WESTERN SYDNEY
UNIVERSITY

Nanoscale Organisation
and Dynamics Group

NANOSCALE RESEARCH NEWSLETTER

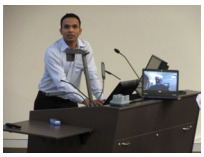
ISSUE 6 – MARCH 2017

SPECIAL POINTS OF INTEREST

401203 - Applications of magnetic resonance from cancer to Neuroanatomy

Many students receive a limited introduction to the field of magnetic resonance if they do an organic chemistry spectroscopy course, but many remain unaware of the myriad of other techniques and applications of magnetic resonance or even that Nuclear Magnetic Resonance (NMR) spectroscopy and Magnetic Resonance Imaging (MRI) are "two sides of the same coin". Autumn semester 2017 marked the first time that the Masters of Research elective 401203 Applications of Magnetic Resonance from Cancer to Neuroanatomy, which is taught by members of the Nanoscale Group, has been held at Western Sydney University. Magnetic resonance provides a suite of versatile information rich and non-invasive techniques of which MRI, Magnetic Resonance Spectroscopy (MRS) and NMR spectroscopy are the best known. These techniques have enormous applications across the sciences (e.g., inorganic and organic chemistry) but increasingly to medicine (e.g., to cancer diagnosis and treatment). This new unit is a timely addition to the units offered at Western Sydney University since the university has state-of-the-art MR infrastructure and an international reputation in MR development. The researchers in the Nanoscale Group have numerous research projects, some involving domestic (e.g., Ingham Institute) and international collaboration, on the development and applications of many of these magnetic resonance techniques ranging from MRI in radiation oncology and lizard brain neuroanatomy to MRI contrast agent development and NMR studies of solution structure in ionic liquids. This innovative new elective unit explores the diverse range of applications and teaches experimental practice and fundamental physical principles that underpin all the MR-based techniques. The elective is intended for medical science, medical and science students who use/intend to use NMR/MRI technology including those wishing to go onto a higher degree involving MR, or merely those wanting a deeper understanding of its rapidly expanding capabilities (e.g., functional MRI) and applications.

7th Western Sydney University NMR, MRI and Diffusion Symposium



Another successful Western Sydney University NMR, MRI and Diffusion Symposium was held late last year. The symposium fills a void in research symposia in Australia – the university is unique in holding the only symposium in Australia to cover this area of research (Diffusion, NMR and MRI) and are held biennially with this being seventh organised by the Nanoscale Research Group.

Lectures were interesting and informative, running along the central theme of diffusion and nuclear magnetic resonance. Prof. Peter Basser (NIH) was scheduled to be our first speaker of the day but, unfortunately due to United Airlines he was unable to deliver his talk in person. However, with no power outages this time, he was able to complete his talk and take questions, via zoom. Prof. Gareth Morris (Univ. Manchester) rose very early in the morning to deliver our last lecture of the day again via zoom. The Conference dinner held at Rydges Hotel Campbelltown and was well attended by academics, students and industry representatives.

The majority of delegates were from Australia or New Zealand, 33% were higher degree students, with JEOL and STELAR sending representatives.

The Symposium was financially supported by Western Sydney University, Bruker Biospin, JEOL, Magtritek, Siemens Healthineers and STELAR .

The Symposium Poster Prize Winners were;

- $200 Cash – Magritek Prize - Neil Mallo (UNSW) for his poster titled Photochromic switching of DASA in organic solvents. The judges felt that the poster presented a clear case describing an exciting problem with a very objective that was met and an excellent chance of conversion into a real world application.
- Registration for ANZMAG2017 - Igor Shikhov (UNSW) for his poster titled Tortuosity prediction from oxygen diffusion via T2 z, t) relaxation NMR.
- £100 RSC Book Voucher – Johnny Chen (WSU) for his poster titled Development of Pulse Sequences for Chemical Exchange Saturation Transfer. The judges commented that this had been selected as it was considered an insightful and clever NMR approach to a long existing question.

60 seconds with Bill Price

THE BUMBLE BEE SHOULDN'T BE ABLE TO FLY, BUT THE BUMBLE BEE DOESN'T KNOW IT SO IT GOES ON FLYING ANYWAY - MARY KAY ASH

How would you describe the research of your group in a few words?

The focus of my research group is on probing molecular association, organisation and dynamics especially through the use and development of advanced magnetic resonance (incl. MRI and diffusion measuring) techniques. As we go to smaller length scales many things have considerable similarity even though at macroscopic length scales they may be seen as very different. For example, grapes and brain tissue appear very different. Yet both are porous media made of metabolite containing cells which are organised into tissues. Similarly, battery electrolytes and associating protein systems both involve the binding and exchange of molecules. Thus, using the same magnetic resonance techniques and modelling we are able to probe a diverse range of systems (e.g., binding of anticancer drugs, conductivity in battery electrolytes, probing porous media including sandstone, biological tissue and tumours). Thus, the research in my group is very multidisciplinary with much of it falling within the general area of 'medical physics'.

What prompted you to investigate this topic?

When I started at university I had never heard of magnetic resonance and MRI was not widely used in clinical medicine. In third year I started to study magnetic resonance from both a chemical and biochemical perspective. I was fascinated by how much information you could obtain not just on what molecules were in the sample but how they moved (remember all of the molecules in a biological cell are constantly rotating and translating), and that you could do so non-invasively – this is in stark contrast to many other scientific techniques. What's more, although it was already a powerful technique, magnetic resonance was (and still is) in its infancy and had incredible potential. But to go further you needed a multidisciplinary approach with expertise including maths, physics, computing, biochemistry and chemistry – exactly what I had studied as an undergraduate. If I look back even just a decade the progress in magnetic resonance has been so enormous. It is a very seductive area to conduct research in and no two days are ever the same.

How did the collaboration for this work arise?

Collaborations have started in a number of ways. Perhaps arising from a casual conversation at a conference or because I realise that I have developed a powerful new technique in need of a good application. More recently, many collaborations have arisen out of WSU being a node of the National Imaging Facility (www.anif.org.au) and so other scientists, who are not magnetic resonance specialists, approach us. Presently we have projects ranging from applications in radiation oncology and pre-eclampsia to lizard brains and ionic liquids.

Welcome to Adjunct Professor - Dr Suzy Rogiers

Dr Suzy Rogiers

We welcome Dr Suzy Rogiers as an Adjunct Professor at Western Sydney University for the next 2 years.

Dr Suzy Rogiers is a principal research scientist with the NSW Department of Primary Industries and she is located at the National Wine and Grape Industry Centre in Wagga Wagga. She has researched fruit development and plant water relations for the last 15 years. She completed her PhD on the physiology and biochemistry of Amelanchier alnifolia (saskatoon) berry ripening through the University of Alberta, Canada. Subsequently she joined the NSW Department of Primary Industries to study viticulture and she has a particular interest in plant responses to abiotic stresses. She has published on topics such as cell senescence, Shiraz berry shrivel, fruit split, source-sink relations on fruit-set, water-use efficiency, night-time transpiration and root-zone temperature effects on grapevine physiology and berry development. Her work relies on a combination of field based and controlled environment studies. Currently she is involved in an ARC Industry Transformation Training Centre project in conjunction with the University of Adelaide exploring viticultural methods to reduce alcohol levels in wine.

Dr Suzy Rogiers was co-supervisor for Dr Ryan Dean (Nanoscale) and has, mentored in the past a number of PhD students in the Nanoscale Research Group. She has published two high profile paper with the group and a third should soon be accepted. It would be advantageous for this mentoring to continue and allow us access to her expertise and knowledge.

Currently, we have a number of early stage collaborative projects with Dr Rogiers and she travels from Wagga Wagga to WSU regularly, for project meetings and to use our facilities.

Prof. Masaya Ishikawa, who is a long standing collaborator for Prof. Price (Senior principal researcher, Project Researcher, Tokyo University of Science) travelled to Charles Sturt University in December last year, at the request of Dr Rogiers, as part of a joint project between WSU, DPI and Tokyo University of Science.

NSW GOVERNMENT Department of Primary Industries

NATIONAL Wine & Grape INDUSTRY CENTRE

Charles Sturt University

Stelar Spinmaster FFC2000 – 1T

Relaxometry refers to the study and/or measurement of relaxation variables in Nuclear Magnetic Resonance and Magnetic Resonance Imaging. In NMR, nuclear magnetic moments are used to measure specific physical and chemical properties of materials. Relaxation of the nuclear spin system is crucial for all NMR applications

Fast Field Cycling Relaxometer Standard NMR equipment is designed to operate at moderate and high static magnetic fields, ranging from 0.5 T up to more than 20 T. However, such equipment is not able to detect relaxation rates at fields in the nanosecond and millisecond range due to insufficient sensitivity, many crucial chemical processes involve the slow dynamics of molecules that occur in this range. Such slow motions are difficult to measure by traditional NMR spectrometers or Magnetic Resonance Imagers. The Fast Field Cycling Nuclear Magnetic Resonance Spectrometer (FFC NMR) is a powerful technique for probing slow molecular dynamics and measuring the nuclear magnetic resonance dispersion. This method (NMR field cycling relaxometry) utilises a field cycle, consisting of three periods with differing magnetic fields

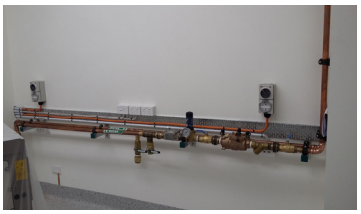
1. Polarization of the nuclear spins in a strong field $\mathbf{B}_{pol}$
2. Relaxation in a variable evolution field $\mathbf{B}_{evo}$
3. Detection of the NMR signal in a strong field $\mathbf{B}_{det}$

Examples of applications where using FFC NMR is very useful include filtration, imbibition (special type of diffusion), conduction, wettability, protein hydration, dynamics of polymers and liquid crystals, MRI contrast agents, durability of cements and concretes, determination of oil to water ratios in rock cores, filtration and water purification in soils, catalysis.

* Operates from 0.01 MHz to 40 MHz
* Measurement of relaxation times from a fraction of a millisecond to several seconds
* Multi-nuclear operations include: 1H, 2H, 19F, 7Li, 23Na, enriched 13C, etc.
* Fully automated acquisition of NMRD profiles

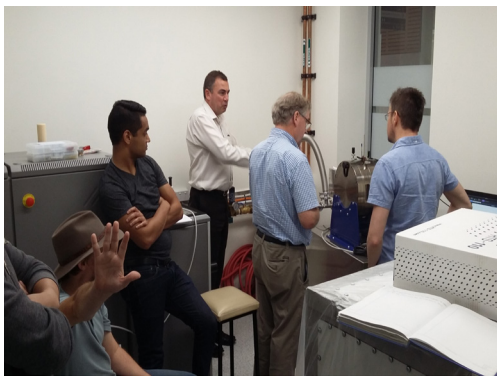


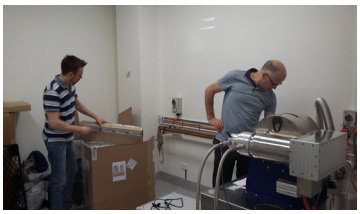








THE FAST FIELD CYCLING NMR RELAXOMETER WAS FUNDED BY;

CANCER INSTITUTE NSW

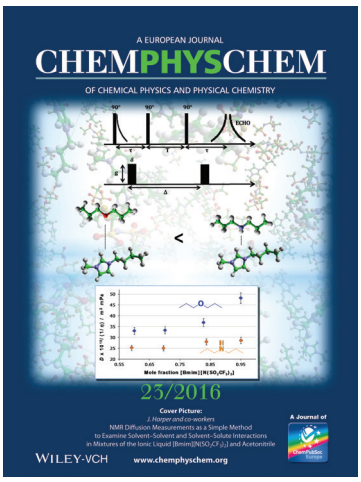
NATIONAL IMAGING FACILITY

EDUCATION IS THE KEY TO SUCCESS IN LIFE, AND TEACHERS MAKE A LASTING IMPACT IN THE LIVES OF THEIR STUDENTS - SOLOMON ORTIZ

ChemPhysChem Vol 17, Issue 23

The Inside Back Cover picture shows the pulse sequence used to determine the diffusion coefficients of components of ionic liquid mixtures. Comparison with viscosity shows the change in the nature of solvation and that interactions with nitrogen centres are more dramatic than with oxygen centres.

(DOI: 10.1002/cphc.201600927).

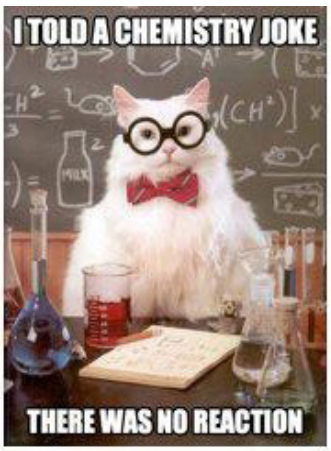


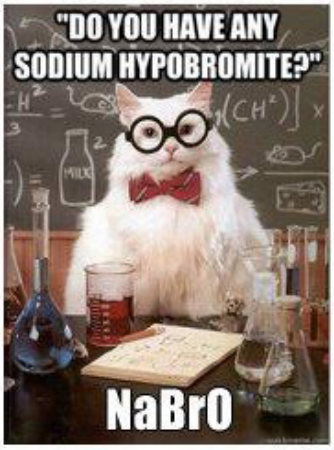
NMR Diffusion Measurements as a Simple Method to Examine Solvent–Solvent and Solvent–Solute Interactions in Mixtures of the Ionic Liquid [Bmim][N(SO2CF3)2] and Acetonitrile

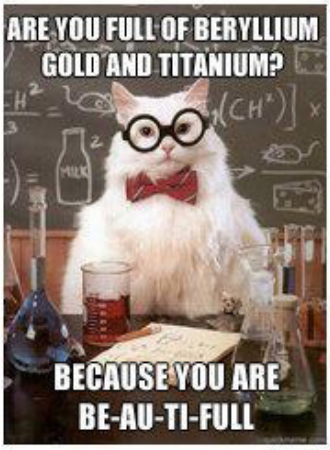
Dr. Sinead T. Keaveney, Karin S. Schaffarczyk McHale, Dr. James W. Stranger, Dr. Batchimeg Ganbold, Prof. William S. Price and Prof. Jason B. Harper

Version of Record online: 6 DEC 2016 | DOI: 10.1002/cphc.201601224

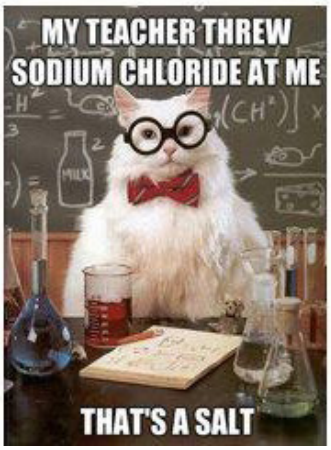
THEORETICAL PHYSICS IS A SCIENCE LOCALLY ISOMORPHIC TO MATHEMATICS

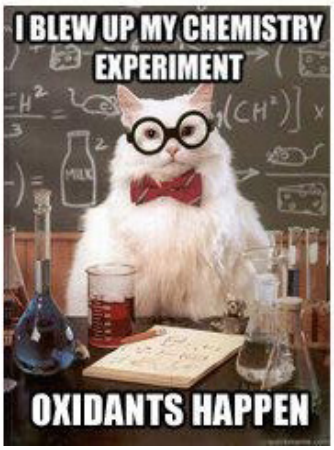






MONEY HAS RECENTLY BEEN DISCOVERED TO BE A NOT-YET-IDENTIFIED SUPER HEAVY ELEMENT. THE PROPOSED NAME IS: UN-OBTAINIUM





How many words can you make from

NUCLEAR

4 letters - 36 words

5 letters - 19 words

6 letters - 8 words

7 letters - 2 words

Answers below.

4 letters

ACNE, ACRE, ALEC, CANE, CARE, CARL, CARN, CAUL, CLAN, CLUE, CURE, CURL, CURN, EARL, EARN, ECRU, ELAN, LACE, LANE, LEAN, LEAR, LUCE, LUNA, LUNE, LURE, NARC, NEAR, NURL, RACE, RALE, REAL, RULE, RUNE, ULAN, ULNA, UREA.

5 letters

CANER, CARLE, CLEAN, CLEAR, CRANE, CRUEL, LACER, LANCE, LEARN, LUCRE, LUNAR, NACRE, RANCE, RENAL, ULCER, ULNAE, ULNAR, UNCLE, UREAL.

6 letters

CUNEAL, LACUNE, LANCER, LAUNCE, LUCERN, NEURAL, UNLACE, UNREAL.

7 letters

LUCARNE, UNCLEAR.

NANOSCALE ORGANISATION AND DYNAMICS

Professor William S. Price
Group Leader
- Medical Physics, MRI, NMR and diffusion

Professor Janice Aldrich-Wright
Lecturer
- Potent in-vivo cytotoxic agents

Professor Annemarie Hennessy
Dean of Medicine
- Preeclampsia

Assoc. Prof. Gary Dennis
Director Research School of Science and Health
- Polymer and surface chemistry

Dr Tim Stait-Gardner
National Imaging Facility Fellow
- MRI and quantum physics

Dr Allan Torres
Research Instrumentalist
Senior Lecturer
- NMR and MRI

Dr Gang Zheng
Lecturer
- NMR pulse sequence development

Dr Scott Willis
Post Doctoral Fellow
- NMR and MRI diffusion measurements

Dr Abhishek Gupta
Post Doctoral Fellow
- MRI contrast agent development and NMR relaxation

Group Meetings

I HAVE NOT FAILED.

I'VE JUST FOUND 10,000 WAYS THAT WON'T WORK

— THOMAS ALVA EDISON

NANOSCALE RESEARCH / GRANT MEETINGS

Nanoscale Research/Grant Meetings are held monthly at Campbelltown.

PROFESSOR WILLIAM PRICE'S LAB GROUP

Meet every Friday at 09:30 am in CA 21.1.65

BMRF USERS MEETING

PROFESSOR JANICE ALDRICH-WRIGHT'S LAB GROUP

Group meet every Friday at 10:00 am in 21.G.23

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