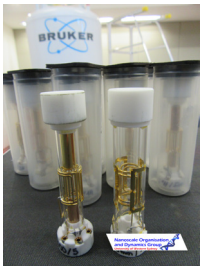
WESTERN SYDNEY UNIVERSITY

Nanoscale Organisation and Dynamics Group

NANOSCALE RESEARCH NEWSLETTER

ISSUE 2 – FEBRUARY 2016



500 MHz Rf Insert for Diff 30 Micro5 Probe

600 MHz Animal Bed suitable for Micro2.5 Probe

Biomedical Magnetic Resonance Facility

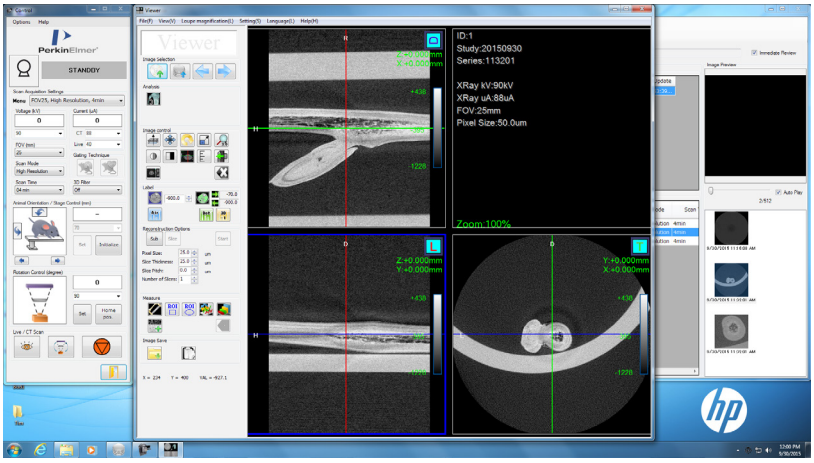
The Biomedical Magnetic Resonance Facility acquired a number of valuable pieces of equipment during January and February this year and the new 600 MHz spectrometer is slowly being returned to operation after a number of interruptions last year. The broadband probe has been repaired and returned to the facility and the 600 MHz is now operational for spectroscopy. Bruker reports that the high-power imaging/diffusion gradient amplifiers have been repaired as well. We expect them to arrive in the facility in March/April and once installed and tested the 600 MHz should be running at peak efficiency. At the moment the 600 MHz is available for spectroscopic experiments and booking time is available.

The facility has also purchased a number of RF inserts for the high gradient Micro5/Diff30/Diff50 probe, including the 19F and the 7Li coils. The two coils are available for performing imaging/diffusion experiments with the 500 MHz spectrometer, along with the existing 1H, 2H, 13C, 31P, 133Cs and 195Pt coils. A list of nuclei available for diffusion/imaging experiments on the 600 MHz will be available once the high power gradient amplifiers are back in operation.

WSU - National Imaging Facility Node

National Imaging Facility

NIF collaboration in February included: the continuation of placenta scans with the School of Medicine for producing a placental atlas and studying preeclampsia; diffusion MRI measurements for prostate cancer diagnosis with Sydney University; nanoparticle contrast agents with CSIRO; electron density mapping project with UNE and the Ingham Institute; investigation of water penetration into chickpeas as part of a Grains Research and Development Corporation (GRDC) project with NSW DPI; and CT scans of acacia seeds with HIE.



Screen shot of microCT scan

WHAT IS BROWN AND STICKY?

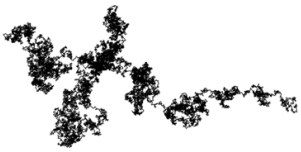
A STICK!

SPECIAL POINTS OF INTEREST

What is Diffusion

IF YOUR CAR COULD TRAVEL AT THE SPEED OF LIGHT, WOULD YOUR HEADLIGHTS WORK?

Much of the research in the Biomedical Magnetic Resonance Facility (BMRF) involves the modelling of diffusion and measurements of the self-diffusion coefficient of a chemical in solution. To understand self-diffusion, consider a drop of ink in a glass of water. The molecules of the ink diffuse into the water (a process called mutual diffusion), each having a unique trajectory like the random walk given in the figure below.



After a time the ink and the water will fully mix and there is no further macroscopic change but each of the ink molecules will still be moving relative to each other and the water molecules. This is self-diffusion. In technical terms, self-diffusion occurs when the chemical potential gradient is zero.

In a mixture (or pure substance) at equilibrium each chemical species will have its own self-diffusion coefficient. If we average over many such molecular trajectories of a single chemical species we find that the mean square displacement (<r2>) of a molecule is proportional to time (t), <r2> = 6Dt, where D is the diffusion coefficient. Thus the higher the diffusion coefficient, the greater the mean square displacement. A 25° C the diffusion coefficient of H2O is 2.3×10-9 m2s-1. With this diffusion coefficient it takes less than a millisecond for water to be displaced on average by more than the length of an Escherichia coli bacterium.

Diffusion can be a lot more complex than this however. In liquid crystals, for example, diffusion is anisotropic meaning a diffusion tensor is needed to quantify it rather than just a coefficient. Diffusion measurements can be used to study drugs binding to proteins, to probe the microstructure of porous materials and to understand many chemical processes and also has important applications in medical imaging. How NMR can be used to measure diffusion will be covered in a future issue.

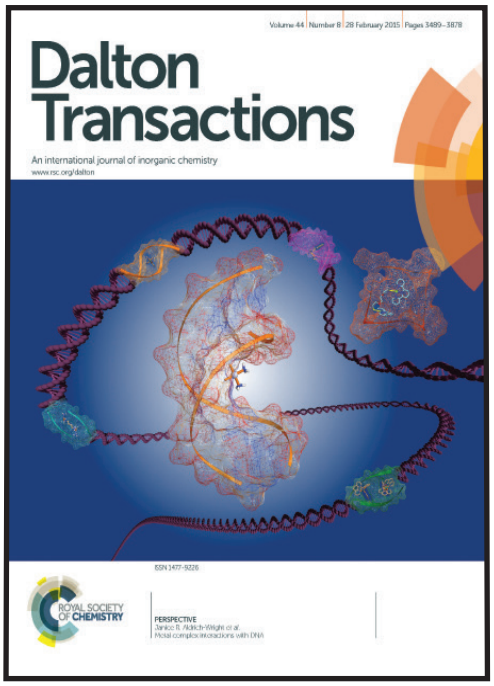
Student Profile - Dj Nadeeja Wijesekera

Dj Nadeeja Wijesekera

Dj Nadeeja Wijesekera completed his B.Sc. (Adv – Medical Nanotechnology) (Honours) in 2014 at Western Sydney University and was awarded the University Medal.

Dj is currently in the second year of his PhD at Western Sydney University in collaboration with the Ingham Institute under the supervision of Prof. William S. Price, A/Prof. Gary P. Liney, A/Prof. Lois C. Holloway, Dr Allan M. Torres and Dr Tim Stait-Gardner. His research interests lie in the fields of NMR, MRI and Radiation Oncology. Dj's current project aims to use MRI Imaging to evaluate hypoxic tumour cells. The significance of this project is that hypoxia plays a great role in acting as a resistance to radiotherapy treatments, hence developing a means to non-invasively detect such tumours would allow identification of those who require more aggressive treatment regimens, potentially leading to significant improvements in patient treatment outcomes.

Dj is currently working in collaboration with the Ingham Institute, as part of Western Sydney University's contribution to the MRI-Linac Project, where the Nanoscale Organisation and Dynamics Group is developing advanced target specific contrast agents (i.e., targeting hypoxic tumour sites). Dj hopes to continue working in this field into the future, aaspiring to take MRI to the forefront of clinical practice.



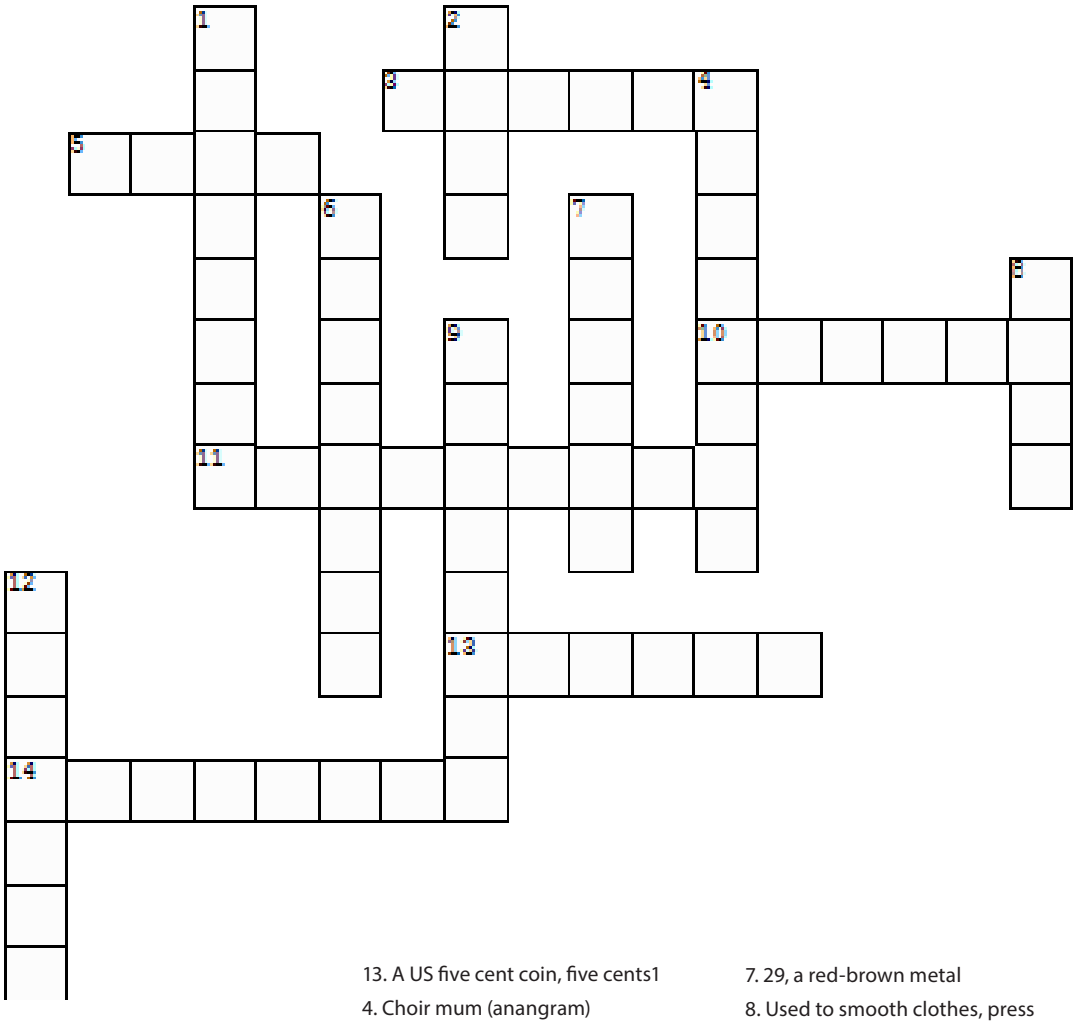
Increasing numbers of DNA structures are being revealed using a diverse range of transition metal complexes and biophysical spectroscopic techniques. Here we present a review of metal complex-DNA interactions in which several binding modes and DNA structural forms are explored.

Inside front cover Dalton Trans: Metal complex interactions with DNA (Dalton Trans 44/2015)(page 3505-3526)

Benjamin J. Pages, Dale L. Ang, Elisé P. Wright, Janice R. Aldrich-Wright.

DOI: 10.1039/C5DT90031J

Transition Metals Crossword



ACROSS

3. Cab lot (anagram)

5. 30, a silvery-white metal which is a contituent of brass

10. 47, a precious shiny greyish-white metal

11. 25, an important component of special steels and magnetic alloys

13. A US five cent coin, five cents1

4. Choir mum (anangram)

DOWN

1 Malta nut (anagram)

2. 79, a yellow precious metal

4. 74, used to make electrical light filaments

6. 22, a hard silver-grey metal of the transition series used in strong, light, corrosion resistant alloys

7. 29, a red-brown metal

8. Used to smooth clothes, press

9. 78, a heavy precious greyish white noncorroding ductile malleable metallic element, that fuses with difficulty

12. 80, the planet nearest the sun

Answers in the next issue of the Nanoscale Research Newsletter.

THERE ARE THREE WAYS TO GET SOMETHING DONE:

DO IT YOURSELF,

HIRE SOMEONE,

OR FORBID YOUR STUDENTS TO DO IT.

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Hatches, Matches and Dispatches

Dr Tim Stait-Gardner

Tim and Yuliani were married at the Mount Annan Botanical Gardens in January. Tim has been the National Imaging Facility Fellow at Western Sydney University since 2008.

Dr Mikhail Zubkov

Mikhail and Roxanne were married in St Petersburg, Russia, prior to his taking up the position of Facility manager.

Dr Abhishek Gupta

Abhishek and Neha were married in India. Abhishek has a Post Doctoral position which is the product of collaboration between Western Sydney University and The Ingham Institute at Liverpool.

I LOVE BEING MARRIED.

IT'S SO GREAT TO FIND THAT ONE SPECIAL PERSON YOU WANT TO ANNOY FOR THE REST OF YOUR LIFE.

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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

Dr Mikhail Zubkov
Biomedical Magnetic Resonance Facility Manager
- Modified diffusion sequences

"THOSE WHO ARE NOT SHOCKED WHEN THEY FIRST COME ACROSS QUANTUM THEORY CANNOT POSSIBLY HAVE UNDERSTOOD IT."

- NIELS BOHR

Group Meetings

NANOSCALE RESEARCH / GRANT MEETINGS

Nanoscale Research/Grant Meetings are held monthly at Campbelltown with the next one to be held in February.

PROFESSOR WILLIAM PRICE'S LAB GROUP

Meet every Friday at 09:30 am in CA 21.1.65

BMRF USERS MEETING

February / May / August / November

PROFESSOR JANICE ALDRICH-WRIGHT'S LAB GROUP

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

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