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Taking things slow

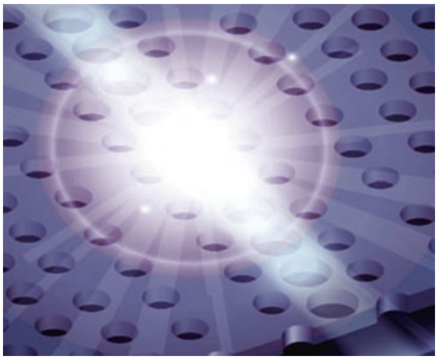
In optical networks of the future, the ability to slow and store light pulses to optimize the flow of data is likely to become indispensable. To celebrate the importance of the topic, this issue has a special focus dedicated to slow light.

At the 8th second of 8.08 pm on the 8th August 2008, the attention of the world will be turning to Beijing, China, for the opening ceremony of the XXIX Olympiad. For a fortnight, athletes from all over the world will strive to perform to the best of their ability and fulfil the Olympic motto, '*Citius, Altius, Fortius*' the Latin for 'Faster, Higher, Stronger'.

Indeed, the quest for increasing speed is a basic human instinct that has been with us since the advent of civilization and appears to have become an obsession in the modern world. Today, almost every aspect of our daily life seems to be closely linked with a desire to do things faster, with an insatiable desire for faster Internet connections, faster cars, and even fast food.

Obviously, science and technology are often important for making advances in speed possible. However, in photonics there is now an increasing number of researchers working in completely the opposite direction — slowing down light.

The motivation of slow-light research may not be self-evident, given that the exceptionally high velocity of light is often touted as a benefit rather than a disadvantage. The answer can be found in this special issue of *Nature Photonics* by reading the collection of articles (two Reviews, two Commentaries and an Interview) written by leading experts in the field. Collectively, they describe the history and evolution of the research into slow light, the fundamental physics behind the effect, popular technologies that are being used to control light and the future applications that lie in store. Although this collection is certainly not completely comprehensive — books have been written on the topic — we hope that it does provide a thought-provoking and valuable insight into the current status of the field.



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The simple truth is that the ability to control the velocity of a light pulse opens the door to a host of new and exciting opportunities as described by Thomas Krauss on page 448. These include enhanced nonlinear optical effects, as the timescale for laser–matter interaction is greatly increased, and the development of sophisticated all-optical information processing that can slow, store, switch and time-delay optical data bits.

A strong motivation is the development of all-optical routers and all-optical buffer memories that serve to provide dynamic control over the flow of data around next-generation telecommunication networks, without the need to convert optical data into the electronic domain. In addition, light travelling at a very low speed is anticipated to have a far-reaching impact on radar systems, radiofrequency signal processing and quantum information science.

Although research into slow light was first investigated as early as the nineteenth century, as Robert Boyd tells *Nature Photonics* in the Interview on page 454, the field did not really take off until 1999 when Lene Hau and colleagues from Harvard University successfully reduced the group velocity of light to just 17 m s^{-1}. Their slow-light trick was based on inducing electromagnetically induced transparency in an ultracold atomic cloud called a Bose–Einstein condensate. An in-depth description of this process, as well as its applications to three-dimensional memory and optical information processing, are detailed by Hau on page 451.

Since then, many other slow-light techniques and technologies have become popular, including the exploitation of coherent population oscillation and stimulated Brillouin scattering, or the artificial resonance created by structured materials, such as photonic-crystal waveguides and microring resonators.

Two of these are covered in detail in this month's Review articles. On page 465, Toshihiko Baba describes the progress that has been made in generating slow light by applying bandgap engineering and photonic-crystal waveguides. On page 474 Luc Thévenaz reviews different approaches for slow- and fast-light generation in optical fibres at telecommunication wavelengths, with an emphasis on stimulated Brillouin scattering.

The realization that the speed of light at 300,000 km s^{-1} is unsurpassable led to a scientific revolution early in the twentieth century. It is ironic that now at the beginning of the twenty-first century, researchers are striving to achieve, manipulate and exploit light at pedestrian speeds. The benefits of this new control of light are eagerly awaited.