

Mathematics Applied to Liquid Crystal Technologies (MALCT-2008) Workshop
8-10th May, 2008

School of Mathematics and Applied Statistics
University of Wollongong, NSW 2500, Australia

Supported by:

**The Australian Mathematical Sciences Institute (AMSI) and
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Overview:

'Mathematics Applied to Liquid Crystal Technologies (MALCT)' is a new area of application of mathematics within Australia, but one with far-reaching possibilities. Nonlinear guided wave propagation in liquid crystals is at the cutting edge of nonlinear optics, applied mathematics, photonics and signal processing. A significant attraction of liquid crystals is their large nonlinear response, which means that compact (~mm) signal processing devices which exploit this response can be developed. The propagation of nonlinear guided waves (nematocons) within liquid crystal media is then of great interest as a test bed and platform for new photonic devices.

Aims and Objectives of Workshop:

A key objective for MALCT-2008 was to promote and develop mathematical science applied to cutting edge technology based on nonlinear guided waves in soft matter.

- The Primary objective was to discuss liquid crystal technologies and future research directions in this field, along with associated mathematical techniques, using the synergy of engineering experimentalists, physicists and applied mathematicians.
- Secondly, to use the workshop to strengthen and expand multidisciplinary collaborations, both nationally and internationally, with regard to research in liquid crystal technologies.

Invited Speakers:

In 2007, Dr. Worthy and A/Prof. Marchant were successful in obtaining a UOW UIC Grant and an AMSI Grant for 2008. These grants covered some costs to bring internationally recognized researchers to the University of Wollongong. Importantly, two such internationally known researchers were Prof. Assanto (University of Rome "Roma Tre", Italy) who is the world leading optical engineer researcher on nonlinear effects in liquid crystals and Dr. Smyth (University of Edinburgh, Scotland) a highly cited researcher in nonlinear waves and applied mathematics in general.

Further, the invited speakers represented some of the leading international researchers in nonlinear optics. These eminent researchers, as listed below, were at the workshop to help foster and develop collaborations and relations. This would not have been possible without the support of both AMSI and UOW.

- *Professor Nail Akhmediev*, Optical Sciences Group, ANU, ACT, Australia
- *Professor Gaetano Assanto*, University of Rome "Roma Tre", Italy
- *Professor Cathy Garica-Reimbert*, Department of Mathematics and Mechanics, Instituto de Investigación en Matemáticas Aplicadas y Sistemas, Universidad Nacional Autónoma de Mexico, Mexico
- *Professor John Harvey*, Department of Physics, Faculty of Science, University of Auckland, NZ.
- *Professor Yuri Kivshar*, Australian National University, Australia
- *Professor. Wiesiek Krolikowski*, Laser Physics Centre RSPHysSE, Institute of Advanced Studies, ANU, ACT, Australia
- *Professor Tim Minzoni*, Department of Mathematics and Mechanics, Instituto de Investigación en Matemáticas Aplicadas y Sistemas, Universidad Nacional Autónoma de Mexico, Mexico
- *Dr Noel Smyth*, School of Mathematics, University of Edinburgh, Scotland
- *Professor Epifanio Virga*, Dipartimento di Matematica, Università di Pavia, Italy

The Outcomes from the MALCT-2008 Workshop:

As stated, this workshop brought together prominent world leading researchers in the field of liquid crystal technologies, and nonlinear optics in general. In particular, Professor Kivshar (an Australian Federation Fellowship holder) from the ANU also made himself available to attend the workshop, stressing the importance of the meeting.

For the first time overseas video conferencing was used to enhance a Mathematics workshop within the University of Wollongong, and probably within Australia. Using these facilities within the School of Mathematics and Applied Statistics Access Grid Room (funding supported by AMSI), a renowned applied mathematician, Professor Minzoni from Mexico, addressed the audience. A real buzz came out of Professor Minzoni's seminar and the positive use of our modern technology to further advance our cause in the development of liquid crystal technologies. This talk incited further discussions at the end of our workshop in 'state of the art' discrete liquid technologies.

Ongoing outcomes from the workshop were:

- Mathematicians' role:
 - Act as a conduit between the physicists and the engineering experimentalists.
 - Simplify, model and fine-tune the needs of the experimentalists and theoreticians.
 - Act as a vital part of research teams in liquid crystal technology.
 - Develop modelling strategies to enhance performance in liquid crystal technologies and to interpret experimental results.
 - Widen and strengthen the use of mathematics in applications
- Creation of an incentive for Australian mathematicians to undertake a leading role in this new area.
- Confirmation on the interplay between the experimental work, lead by Prof Assanto, and applied mathematics.
- Cultivation of new, and strengthening, of future research collaborations.
- Applications for grants, both within Australia and overseas.
- All participants being enthusiastic that there should be future and similar workshops held in liquid crystal technologies. The next such workshop will be held at the Universidad Nacional Autónoma de Mexico, Mexico, at the end of March/beginning of April, 2009.
- In particular, the synergy between the world's leading experimental group and the theoretical teams.

Summary:

The MALCT-2008 workshop has been able to promote, develop and foster relationships between a wider research community involving engineers, physicists and applied mathematicians, with a view to develop technology. This workshop also has

- Moved research into liquid crystal technologies forward.
- Created collaboration and lead to joint grants (eg ARC Linkage applications, EPSRC grants, EU grants) and refereed journal articles. In particular the paper G. Assanto, T.R. Marchant and N.F. Smyth, "Collisionless shock resolution in nematic liquid crystals", has been submitted to *Physical Review A*. This paper grew directly out of work started at the workshop.
- Aided the development of sophisticated analytical and numerical techniques.
- Help model and discover mathematically the design requirements and basis for reconfigurable nematicon circuits.
- Compare theoretical analysis with numerical and experimental results and delivered findings to experimental engineers for improvements in photonic devices and
- Suggest future directions for the experimental team and visa versa.

Without the support and sponsorship of the UOW, AMSI and the School of Mathematics and Applied Statistics this workshop could not have been possible.

Director:

Dr Annette L. Worthy,
School of Mathematics and Applied Statistics
Wollongong, NSW 2500 Australia

Phone: + 61 2 42 213845

Email address: annette_worthy@uow.edu.au