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Complex Light and Optical Forces V

**David L. Andrews
Enrique J. Galvez
Jesper Glückstad**
Editors

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Introduction

It has been six years since the launch of the conference whose proceedings follow. Starting from lowly beginnings under the auspices of a growing Photonics West congress held in San Jose and working with the initial title Nanomanipulation with Light, this conference has evolved with remarkable speed into an established fixture in the international conference calendar, quickly becoming a recognized forum for reporting progress in this highly active and rapidly advancing field of optical physics. In a very real sense, the growth and development of the conference itself reflects an intensification of research activity in the subject area.

The specific linkage of optical forces with complex beams is once again a distinctive motif in many of the studies reported this year, studies which exploit the richly structured potential surfaces generated by optical beams of unusual structure. It is now well known that optical singularities link inextricably with phase vortices, and experimental applications frequently make use of the associated angular momentum to rotate optically trapped particles. The scope for such optical manipulation accommodates particles as diverse as cold atoms and biological micro, and in the latter case the pace of development is such that commercialization is now in view.

If this connection of complex light with optical force is regarded as a middle ground for the conference, the full remit nonetheless extends over a much wider range. Indeed, these proceedings include many examples of optical nanomanipulation with conventional optical modes. Some of the emerging microfluidic and particle sorting applications are achieving results that, not long ago, would have seemed entirely fanciful. Even the capacity to directly exploit radiation pressure is now leading to new possibilities for producing optical lift. Moreover, advances in nanofabrication are allowing the development of exquisitely structured components, tailored to rotate under the influence of light, fuelling the potential for future developments.

Research studies that specifically address the properties of phase-structured and singular beams, such as those of Bessel and Laguerre-Gaussian form, commonly engage deep fundamental principles whose theoretical constructs also remain under active development, notably those concerned with the orbital angular momentum of light. As the theory is being consolidated, there is an increasing focus on devising methods to unambiguously identify beams with unknown angular momentum content, and notable advances are being made. Here, the

associated issues have a significant bearing on the viability of schemes for quantum information transmission. This is a rich ground for theoretical work and it is highly encouraging to see an active engagement between theoreticians and experimentalists. It is, indeed, another distinctive feature of this conference.

The term 'complex light' encompasses more than just light beams with exotic wave-front structures. There is considerable progress in the devising of optical elements that can produce such structures and there are close links to the polarization layout in beams of radial and azimuthal polarization, also associated with 'hollow' beams. Recognition of these links has paved the way for the novel imaging applications now being reported. Cases of temporal, rather than spatial, structure are also rising in prominence, through studies where active phase masks and spatial light modulators are deployed. Even laser filamentation, a phenomenon that first came into prominence twenty years ago, largely as a curiosity characterized by its unpredictability, has now been brought under control to the extent that bundles of co-propagating beam filaments can assist in the cause of divergence-free propagation.

Bringing these papers to the proceedings provides a welcome opportunity to thank all the contributors. I very gladly acknowledge the support of my very able co-chairs Kiko Galvez and Jesper Glückstad. Together we also express sincere gratitude to the members of our highly active and supportive Program Committee, whose sterling work underpins the success of this conference each year. We remain indebted to the SPIE staff at every level, for reliable management and production processes, achieved with customary hallmark professionalism.

David L. Andrews