Trapped rainbow: New technique to slow down, stop and capture light offers bright future for internet, powerful computer

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Professor Ortwin Hess, his PhD student Kosmas Tsakmakidis of the Advanced Technology Institute and Department of Physics at the University of Surrey and Professor Alan Boardman from Salford University have revealed a technique which may be able to slow down, stop and capture light.

The technique would allow the use of light rather than electrons to store memory in devices such as computers, enabling an increase in operating capacity of 1,000% by using light's broad spectrum rather than single electrons. Slow light could also be used to increase the speed of optical networks, such as the Internet.

At major interconnection points, where billions of optical data packets arrive simultaneously, it would be useful if we could control this traffic optically, by slowing some data packets to let others through. This system would work in the same way as traffic congestion calming schemes do on our motorways, when a reduction in the speed limit enables swifter overall flow of traffic.

Previous attempts to slow and capture light have involved extremely low or cryogenic temperatures, have been extremely costly, and have only worked with one specific frequency of light at a time. The technique proposed by Professor Hess and Mr Kosmas Tsakmakidis involves the use of negative refractive index metamaterials along with the exploitation of the Goos Hänchen effect, which shows that when light hits an object or an interface between two media it does not immediately bounce back but seems to travel very slightly along that object, or in the case of metamaterials, travels very slightly backwards along the object.

Professor Hess' theory shows that if you create a tapered layer of glass surrounded by two suitable layers of negative refractive index metamaterials a packet of white light injected into this prism from the wide end will be completely stopped at some point in the prism. As different component 'colours' of white light have different frequencies each individual frequency would therefore be stopped at a different stage down the taper, thereby creating the 'trapped rainbow'.

The negative index metamaterials that allow for unprecedented control over the flow of light have a sub-structure with tiny metallic components much smaller than the wavelength of the light and have recently been demonstrated experimentally for THz and infrared wavelengths. Covering the full rainbow colours in the visible frequency spectrum should be within science's reach in the very near future.

Professor Hess comments: Our "Trapped Rainbow" bridges the exciting fields of metamaterials with slow light research. It may open the way to the long-awaited realization of an "optical capacitor". Clearly, the macroscopic control and storage of photons will conceivably find applications in optical data processing and storage, a multitude of hybrid, photonic devices to be used in optical fibre communication networks and integrated photonic signal processors as well as become a key component in the realisation of quantum optical memories. It may, further herald a new realm of photonics with direct application of the 'Trapped Rainbow' storage of light in a huge variety of scientific and consumer fields.

Source: University of Surrey