Report on the 18th Optics of Liquid Crystals Conference, 8th-13th September 2019, Quebec City

In Quebec City, facing north, from the Pierre-Dugua-De-Mons Terrace (a small hill close to the city centre), there is a particularly spectacular view overlooking the city (see Figure 1). The view here encompasses many of Quebec’s famous sites: On the left, there is the eminent Chateau Frontenac, a luxury hotel built to attract visitors from around the world; in the centre, there is the historic Quebec old town, a UNESCO world heritage site; and on the right is the St Lawrence river, dominating the landscape and dotted with the occasional cruise ship to bring people from far-flung lands into the city. All of these sights show Quebec to be a city that celebrates the coming together of international travelers: even the name ‘Quebec’ is taken from the Algonquin word ‘kébec’ meaning ‘where the river banks come together’. As the sun sets, the view from the Pierre-Dugua-De-Mons Terrace is bathed with a pinky-orange light, emphasising the view’s beauty. Together these two key elements, the coming together of people and the presence of beautiful light, seemed to make Quebec a fitting place for an international optics conference.

The 18th Optics of Liquid Crystals (OLC) conference took place in Quebec City from the 8th until the 13th of September 2019 and was hosted by the Laval University, with Professor Tigran Galstian heading the organising committee, together with Dr David Hélie and Diane Déziel of the Centre for Optics, Photonics and Lasers and Cora Roy of Conferium. As the first OLC to be hosted in Canada, and given Quebec’s international appeal, it was appropriate to find that the conference was a truly international event, attracting representatives from 20 countries, with delegates from as far as Portugal, India, Poland, Russia, France, Italy, Japan, South Korea, China, as well as the United States and of course Canada. The delegates met at the conference site, the Hotel Laurier, which overlooks the famous Plains of Abraham, the site of the 1759 battle where the French lost control of Quebec to the British. To start the conference off a welcome drink was provided on the Sunday evening by the conference sponsors, including Lens Vector, Sentinel North, Crystals, Taylor and Francis, Thorlabs, SID, COPL, Université Laval, Fonds de Recherche Nature et technologies Quebec, Cercle des Ambassadeurs de Quebec and Your Quebec City. This gave delegates the opportunity to reacquaint with old friends and collaborators, as well as forge new connections with the international community working within the field.

Monday

The OLC conference began with warm words of welcome from Professor Galstian, with an overview of the week’s events, the scientific programme and of course a stream of advice regarding the sights to see and the food to eat while staying in Quebec City. The first talk of the conference was given by Dr Nelson Tabiryan of Beam Ltd, looking back at the life of Boris Zeldovich who sadly passed away in December 2018. The talk offered a point of reflection to look back, firstly at the huge scientific contribution given by Professor Zeldovich, particularly in the field of non-linear optics, but also his passion for teaching and his engagement of young scientists in the field. Personal highlights of this were being shown pictures of him demonstrating optical phenomena with his pendulum on a rotary platform and also examples of Boris’ jokes, a favourite being: ‘were you at the last meeting’ ‘no, but I would have been if I’d known it would be the last’. Clearly, Professor Zeldovich was a giant within the fields of both optics and liquid crystals and will be sorely missed by those who knew and worked with him.

After this, the scientific programme proper began, with an invited talk from Professor Philip Bos of Kent State University. Here, Professor Bos discussed his recent work in enhancing the thermo-optical response of LCs using confinement. In such, new judicious designs of thermally isolating geometries were displayed, in addition to the use of novel photo-alignment using azobenzene dyes. This was followed by a keynote speaker, Professor Francesco Simoni of University Politecnica Marche, Italy. In this, Professor Simoni conducted a critical overview of recent developments in the field of non-linear optics, introducing many key concepts of the field, setting the scene for the audience for the remainder of the sessions on non-linear optics. At the beginning of the
talk, Professor Simoni was awarded a symbolic prize for his outstanding contribution to the OLC community (see Figure 2). Following this, intriguing modelling work was presented by Dr Guilem Poy of Ljubljana, modelling the propagation of light within an optical fibre filled with liquid crystal material which experienced an optical torque. Professor Magosia Kaczmarek of Southampton University, UK, then reported on light-driven photovoltaic and photo-addressed modulators, as well as on an effective method of characterising their performance.

Monday afternoon’s sessions included talks on a wide range of liquid crystal phenomena, including inducing tristable LC states, chiral sorting and plasmonics. From the first session, one highlight was Professor Kenji Katayama of Chuo University, Japan, discussing the effects on host LC transition dynamics of optically driving guest azobenzene molecules. Also, Professor Victor Reshetnyak of Taras Shevchenko National University of Kyiv, Ukraine, presented some highly interesting work on using the controllable dielectric properties of liquid crystals to create tunable plasmonic devices. Following this was a session on ‘Tailored optical properties of liquid crystals’, with two invited talks. First from Professor Etienne Brasselet of CNRS, Bordeaux, who started the session, with a talk on utilising spin dynamics of both polarised light and chiral liquid crystals, to sort chiral enantiomers optically for applications in safe and efficient drug production. Second, Professor Cesare Umeton of Calabria University, Italy, where the use of polymer/LC polymer diffractive gratings (POLICRYPs) to create plasmonic thin-film devices was discussed.

**Tuesday**

Tuesday morning’s sessions were concerned with ‘Light steering and material deformation’ and ‘Photo Patterning of Chiral Systems’. One highlight was a lively talk from Professor Yue Zhao of Universite de Sherbrooke, Canada, displaying his work on the thermal response of his custom-designed liquid crystal polymers. Through the inclusion of azobenzene molecules within the material, the nematic to isotropic transition could be optically driven, allowing light-
induced actuation. The presentation was filled with many fabulous videos of this process, with both optical and thermal modes demonstrated, to create pistons, crawlers and rotating wheels. Another was a keynote from Professor Oleg Lavrentovich of Kent State University, USA, discussing his work on the photopatterning of elastomer systems. In this, a demonstration of how the elastomer's topological properties induce measurable changes in its surface topography was made. This was then used as a platform to align colloidal particles and also biological cells, demonstrating that such methods could have exciting applications in biological sciences.

The afternoon of Tuesday had sessions on 'electrooptic systems' and 'periodic structures'. The first of these was kicked off by an invited talk from Professor Wei Lee of the National Chiao Tung University, Taiwan, who discussed the use of dual-frequency liquid crystal materials to instigate reversible textural changes in helicoidal LCs from planar alignment to underlying helix to focal conics. This was followed by talks on reorientating slippery alignment layers using magnetic fields by Professor Jun Yamamoto from Kyoto University, Japan, and fabrication of diffractive waveplates by Dr Timothy Bunning of the Air Force Research Laboratory, as well as some excellent jokes told by the chair, Professor Liang-Chy Chien! Another highlight of this session was a talk on the use of polymer-dispersed liquid crystals to imitate sun chromaticity for use in indoor windows given by Simone Bonanomi of Coelux and the University of Insubria, Italy (see links to industry).

Posters

The conference also offered two poster sessions, providing to everyone, but especially to students, the opportunity to display their work in a less formal, relaxed and friendly environment with the company of refreshing apéritives. A plethora of high-standard posters was presented to the participants, varying from lenses and imaging to the more fascinating metamaterials and bio-applications. Great attention was captured by the project of Ismaël Duchesne and Tigran Galstian from Laval University, Canada, which studied the optical control of bacterial motility in high-viscosity water-based liquid crystal disodium cromoglycate solutions. It is a work about the movement of flagellated bacteria which can be completely controlled by using a water-based liquid crystal where the anisotropic to isotropic transition is triggered by UV light. Another intriguing poster was presented by Alice Goillot again from Laval University. Her work was about an electro-optic fibre component with integrated liquid crystal cladding. There she described an optical fibre with embedded liquid crystal cladding that enables control over the power of light propagating through the core utilising the application of an electric field.

Wednesday

Wednesday was a half-day, allowing delegates to go out and see some of the beautiful city of Quebec. Regardless, the morning offered many talks displaying some really excellent work on topics focussing on chirality, both in nature and application to displays. One particularly fascinating talk was given by Professor Maria Helena Godinho of Universidade Nova de Lisboa, Portugal, discussing the chiral structures we observe in many natural systems, notably cellulose, beetle shells and peacock feather, and in particular how the chirality of such systems can be tuned by their environment. A more fundamental keynote talk was later given by Professor Peter Palffy-Muhoray of Kent State, which offered itself as a discussion of the nature of cholesterics and what precisely makes them different to nematics. In this, Professor Palffy-Muhoray skilfully led the conference through Floquet’s theory as a means to model the emergence and photonic bandgaps in cholesterics. This, combined with a sprinkling of circuit electronics, gave a valuable reminder about how fundamental it is to retest the assumptions in the theories that we use.

Thursday

Thursday morning offered talks on the development of new novel materials for a breadth of applications. Dr Yi-Hsin Lin of the National Chiao Tung University, Taiwan, gave an intriguing talk on the applications of liquid crystals for water harvesting, where liquid crystals were being used to tune the hydrophobicity of surfaces for more efficient moisture capturing devices. Two talks were also given successively by Dr Simon Rainville and Marc-Antione Boule, both of Laval University, on lyotropic liquid crystal systems dispersed with bacteria. In these, they demonstrated novel alignment effects of the bacteria due to a coupling between director orientation and bacteria long axis. In these sessions, a keynote invited talk was also given by Professor Mohan Srinivasarao of Georgia Institute of Technology, on the emergence of chirality from achiral molecules. His talk including chromonics, confinement effects and pictures of his poodles took the audience through
what is a highly developed area of science with implications beyond that of liquid crystals in a fun and dynamic way.

Thursday afternoon was almost entirely focussed on liquid crystal lenses with a huge variety of methodologies to create new devices being presented. Professor Cliff Jones of The University of Leeds, UK, discussed his recent work on the creation of polarisation-independent lenses through a novel matched grating geometry. Despite almost getting stuck in Montreal for the conference, one of the most exciting talks was given by Professor Atsushi Shishido of Tokyo Institute of Technology, Japan, who reported on a new unpolarised photoalignment technique. Clearly, such a tool could have far-reaching applications for both industry and research, especially with the high-quality dark and bright states which were shown. Another highly practical and informative talk was given by Dr Andrej Petelin of the Joseph Stefan Institute Slovenia. Here, Dr Petelin exhibited a new software package he has written for comparing optical microscopy images to that would be created by certain director configurations.

Friday

Friday morning was dedicated to the recent developments in OLC. First to present was Professor Rafik Hakobyan who introduced us the solid nematic materials, such as nematic liquid crystalline elastomers, polymers and gels. There he proposed a novel approach to study the properties of the mechanical deformations of these solid nematics. After this, Eleni Perivolari from the University of Southampton and Professor Janusz Parka from the Military University of Technology in Poland talked about THz radiation. Eleni suggested a compact optically driven liquid crystal modulator based on planar metamaterials for the THz frequencies. And Professor Parka reported on liquid crystal properties in 0.3–10.0 THz range and their applications. Great interest was then revealed to Professor Linda Reven, from McGill University Montreal in Canada, who presented her work about LC dispersions of nanoparticles with flexible and semiflexible polymer ligands. Finally and because we always keep the best for the end, we had the opportunity to enjoy one of the best speakers at the conference. It was Professor Pawel Pieranski from Laboratoire de Physique des Solides, Université Paris-Sud. His talk with the title ‘Physics of the island’ was full of beautiful images and videos from experiments with the Dowsons Collider. Last but not least, Professor Etienne Brasselet, from Université de Bordeaux, unwrapped 40 years of research about Fréedericksz transition. Tigran ended this amazing meeting of old and new friends with best wishes for safe journeys home.

Entertainment

As well as the intellectual enjoyment from the extensive academic programme, the conference also offered opportunities for attendees to have fun less formally. On Wednesday, a tour of Quebec’s many sights was offered (see Figure 4), including the cities famous walls, the Notre Dame Cathedral, the Chateau Frontenac and the (rather small that time of year) snow pit. The tour also allowed delegates to explore the countryside outside of Quebec, with a cable car ride up the Montmorency Falls (see Figure 3), a picturesque crossing of the St Lawrence River, and a Canadian cider tasting tour in the nearby countryside.

The conference dinner of course also allowed delegates the opportunity to make merry and forge new friendships.

Figure 3. View of the bottom and top of the spectacular Montmorency Falls. Photo credit, Eleni Perivolari, University of Southampton.
connections. The entertainment of this included some fantastic live music while eating, a hilarious (perhaps for the wrong reasons) joke-telling contest and culminated in a hilarious quiz on Canadian history. This came down to a tense finale between the predominantly Canadian organisers and sponsors versus the UK headed team who had persistently managed to get through to the next round on pot luck. The non-locals were then of course soundly defeated by the last question!

**Industrial links of the conference**

The conference was also a clear example of the symbiotic nature between industry and academia in the field of liquid crystals. This was seen by representatives attending the conference from many companies such as LensVector, Facebook, Dynamic Vision Systems, The US Air Force Research Laboratory and Coelux in attendance. In fact, many of the standout talks from the conference were given by representatives from the industry. One such of particular note was from the early-career scientist, Simone Bonanomi of Coelux systems, Italy (see Figure 5), who gave a talk discussing the application of polymer-dispersed liquid crystals as a scattering medium for representing the sky in artificial indoor windows. This, with its applications, for example, in placement in hospital wards, demonstrated an exciting reminder of how new applications of liquid crystals.

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**Figure 4.** Beautiful Quebec old town and the picturesque Chateau Frontenac. Photo credit, Eleni Perivolari, University of Southampton.

**Figure 5.** Industry in action. Top left shows Professor Galistian holding a webcam. The technology behind the lens of the webcam was developed by Professor Galistian at Laval University. Top right shows Simone Bonanomi enjoying the Wednesday afternoon at the Montmorency Falls, and the bottom shows an example of one of the indoor windows created by Coelux, here placed in a radiotherapy ward. Photo credit, Alex Vasile, Waterloo University (top 2) and Coelux brochure (bottom).
crystals can have a creative and positive impact upon society.

The links between industry and academia were further emphasised on the last day of the conference. Here, Professor Galstian provided a tour of the facilities available at Laval University, which is currently running as a satellite research and development centre for LensVector. Here, Professor Galstian, as well as his students and scientists from LensVector, was able to show both exciting prototype devices and products currently on the market (see Figure 5).

Conclusion

Overall, we believe that the OLC conference should certainly be of interest to any established academic, student, early-career scientist, jobseeker or member of the industry who works not just in the field of liquid crystal optics but in the field of development of new optically based systems more generally. The hosts and other attendees were all highly welcoming and excited to chat about of course optics and liquid crystals but also the wide-ranging topics of art, politics and history. This made it a highly enjoyable conference, and we would highly recommend it.

As a note, Professor Lavrentovich announced during the conference that bidding for the location for the next OLC is now open, so any universities which would like to host the event in 2020 should contact the scientific committee for further details.

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