A year to remember

2015 marks the 150th anniversary of Maxwell's formulation of his theory of electromagnetism and a year-long celebration of the importance of optics.

Happy New Year. This month marks the start of the International Year of Light and Light-based Technologies (IYL 2015) — an initiative driven by UNESCO (United Nations Educational, Scientific and Cultural Organization) to raise awareness of the importance of optical technologies to citizens of the world. The aim is to promote improved public and political understanding of the benefits of photonics in the modern world, and the solutions it provides in the areas of energy, communications, healthcare, agriculture and education.

In many ways, a perfect illustration has recently been serendipitously provided in the form of the 2014 Nobel Prizes, announced in October. The 2014 Nobel Prize in Physics and the 2014 Nobel Prize in Chemistry were awarded to the inventors of two exciting and impactful developments in photonics: the realization of the blue GaN LED, which underpins a revolution in highly-efficient solid-state white LED lighting, and the development of super-resolution microscopy, which has profound implications for the study of biological processes. For detailed coverage of these individual achievements please refer to the articles in our December issue (*Nature Photon.* **8,** 884–886; 2014, and *Nature Photon.* **8,** 887–888; 2014).

As for the formal plans for IYL 2015, it will officially kick off with an opening ceremony on 19–20 January in Paris, France, followed by a series of educational events around the globe that will celebrate optics and its connection to society with a host of visual and fun demonstrations. A full calendar of events and a programme of activities can be found on the IYL 2015 website (www.light2015.org).

Alongside a long list of partners and sponsors that includes notable scientific societies, universities and companies, *Nature Photonics* is pleased to be a gold associate of the initiative and will be contributing by publishing a series of dedicated articles throughout the year.

There seems to be no better way to start than with a celebration of the 150th anniversary of James Clerk Maxwell's equations that predicted the existence of electromagnetic waves and underpin the behaviour of light. This issue of *Nature Photonics* brings together a collection of articles that provide the historical context of the formulation of Maxwell's equations and their present day utilization.

On page 2, Basil Mahon — the author of several books about key figures that played pivotal roles in the development of our understanding of electromagnetism, including Michael Faraday, James Clerk Maxwell and Oliver Heaviside — provides a fascinating historical commentary that explains how the equations came about in the middle of the nineteenth century and how they were received at the time. Interestingly, many people don't realize that it was the English mathematician Oliver Heaviside who actually formulated the equations in their current, succinct and famous form of four short expressions involving vector field calculus. Maxwell's initial formulation was far more complex, involving 20 equations and 20 variables. Many also don't realize that Maxwell was residing at King's College London (which has been running a series of anniversary lectures) when he penned his equations.

Unsurprisingly, the significance of the equations and their hypothetical waves was not truly appreciated at the time. It was only many years later when electromagnetic waves, in the form of radio waves, where experimentally proven to exist by the German scientist Heinrich Hertz and later investigated for communication purposes by the Italian Guglielmo Marconi that things really started to change.

Leaping ahead 100 years, Allen Taflove at Northwestern University in the USA pioneered the development of efficient numerical schemes for solving Maxwell's equations in the 1970s and 80s, in particular, the so-called finite-difference time-domain (FTDT) technique. We interview Taflove on page 5. The creation of practical and computationally-efficient schemes for dealing with Maxwell's equations has proved to be vital for the design and simulation of a wide range of devices spanning from radio wave radar to microwave components and optoelectronic and photonic devices. Whereas today, advances in computing power mean that such simulations can often be run on personal computers, Taflove comments that during the early days he heavily relied on supercomputers and that this generated considerable scepticism from critics.

Taking another step forward in time, the idea of producing artificially-engineered metamaterials with custom-designed values of permittivity and permeability (and thus refractive index) that cannot be found in natural materials created new opportunities for manipulating Maxwell's equations. In 2006, John Pendry and Ulf Leonhardt published a new way of looking at Maxwell's equations called 'transformation optics'. They realized that the equations' invariance to coordinate transformation offered a means of designing all kinds of optical devices with interesting and unusual functionality such as invisibility cloaks, energy collectors and perfect lenses. On page 15, Huanyang Chen and Lin Xu of Soochow University in China review the principles and capabilities of transformation optics and the possibilities that it creates. Indeed, the combination of transformation optics with advances in nanoscale fabrication technology and the ability to actually make artificially-engineered metamaterials has given a new lease of life to Maxwell's equations and photonic design. It is now possible to actually create materials that can manipulate light and other forms of electromagnetic radiation in ways that would have probably astonished Maxwell. ❐

Corrected after print: 6 January 2015

Correction

In the Editorial 'A year to remember' (*Nature Photonics* **9,** 1; 2015), the page number of the Review Article by Huanyang Chen and Lin Xu was incorrect and should have read 15. This has now been corrected in the online versions after print 6 January 2015.