subsequent tagging reactions. Predominantly, nitroxide labels are preferentially used for their stability and selectivity, the gold standard among these being 'MTSL' (C<sub>10</sub>H<sub>18</sub>NO<sub>3</sub>S<sub>2</sub>), a highly reactive thiol-specific spin label. However, this well-established chemistry is non-translatable to proteins containing surface exposed cysteine residues of structural or functional significance, thus there is currently a lack of generally applicable labelling techniques not reliant upon cysteine residues. To address this limitation, we used an efficient expression system optimised by our collaborators at the

Australian National University (T. Huber and N. Cox) that enables genetic incorporation of non-canonical amino acid (ncAA) cyanopyridylalanine using amber stop codons for site-specificity [1, 2]. Our test system for this type of spin labelling is ERp29, an endoplasmic reticulum luminal protein which functions as a chaperone during protein folding and was selected as our model protein due to a pre-existing high quality X-ray crystallography structure. Through Nitrile-AminoThiol (NAT) click reaction chemistry we were able to attach novel gadolinium (Gd<sup>3+</sup>-DOTA) labels of varying designs (synthesised by V. Bayya) through conjugating the aminothioliol group in the spin label to the encoded cyanopyridylalanine within the purified ERp29 protein, forming a stable reaction product via macrocyclisation [3]. This reaction is highly efficient and widely biocompatible, able to be performed spontaneously in neutral buffers, with the labels themselves designed to contain a stable paramagnetic centre (a Gd<sup>3+</sup>) in cellular environments without hindering binding/other functional activities or altering protein structure. The exact NAT-click reaction conditions required optimisation, with labelling percentages monitored via LC-MS analysis, as well as further purification being necessary to remove excess spin label and reagents from the samples prior to measurement. We have successfully demonstrated the production of Gd<sup>3+</sup> spin-labelled, cysteine-containing ERp29 protein using the NAT-click reaction and subsequent DEER measurements at Q-band (using a 3 mm Bruker resonator at 15 K) displaying a Gd<sup>3+</sup>-Gd<sup>3+</sup> mean distance of approximately 65 Å. Following this initial proof of concept validation, we are currently trialling other spin label designs with linkers of different lengths and properties. Once the methodology developments are completed, the aim is to apply the techniques to two applications. Both these research targets are cysteine-rich proteins we are interested in determining the structure-function relationship of (e.g., a loop motif presumed to act as a gate to control the access of substrates to the binding pocket). In summary, this research project aims to develop a general spin labelling technique to broaden the applicability of dipolar EPR spectroscopy, particularly for proteins with natively crucial cysteine residues, with a highly specific and stable label capable of performing comparatively to the MTSL gold standard.

1. Huber T, Naganathan S, Tian H, Ye S, Sakmar TP. Unnatural amino acid mutagenesis of GPCRs using amber codon suppression and bioorthogonal labelling. *Methods in enzymology*. 520: Elsevier; 2013. pp. 281–305.
2. Wang L, Xie J, Schultz PG. *Annu Rev Biophys Biomol Struct*. 2006; 35(1), 225–49.
3. Brabham R, and Fascione M. *ChemBiochem*. 2017; 18(20), 1973–1983.

## Jeffrey Harmer:

Jennifer joined my group at the Centre for Advanced Imaging, University of Queensland, in February 2023 as a scholarship HDR student, having previously completed a Biomedical Science Honours degree (First Class) at the University of Otago and a Bachelor of Science in Biochemistry at the University of Canterbury. Jennifer's PhD is supervised jointly by myself and Prof. Mobli, a world leader in the field of Nuclear Magnetic Resonance, with whom she is working on stabilising resting state voltage-gated sodium ion channels (Na<sub>v</sub>1.7), using NMR spectroscopy and isotope labelling to solve this membrane protein structure. She also has two projects focused on utilising the technique of EPR, both of which involve spin labelling proteins. The first investigates a di-domain construct of a non-ribosomal p<sup>e</sup>ptide synthetase (NRPS) that synthesises teicoplanin, a heptapeptide antibiotic used as a last resort for multi-drug-resistant bacterial infections, using nitroxide MTSL labels and DEER spectroscopy. Here we aim to determine the structure-function relationship of this interaction within its complex biomolecular system. The full NRPS has many surface-exposed cysteines, so we became interested in labelling approaches using unnatural amino acids via a NAT-click reaction. We are currently investigating the general applicability of this approach and hope it can become an accessible option for proteins where cysteine labeling is not feasible. Jennifer has been a great asset to my lab during her PhD and has enabled these projects to advance to maturity, a fantastic technical achievement. We have had a lot of fun on this journey and hopefully there is some more to come before she completes her PhD in the middle of 2026.



# IES Poster Prize at the RMC 2025



## Pathorn Teptarakulkarn:

I am truly honored to receive this poster award and the opportunity to present my research in the *EPR newsletter*, especially since the 2025 Rocky Mountain Conference on Magnetic Resonance (Snowbird, Utah) was the first EPR-focused conference I attended during my graduate career. For this, I would like to express my sincere gratitude to the International EPR (ESR) Society. The poster I presented at the conference showcases the use of dipolar EPR spectroscopy to study the redox landscape of the oxygen-insensitive Huc [NiFe]-hydrogenase. This research is in collaboration with Prof. Chris Greening (Monash Biomedicine Discovery Institute, Australia) and Prof. Rhys Grinter (University of Melbourne, Australia), who generously provided us with the protein samples.

Huc [NiFe]-hydrogenase (Huc) is a membrane-associated protein complex involved in the respiratory chain of *Mycobacterium smegmatis* [1]. Huc possesses the ability to selectively extract electrons from atmospheric hydrogen gas ( $H_2$ ), driving ATP synthesis. The process is not affected by oxygen gas, which is known to inhibit many other [NiFe]-hydrogenases to varying degrees [2]. These properties make Huc a promising platform for developing biocatalysts that operate in air. Despite being a protein complex with a central stalk and eight [NiFe]-hydrogenase units, each unit shares common features with other [NiFe]-hydrogenase homologs: (I) a large subunit, where the [NiFe] active site resides, and (II) a small subunit, housing three iron-sulfur clusters, which act as an electron transport chain to and from its redox partner. When comparing Huc to other homologs, the [NiFe] active sites and

relative positions of iron-sulfur clusters are almost indistinguishable. However, unlike other [NiFe]-hydrogenases, where the small subunit contains a mixture of low- and high-potential iron-sulfur clusters, Huc has three high-potential [3Fe-4S] clusters. As a result, we believe that the redox landscape of Huc plays a vital role in its outstanding catalytic properties. Unfortunately, the non-zero spin state of the [3Fe-4S] clusters, regardless of their oxidation state, enhances electron relaxation via dipolar interactions, preventing the use of pulsed EPR spectroscopy on this system.

To overcome this challenge, continuous wave EPR spectroscopy was used instead. The EPR spectrum of an as-isolated Huc sample collected at 40 K shows a significant isotropic signal around  $g = 2$ , assigned to  $[3Fe-4S]^+$  cluster(s), and a set of lower-intensity signals between  $g = 2.1$  to 2.5, characteristic of Ni-centered signals in [NiFe]-hydrogenases [3]. These signals can be simulated using three sets of rhombic species. Upon photolysis at 25 K, one of the species increases in intensity, one decreases in intensity, and one was unaffected. This observation led us to the conclusion that the three species observed are Ni-L, Ni-C, and Ni-B, respectively. Even though the presence of catalytic intermediates (Ni-C and Ni-L) in an air-exposed, as-isolated sample has not been observed before in other [NiFe]-hydrogenases, it was not unexpected considering that Huc can oxidize atmospheric  $H_2$ .

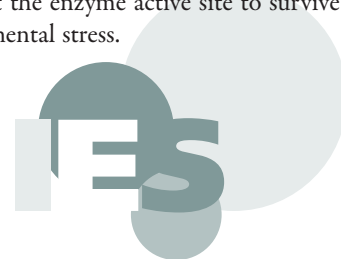
Knowing what we are looking at in the spectrum, we conducted variable-temperature EPR (VT-EPR) experiments. As the temperature decreased, we observed a decrease in the Ni-centered signals, accompanied by an increase in Ni-centered signals split around the high-temperature value. The splitting was assigned to the  $Ni^{III}-[3Fe-4S]^+$  dipolar interaction [4]. At the same time, we also observed peak splitting for the  $[3Fe-4S]^+$  signal – however, that splitting shifts with temperature. The distinct temperature-dependent behavior led us to assign this to be a different dipolar interaction. Using EasySpin to simulate the spectra, this interaction was suggested to be between an oxidized  $[3Fe-4S]^+$  and a reduced  $[3Fe-4S]^0$  cluster [5]. The large dipolar coupling constants indicate that these clusters are adjacent to each other, with the proximal cluster in the oxidized state and the medial cluster in the reduced state. Ongoing work is aimed at obtaining a more quantitative picture of the redox landscape of Huc.

I would like to conclude by thanking my advisor, Prof. Hannah Shafaat, who gave me the opportunity to work on this exciting project, along with all of my colleagues for their input and support.

1. Grinter, R.; Kropp, A.; Venugopal, H.; Senger, M.; Badley, J.; Cabotaje, P. R.; Jia, R.; Duan, Z.; Huang, P.; Stripp, S. T.; Barlow, C. K.; Belousoff, M.; Shafaat, H. S.; Cook, G. M.; Schittenhelm, R. B.; Vincent, K. A.; Khalid, S.; Berggren, G.; Greening, C. *Nature* **2023**, 615 (7952), 541–547.
2. Jespersen, M.; Greening, C.; Ernst, L.; Leung, P. M.; Shafaat, H. S.; Grinter, R. *Diverse Trends Biochem. Sci.* **2025**, 50 (7), 596–609.
3. Shafaat, H. S. [NiFe] Hydrogenases: In *Comprehensive Coordination Chemistry III*; Elsevier, **2021**; pp. 707–730.
4. Elsässer, C.; Brecht, M.; Bittl, R. *J. Am. Chem. Soc.* **2002**, 124 (42), 12606–12611.
5. Stoll, S.; Schweiger, A. *J. Magn. Reson.* **2006**, 178 (1), 42–55.

## Hannah Shafaat:

It is my great pleasure to introduce Pathorn (Henry) Teptarakulkarn. Henry joined my research group first as a visiting undergraduate researcher in Summer 2019 from Mahidol University in Bangkok, Thailand. After completing his M.S. in Inorganic Chemistry working with Prof. Chantarojsiri in 2021, Henry joined us at The Ohio State University for his Ph.D. studies, moving with the group to UCLA in summer 2023. Henry's research project centers around enzymes that can produce hydrogen gas, called hydrogenases, and their models. The goal is to understand how these hydrogenases work, with the ultimate goal of being able to combine their favorable reactivity with the robustness of a model system. Towards this end, Henry has been pursuing a wide array of techniques, ranging from EPR and paramagnetic NMR spectroscopy to electrochemistry to inorganic synthesis. He has taken the lead on all of these studies, from the experimental design to implementation to analysis. The work he presented at the RMC illustrates the power of EPR spectroscopy to answer questions about complex biomolecules. Specifically, Henry's work has revealed how nature can use auxiliary redox cofactors rather than having to entirely resculpt the enzyme active site to survive environmental stress.



# IES Poster Prize at the RMC 2025



## Camille McDonnell:

This year at the Rocky Mountain Conference, I was grateful for the opportunity to present a poster on developing Nitrogen Vacancy (NV) sensing technology for Nuclear Magnetic Resonance (NMR) Imaging applications.

NMR is a powerful tool capable of performing non-invasive chemical analysis. Of particular interest is its biological application to in-cell studies and metabolic reaction monitoring. This has important applications for cancer research, drug screening, and detection of key life-forming processes. However, to accurately perform these analyses, NMR necessitates a large sample volume (mL-scale) and high magnetic fields (T-scale) to overcome NMR's inherently weak Boltzmann spin polarization. As a result, NMR becomes expensive in terms of equipment and experiment time.

To address these limitations, NV centers in diamond have demonstrated the ability to perform NMR measurements on small sample volumes (pL-scale). The Coherently

Averaged Synchronized Readout (CASR) protocol integrates NV AC-magnetometry pulse sequences (XY8-N) with optical NV spin-state readouts synchronized to an external clock, achieving a spectral resolution of  $\sim 1$  Hz [1]. Furthermore, NV centers offer a major advantage through their powerful imaging capabilities, enabling real-time, real-space NV-NMR imaging of narrowband signals. This capability is groundbreaking for further characterization of chemical analysis.

Despite these advantages, the low volume limit of NV-NMR measurements requires the high analyte concentration, which poses challenges for biochemical studies where target molecules are often present at intrinsically low concentrations.

To surmount this, we incorporate the hyperpolarization technique Dynamic Nuclear Polarization (DNP). DNP utilizes microwave irradiation to induce the hyperfine-mediated electron-nuclear transitions, creating a highly populated non-Boltzmann nuclear spin state. This increased population manifests itself as an enhancement in NMR signal, vastly improving the sensitivity and lowering the necessary experiment time. For proton NMR, DNP has a theoretical limit of  $\sim 600\times$ , although experimental enhancements are typically  $\sim 100\times$ . By leveraging the high sensitivity of NV-based detection applied to a hyperpolarized sample, enhancements on the order of  $\sim 200\times$  are attainable [2]. Coupling NV-detection with hyperpolarization techniques thus addressed key obstacles inherent to classical NMR.

My colleague Zechuan Yin and I are developing a Radio-Frequency Quantum Diamond Microscope (RF-QDM) capable of imaging hyperpolarized NMR signals. In 2024, Zechuan Yin published results demonstrating the imaging capabilities of the RF-QDM by char-

acterizing two microcoils [3]. He showed that the RF-QDM achieves a spatial and spectral resolution of  $2\ \mu\text{m}$  and  $1\ \text{Hz}$ , respectively, with an overall sensitivity of  $1\ \text{nT}\cdot\text{Hz}^{-1/2}$ . Furthermore, he demonstrated simultaneous amplitude and phase imaging across a range of narrowband frequencies. Building upon this work, we are expanding the RF-QDM capabilities to imaging chemical-NMR signals. To prepare for this, I studied the DNP procedure using 4-hydroxy-TEMPO as the free radical in a classical NMR system. Through systematic investigations of microwave power, DNP polarization time, magnetic field strength, solvent composition, and related variables, I identified the key parameters that critically influence DNP performance. An enhancement of  $\sim 50\times$  was achieved at  $375\ \text{G}$ , substantially reducing the required measurement time. We are now working to replicate and ultimately surpass these results using the RF-QDM through simultaneous classical and NV-NMR measurements. Our goal is to image hyperpolarized signals directly on the NV diamond surface, and in the future, to incorporate microfluidic components to enhance sample and enable channel-resolved imaging and monitoring.

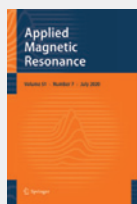
I would like to express my thanks to my advisor, Dr. Ronald Walsworth, and to staff scientists Dr. John Blanchard and Dr. Stephen DeVience for their mentorship and encouragement. I also thank my colleague Zechuan Yin for his guidance and expertise. Finally, I thank the NSTGRO fellowship for giving me the opportunity to travel and present at the Rocky Mountain Conference.

1. Glenn, D. R. et al., *Nature*, **2018**, 555, 351–354.
2. Bucher, D. B. et al., *Phys. Rev. X*, **2020**, 10(2), 021053.
3. Yin, Z. et al., *Phys. Rev. Applied* **2024**, 22(5), 054050.



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## Applied Magnetic Resonance



Applied Magnetic Resonance provides an international forum for the application of magnetic resonance methodology in physics, chemistry, biology, medicine, geochemistry, ecology, engineering, and related fields.

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- Emphasizes new applications and new experimental methods.
- Publishes regular and review articles, as well as topical issues.
- 100% of authors who answered a survey reported that they would definitely publish or probably publish in the journal again.

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# IES Poster Prize at the FGMR Bonn 2025



## Matan Perez:

My research deals with using electron paramagnetic resonance (EPR) for the advancement of lithium-ion batteries, which play an important role in many areas, from smartphones and electric vehicles all the way to renewable energies. However, the most commonly used anode material (graphite) has a relatively low specific capacity. This limitation restricts the energy density of the battery, making it difficult to achieve higher performance in applications that demand a long runtime or compact energy storage.

To pave the way for a new generation of batteries, the use of lithium metal as an alternative anode material could offer up to about ten times the specific capacity of graphite. One hurdle yet to overcome is the formation of needle-like micro-structures during battery charging, called dendrites, which reduce the battery capacity and pose a significant safety hazard due to internal short-circuits. The mechanism behind the growth of lithium dendrites is still poorly understood, a fact that has elicited major research effort in recent years to study their formation mechanism and its interplay with different battery parameters.

Magnetic resonance spectroscopy turns out to be a very suitable method for this purpose, thanks to its high sensitivity and the selectivity it offers in directly detecting lithium. Lithium metal is paramagnetic, has a high concentration of conduction electrons (CE), and the diameter of the dendrites tends to be in the order of its skin depth at X-band frequencies, which are used to probe the spin of the CE. Following this, EPR allows us to differentiate between the various structures it forms on a

microscopic level, which have a major impact on the CE resonance shape.

Despite this potential, so far, commercially-available X-band cavity resonator EPR systems exhibit limitations in monitoring their formation during *operando* experiments. Apart from the requirements for a customized design of the battery to be able to fit into the cavity, isolating the CE signal of the deposited lithium on the anode from the bulk lithium of the counter electrode makes resonator-based EPR of lithium-ion batteries a daunting task.

In a collaboration between the Helmholtz-Zentrum Berlin (HZB) and the University of Stuttgart, we develop and apply EPR-on-a-chip (EPRoC) microresonator-based EPR sensors for the study of lithium-ion batteries during operation. Given the fact that its field-generating coils are able to offer a detection region of less than a hundred micron away from the sensor's surface, we realized the advantages of this property to isolate EPR signals of lithium deposited on a copper wire from the bulk lithium of the counter electrode.

By acquiring the continuous wave (CW) EPR spectra during battery cycling, we monitored the deposited lithium as it accumulated on the copper wire. The deposited lithium spectra we obtained could be fitted to the theoretical, thin-film Dysonian model that describes the EPR signal of conduction electrons in thin metal plates. This, in turn, enabled us to calculate the time evolution of the model parameters and deduce different stages of growth based on how the EPR signal amplitude, resonance position, width and asymmetry evolved during the charging process: from the formation of small lithium islands to the growth of dendrites and finally to oxidation and the creation of solid electrolyte interface (SEI), which affected the acquired signals indirectly despite being EPR-silent.

As a next step, we designed a triple-phase stochastic model to represent the growth of lithium dendrites and how it reflects on the model parameters. With utilization of neural network surrogate models, we were able to optimize the model variables to match the *operando* EPR spectra. This way, we were able to map spectroscopic parameters to practical dendritic growth variables (like their diameter and growth rate). This process could open the door to the utilization of microresonators for understanding how to achieve the next generation of lithium-ion batteries, and we are eager to continue exploring all the new possibilities.

At last, I am very honored to receive the 2025 FGMR IES poster award, and would like to acknowledge the team involved in this work, namely Prof. Dr. Klaus Lips, Prof. Dr. Jens Anders, Dr. Pedro B. Groszewicz, Dr. Annica Freytag, and Dr. Michal Kern.

## Klaus Lips and Pedro B. Groszewicz:

It was with great pleasure that we received news about Matan's Poster Prize at the FGMR Bonn 2025! Matan has joined our group in September 2024 and managed to learn very swiftly the nuts and bolts of EPR in general, and of the setup for the EPR-on-a-chip in particular. This allowed him to dive straight into its application to investigate the *operando* deposition of lithium metal on copper as a model for anode-less batteries. Furthermore, the in-depth model he developed to relate the evolution of EPR parameters to the different stages on lithium microstructures formation was quite unique, and allowed us to unravel aspects from the early onset of lithium dendrite growth in an unprecedented manner.

Matan completed his Bachelor's degree in physics at the Hebrew University of Jerusalem in 2022. During his undergraduate studies, he developed a strong interest in quantum physics and in the practical use of quantum mechanical concepts for real-world applications. In his third year, he began working on his Master's thesis after joining a research group focused on microwave quantum technologies. More specifically, he worked on developing quantum encryption methods using quantum mechanical circuits operating at microwave frequencies. Through this work, Matan gained experience in many aspects of microwave engineering, including the simulation and design of microwave components for different applications.

He received his Master's degree from the Hebrew University of Jerusalem in 2023, completing his thesis titled "Toward the Realization of Microwave Quantum Key Generation in High-Loss Systems Using Quantum Mechanical Circuits."

Following his graduate studies, Matan worked in industry designing telecommunication chips operating at infrared frequencies, and is currently a PhD candidate in the Department of Spins in Energy Conversion and Quantum Information Science at HZB in Berlin.

# IES Poster Prize at the FGMR Bonn 2025



## Jascha Rüter:

Bioconjugation of paramagnetic centers is essential for EPR spectroscopic investigations on the structure and dynamics of biomolecules such as proteins. The development of paramagnetic centers ready-made for bioconjugation is a topic in the research group of Prof. Godt and I enjoy a lot to contribute to it. With the aim of performing bioconjugation of paramagnetic centers in a biological, possibly even intracellular environment, the bioconjugation reaction must be biorthogonal. The reaction sequence consisting of an inverse electron demand Diels-Alder cycloaddition (IEDDA) between tetrazines and a strained alkyne or alkene and a cycloreversion with nitrogen elimination is biorthogonal. In addition, it can proceed very fast and is therefore interesting for spin labeling of biomolecules even at nanomolar concentration as is the case in cells [1]. I was very happy to be able to demonstrate my research and to discuss it with EPR spectroscopy specialists at the 46th FGMR Annual Discussion Meeting.

My research presented at the meeting focused on the development and bioconjugation of different  $Gd^{3+}$  complexes, all of which contain tetrazine moieties and are therefore suitable for spin labeling. I studied their reaction with peptides, which are models for proteins that contain strained alkynes, e.g. bicyclo[6.1.0]non-4-yne, or strained alkenes, e.g. *trans*-cyclooctene, in their side chains. Non-canonical amino acids containing such strained dienophiles have been genetically incorporated into proteins [2].

Bioconjugation must be very fast in order to achieve high labeling efficiency in cells at potentially nanomolar concentrations. The

design of the tetrazine-substituted  $Gd^{3+}$  complexes is based on the idea of making use of the pyridine ring, a frequently occurring structural unit in lanthanide complexes, as an IEDDA-accelerating substituent. Indeed, the complexes were found to react highly chemoselectively and with a reaction rate constant of  $k = 17 \text{ M}^{-1}\text{s}^{-1}$  sufficiently fast [3] for intracellular labeling. Because the tetrazinyl group is directly linked to the complex *via* a C–C bond, after bioconjugation, the distance between the  $Gd^{3+}$  ion and the labeled position on the peptide or protein backbone is as short and geometrically defined as much as possible in respect to the contribution of the spin marker to these aspects. This is intended to keep the distance distribution narrow when determining  $Gd^{3+}$ – $Gd^{3+}$  distances. Notably, the progress of the IEDDA of tetrazines can be monitored with standard UV-Vis spectroscopy through the loss of the characteristic pretty pink color of the tetrazine moiety.

I presented a set of different  $Gd^{3+}$  complexes that show various EPR spectroscopic properties, such as large and small line widths. A variety of  $Gd^{3+}$  complexes ready-made for bioconjugation enables the EPR spectroscopist to choose a complex best suited for the concrete application in respect to the type of method to be applied or to the range of distances to be determined. Besides, the intensity of the EPR signal from  $Gd^{3+}$  complexes in cells stays constant, which makes them useful for intracellular studies over a long period of time [4].

My spin markers should be suitable for in-cell labeling, and my dream is to introduce them into cells where they label genetically encoded proteins furnished with strained dienophiles, and to elucidate the intracellular structures of the proteins. The ligands of the presented paramagnetic  $Gd^{3+}$  complexes are also suitable for the formation of fluorescent  $Eu^{3+}$  and  $Tb^{3+}$  complexes, whose fluorescence is largely quenched by the tetrazine moiety. Through bioconjugation, the quenching effect ends and the fluorescence intensity is fully present [5]. This provides an opportunity to combine EPR spectroscopy with fluorescence microscopy, which could be useful in intracellular structural elucidation.

I would like to thank the International EPR Society, the FGMR of the GDCh and the organizers of the 46th FGMR Annual Discussion Meeting, Prof. Schiemann and his coworkers, for the scientific exchange, every-

one who collaborates with me on my research, and especially my mentor, Adelheid Godt, for her excellent scientific support.

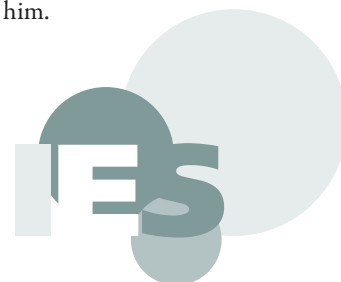
1. S. Jana, E. G. B. Evans, H. S. Jang, S. Zhang, H. Zhang, A. Rajca, S. E. Gordon, W. N. Zagotta, S. Stoll, R. A. Mehl, *J. Am. Chem. Soc.* **2023**, *145*, 14608–14620.
2. K. Lang, L. Davis, S. Wallace, M. Mahesh, D. J. Cox, M. L. Blackman, J. M. Fox, J. W. Chin, *J. Am. Chem. Soc.* **2012**, *134*, 10317–10320.
3. F. Saito, H. Noda, J. W. Bode, *ACS Chem. Biol.* **2015**, *10*, 1026–1033.
4. M. Qi, A. Gross, G. Jeschke, A. Godt, M. Drescher, *J. Am. Chem. Soc.* **2014**, *136*, 15366–15378.
5. W. Chi, L. Huang, C. Wang, D. Tan, Z. Xu, X. Liu *A, Mater. Chem. Front.* **2021**, *5*, 7012–7021.

## Adelheid Godt:

What great luck that Jascha Rüter decided a few years ago to take the challenge of developing lanthanide complexes which are ready for a very fast and chemoselective bioconjugation! Through his results, he serves the application of EPR spectroscopy in elucidation of the molecular structure of macromolecules, including biomolecules, and molecule aggregates in their individual natural environment. His spin labels look very likely to be applicable for in-cell spin labeling.

Jascha Rüter was an ordinary student of the bachelor and master programs. Once starting his own research project with his master thesis, he took off and became the pilot. He clearly enjoyed the freedom to make some extra, explorative and artistic loops, without losing sight of the goal and pushing his research towards it. His enthusiasm infected many students and coworkers and his critical thinking makes him a thought-after and highly respected partner for discussions.

In addition to his strong commitment to chemistry, he serves the community as a member of the volunteer fire department at an advanced level. Also outside of the university, he is a highly valued individual. I have never seen so many guests at a PhD celebration in the evening of the day of PhD defense. Even neighbours of his childhood came to celebrate with him.



# IES Travel Prize at EUROMAR 2025



**Yannik Limbach:**

I am a joint PhD student in the research group of Prof. Olav Schiemann and Dr. Bela Bode at the University of Bonn in Germany and the University of St Andrews in the United Kingdom. Currently I am at the end of my third year of my PhD program and was able to present recent in cell EPR measurements during the EUROMAR 2025 conference.

The work I presented is focused on performing pulsed dipolar EPR measurement such as PELDOR, RIDME and DQC in mammalian and bacterial cells to shed light onto protein conformations within their native environment. Different combinations of spin labels such as Trityl and Gadolinium based tags were employed to label two different model systems, GB1 and YopO. The simpler GB1 proved useful as a model system to test for the stability of labelled constructs within HeLa cells over the course of cell recovery. A more general trend could be observed which would hint towards aggregation, thereby lim-

iting the accessible recovery time of the cells in which useful information can be extracted from the measurement.

The conference featured an interesting and multidisciplinary environment from all fields of EPR, NMR, MRI and hyperpolarisation. I found applications of NMR spectroscopy to biological systems and related topics particularly interesting and could gain valuable insights into the preparation of biomolecular samples as well as applications of in cell techniques in NMR spectroscopy which might provide useful for my own research, as I am trying to develop the field of in cell EPR. Furthermore, the increasing attention paid to Intrinsically Disordered Proteins by the NMR and EPR communities was noteworthy. IDPs are an emerging topic escaping most structural methods but posing very intriguing targets for in cell applications.

Going beyond the scientific knowledge exchange, I was able to foster new connections with colleagues from the field of Bio NMR. The conference organisational structure and exiting social events made it a memorable occasion, that I thoroughly enjoyed.

Finally, I would like to express my gratitude for receiving this IES travel grant, enabling me to participate at the EUROMAR 2025 through a travel award. Furthermore, I would like to thank my supervisors Dr. Bela Bode and Prof. Olav Schiemann for their support and encouragement.

**Bela Bode:**

I am delighted for Yannik to have been awarded an IES travel award to present his work at the EUROMAR 2025 conference. Yannik is following a co-tutelle PhD

programme between the Universities of Bonn and St Andrews jointly supervised by Olav Schiemann and I. The award enabled Yannik to share his results with the wider magnetic resonance community.

Yannik's project focuses on advancing in-cell EPR spectroscopy, with particular emphasis on enabling pulse dipolar EPR spectroscopy (PDS). This requires careful optimisation of labelling strategies, cell handling, and spectroscopic data acquisition. Yannik has shown exceptional motivation and experimental skill in navigating this. The work presented at EUROMAR – using trityl and Gd-based spin labels to investigate the behaviour of GB1 and YopO in mammalian and bacterial cells – provided valuable insights into label stability and aggregation that limit the accessible recovery time in in-cell experiments. These findings contribute to making in-cell EPR a robust and widely applicable structural biology tool.

Especially the breadth of Yannik's work is impressive and covers the required molecular biology including mutagenesis, protein expression and purification and cell culture as well as all EPR spectroscopy related work from spin-labelling (*in silico* and *in vitro*) to structure modelling to PDS using DQC, RIDME and PELDOR (3-, 4- and 5-pulse DEER) including analysis with different approaches. More importantly Yannik is not only very talented in the wet and EPR labs but also a great team player always happy to contribute and help less experienced lab members. Finally, his enthusiasm and curiosity have been a great pleasure for supervisors. Yannik will not hesitate to put intriguing scientific ideas to the test in the lab. I am grateful for the IES enabling Yannik's presentation at Euromar and for his efforts to making this a success.



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# Bruker Thesis Prize 2025



## Yujie Zhao:

Receiving this award is especially meaningful to me because it recognizes the period of research in which many of my foundations were built. I would also like to take this opportunity to acknowledge the colleagues and collaborators I have had the chance to work with, whose ideas, generosity, and support have shaped the way I think about research. My PhD gave me not only an entry into magnetic resonance, but also a way of working that continues to guide me now.

I came into the field through instrumentation and method development in EPR and DNP, where experimental sensitivity and control often determine which questions can be addressed at all. During my PhD at the University of St. Andrews with Prof. Graham Smith, much of my work centred on extending the capabilities of the 94 GHz home-built high-power spectrometer HiPER, including writing control software, developing parts of the hardware setup, and establishing experimental protocols that enabled a broader range of pulsed experiments. That experience taught me how closely progress in magnetic resonance depends on the details of instrumentation and experimental design.

From there, I became increasingly drawn to DNP itself and to the question of how different polarization-transfer mechanisms respond to strong pulsed control. My work explored problems across the cross-effect, solid-effect, and Overhauser effect, while EDNMR and ENDOR just became a natural extension of the same broader interest in how electron and nuclear spin interactions can be manipulated and understood. What I found especially exciting was the constant feedback between

experiment and physical insight: a new pulse sequence or hardware modification could improve performance, but it would also expose hidden effects that are not easily detected and usually connected to a deeper question about spin dynamics.

By using high-power chirped inversion pulses, I showed that stronger pulsed control can generate a larger electron polarization gradient in nitroxide systems and produce very large static cross-effect enhancements. Seeing this result, I began to consider whether the same control strategy could be applied to related pulsed EPR experiments. Applying chirped pulses in ENDOR, we were indeed able to achieve a signal-to-noise enhancement of about a factor of three, confirming that these approaches could be carried across different techniques rather than remaining specific to DNP.

At the same time, advances in the instrumentation were opening up observations that were not previously visible. The short dead time of our setup allowed us to directly detect strong modulations in the FID, which could be associated with formally forbidden transitions that are usually difficult to observe. Comparing FID-detected and echo-detected field sweeps further revealed that a significant portion of the signal is effectively missed in conventional measurements.

These observations raised additional questions about what contributions might be hidden in standard experiments. In particular, the missing components may correspond to locally concentrated spin systems with very fast relaxation, which are not easily captured in echo-based detection but could still play a role in DNP through mechanisms such as thermal mixing. Together, these results made it clear that improving experimental control does not simply enhance signals, but can also expose parts of the spin system that are otherwise overlooked, and with them, new questions about how polarization is generated and transferred.

My postdoctoral work at MIT with Prof. Robert Griffin has grown naturally out of this background. In addition to experiments, I have become increasingly interested in simulation, from first-principles pulsed DNP modelling to approaches used in solid-state NMR and EPR spectral analysis, as well as in questions related to molecular design. One of the projects about boron-containing radicals gave me a clearer sense of how electron-deficient boron centres can be used to delocalize spin through  $p-\pi$  interactions, and how ligand coordination can be

used to tune electronic structure and magnetic behaviour. I have also become interested in how local radical–substrate interactions shape likely DNP pathways and experimental outcomes.

Challenging as it often is to fill the gaps in our understanding of EPR, DNP, and NMR, it continues to be deeply rewarding. Once again, I feel very fortunate that this award recognizes that stage of my work, and I hope to keep building on this and to continue contributing, in however small a way, to the magnetic resonance community.

## Graham Smith:

The 2025 prize was awarded to Dr. Yujie Zhao, who presented a wonderful prize lecture at the RSC EPR Group International Conference in London, describing her work on pulsed DNP, ENDOR and improved EPR sensitivity at W-band using the home-built HiPER system at St. Andrews.

Yujie started her PhD in late 2019 under the China Scholarship Council programme, having won several awards in China. Despite being forced to spend most of her first year in St. Andrews online, during COVID, her subsequent achievements in magnetic resonance were considerable.

Reviewers praised her “*timely and relevant insights and conclusions ..... from the design and building of hardware, experimental implementation, theory, simulation and experiment...*”. Yujie improved the concentration sensitivity of HiPER (already  $\sim 50\times$  better than X-band); she used zero-deadtime techniques to characterise DNP polarisers; she developed a wideband high power DNP probe that offered in-situ simultaneous EPR. She developed new protocols for chirped pulse DNP work, which gave new insights into the cross-effect and demonstrated direct enhancements  $>330$  using simple TEMPO radicals. She also initiated collaborations with Dr. Guinevere Mathies (Konstanz) on solid-effect pulsed DNP and started a new high-field pulsed ENDOR program, following the work of Prof. Marina Bennati’s group (Göttingen).

Following her PhD she moved to Prof. Robert Griffin’s lab at MIT, where she currently works on his flagship high-field DNP programmes. Outside the lab, Yujie is a keen sportswoman and regular swimmer, and ran a popular Chinese cooking blog during the COVID lockdown. Many readers may also know Yujie from her co-hosting of the weekly IVEM online EPR talks.

Dr. Yujie Zhao is a thoroughly deserving winner of the 2025 Bruker Thesis Prize. ●

# Making the Invisible Visible

## A Journey from Free Radicals to Clinical EPR Oximetry



### Perianan (Kupps) Kuppusamy, PhD

Fellow, International EPR Society (2026)  
kuppu@dartmouth.edu

#### *Early Inspiration: Discovering the Invisible Through EPR*

I still remember the first time I saw an EPR spectrum. It was during my PhD (1980–1985) at the Indian Institute of Technology, Madras. At the time, it appeared as little more than a set of lines – signals from an unpaired electron. I did not yet appreciate its full significance. But something about it stayed with me. There was a quiet sense that I was observing a phenomenon that revealed a deeper layer of reality – one that could not be seen directly but could be understood through careful measurement. In retrospect, that moment quietly set the course of my scientific life.

My early training in chemistry at the University of Madras immersed me in physical chemistry and spectroscopy. Those formative years shaped how I approached problems – grounding me in thermodynamics, molecular structure, and quantum principles. Yet EPR stood apart. It was not simply another spectroscopic method. It offered a unique perspective – a way to detect species that were otherwise invisible but fundamentally important. Free radicals, transition metals, and eventually oxygen itself became part of this invisible landscape. I began to appreciate that what could not be seen often mattered most!

Even then, a question began to form: could this technique, rooted in physics and chemistry, be extended into biology – and perhaps into medicine? At that stage, I did not yet know how such a transition could occur. But the question persisted, quietly shaping my thinking and guiding my decisions in the years that followed.

#### *Formative Turning Point: Shaping a Scientific Vision*

My postdoctoral training at the NIH and Johns Hopkins University (1986–1989) marked a defining turning point in my career. It immersed me in an interdisciplinary environment where the emphasis shifted from technique to meaningful biological questions. This experience

reshaped my approach to science – from focusing on methods to addressing problems of consequence.

During this time, I was influenced – both directly and indirectly – by pioneers such as James Hyde and Gareth Eaton, whose work helped define modern EPR instrumentation and methods. Their contributions demonstrated how advances in instrumentation can expand the boundaries of scientific inquiry. Equally important was the culture of curiosity, where discussions extended beyond techniques to broader biological and clinical questions. I came to understand that the value of a method lies not in its sophistication, but in its capacity to reveal new insight.

This realization transformed my view of EPR – from a spectroscopic tool into a bridge connecting the physical sciences with biology and medicine.

I have also been fortunate to be guided by exceptional mentors, peers, and collaborators. Prof. P. T. Manoharan shaped my early interest in EPR spectroscopy and scientific inquiry. Dr. Jay L. Zweier's mentorship directed my work toward biologically and clinically relevant cardiovascular problems. Dr. Murali C. Krishna has been a valued peer whose insights and collegial exchanges have consistently enriched my work in the area of cancer research. Collaborations have been equally important: Prof. Aharon Blank has contributed significantly to advances in instrumentation and translation, while Prof. Kalman Hideg's expertise in spin probe development has been central to several key aspects of my studies on molecular therapeutic. Together, these influences reflect a broader truth: scientific progress is a collective endeavor, built on shared ideas and sustained collaboration.

#### *Defining the Central Problem: Oxygen in Biology and Disease*

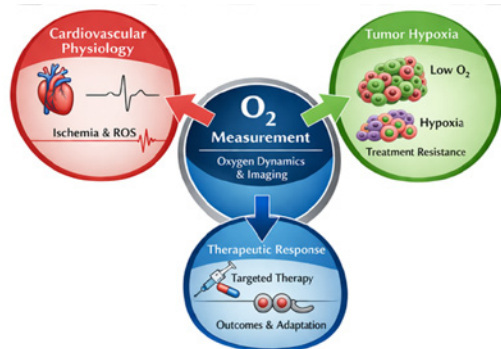
My early research focused on free radicals and oxidative stress – fields that revealed the dynamic chemistry underlying biological systems. These studies highlighted how reactive species influence cellular signaling, damage, and disease progression. Over time, however, my attention shifted toward oxygen.

Oxygen is deceptively simple but unique; a ground state triplet, a paramagnetic molecule! It is essential for life, yet its distribution within tissues is highly heterogeneous. In cancer, regions of low oxygen – tumor hypoxia – play a decisive role in determining treatment outcomes. Hypoxic tumors are more resistant to radiation therapy and are often associated with more aggressive behavior. Despite its importance, oxygen has remained difficult to measure directly in living systems. Most available methods are indirect or lack the resolution needed to capture dynamic changes.

EPR offered a unique solution. Because paramagnetic molecular oxygen physically interacts with paramagnetic probes through collisions to influence spectral linewidth, it can be measured directly and quantitatively. This concept – linking a physical interaction to a biological parameter – was both elegant and powerful. At this point, my research direction became clearly defined. Oxygen measurement was not merely a technical challenge; it was an opportunity to address a fundamental problem in biology and medicine.

#### *Bridging Disciplines: From Cardiovascular physiology to Cancer*

My early interest in reactive oxygen species (ROS), particularly in the context of myocardial infarction, played a pivotal role in shaping the direction of my research. Studies of oxidative stress during ischemia and reperfusion highlighted the complex interplay between oxygen availability, radical formation, and tissue injury. These investigations made it clear that understanding disease processes requires not only



**Figure 1.** Oxygen as a unifying axis in my research – technology development for oxygen measurement, bridging biology and medicine.

detecting reactive species but also quantifying the underlying oxygen dynamics that drive them.

This realization led naturally to the development of EPR-based imaging and oximetry approaches, allowing us to move from indirect assessments of oxidative stress to direct, quantitative measurements of oxygen and redox status in living systems. Importantly, the conceptual framework established in cardiovascular research – linking oxygen gradients, redox imbalance, and tissue response – translated directly to cancer biology, where tumor hypoxia and oxidative stress similarly govern progression and therapeutic resistance (Figure 1).

Looking back, this progression represents one of the clearest examples of “connecting the dots” in my work – where insights gained in one field unexpectedly informed and enriched another, ultimately converging into a unified perspective on oxygen as a central determinant across disease processes.

#### **Technical Milestone: 3D EPR Imaging of the Beating Heart**

Another important direction in my research involved the development of three-dimensional EPR imaging of the beating heart, aimed at capturing oxygen and redox dynamics in a physiologically active organ. This effort required overcoming significant technical challenges, including motion artifacts, rapid signal acquisition, and synchronization with cardiac cycles.

By integrating advances in instrumentation, imaging reconstruction, and physiological control, we demonstrated the feasibility of mapping oxygen-related parameters in a moving system. This capability opened new avenues for studying cardiovascular disease models, particularly ischemia and reperfusion injury. By enabling direct assessment of myocardial oxygenation and redox changes under dynamic conditions, these approaches provided insight into tissue viability, metabolic stress, and recovery following ischemic events.

This work underscored the potential of EPR imaging to deepen understanding of cardiac pathophysiology and to inform strategies aimed at improving outcomes in ischemic heart disease.

#### **Expanding Capability: Imaging Redox State and Tumor Oxygenation**

An important component of my research has been the development of methods to image both the redox state and oxygenation of tumors in vivo. By leveraging EPR-based probes sensitive to redox changes and oxygen levels, we were able to characterize the biochemical environment of tumors beyond structural imaging.

These approaches provided insight into the dynamic interplay between oxidative stress and hypoxia – two critical factors that influence tumor progression and therapeutic response. Assessing redox status alongside oxygenation offered a more comprehensive view of the tu-

mor microenvironment, bridging molecular processes with physiological function and contributing to more targeted treatment strategies.

#### **Building a Field: Establishing Biomedical EPR at Ohio State**

My time at The Ohio State University (2002–2013) was a period of both construction and discovery. There was no established framework for biomedical EPR – only a set of possibilities. We built instrumentation specifically designed for biological applications, often developing components from the ground up.

We established experimental systems capable of supporting in vivo studies and fostered an environment that encouraged interdisciplinary collaboration. These collaborations were essential. Physicists, engineers, chemists, and clinicians each brought distinct perspectives, enabling us to address challenges that no single discipline could solve alone.

Gradually, a new field began to take shape – one that extended EPR beyond traditional spectroscopy into the realm of biology and medicine.

#### **Demonstrating Feasibility: Direct In Vivo Oxygen Measurement**

A major milestone was demonstrating that tissue oxygen could be measured directly and noninvasively using EPR. This achievement required the integration of multiple elements. Probe chemistry, instrumentation, and biological validation had to work together seamlessly. We improved probe sensitivity and stability, refined acquisition techniques, and ensured reproducibility across different experimental conditions. The result was a method capable of measuring oxygen quantitatively and repeatedly in living systems. For the first time, it became possible to monitor oxygen dynamics in vivo. This capability opened new avenues of research, particularly in understanding tumor hypoxia and its role in therapy.

#### **Foundational Innovation: LiNc-BuO and the Path to Translation**

A key advance in our work was the development of the lithium naphthalocyanine (LiNc-BuO)-based oximetry probe, which provided a robust and highly sensitive platform for measuring oxygen in biological systems. This probe exhibited exceptional oxygen-dependent line broadening with a linear response over a physiologically relevant range, while maintaining remarkable stability and biocompatibility.

Its particulate nature enabled localized implantation, allowing repeated and reliable measurements of tissue pO<sub>2</sub> over extended periods. The introduction of LiNc-BuO significantly improved the precision and practicality of EPR oximetry and played a central role in enabling both preclinical studies and clinical translation.

This foundational work led directly to implantable devices such as the OxyChip, establishing a clear trajectory from probe chemistry to clinical trials and patient application.

#### **Translational Breakthrough: The OxyChip**

Among the developments in my career, the OxyChip stands out as a direct link between laboratory innovation and clinical application. The concept was straightforward: an implantable sensor capable of repeated oxygen measurements. The implementation, however, required careful design and rigorous validation.

We optimized materials for long-term stability, ensured biocompatibility, and refined sensitivity. Multiple iterations were required to achieve reliable performance. The first application of the OxyChip in human studies was a defining milestone, demonstrating that EPR could move beyond the laboratory and into clinical practice.

#### **Overcoming Complexity: The Challenge of Translation**

Turning this concept into reality proved to be a formidable challenge. Biological systems are inherently complex – signals are weak, ▶

environments heterogeneous, and conditions variable. Conventional EPR instrumentation was not designed for such contexts.

We rethought nearly every aspect of the approach. Oxygen-sensitive probes had to be stable and responsive; calibration methods had to be precise; instrumentation had to function reliably *in vivo*.

Progress was incremental and often uncertain. Yet these challenges drove innovation, leading to methodologies capable of operating robustly in complex biological environments.

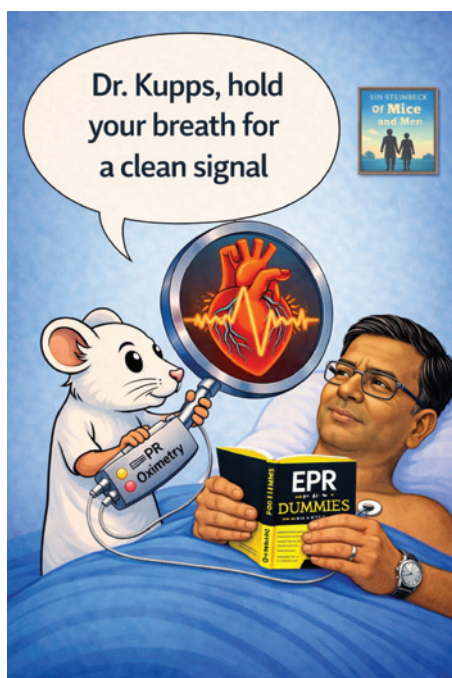
### *A Continuous Arc: Discovery to Clinical Application*

Looking back, one of the most striking aspects of my work is its continuity. From fundamental chemistry to clinical studies, each stage built upon the previous one. Early investigations into free radicals and paramagnetic probes provided the conceptual and technical foundation for later advances in oxygen measurement and imaging. This progression was not always linear, but it was coherent, with each step informing and enabling the next.

Translation was not an endpoint – it was an integral part of the process. Questions that arose in clinical contexts often led back to fundamental investigations, while insights from basic science helped shape new clinical approaches. In this way, the boundary between discovery and application became less distinct, forming a continuous and evolving cycle of inquiry.

### *Bench to Bedside: EPR Oximetry from Mice to Men*

A central theme of my scientific journey has been the deliberate progression of EPR oximetry from controlled experimental systems to real-world clinical application. What began as proof-of-principle studies in small animal models – where we established the feasibility of quantitatively measuring tissue  $pO_2$  using oxygen-sensitive paramagnetic probes – gradually evolved into increasingly sophisticated *in vivo* investigations in tumors and cardiovascular systems (Figure 2). These early studies provided not only technical validation but also critical biological insights, particularly into tumor hypoxia and its role in therapeutic resistance. Building on this foundation,



**Figure 2.** EPR measurements from mice to men.

we advanced probe development, instrumentation, and calibration methodologies to meet the stringent requirements of human application. This continuum culminated in first-in-human clinical studies, where implantable sensors such as the OxyChip enabled repeated, localized measurements of tumor oxygenation in patients. This “mice to men” trajectory reflects more than technological advancement – it represents a sustained commitment to translation, demonstrating that rigorous physical science methodologies can be successfully integrated into clinical research to address fundamental challenges in medicine.

### *Clinical Transition: Advancing EPR at Dartmouth*

My transition to Dartmouth marked a shift in focus. Here, the emphasis was on applying EPR in clinical settings, moving from primarily methodological development toward direct patient-oriented research. Working closely with clinicians introduced new challenges and new opportunities – requiring not only technical adaptation, but also a deeper understanding of clinical priorities, workflow constraints, and patient needs. Could oxygen measurements be integrated into routine patient care? Could they inform treatment decisions in real time? Could they ultimately improve outcomes by guiding therapy more precisely? These questions continue to guide my work.

### *Clinical Impact: EPR Oximetry in Patients*

At Dartmouth, we advanced EPR into clinical practice. Instrumentation was refined for patient use, with careful attention to safety, reliability, and ease of integration into clinical workflows. Implantable sensors were adapted and validated for use in human studies, enabling repeated, localized measurements of tumor oxygen over time. These efforts allowed us to move beyond single time-point assessments and begin capturing the dynamic nature of tumor oxygenation in patients. The ability to monitor oxygen longitudinally has provided valuable insights into treatment response, particularly in the context of radiation therapy and oxygen-modifying interventions. It has also opened the possibility of identifying patients who may benefit from tailored therapeutic strategies based on their tumor oxygen profile. This work represents a significant step toward establishing oxygen as a clinically actionable biomarker – one that can inform treatment planning, guide therapeutic adjustments, and ultimately contribute to more personalized approaches to cancer care.

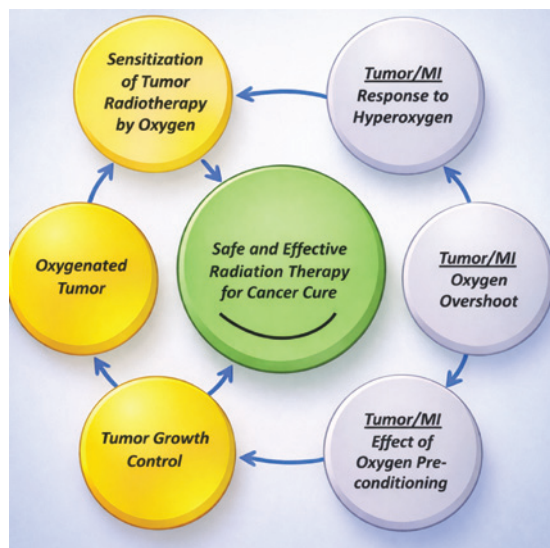
### *Broad Impact: Integrating Across Disciplines*

EPR oximetry has had broad impact. In cancer biology, it has improved understanding of tumor hypoxia and treatment resistance, helping to clarify why certain tumors respond poorly to therapy and how oxygen modulation might enhance treatment efficacy. In cardiovascular research, it has enabled studies of oxygen dynamics under ischemic conditions, providing insights into tissue viability and recovery following injury. In imaging science, it has contributed to the development of quantitative measurement techniques that move beyond qualitative contrast toward absolute physiological parameters.

More broadly, it has helped bridge molecular biology and functional imaging – advancing the integration of physical science methods into biomedical research and clinical practice.

### *Connecting the Dots: A Unifying Perspective*

One idea that has resonated with me throughout my career is Steve Jobs’ observation that “you can’t connect the dots looking forward; you can only connect them looking backward”. In many ways, this perfectly reflects my scientific journey. Early work on free radicals,



**Figure 3.** Connecting the dots. Convergence of cardiovascular physiology, tumor hypoxia, and treatment response into a unified framework centered on oxygen measurement.

which at the time seemed focused on fundamental chemistry, gradually led to deeper questions about oxygen – its role in biology, disease, and therapy. Years later, those seemingly separate efforts converged in unexpected ways, connecting cardiovascular physiology, tumor hypoxia, and treatment response into a unified framework centered on oxygen measurement (Figure 3). What once appeared as isolated lines of inquiry now form a coherent narrative: understanding oxygen dynamics as a common thread linking diverse diseases and therapeutic strategies. This realization has reinforced an important lesson – that pursuing important questions, even without a clear endpoint, often leads to connections that only become visible with time.

#### *Looking Forward: From Measurement to Action*

The future of EPR in medicine is promising, and in many ways, we are only beginning to realize its full potential. Efforts are underway to integrate EPR with MRI, creating complementary platforms that combine quantitative oxygen measurement with high-resolution anatomical imaging. At the same time, advances in sensor technology – particularly in implantable and minimally invasive probes – are improving sensitivity, stability, and clinical usability.

Another important direction is the development of systems capable of real-time and longitudinal monitoring during therapy. The ability to track oxygen dynamics continuously – during radiation, drug delivery, or hyperoxic interventions – opens new possibilities for adaptive

and personalized treatment strategies. Rather than relying on static measurements, we can begin to understand oxygen as a dynamic biomarker that reflects treatment response in real time.

These advances are moving us toward a broader goal: to make oxygen measurement not only feasible, but routine in clinical practice. Just as imaging modalities have become indispensable in diagnosis, quantitative oxygen assessment has the potential to become a standard component of patient management.

Ultimately, the goal is not simply to measure oxygen, but to act on it – to use this information to guide therapy, improve outcomes, and tailor treatment to individual patients. In that sense, the future of EPR lies not only in technological innovation, but in its integration into clinical decision-making.

#### *Advice to the Next Generation: Lessons from a Translational Journey*

For those entering the field, I offer a few reflections from my journey.

First, focus on meaningful problems. Technologies evolve, but impactful work is driven by questions that matter to biology, medicine, and patients. My focus on oxygen was guided by its importance, not convenience – and that decision shaped my path.

Second, be patient. Translation from discovery to application takes time. There were many periods of failed experiments and slow progress, but persistence through such phases is essential.

Third, embrace interdisciplinary thinking. Advances often arise at the intersection of fields. My work has relied on integrating chemistry, physics, engineering, and medicine, often inspired by diverse perspectives.

Equally important is resilience. Progress rarely comes from a single breakthrough; it is usually the result of sustained, incremental effort.

Finally, remain curious. Science is about asking better questions. Unexpected observations often open new directions and pursuing difficult problems – despite uncertainty – is what ultimately drives progress.

#### *Closing Reflection: The Continuing Journey of EPR*

From the first EPR spectrum to measuring oxygen in human tumors, the journey has been long and at times uncertain. Periods of doubt and slow progress ultimately shaped the work and made each advance more meaningful.

Being elected a Fellow of the International EPR Society is deeply meaningful – not as a personal milestone alone, but as recognition of the collective contributions of mentors, collaborators, and trainees. Science is never an individual endeavor.

What has remained constant is curiosity about the unseen. EPR allows us to make the invisible visible – revealing processes otherwise hidden. As technologies advance and collaborations deepen, the possibilities will continue to expand, making it both humbling and exciting to be part of this ongoing journey. ●

#### NOTICES OF MEETINGS

June 28 – July 2, 2026  
**EUROMAR**, Gothenburg, Sweden  
<https://www.euromar.org>

August 2 – August 6, 2026  
**Rocky Mountain Conference (EPR)**, Snowbird, Utah, USA  
<https://rockychem.com>

#### NOTICES OF MEETINGS

August 29 – September 5, 2026  
**EF-EPR**, Brno, Czech Republic  
<https://www.ta-service.cz/efep2026>

September 20 – September 24, 2026  
**Spin Chemistry Meeting**, Padua, Italy  
<https://research.chimica.unipd.it/SCM2026>

#### NOTICES OF MEETINGS

September 6 – September 10, 2026  
**HYP26**, Göttingen, Germany  
<https://hyp26.org>

October 18 – October 22, 2026  
**APES-SEST 2026**, Saitama, Japan  
<https://sest-nenkai.org/APES2026>

# The Spectroscopist's Guide to the Multi-Harmonic Galaxy

Yu-Kai Liao

Bruker BioSpin GmbH & Co. KG, Ettlingen, Germany

The pursuit of higher sensitivity is an everlasting quest for any analytical technique. It is essential when it comes to measuring trace amounts of samples within reasonable time, especially for species that evolve over time. For continuous wave electron paramagnetic resonance (CW-EPR), the introduction of multi-harmonic detection (MHD) broadens the horizon and brings new perspectives [1]. MHD significantly boosts EPR sensitivity and not only improves the signal-to-noise ratio of field-sweep experiments, but it also makes kinetic studies possible for samples with a weak EPR signal.

CW-EPR is measured through lock-in detection by modulating the external magnetic field. Conventional CW-EPR is done by measuring the first harmonic of the modulation frequency. To avoid lineshape distortion, the modulation amplitude must be smaller than the linewidth (typically  $< 1/3$  of the linewidth to minimize the lineshape distortion). Larger modulation amplitudes increase the signal intensity, but also broaden the lineshape, an effect known as over-modulation.

MHD overcomes this limitation by measuring multiple harmonics, allowing reconstruction of the intrinsic lineshape at an improved signal-to-noise ratio. It is not science fiction, but it does require some experimental considerations. This guide gives practical hints to get the most out of this new technology.

## 1. Modulation Amplitude and Modulation Frequency

To benefit from MHD, higher harmonics must be detectable. The intensity of the first harmonic increases with the modulation amplitude only up to a certain point; once the modulation amplitude approaches the linewidth, the response becomes nonlinear and the signal intensity eventually decreases. Each subsequent harmonic behaves differently with respect to the first harmonic. Simulations for a single Lorentzian line (Figure 1) show that higher harmonics increase in intensity more slowly with increasing modulation amplitude.

In practice, larger modulation amplitudes push more harmonics above the noise floor, and this trend is evident in simulations (Figure 2): at 1 G modulation amplitude, the 3rd harmonic is barely visible; at 10 G, harmonics up to the 15th emerge; and at 19 G, harmonics up to the 30th can be observed – consistent with results by Z. Yu et al. [2].

Although this sounds like an invitation to simply increase the modulation amplitude, the usefulness of those additional harmonics depends on whether they can pass your detection chain without excessive attenuation. This brings us to bandwidth considerations.

Before moving on, it's worth mentioning that the modulation frequency ( $f_{Mod}$ ) also plays a role. Together with the modulation amplitude ( $B_{Mod}$ ), it defines the scan rate  $\pi f_{Mod} B_{Mod}$ . The scan rate can have two impacts on the signal, namely the signal bandwidth and the passage effect. For those eager to travel deeper into the Multi-Harmonic Galaxy, the literature is rich with guidance [3–5].

The bandwidth of the signal is proportional to the scan rate, and the higher scan rate (higher  $f_{Mod}$  and/or  $B_{Mod}$ ) produces larger signal bandwidth. In fact, signal bandwidth and the number of generated harmonics go hand in hand. The signal bandwidth is related to the harmonics and the frequencies they carry. Meanwhile, the passage effect is a known phenomenon when the scan rate goes faster than the relaxation rate. In such a case, transient oscillations are generated in the time domain. This can be taken care of by adding a step of deconvolution in the data processing. Figures and examples assume that passage effects are not present.

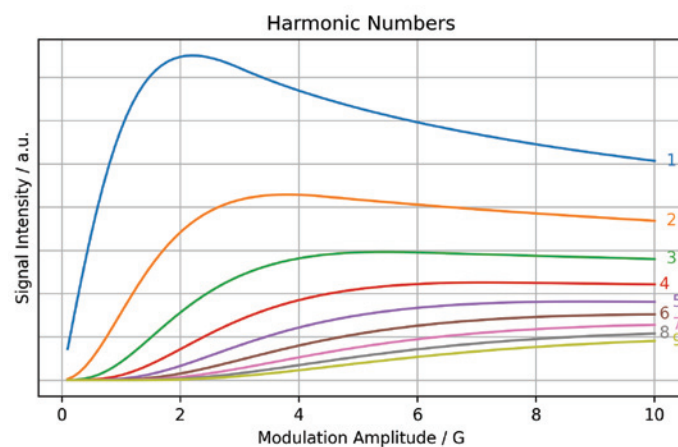


Figure 1: Simulations of the signal amplitude for each harmonic as a function of the modulation amplitude for different harmonics of a 1 G linewidth signal.

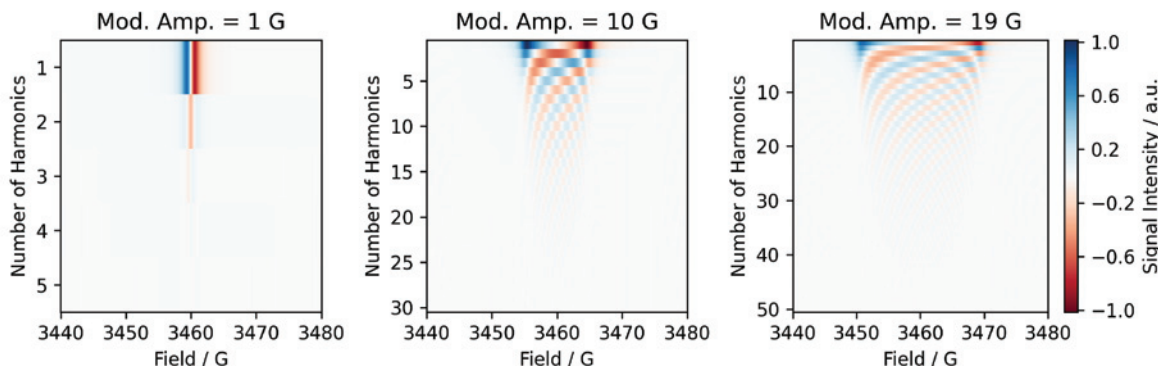


Figure 2: Simulations of the MHD spectra of a signal with 1 G linewidth modulated by 1, 10, and 19 G modulation amplitude (Mod. Amp.). Along the x-axis shows the field sweep, the blue color indicates the peaks, and the red color indicates the trough. The y-axis marks the indices of the harmonics. The spectra show that with higher modulation amplitude with respect to the non-modulated linewidth, more harmonics can be detected.

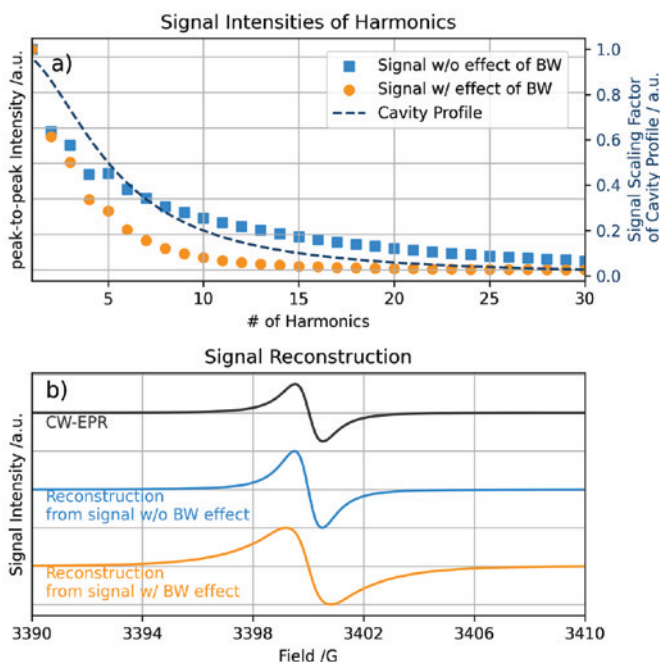
## 2. Bandwidth

It is tempting to maximize the modulation amplitude to generate as many harmonics as possible. However, the bandwidth of the resonator and the detection chain must be considered: Harmonics are spaced by multiples of the modulation frequency; with a 100 kHz modulation, the 5th harmonic lands 500 kHz away from the microwave frequency. The resonator bandwidth – primarily controlled by the Q-value – determines which of those harmonics are transmitted with minimal attenuation. The cavity bandwidth for the harmonics can be written as  $BW = \nu_{mw}/2Q$  [6]. For example, a cavity with  $Q \sim 9500$  at microwave frequency ( $\nu_{mw}$ )  $\sim 9.5$  GHz has bandwidth of 500 kHz, which is representative of the Bruker SHQE resonator. Lower modulation frequencies shift harmonics closer to the carrier, allowing more of them to fall inside the cavity bandwidth; moving from 100 kHz to 30 kHz can increase the number of usable harmonics from roughly 5 to 16.

Because the cavity profile gradually suppresses off-resonance components (Figure 3a), the detected harmonics may not represent their true relative intensities. If you reconstruct without considering this frequency response, artificial broadening appears (Figure 3b). You can mitigate this by using fewer harmonics for reconstruction which improves the lineshape fidelity but sacrifices the signal-to-noise ratio (SNR) gain.

This is the same as looking at the signal bandwidth. The calculation for the signal bandwidth differs between lineshapes [4]. One needs to consider how much line broadening is acceptable and if that fits the signal bandwidth into the bandwidth of the resonator and the detection chain.

Pre-amplifiers in the detection path also have a limited bandwidth, it's between 400 kHz and 6.5 MHz for the Bruker microwave bridges.



**Figure 3:** Simulations of signal detection and reconstruction of a Lorentzian line of 1 G linewidth modulated by 10 G modulation amplitude and 100 kHz modulation frequency, with and without considering the suppression of signal intensity by the cavity profile (500 kHz bandwidth). a) Blue and orange dots mark the signal intensities of harmonics. The red dashed line indicates the cavity profile which suppresses higher harmonics. b) Results of reconstruction (blue and orange spectra) and the spectrum of CW-EPR (black). The blue spectrum is a reconstruction from the data not affected by the resonator bandwidth and shows reconstruction of the correct lineshape. The orange spectrum is a reconstruction taking the data affected by the resonator bandwidth and shows distortion compared to the correct lineshape.

For conventional CW-EPR, this is beneficial for filtering out high-frequency noise. For MHD, they limit the highest usable harmonics.

Consequently, extremely large modulation amplitudes are not universally beneficial: they only help when the resulting harmonic frequency offset and amplitude align with the bandwidth of the cavity and detection electronics.

## 3. Sample Dimensions

It is not only crucial to choose the appropriate modulation amplitude but also important to know what field modulation the sample is experiencing due to the field inhomogeneity generated by the modulation coils. Different resonators produce different modulation profiles, and the experienced field depends on the sample's position relative to the resonator center.

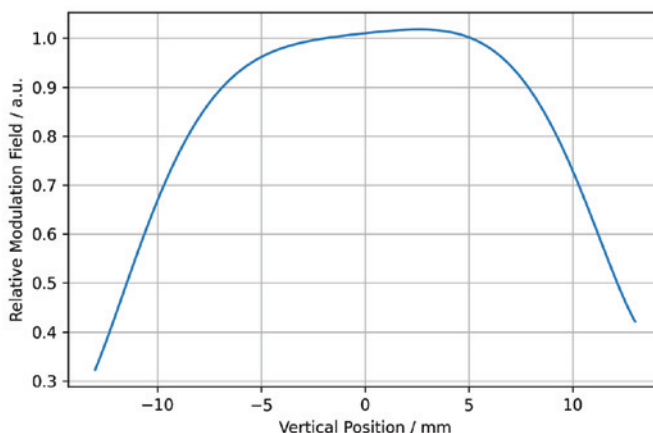
Under conventional CW-EPR conditions, this is rarely of concern because the modulation amplitude is kept well below the linewidth, minimizing distortion even where modulation field is weaker. Nevertheless, for spin quantification, the signal intensities as a function of sample positions in the cavity are characterized for most Bruker waveguide resonators.

In MHD, however, one intentionally overmodulates to record higher harmonics; a long sample that fills the whole cavity experiences a spread of modulation amplitudes across its height, and the reconstruction becomes a composite of these distributed conditions, leading to additional broadening. The practical fix is simple: shorten the sample length so that it resides within the most homogeneous portion of the modulation field. This is a trade-off between lineshape fidelity and signal intensity.

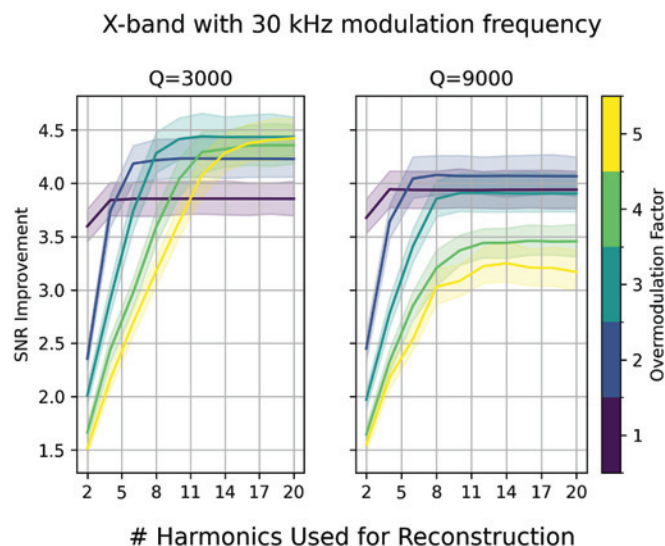
Taking the cavity of ESR5000 for instance (Figure 4), conventional practice might fill tubes to roughly 22 mm in height, i.e., the cavity length. At high modulation amplitude, however, only the central region of the sample experiences the intended field; sections above and below can receive down to only half the strength of the set amplitude. By reducing the filling height to around 10 mm, the sample is concentrated in the uniform zone, and the reconstruction fidelity can be greatly improved.

## 4. Optimize Experimental Parameters

Parameter selection in MHD is best approached as a comprehensive process where modulation amplitude, modulation frequency, Q-value, and the number of harmonics used in reconstruction are balanced



**Figure 4:** Actual modulation field relative to the set value along the vertical axis of the cavity with respect to the cavity center.



**Figure 5:** Simulations of SNR improvement for a single Lorentzian line under different conditions of experiments and reconstructions. The improvement is calculated by normalizing the SNR of the reconstructed signal to the SNR of a measurement using modulation amplitude = 1/3 intrinsic linewidth. Shaded regions indicate the confidence interval.

against each other. Begin by deciding to overmodulate relative to the expected linewidth of the species under study, since pushing the modulation amplitude above the linewidth is the mechanism by which higher harmonics are generated. Next, favor the lowest modulation frequency permitted by your hardware to transmit more harmonics into the cavity and pre-amplifier bandwidths. Then, avoid an unnecessarily large modulation amplitude that creates harmonics predominantly outside those limits. Finally, choose a reconstruction strategy that includes as many harmonics as remain strong and well-passed, optionally compensating for the cavity profile if Q-value is high and the frequency response is steep.

The general concept can be demonstrated by simulations. Figure 5 shows simulations assuming a single Lorentzian signal measured at X-band with 30 kHz modulation frequency, low and high Q-values, and different overmodulation factors, defined as the ratio of modulation amplitude and intrinsic linewidth. With overmodulation factor of 1, the intensity of the first harmonic can already be around three times stronger than the undermodulated signal. After reconstruction with a few more harmonics, the SNR improvement is about 3.5 in this case. We can see that at a low Q-value, which mimics a lossy sample, overmodulation factors in the range of 3 to 5, combined with reconstruction using 10 or more harmonics, yield the best SNR gains because the broadened bandwidth admits more harmonics. Under high Q conditions, the benefit saturates around an overmodulation factor of 2 and adding harmonics beyond about 8 offers little improvement; here, the narrower bandwidth and sharper frequency response limit how much additional harmonic information can be retained

usefully. When using an even higher overmodulation factor, as seen in Figure 1 that the signal intensity of the first harmonic starts to decrease while higher harmonics are strongly attenuated, the SNR improvements decrease.

Note that these simulations are theoretical representations. In practice, some samples perform better than these simplified cases and some perform worse. Nevertheless, they are consistent with experimental results reported in the literature [2, 7, 8].

## 5. Before You Turn the Page: Take-Home Messages

*Measure smart, not just “more.”* Increasing the modulation amplitude helps only as long as the resulting harmonics remain inside the cavity and pre-amplifier bandwidths; beyond that, gains stall and reconstruction fidelity can suffer. *Mind the bandwidths at all times.* Lower modulation frequency transmits more harmonics into the usable window, while high Q-value narrows that window and demands either selective harmonic use or amplitude rescaling. *Less is more.* Avoid tall samples; smaller filling heights maintain modulation homogeneity and protect reconstruction quality. *Watch out for the fast passage.* For most cases it's not of concern. In case it appears, take the step of deconvolution and you are back on track.

That's it – your quick hop across the *Multi-Harmonic Galaxy*. Start modestly, keep bandwidth in mind, shorten the sample when you over-modulate, and let the harmonics do the heavy lifting. *Happy over-modulating!*

## 6. Acknowledgements

The author would like to express special thanks to Gareth R. Eaton and Sandra S. Eaton. The discussions with them and their feedback provided invaluable insight for this article.

1. M. Tseitlin, S. S. Eaton and G. R. Eaton: Reconstruction of the first derivative EPR spectrum from multiple harmonics of the field-modulated continuous wave signal. *J. Magn. Reson.*, pp. 277–281, 2011.
2. Z. Yu, M. Tseitlin, S. S. Eaton and G. R. Eaton: Multiharmonic Electron Paramagnetic Resonance for Extended Samples with both Narrow and Broad Lines. *J. Magn. Reson.*, vol. 254, pp. 86–92, 2015.
3. G. R. Eaton, S. S. Eaton, D. P. Barr and R. T. Weber: *Quantitative EPR*, Springer Vienna, 2010.
4. J. Möser, K. Lips, M. Tseitlin, G. R. Eaton, S. S. Eaton and A. Schnegg: Using rapid-scan EPR to improve the detection limit of quantitative EPR by more than one order of magnitude. *J. Magn. Reson.*, vol. 281, pp. 17–25, 2017.
5. S. S. Eaton, R. W. Quine, M. Tseitlin, D. G. Mitchell, G. A. Rinard and G. R. Eaton: Rapid-Scan Electron Paramagnetic Resonance. In *Multifrequency Electron Paramagnetic Resonance: Data and Techniques*, Wiley-VCH Verlag GmbH & Co. KGaA, 2014.
6. S. S. Eaton and G. R. Eaton: Rapid-Scan Electron Paramagnetic Resonance. In *eMagRes*, John Wiley & Sons, Ltd., 2016.
7. J. Oh, C. U. Koo, J. I. Park, K. Choi, J. Lee, H. Hirata and S.-J. Ye: Accuracy enhancement of L-band EPR tooth dosimetry by implementing multiple harmonic detection. *Radiation Measurements*, vol. 176, p. 107185, 2024.
8. R. Nakaoka, K. Kato, K. Yamamoto, H. Yasui, S. Matsumoto, I. A. Kirilyuk, V. V. Khramtsov, O. Inanami and H. Hirata: Electron paramagnetic resonance implemented with multiple harmonic detections successfully maps extracellular pH in vivo. *Anal. Chem.*, vol. 95, pp. 3940–3950, 2023.



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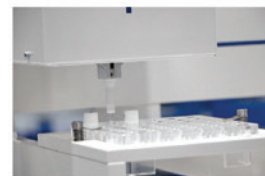
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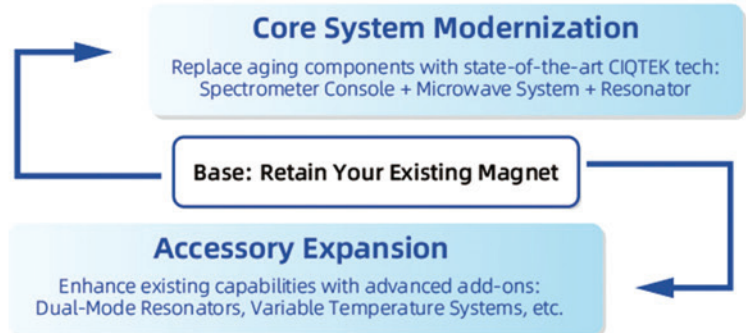
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## Conference reports

### 10th EFEPR Summer School on Fundamental Theory and State-of-the-Art Applications of EPR Spectroscopy

August 31 – September 6, 2025, Manchester, UK

The 10th and latest edition of the European Federation of EPR (EFEPR) Groups Summer School was recently held in sunny Manchester (UK). These intensive, week-long schools are aimed at PhD, Masters and post-doctoral researchers. The first was held in 1999 in Caorle (Italy), with subsequent events held every few years until the dark times of the Covid-19 pandemic necessitated a break. After that short hiatus, the event recommenced in spectacular style in 2023 in Geneva where the local organiser (Enrica Bordignon) and her team ran a fantastic event which reminded everyone involved what they had been missing. The baton was passed to Manchester.

Two years later, over 150 people gathered in Manchester for the 10th Summer School, comprising of 117 attendees, 24 expert lecturers, and several exhibitors. The attendees came from 58 different academic institutions across 22 countries, making it a truly international event. Over 58% of the attendees were female and additionally 40% of the lecturers, matching well with the numbers from the Geneva event; this was not forced in any way but

rather is a statement on the healthy diversity of the discipline.

The meeting started with a lively social on the Sunday evening, before Daniel Klose commenced scientific proceedings the following morning with a lecture on ‘*The fundamental principles of electron spin and EPR*’. That first day focussed on spin Hamiltonians and parameters, continuous wave (cw) EPR methods, instrumentation and theory.

Day 2 introduced pulsed EPR, from fundamentals of spin dynamics, time dependence in quantum mechanics, pulsed instrumentation and methods. That afternoon focussed on pulsed hyperfine methods, whilst the morning of day 3 focussed on pulsed electron-electron dipolar methods before concluding with a remote demonstration, from the local EPR labs, of setting up basic spin echo experiments.

The afternoon of day 3 was left free for the attendees to explore the local sights of Manchester. Which, being the first great city of the Industrial Revolution, has a rich social, cultural, scientific and industrial heritage.

Day 4 was a day of practicals and tutorials. Students engaged hands-on in a diverse range of experiments that they had selected in advance, including multi-frequency cw, light-induced, rapid-scan and multi-harmonic acquisition, DEER/PELDOR, ENDOR and ESEEM/

HYSCORE methods. Tours were also available of local biological EPR and DNP facilities. Despite the large number of attendees, students were able to get hands-on experience in groups of 2-3, exploiting the wide range of equipment available in the EPSRC-funded UK National Research Facility (NRF) for EPR Spectroscopy at Manchester.

In addition to the practicals, each student attended two tutorial sessions from a range on offer that covered topics including density matrix methods, *ab initio* electronic structure calculations, and EPR data modelling and analysis.

Day 5 concluded the science content with a series of application lectures covering biological, catalytic, quantum information, light-induced and electrically-detected methods. The final lecture of the Summer School was a little more light-hearted, with Ilya Kuprov giving advice on how to navigate the scientific publishing process.

There were three lively poster sessions, with over 100 posters presented, held in the evenings across the week. The School closed with a banquet on the Friday evening at which six poster prizes were awarded; two each kindly sponsored by the Groupement Ampere, the IES, and the UK NRF for EPR. Our congratulations to all six winners.



Summer School Group photo



Practical/tutorial sessions

The 11th EFEPR Summer School will be held in 2027 hosted at the University of Barcelona, for updates see [www.EFEPR.org](http://www.EFEPR.org). The local organic organiser (Valentin Novikov) gave a short presentation announcing this. He seemed to be confident that it would be sunnier than Manchester.

The organisers are hugely grateful to the lecturers, not only for the delivery of the lectures, workshops and demonstrations, but

also for doing so at their own expense. (The long-distance prize goes to Stefan Stoll who travelled from Seattle to deliver two EasySpin masterclasses.) They are also grateful for the generous sponsorship by Bruker BioSpin, SciMed/CIQTEK, Cryogenic Ltd – all of whom attended as exhibitors – Amplify My Probe, Springer, the International EPR Society (IES) and, the Groupement Ampere, which will be a sponsor of the XIII EFEPR Conference

Brno (Czech Republic) August 29 to September 5, 2026. All these contributions helped to keep the attendance fee as low as possible.

Finally, our thanks to all the attendees: they make the Summer School what it is – a hugely enjoyable, educational and engaging experience.

Local Organising committee:

Adam Brookfield, Alice Bowen, David Collison, Elizabeth Fleming, Eric McInnes, Muralidharan Shanmugam, Floriana Tuna

### The 13th International Workshop on EPR in Biology and Medicine

October 13–16, 2025, Kraków, Poland

The 13th International Workshop on EPR in Biology and Medicine was attended by 128 participants, including 20 invited experts in the field of Electron Paramagnetic Resonance (EPR) and its biomedical applications, representing institutions worldwide – from the USA, Germany, France, Israel, Japan, Croatia, and Poland. The four-day event featured lectures focused on biomedical applications of EPR. The meeting was chaired by Martyna Elas (Department of Biophysics and Cancer Biology, Jagiellonian University) and Marcin Sarewicz (Department of Molecular Biophysics, Jagiellonian University).

In total, 64 presentations were delivered across eleven thematic sessions: \*Imaging, Oximetry, Technology, Lipids and Membranes, Spin Probes, Redox and Oxidative Stress, Metalloenzymes, Structural Biology, Mitochondrial Redox Signaling\*. Each talk was followed by a short discussion. Additionally, 31 posters were presented, and one dedicated session was held to discuss these results. Scientific discussions continued during breaks and evening gatherings. The main objective of the meeting – direct exchange of information on the latest research findings and achievements in EPR applications in biology and medicine, as well

as strengthening collaboration among leading international and national experts – was successfully achieved.

The primary means of disseminating conference results was the abstract booklet. Participants were also offered the opportunity to submit their work for peer-reviewed publication in a special issue of \*International Journal of Radiation Biology\*. sixteen manuscripts were submitted.

On Tuesday, October 14, a ceremonial awarding of the \*Merentibus\* Medal took place, honoring Professor Howard Halpern, who has been closely associated with our Faculty for many years. That evening, a poster session was held, during which a three-member committee (Benoit Driesschaert, Oxana Tseytlin, Martina Huber) selected the award winners: \* \*\*Best oral presentation by a young scientist:\*\* Conner Ubert – \*‘‘A Flexible RF Coil Design (OxyTrack) for Oxygen Measurements in Body Cavities’’\*

\* \*\*Best posters:\*\* Bartosz Płóciennik – \*‘‘Oxygen Nanobubbles for Theranostic Cancer Applications’’\* and Dilara Ögütçü – \*‘‘The Role

of Conformational Dynamics for Y Receptor Activation’’\*.

The awards, sponsored by the International ESR Society, included a cash prize of USD 200, and one-year membership in the Society.

The conference program also featured social and educational activities: a guided tour of the Collegium Maius Museum, a city game related to the history of science in Kraków, and demonstrations of state-of-the-art EPR equipment on the Jagiellonian University campus. Instrument demonstrations were organized at the Faculty of Chemistry and the Faculty of Biochemistry, Biophysics and Biotechnology in collaboration with Bruker Biospin, Novilet, and O2M Technologies.

Martyna Elas



Merentibus ceremony, from left: Vice-Rector of the Jagiellonian University, Prof. Jarosław Górniak, Dean of the Faculty of Biochemistry, Biophysics and Biotechnology, Prof. Jolanta Jura, awardee, Prof. Howard Halpern, and Prof. Martyna Elas.



The authors of the best posters (IES awards) – Bartosz Płóciennik (left) and Dilara Ogutcu (right) and best oral presentation for young researchers – Conner Ubert (middle). (Left: M. Elas, B. Płóciennik, B. Driesschaert, middle: M. Elas, P. Kuppusamy, C. Ubert, B. Driesschaert, right: M. Elas, D. Ogutcu, B. Driesschaert.)

## Conference reports

### The 53rd Southeastern Magnetic Resonance Conference

November 14–16, 2025, University of Florida, Gainesville, USA

The 53rd Southeastern Magnetic Resonance Conference (SEMRC) marked another chapter in a long-standing tradition for the magnetic resonance community. Since its inception, the SEMRC has served as a cornerstone for the MR community in the Southeast, fostering a unique and diverse environment that brings together MR experts and young researchers from academic institutions, national laboratories, and industry. This year's gathering continued that legacy, bringing together 130 participants (including approximately 70 graduate and undergraduate students) from 16 states. The event highlighted research developments in a region that has historically been productive for magnetic resonance, supported by major hubs such as the National High Magnetic Field Laboratory in Tallahassee and Gainesville.

The SEMRC 2025 program is notable for its inclusion of multiple disciplines, spanning NMR, EPR, MRI, and hyperpolarization, with applications across medicine, biology, chemistry, and materials science. By bringing these communities together, the conference facilitates technical exchange across different specialties and career stages. This multidisciplinary approach allowed attendees to observe how fundamental spin physics is applied dif-

ferently across various fields, from imaging live human brains with MR elastography to resolving the structural dynamics of cobaltocenium compounds. The ability to pivot from a talk on quantum sensing to one on clinical diagnostic tools within the same session remains one of the SEMRC's most valuable characteristics.

This year, the EPR community saw strong participation in both oral and poster sessions. Contributions covered a wide range of topics, including spins for quantum information, radical spin-labels, photoexcited triplet states, and metal centers in biochemistry. A brilliant keynote talk on spin-dependent electronic processes in condensed matter was delivered by Dr. Christoph Boehme from the University of Utah, while Dr. Brad Pierce from the University of Alabama gave an invited talk on hyperfine spectroscopy methods used to study enzyme catalysis.

A core mission of the SEMRC is to remain accessible to graduate students and postdoctoral researchers. This is achieved by providing low registration fees and travel support to young scientists who, in recent years, have often missed in-person meetings due to rising travel costs and stagnant research funding. These efforts are made possible by generous sponsors, including the International EPR Society (IES), whose contributions helped cover registration waivers and lodging for several students, as well as the prizes awarded to young researchers.

Furthermore, the conference allowed ample occasions for networking, fostering a

mentorship-rich environment. Many of the student attendees also took advantage of the pre-conference workshop focused on radio frequency coil building, held at the AMRIS facility at the University of Florida.

Among the awarded prizes, we would like to highlight the First Place for Best EPR Talk, awarded to Sebastian Atwood (Florida State University / National High Magnetic Field Laboratory) for research on multiphoton state transitions, and the First Place for Best EPR Poster, awarded to Hana Alsheikh (Emory University) for her work with dual EPR spin labels in amyloid fibrils.

The SEMRC 2025 was chaired by Chalermchai Khemtong (UF), and co-organized by William Brey (NHMFL & FSU), Malathy Elumalai (NHMFL & FSU), Luiza Nogueira (UF), and Tomas Orlando (NHMFL & FSU).

The organizers wish to thank the following sponsors: Tecmag, SpinCore, Cryogenic, Cambridge Isotope Laboratories, Intl. EPR/ESR Society (IES), JEOL, O2M Technologies, GE HealthCare, Bruker, Phoenix NMR, NVision, Doty Scientific, and the UF Department of Biochemistry and Molecular Biology.

Looking ahead, the next edition of SEMRC is scheduled for the fall of 2026 in Tuscaloosa, Alabama. EPR is well-positioned to lead the Southeastern magnetic resonance community's efforts for the 2026 conference, with Dr. Brad Pierce, who leads the EPR Group at the University of Alabama, acting as conference chair. Attendees can expect the same broad scientific coverage and student-focused atmosphere that have defined the SEMRC for over half a century. We encourage all IES members, especially those in the Southeastern United States, to save the date and join us in Alabama for another important gathering of the magnetic resonance community.

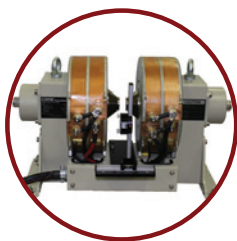
Tomas Orlando (SEMRC 2025 organizer,  
torlando@magnet.fsu.edu)

Brad Pierce (SEMRC 2026 chair,  
bspierce1@ua.edu)



Left. Tomas Orlando (NHMFL) awarding Hana Alsheikh (Emory Univ.) with the First Place for Best EPR Poster.

Right. Sabastian Atwood (FSU, left) receives the First Place for Best EPR Talk from Chalermchai Khemtong (UF).



- GMW Laboratory Electromagnets are now available with High Uniformity Poles, with uniformity in the range of a few ppm. Spectroscopy is now possible with a benchtop electromagnet.
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**The 64th Annual Meeting of the Society of Electron Spin Science & Technology**  
November 21–23, 2025, Kiryu, Japan

The 64th Annual Meeting of the Society of Electron Spin Science & Technology (SEST2025) was held from November 21st to 23rd, 2025, at Kiryu City Performing Art Center, Japan (URL: <https://sest-nenkai.org/2025>). The Society of Electron Spin Science & Technology (SEST) in Japan was established in 2002 in Tokyo where the joint conference on the 41st ESR Symposium and the 7th *in vivo* ESR Workshop was held. Since then, SEST has held scientific meetings annually in various cities in Japan, and in 2025, the annual meeting SEST2025 was held at Gunma Prefecture for the first time. Kiryu is a small city and is located just in the boundary of plain area and mountain area at 100 km north of Tokyo,

The total number of participants to the scientific part of the meeting SEST2025 was 189 including 83 graduate and undergraduate students. We had 36 oral and 80 poster presentations in addition to one plenary lecture, four award-winning lectures and two mini-symposia consisting of ten talks. The number of presentations and the number of participants were comparable to those at recent annual meetings but we had much more numbers of poster presentations by students than usual year. This may be because Kiryu is at a close distance from Tokyo, and travels to Kiryu including accommodation are not expensive.

In the afternoon of November 22nd, the SEST annual general meeting (AGM) was held. Board members of SEST reported the current status & activities, and the future plans of the society to the members. After the AGM, award ceremonies and award lectures for the

SEST Awards, SEST Academic Award and Young Investigator Award were held. The SEST Awards were given to two researchers. Prof. Hiroshi Hirata (Hokkaido University) received the SEST Award for his achievement entitled “The Development of 4D EPR Spectroscopic Mapping and Its Application in Biomedical Studies”, and Prof. Ken-ichi Yamada (Kyushu University) received the SEST award for his achievement entitled “Development and Application of Technology for the Detection of Lipid Radicals and Oxidized Lipids”. SEST Academic Award was given to one researcher: Prof. Tomoaki Yago (Saitama University) for his achievement entitled “Spin Dynamics in Triplet Pairs”. The Young Investigator Award was given to one researcher: Prof. Lewis M. Antill (Sungkyunkwan University) for his achievement entitled “Development of High-Sensitivity Microspectropic Methods and Spin Dynamics Software for Investigating Quantum Spin Effects in Flavin-Based Radical Pairs”. In addition to these awardees, Special Contributed Award was given to Prof. Aki Hirayama for his long-standing contributions to SEST.

In this annual meeting, Dr. Sun Hee Kim (Metropolitan Seoul Center, KBSI, Republic of Korea) was invited for the plenary lecture. She is currently a Vice President of the International EPR (ESR) Society and gave a lecture entitled “Spins in Action: Advanced EPR Approaches to Biology, Catalysis, and Quantum Systems” in the morning of November 22nd. Following the plenary lecture, one of the two mini-symposia was held on the morning of November 22nd as an English session. Dr. Hiroki Nagashima (Saitama University) and Dr. Ikuo Nakanishi (The National Institutes for Quantum Science and Technology) organized this symposium session entitled “Spin and Quantum Aspects of Biological Systems”. After the short introduction by Dr. Nagashima,

four speakers were scheduled. The first talk was “Elementary Reaction Rate Constants of Free Radicals Measured by Spin Echo Observation using Pulsed ESR Spectroscopy” by Prof. Akio Kawai (Kanagawa University). The second lecture was presented by Prof. Jonathan Woodward (Tokyo University) entitled “Microscopic Tools for Studying Radical Pairs in Biological Systems”. Prof. Shigeki Arai (The National Institutes for Quantum Science and Technology) gave the third talk on his findings on “Discovery of Hidden Magnetic Property in Iron-Sulfur Proteins Using ESR and SAXS”. The last presentation was entitled “Complementary Relationship in Protein Molecule Structure Analysis and Spin Structure Analysis”, presented by Prof. Hiroyuki Mino (Nagoya University).

The other mini-symposium was held in the morning of November 23rd entitled “Spin and Computational Chemistry: Practical Approaches to Magnetic Parameters and Fluctuations” and organized by Prof. Motoko S. Asano (Gunma University) and Prof. Kiminori Maeda (Saitama University). After the short introduction by Prof. Asano, six presentations followed: the former four topics were on EPR parameters and quantum calculations whereas the latter two topics were on molecular dynamical approaches to spin systems containing radicals. The first speaker, Prof. Masaaki Fuki (Kobe University) presented his talk on “Synergistic Approach to Transient Radical Analysis: Time-Resolved EPR Experiments and Quantum Chemical Calculations”, which was followed by Prof. Kazunobu Sato (Osaka Metropolitan University) with a lecture entitled “Understanding Magnetic Parameters and Electronic Structures of Paramagnetic Molecules with the Help of Quantum Chemical Calculations”. These two talks raised discussion on relation between experiments and



SEST award winners, from left to right: Tadaaki Ikoma (SEST President), Lewis M. Antill (Young Investigator Award), Tomoaki Yago (SEST Academic Award), Hiroshi Hirata (SEST Award), Ken-ichi Yamada (SEST Award).



Poster Presentation and Excellent Presentation award winners at SEST2025, from left to right: Tadaaki Ikoma (SEST President), Ibuki Torioka, Hayato Ito, Yuki Yamamoto, Kastuki Miyokawa, Satoha Numakura, Kota Yasutomi, Wakaba Somiya (Poster Presentation Awards), Misa Ohba (Excellent Presentation Award).

## Conference reports

computational calculations. After these two talks, two theoretical aspects were lectured: “Electron Spin Dynamics in Quantum Chemistry: Transitions, Polarization, and Relaxation” by Prof. Yuki Kurashige (Kyoto University) and “Theoretical Calculation Of Zero-Field Splitting by the SAC-CI Method” by Prof. Kazuo Toyota (Osaka Metropolitan University). In view from molecular dynamic aspects, Prof. Kiminori Maeda (Saitama University) presented “Spin Dynamics of Radical Pairs and Molecular Dynamics Calculation” and Prof. Yasuhiro Matsunaga gave his talk on “Molecular Dynamics Simulation of Radical Pairs in the Binding Pocket of Bovine Serum Albumin”.

SEST recognizes several young members with two types of presentation awards, the Excellent Presentation Award and Poster Presentation Award, in every annual meeting to encourage young researchers. The winners of these awards are selected by judging processes among presenters who have applied in advance. The Excellent Presentation Award is given to young researchers under the age of 32 who give outstanding oral presentations. In SEST2025, this award went to Misa Ohba (Hokkaido University) “Oxygen Partial Pres-

sure Measurement Based on Relaxation Times Using OX071 and 750 MHz CW-EPR” out of five candidates. The Poster Presentation Award is given to students who presented their research results with well-prepared posters. In SEST2025 eight poster presenters were selected among 50 poster applications. The recipients of this award were Ibuki Torioka (Shizuoka University), Hayato Ito (Fukui University), Yuki Yamamoto (Kyoto University), Kastuki Miyokawa (Kyoto University), Satoha Numakura (Niigata University), Wakaba Somiya (Tsukuba University), Kota Yasutomi (Niigata University), and Reo Tabada (Tokyo Science University).

The conference banquet was held at Bikini Hall near Kiryu JR-railroad Station in the evening of November 22nd. The banquet was started by greeting of the president of SEST, Prof. Tadaaki Ikoma and followed by the conference chair. Welcome message was given by Prof. Tuneaki Ishima, Dean of the Graduate School of Science and Technology, Gunma University. The four honorary SEST members were invited and the 124 participants greatly enjoyed the food and drink, including local dishes and alcohols. In the middle, short talks were given by Mr. Hidehito Yashima

(Bruker Japan K.K.), Mr. Masaki Takahashi (JEOL Ltd.), and Miss Haruka Kitahara (LA systems) as well as the award winners. Time was too short to talk and laugh together under face-to-face mutual communications. Closing was done by “1-ppon JIME”, a Kiryu style performance, conducted by Prof. Ishima with all the participants.

The meeting would not have succeeded without support of Kiryu city, Gunma University, and the sponsorship of 16 companies and two associations. At last but not least, great help from so many people was really appreciated.

The next annual meeting is scheduled as a joint conference with Asia-Pacific EPR/ESR international conference, APES-SEST 2026 in October 18–22, 2026, in Urawa, Saitama prefecture, Japan. (<https://sest-nenkai.org/APES2026/>) We are looking forward to lively discussions there.

Motoko S. Asano, Professor,  
Chair of SEST2025, Gunma University  
Kiminori Maeda, Professor,  
Vice-chair of SEST2025, Saitama University  
Naoki Asakawa, Professor,  
Vice-chair of SEST2025, Gunma University  
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## Free Radical and Spin-Based Functional Materials Symposium at PACIFICHEM 2025

December 15–17, 2025, Honolulu, Hawaii, USA

The symposium on Free Radical and Spin-Based Functional Materials (MAT011) was successfully held from December 15th to 17th, 2025, at PACIFICHEM 2025 in Honolulu, Hawaii. The symposium was organized by Prof. Alex I. Smirnov (North Carolina State University, USA), Prof. Steven Bottle (Queensland University of Technology, Australia), and Prof. Naoki Yoshioka (Keio University, Japan). This symposium built upon the success of three previous symposia at Pacificchem 2010, 2015, and 2021, which primarily focused on nitroxide free radicals. The 2025 edition expanded its scope to encompass the broader landscape of spin-based functional materials and their application to redox-active systems, spintronics, and quantum sensing and quantum information science.

Just one day before the symposium, unusually cold weather and heavy snowfall across the continental United States caused significant flight delays, particularly in the eastern part of the country. Despite these widespread disruptions to air travel, only one invited speaker was unable to arrive in Honolulu in time for the first day's sessions. In contrast to the severe winter conditions on the mainland, Hawai'i offered a warm and welcoming haven for conference attendees.

Honolulu and the surrounding island of O'ahu are considered a deeply significant gathering place (wahi ho'okipa in the Hawaiian language), where guests are welcomed and connections are nurtured. Through the islands' history to the present day, O'ahu and Honolulu have served as a hub for people, cultures, and commerce across the Pacific. As the capital of the former Hawaiian Kingdom

and now the state, Honolulu functions as a vital center for preserving, practicing, and celebrating Hawaiian traditions, acting as a true crossroads of the Pacific. This unique role as both a cultural anchor and an international meeting point made Honolulu a particularly fitting location to bring together scientists with diverse expertise, fostering the interdisciplinary exchange and collaboration that the symposium aimed to promote.

The event attracted a diverse, international audience of researchers from the United States, Canada, Australia, Japan, South Korea, China, and European countries including the United Kingdom, Sweden, and Italy. Over three intensive days, the program featured approximately 35 oral presentations and a poster session, covering cutting-edge developments across multiple disciplines.

The symposium explored materials and molecules possessing unpaired electronic spins, which exhibit unique chemical and exotic physical properties. These spin centers serve as powerful reactive chemical tools and sensitive spectroscopic probes. Recent advances have demonstrated their potential as key components in quantum sensors and quantum information systems, as molecular magnets and redox-active systems, and in spintronic devices that exploit spin as an additional degree of freedom.

The program was organized around several major thematic areas:

### 1. Biomedical Applications and Spin Probes

The opening sessions featured substantial focus on EPR probes for biomedical applications. Prof. Benoit Driesschaert (West Virginia University) presented new stable triarylmethyl radicals for biomedical EPR applications, while Prof. Valery Khramtsov (West Virginia University) discussed nitroxide

and trityl radicals with designed functionality for in vivo molecular EPR spectroscopy and imaging of cancer. Several presentations from the Smirnov group at NC State University highlighted ionizable lipid-based EPR probes for membrane studies and pH-sensitive probes for investigating local electrostatics in transmembrane domains. Prof. Zhongyu Yang (University of Missouri) demonstrated the use of nitroxide spin probes in enzyme-nanomaterial systems. The session concluded with Prof. Alex Smirnov's presentation on spin probes and EPR in drug and vaccine development.

### 2. Photochemistry and Radical Generation

The symposium devoted significant attention to photochemical approaches to radical generation and manipulation. Prof. Manabu Abe (Hiroshima University) presented work on photochemical generation of nitroxides, while Jessica Bradford (Queensland University of Technology) demonstrated logic gating of photochemical states utilizing nitroxide free radicals. Prof. Eunsung Lee (Seoul National University) discussed innovations in designing carbene-derived stable organic radicals and highlighted their applications.

### 3. Radical-Based Polymers and Energy Storage

A major theme throughout the symposium was the application of organic radicals in energy storage systems. Prof. James Blinco (Queensland University of Technology) in his talk placed "A new spin on organic radical batteries" by highlighting recent advances in radical-based battery technology. Prof. Kenichi Oyaizu (Waseda University) discussed electroactive radical polymer systems for high-performance organic batteries and devices, while Kohei Ishigami (Waseda University) presented a redox-active polyelectrolyte approach for viscosity reduction in polymeric



Prof. Kazunobu Sato (Osaka Prefecture University) delivering his invited lecture "Local Structure of Heterochromatin Protein with Nitroxide Spin Labels by DEER Spectroscopy and Molecular Dynamics Simulation" to symposium audience (left), while the famous Waikiki Beach appeared noticeably less crowded during the talk (right). Photo credits: Smirnov, Yoshioka, Vovnov.

## Conference reports

redox flow batteries. Prof. Claudia Avalos (New York University) provided theoretical insights into calculations of magnetic exchange interactions in binitroxide pentacene complexes using broken symmetry density functional theory.

### 4. Luminescent Radicals and Supramolecular Assemblies

The program featured cutting-edge research on luminescent radical materials. Prof. Ken Albrecht (Kyushu University) presented synthesis and properties of luminescent radical core carbazole dendrimers, while Prof. Tetsuro Kusamoto (University of Osaka) discussed photoluminescence of assembled radicals. Prof. Takuya Hosokai (National Institute of Advanced Industrial Science and Technology) investigated photodegradation mechanisms of organic luminescent radicals. Prof. Yoshiaki Uchida (Osaka University) explored low-temperature liquid-crystalline nitroxide radicals, and Prof. Naoki Yoshioka (Keio University) presented work on stable nitroxyl radical self-assemblies exhibiting magnetic interactions.

### 5. Advanced EPR Instrumentation and Quantum Sensing

The symposium included several presentations on state-of-the-art EPR instrumentation and quantum sensing technologies. Prof. David Britt (University of California, Davis) described the design and performance of a high-power (10 W) TWT-based pulse EPR spectrometer operating at 263 GHz. Prof. Alexander Nevzorov (North Carolina State University) presented work on probing electron spins and spin clusters in synthetic diamonds by ns-scale pulsed EPR and pulse dynamic nuclear polarization at 7 T (197 GHz electron spin resonant frequency) using a unique spectrometer constructed at North Carolina State University. Prof. Gareth R. Eaton (Uni-

versity of Denver) demonstrated a compact 1 GHz EPR spectrometer and imager, while Marco Torelli (Adamas Nanotechnologies) discussed nanodiamond quantum sensing of free radicals in biological systems.

### 6. Distance Measurements and Protein Structural Studies

Advanced EPR techniques for structural biology were prominently featured. Prof. Jeffrey R. Harmer (University of Queensland) presented structural characterization of proteins using DEER spectroscopy with non-natural amino acids conjugated to paramagnetic labels via NAT-click chemistry. Prof. Sunil Saxena (University of Pittsburgh) summarized his pioneering work on employing Cu(II)-based spin labels for measuring distances in biomolecules including in-cell experiments. Prof. Nick Cox (Australian National University) demonstrated measurements of long-range distances in proteins using  $^{19}\text{F}$ -ENDOR between  $^{19}\text{F}$  and  $\text{Gd}^{3+}$ . Dr. Giulia Da Ros (University of Manchester) reported on orientation-selective light-induced pulsed dipolar spectroscopy in combination with molecular dynamics. Prof. Peter Qin (University of Southern California) employed DEER to dissect the mechanisms of CRISPR-Cas9 target discrimination. Additional presentations included Boris Dzikovski (ACERT and Cornell University) on new distance rulers for pulse dipolar ESR spectroscopy, Prof. Kazunobu Sato (Osaka Prefecture University) on determination of local structure of a heterochromatin protein, and Prof. Fikret Mamedov (Uppsala University) on investigating tyrosine radicals in Photosystem II.

### 7. Switching Systems and Functional Materials

The final morning session also featured a presentation of Prof. Takayuki Ishida (University of Electro-Communication) on preorganized

bisnitroxide systems switching between diamagnetism and paramagnetism, representing emerging directions in stimuli-responsive radical materials.

Overall, the symposium successfully united organic chemists, materials experts, spectroscopists, and quantum scientists in a true cross-disciplinary mix. It offered a rare chance to share cutting-edge free radical research across fields and Pacific Rim communities, sparking fresh collaborations and breakthroughs set to reshape the field.

The symposium clearly demonstrated the continued vitality and expanding scope of spin-based functional materials research. From fundamental organic synthesis to quantum sensing applications, from biomedical probes to energy storage solutions, the field continues to evolve at the intersection of chemistry, physics, materials science, and biology, with magnetic resonance and EPR as the major experimental tool. The success of this fourth symposium in the series establishes PACIFICHEM as a premier venue for the free radical and spin chemistry magnetic resonance community, with strong participation from researchers across the Asia-Pacific region and beyond. In the spirit of the islands, the organizers closed the symposium with the words *A hui hou* ("until we meet again"), looking forward to the next PACIFICHEM in five years.

The symposium organizers express their gratitude to all speakers, poster presenters, session chairs, and participants who contributed to the scientific excellence and collegial atmosphere of the meeting. Special thanks to PACIFICHEM 2025 for providing excellent facilities and organizational support at the Sheraton Waikiki, Sheraton Princess Kaiulani, and Hawaii Convention Center venues.

Alex I. Smirnov

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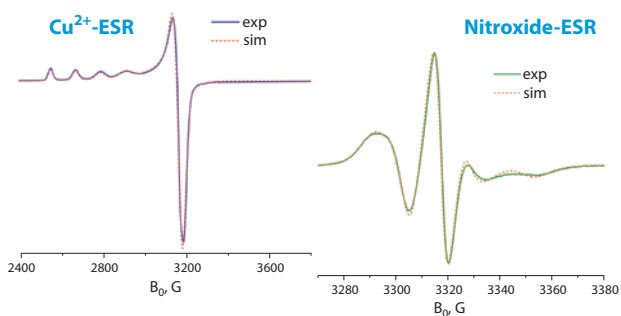


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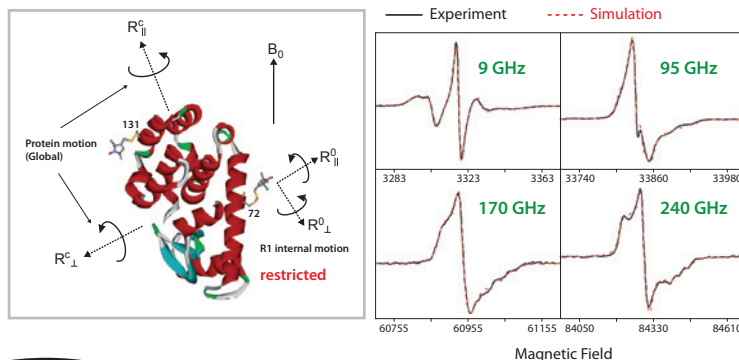
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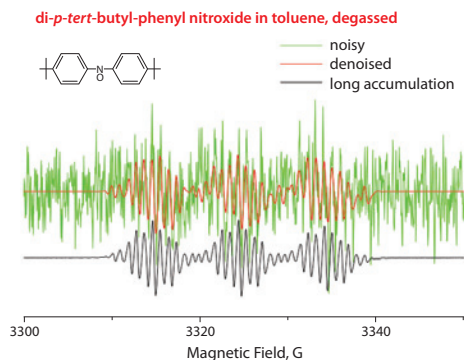
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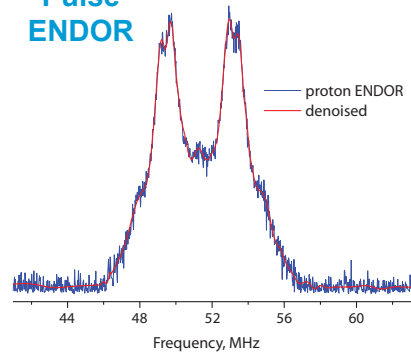


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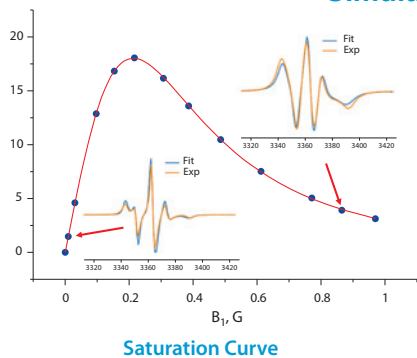


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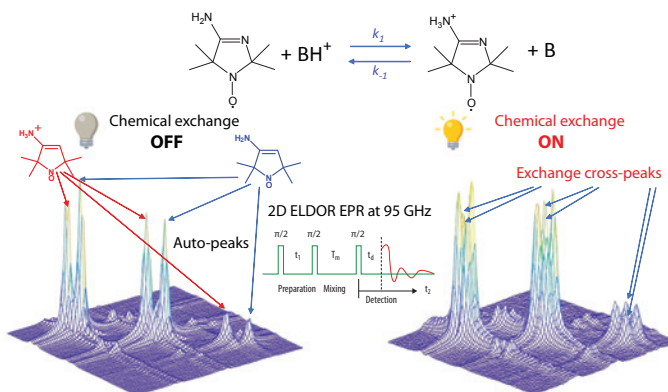
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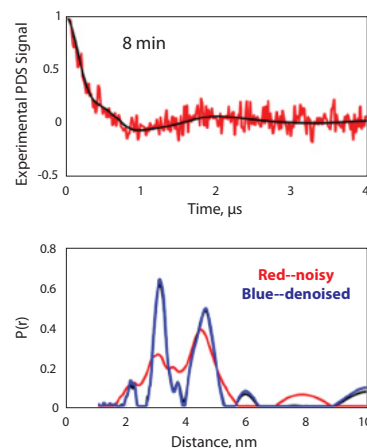
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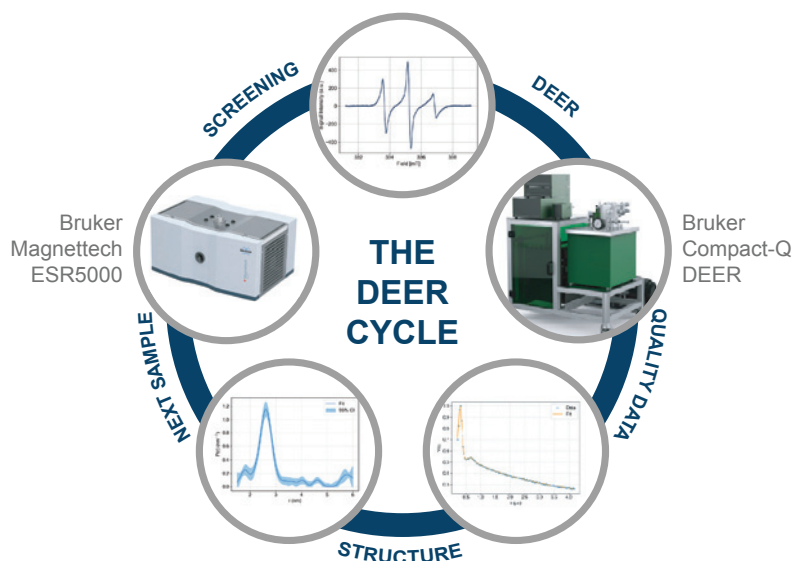
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