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Editorial

Focus on advanced optics—optical enlightenment

Once upon a time, in the ancient world—when the centres of learning were few and far between, and the number of scholars was a minute fraction of the population—communication of wisdom was simple and direct. Followers learned almost immediately of newly developed strands of construction upon the world, and some students were indeed involved in developing the new concepts. Over time, following the introduction of printing and new routes of circulation in an expanding world, the channels of dissemination greatly increased, extending well beyond the immediate and sometimes esoteric circles of individual scholars. One of the main landmarks in the history of optics, Isaac Newton's *Opticks*, published in 1704, enabled his foundational studies of light to quickly reach unprecedented numbers—though its scientific viewpoint was not by any means universally accepted. But this did follow along the long-established pathway of philosophical deliberations, herein consolidated in some kind of text-book form. Eventually, through the work of Maxwell and numerous others, and then the development of quantum theory, the science of light became more substantial and joined the canon. Taught aspects of its principles and theory would be enshrined in a range of text-books, notable for their similarity of vision, and used for the instruction of many thousands per year, with translations spreading the message. The vested interest in such solidarity meant that newer developments were more critically considered; a case can be made that the last big shift in terms of introducing new material came after the introduction and development of the laser.

Nonetheless, since around the dawn of the third millennium a range of new advanced topics in optics, many of which we now cast under the umbrella term 'photonics', has come to the fore with remarkable speed—often maturing over a short span of years from the cutting-edge to commercial development and widespread societal usage. And so it is, that while many text-books have failed to move with sufficient alacrity to account for such fast burgeoning science, there is a need to bring digestible representations of it to the classroom. This is indeed a daunting task and ambition, as the fast development of scientific advances is paralleled in many cases by a no less rapid decay, if not evanescence, of some initially promising and sometimes pompously aggrandized 'breakthroughs'. Nevertheless, students now in our lab classes and lecture rooms need to be prepared for a peak in their career that will typically occur in the next 20 years. This places a considerable burden of responsibility on the material of choice for their current education, and once more emphasizes the need for acquiring a solid background in foundational science, rather than concentrating on state-of-the-art advances and recipes—which may be rather deceptive in the medium if not short term.

In spite of those difficulties, and well aware of the risks, the rationale for the special collection of papers now published in this focus issue of the *European Journal of Physics* is

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to provide students and educators, from high school to university, a vision of what the editors believe to be solid cornerstones in modern optics, from fundamentals [1, 2] to engineering [3], from theory [4, 5] to experiment [6, 7], and, best of all, when these four ingredients are combined in good scientific practice. In that respect, the complementarity and synergy between classical ray optics, semi-classical or statistical optical physics, Maxwellian and quantum mechanical points of view are stressed in this issue [8–12], considered as constantly reinforced building blocks of contemporary optics, rather than as conflicting or even incompatible visions.

Who could have predicted, say two decades ago, that waveguides, the cornerstone of integrated optics as we knew it throughout the 1970s to the 1990s, would then be supplemented by high-quality factor microcavities (both active and passive) [13], photonic crystals, and nanophotonic solutions—not to mention metals coming in to play a role comparable to semiconductors in some optical applications? Or that the realm of molecular nonlinear optics would begin to feature more in bio-imaging—where it now offers unprecedented scales of resolution—rather than in telecom, its initially triggering domain of applications? The development of optomechanics, with optical tweezers and other confining techniques [14, 15], also appears to be here to stay, with a better understanding and new applications running far beyond the reach of the pioneering but limited laboratory experiments in the 1980s. We hope that these domains, all represented in this issue, will find their way sooner rather than later into the canon of teaching from high schools to universities and engineering colleges, with the assistance of material devoted to pedagogic issues and low cost implementations at the introductory level [16–19].

It is therefore the hope of the editors and contributors to this compilation that they will have fulfilled their mission if a reasonable portion of its content will have withstood the trial of time and still appear of value in a decade from now, notwithstanding the shortened average lifetime for scientific results as well as the timescale for renewal of ideas and practice in science.

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