MACQUARIE UNIVERSITY | MQ PHOTONICS RESEARCH CENTRE

NEWSLETTER

Issue 54 – 2 May 2013

MQ Photonics Newsletter is an informal internal publication of the ***MQ Photonics Research Centre*** <http://web.science.mq.edu.au/groups/mqphotonics/>.
We aim to distribute it by e-mail every 3 weeks. Please send copy to <Elizabeth.Bignucolo@mq.edu.au> by 9 a.m. on the due date. **Next due date: to be advised**

Focal Points

Our members continue to shine on the international stage. In particular, Dr Yiqing Lu and Tim Zhao were recently recognised for their contributions to biophotonics (see below); both receiving prestigious awards. Well done to the both of you.

Congratulations to Zhen Song, Alanna Fernandes, Patrick Chen and Jipeng Lin, all of whom received their PhD's in the recent graduation ceremony. Vincent Ng and Jacob Evans also received their Hons degrees.

The preparation for the MQ Photonics Review on the 23rd May is progressing nicely. I will give further updates and summaries leading up to this event at upcoming MQ Photonics Seminars.

Finally, I welcome A/Prof. David Coutts into the new role of Deputy Director, MQ Photonics. David and I will work together to ensure our Review Day is a success. Thanks to all those centre members who also lodged expressions of interest for this role. Your interest reflects well on the strong collegial culture that exists in the centre.

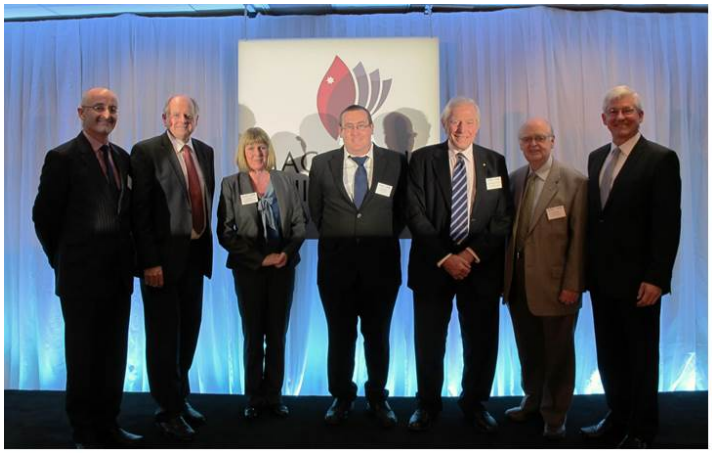
Michael Withford

Thank you to Jipeng and Patrick for the above photos.

Celebrating the opening of the Australian Hearling Hub:

The 17th of April 2013 marked the opening of the Australian Hearing Hub at Macquarie University by Senator John Faulkner, the base of the laser microfabrication groups (including CUDOS@MQ and Optofab, ANFF). Through embedding the laser microfabrication facilities and offices in the Australian Hearing Hub the group hopes to further facilitate the transfer of research into real world industrial solutions for the benefit of auditory and speech organizations such as hub partners Cochlear, Australian Hearing, the National Acoustic Laboratories and our other colleagues in the Australian Hearing Hub.

Graham Smith



Congratulations

Congratulations to **Dr. LU, Yiqing** for being selected as the prestigious **ISAC Scholar (2013-2017)** by the **International Society for Advancement of Cytometry**! LU becomes the only successful Australian-based recipient from the new selection round. This is to recognize his contribution to high-speed cell detection by his novel scanning cytometry techniques developed during his PhD candidature period at Macquarie.

The ISAC Scholars Program is designed to enhance the scientific and leadership experiences of emerging leaders in the field of cytometry. The program provides opportunities for leadership training, presentation opportunities, financial support for membership of the Society, as well as other valuable mentoring activities. Being chosen ISAC Scholar is an indication of leadership potential, scientific skills and ability to achieve career goals.

This five-year program provides Scholars with a complimentary membership in the Society, subscription to Cytometry Part A, the official Journal of ISAC, complimentary registration to CYTO and travel funds for the conference and possibly a one-time mentor training opportunity.

Dayong Jin

Congratulations to **Tim (Jiangbo) Zhao** for winning the **2013 Exceptional Student Award Finalist** by the Awards Committee of the International Society for Advancement of Cytometry.

The Exceptional Student Award recognizes continuing Exceptional performance by a student with service to the field and to the Society. To be eligible for this award, a candidate must be a member of the Society, be a pre-doctoral student, and follow a field of study in any physical or natural science with a goal of working in analytical cytology.

The Awards committee comprises significant individuals in science and cytometry able to assess the breadth and depth of a nominee's contributions. The committee chose Tim for his abstract "SUPER Dots: the next-generation bio-labels". He is invited to make a high impact presentation of his PhD studies, aimed at a length of no more than 13 minutes, to a panel of judges on Sunday, May 19 at the San Diego Convention Center during CYTO 2013. The 2013 Exceptional Student Award winner will be announced and honored during an Awards Ceremony on Wednesday, May 22 during CYTO 2013 in San Diego.

Tim has been supported by the Faculty of Science to present his work at CYTO 2012 congress at Leipzig, Germany in 2012. He was nominated as one ISAC Presidents' Award Finalist on CYTO 2012, and the final winner was a Postdoctoral Research Fellow at Stanford University who recently published a *Science* paper in 2011. Let us wish Tim a good luck to bring the final 2013 Exceptional Student Award back to Macquarie!

Dayong Jin

Conference

Progress in Ultrafast Laser Modifications of Materials
Cargèse, Corsica, France, 14-19 April 2013
http://femtomicromachining.org/index.php/cargese

Mid April, Mick and I attended a workshop on "Progress in Ultrafast Laser Modifications of Materials". The workshop was hosted by the Institut d'Étuded Scientifiques de Cargèse in Cargèse, Corsica, France which is located at the beautiful Mediterranean coast (see photo). The workshop had a total of 75 attendees from the world leading groups in the field of femtosecond laser micromachining and the interaction of ultrafast pulses with transparent dielectrics. MQ Photonics was well represented with Mick giving an invited talk and me having been awarded one of only eight contributed talks at the workshop. On the last day the workshop was wrapped up with a boat trip to the Scandola Nature Reserve (see photo).

Simon Gross

Lunch break at the conference venue.

Scandola Nature Reserve

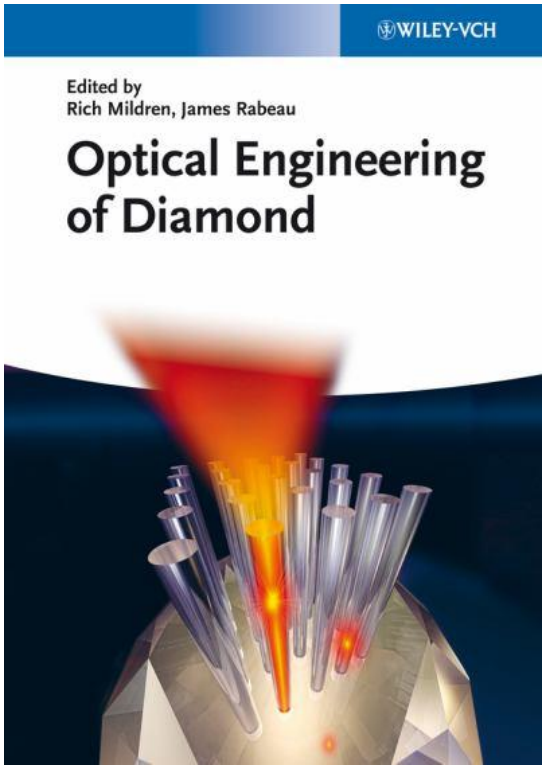
In April I had the opportunity to visit Japan to attend two conferences. I presented one contributed paper at the International Workshop on Optical Terahertz Science and Technology (Kyoto) and one invited paper at the Laser Display Conference (Yokohama). I also visited Professor Kono Kawase's labs at Nagoya University. It was a great opportunity to meet Prof Kawase and spend time chatting to him about all things THz and a little about baseball (though I am no expert). Prof Kawase is perhaps the world leader in solid-state based THz sources. Both conferences were very interesting and I made new links with some of the key players in the THz field, notably Prof Kawase and also Prof Hiroaki Minamide from Sendai University. The laser display conference was an eye opener and has given me a few ideas on how we can extend our Raman laser technology into this area, very exciting! During the trip I also touched base with Prof Takunori Taira (who visited MQ Photonics in 2011), and I caught up with one of our favourite colleagues, Prof Takashige Omatsu, no doubt you will be seeing him again in the corridors of E7B later this year!.

Andrew Lee

(trying to get a good shot of Mt Fuji)

Publications

Recently published articles



Congratulations to **Rich Mildren** and **Jim Rabeau** on the release of book titled "Optical Engineering of Diamond".

Edited by **Rich Mildren** and **Jim Rabeau**, this book's scope spans details of diamond optical properties, methods for fabricating and shaping optical devices, and diamond optical device applications. Three chapters on diamond nitrogen vacancy centres, intrinsic diamond properties, and diamond Raman lasers were authored by MQ Photonics members including **Jim Rabeau**, **Carlo Bradac**, **Torsten Gaebel**, **Alex Sabella**, **Ondrej Kitzler**, **David Spence**, **Aaron McKay** and **Rich Mildren**.

Nature Photonics, 7, 341 (2013) doi:10.1038/nphoton.2013.99

Introduction: Diamond is finding increasingly useful applications in photonics, owing to its many beneficial properties. It has the largest optical bandgap of any known material and is transparent from the deep ultraviolet to the infrared. It is also biocompatible, chemically robust and exhibits excellent thermal properties. Perhaps most importantly, it also features a defect — the nitrogen–vacancy colour centre — which is proving useful for applications in quantum information processing, where it can function as an efficient emitter of single photons and provide room-temperature possibilities for single-spin polarization and read-out. This text reviews the optical properties of diamonds grown by various means, as well as the physics and applications of colour centres. It also discusses the uses of nanodiamond in biomedicine and spectroscopy, and the various diamond-based nanophotonic and integrated optical structures that have been demonstrated so far.

L Zhang, A Mckay, D Jin, "High-throughput 3-Dimentional Time-resolved Spectroscopy: Simultaneous Characterisation of Luminescence Properties in Spectral and Temporal Domains", *RSC Advances* (a new journal of the Royal Society of Chemistry, full impact factor will be available by 2014), DOI:10.1039/C3RA40637G

Abstract: Lanthanide luminescence is presented in full spectral and temporal detail by challenging the limits of low-light sensing and high-speed data acquisition. A robust system is demonstrated, capable of constructing high-resolution time-resolved spectra with high throughput processing. This work holds real value in advancing characterisation capability to decode interesting insights within lanthanide materials.

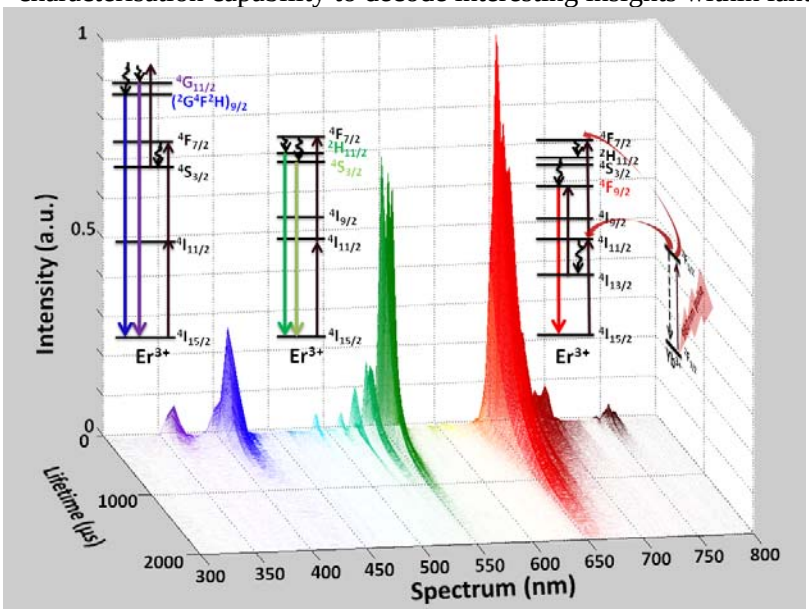


Figure 1 The 3-dimensional time-resolved luminescence spectra from NaYF4: Yb/Er nanocrystals with the simplified energy levels shown in inset. The pseudo colours were added to match different wavelength colours for improved spectrum presentation, and transparency factor was adjusted according to the intensity values on each colour channels for improved visibility on lifetime decays.

S Gross, D G Lancaster, H Ebendorff-Heidepriem, T M Monro, **A Fuerbach**, **M J Withford**, " Femtosecond laser induced structural changes in fluorozirconate glass", *Optical Materials Express*, 3 (5), 574-583 (2013).

Abstract: Fluorozirconate glasses, such as ZBLAN (ZrF4-BaF2-LaF3-AlF3-NaF), have a high infrared transparency and large rare-earth solubility, which makes them an attractive platform for highly efficient and compact mid-IR waveguide lasers. We investigate the structural changes within the glass network induced by high repetition rate femtosecond laser pulses and reveal the origin of the observed decrease in refractive index by using Raman microscopy. The high repetition rate pulse train causes local melting followed by rapid quenching of the glass network. This results in breaking of bridging bonds between neighboring zirconium fluoride polyhedra and as the glass resolidifies, a larger fraction of single bridging fluorine bonds relative to double bridging links are formed in comparison to the pristine glass. The distance between adjacent zirconium cations is larger for single bridging than double bridging links and consequently an expansion of the glass network occurs. The rarified glass network can be related to the experimentally observed decrease in refractive index via the Lorentz-Lorenz equation.

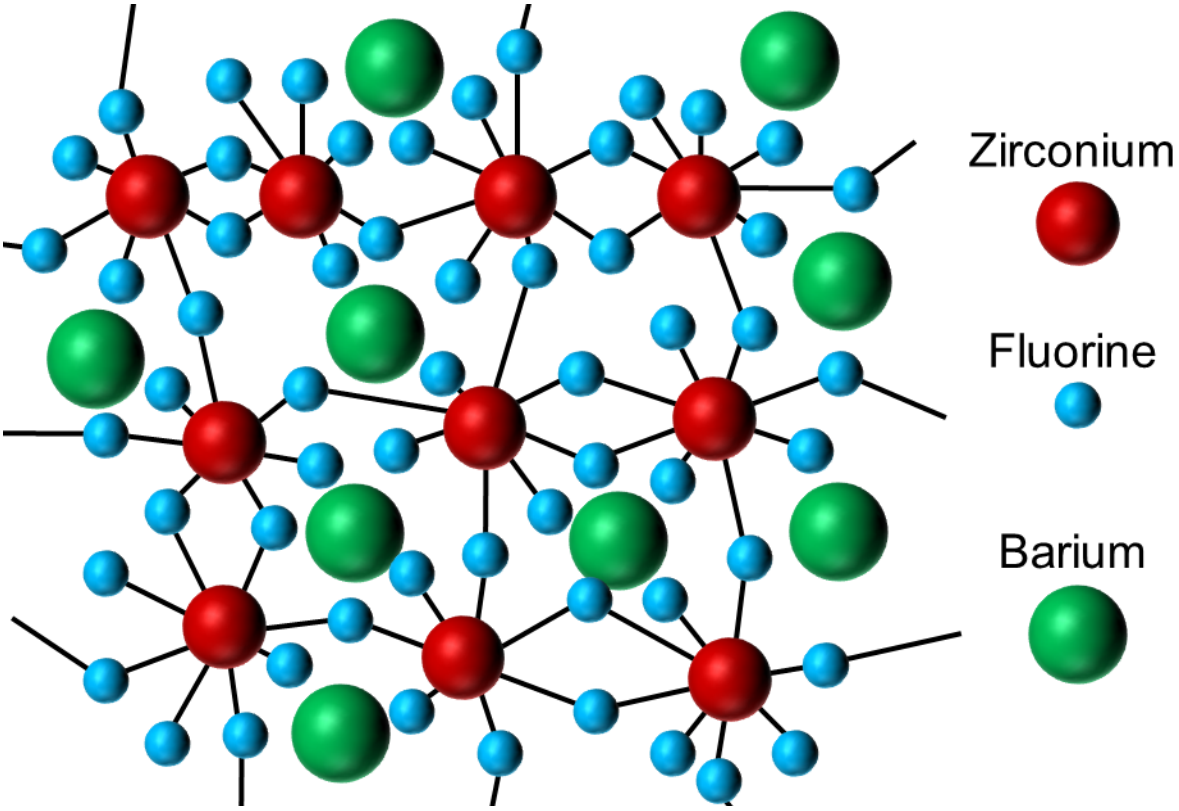


Fig. 1. Structure of the BaZr2F10 glass based on Zr2F13 dimers (ZrF7 and ZrF8 polyhedra linked by a fluorine double bridges) forming a ring-like network (illustration derived from [32]).

Recently accepted articles

Brian J Orr and **Yabai He**, "Cavity-based absorption spectroscopy techniques", accepted (19 April, 2013) for publication as Chapter 5 of '*Laser spectroscopy for sensing: fundamentals, techniques and applications*'; ed. Matthieu Baudelet; Woodhead Publishing Ltd, Sawston, UK; 48 manuscript pages, including 268 refs.

Introduction: The wavelength dependence of optical absorption has long been recognised as a spectroscopic means of characterising atoms, molecules and media in the chemical, physical, biological and earth sciences. In particular, it yields dependable and highly sensitive means of qualitative and quantitative analysis in many contexts: laboratory, environmental, industrial, clinical and beyond. Here we are concerned with 'cavity-based' variants of absorption spectroscopy, in which use of an optical cavity (usually resonant with one or more of the wavelengths of radiation used to observe absorption) can enhance the sensitivity (and, necessarily, the signal-to-noise ratio) by orders of magnitude relative to absorption spectroscopy performed without such a cavity. Various forms of cavity-based absorption spectroscopy are already well established, as is evident from many topical review articles and several relevant books (Busch and Busch, 1999; Van Zee and Looney, 2002; Berden and Engeln, 2009). This Chapter aims to provide some general technical insights into the subject, to outline selected specific applications and to indicate particular areas of current scientific interest and opportunity. This is a rapidly expanding area, so that we intend to offer useful perspectives, rather than to provide a comprehensive coverage.

S Gross, M Alberich, **A Arriola**, **M J Withford**, **A Fuerbach**, "Fabrication of fully integrated anti-resonant reflecting optical waveguides (ARROWs) using the femtosecond laser direct-write technique", *Optics Letters* (accepted 1st May 2013).

Abstract: Utilizing a recently developed novel two-step fabrication process, we have experimentally demonstrated what is to the best of our knowledge the first ever integrated anti-resonant reflecting optical waveguide (ARROW), directly inscribed into bulk optical glass. The waveguide consists of an array of high-index contrast rods that surround an unmodified core. The transmission spectrum reveals the formation of discrete bandgaps that can be tuned by varying the diameter of the individual rods.

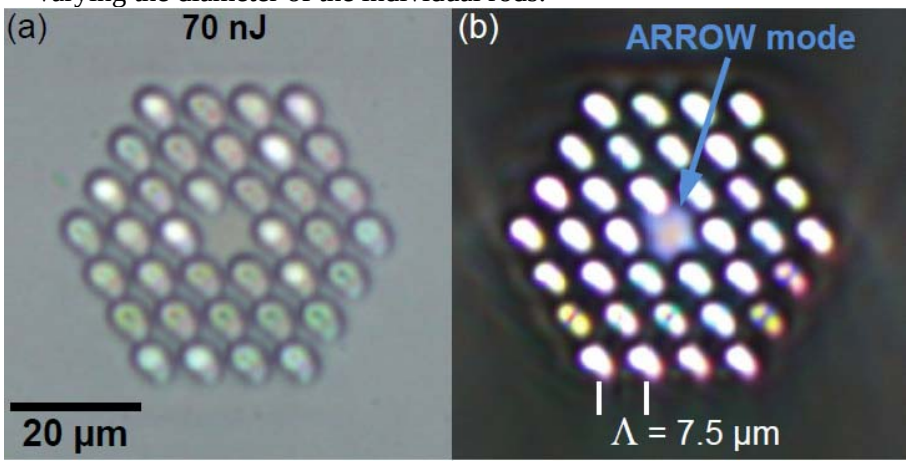


Fig. 1. End-on view of an ARROW inscribed with 70 nJ pulse energy at (a) normal exposure and (b) long ex-posure to reveal the ARROW mode. The writing laser beam was incident from the top.

Ding Y, Zhang Y, Peng T, **Lu Y, Jin D**, Ren Q, Liu Y, Han J, Xi P, "Observation of mesenteric microcirculatory disturbance in rat by laser oblique scanning optical microscopy" *Scientific Reports* (by Nature Publication Group), accepted 15th April 2013.

Abstract: Ischemia-reperfusion (I/R) injury model has been widely applied in study of the microcirculation disturbance. In this work, we employed a robust technique of laser oblique scanning optical microscopy (LOSOM) to observe microcirculation system in the mesentery of rat. With a localized point-scanning detection scheme, high-contrast images of leukocytes were obtained. The extended detection capability facilitates both the automatic in vivo cell counting and accurate measurement of the rolling velocity. The statistical analysis suggested that the distinction between I/R and sham groups with time lapse is significant.

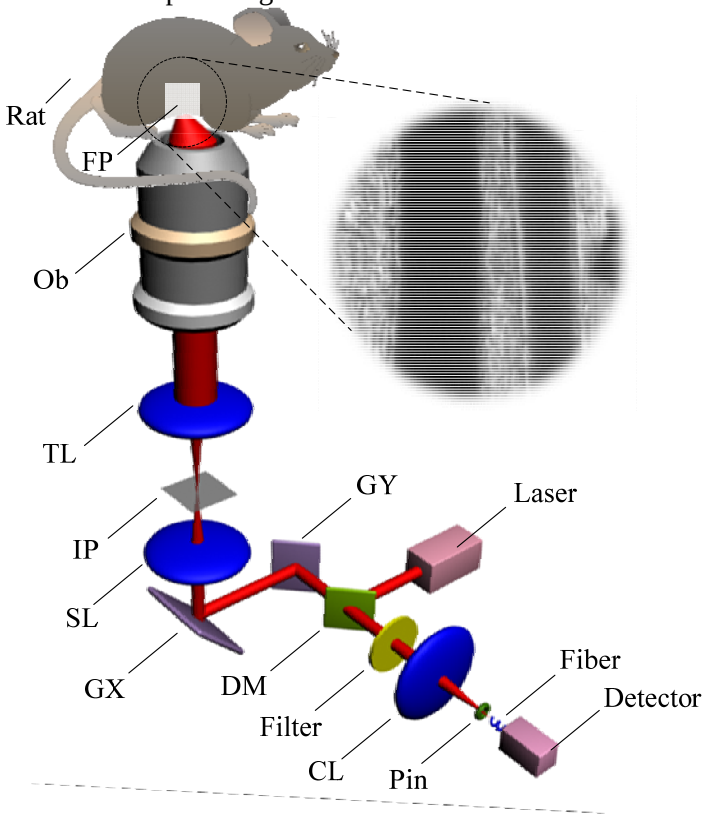


Figure 1 Schematic LOSOM system for *in vivo* rat mesenteric microcirculatory monitoring.

Seminars

MQ Photonics Seminars:

Time: 11am, Fri 3rd May TOPIC: Excursions in Nonlinear Periodic Structures	Place: W5A T2	Presented by: **Prof Herbert Winful** (University of Michigan)
Time: 11am, Fri 10th May TOPIC: TBA	Place: TBA	Presented by: Jie Lu / Tim Zhao
Time: 11am, Fri 17th May TOPIC: TBA	Place: TBA	Presented by: Assoc Prof Helen Pask
Time: 11am, Fri 24th May TOPIC: TBA	Place: TBA	Presented by: **Dr Chunyu (Ryan) Zhang** (Beijing Institute of Technology, China)

People and Progress

Welcome to Xianlin Zheng

Mr. ZHENG Xianlin is joining our Advanced Cytometry Labs @ Macquarie to undertake his PhD research program. He will be jointly supervised by Prof. Piper and me for the next three years in Biophotonics and Cytometry Devices. Xianlin has been trained at advanced level in Electronics and Automations with B. Sc. and M. Sc. Degrees (high distinctions) received from Automation College of Electronic and Engineering, Heilongjiang University, China. He will be closely working with Lixin and Lu in our optics labs (E7B 202 and 204).

Dayong Jin

OSA Student Chapter update

New OSA Student Chapter representatives were elected late in March.

Ondrej Kitzler became president after Thomas Meany, and Zachary Chaboyer took over from Barbara Zittermann as vice president. Barbara will still help as new treasurer.

OSA Student Chapter aims to bring together optics students, engineers, scientists, and researchers in the community to encourage the exchange of ideas and promote awareness in the optical sciences. Anyone can join! Just come by our meetings or send an email to one of the officers.

Let's have another successful year of promoting science!

Ondrej Kitzler

from left Zachary, Ondrej, Barbara, Jocelyn