Rainbow trapping in light pulses

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Over the past decade, scientists have succeeded in slowing pulses of light down to zero speed by letting separate frequency components of the pulse conspire in such a way that a receptive medium through which the pulse is passing can host the information stored in the pulse but not actually absorb the pulse's energy. Trapping light means either stopping the light temporally or confining the light in space. Scientists have also been able to trap a light pulse in a tiny enclosure bounded by metamaterials; the light pulse retains its form but is kept from moving away.

Previously only light of a short frequency interval could be trapped in this way. Now a group of scientists at Nanjing University in China have shown how a rather wide spectrum of light -- a rainbow of radiation -- can be trapped in a single structure.

They propose to do this by sending the light rays into a self-similar-structured dielectric waveguide (SDW) -- essentially a light pipe with a cladding of many layers.

Light of different colors propagates separately in (or is contained within) different layers, the layers each being tailored by color. They replace the conventional periodically-spaced, identical cladding layers with a non-periodic, self-similar pattern of successive layers made from two materials, A and B, with slightly different thicknesses and indices of refraction.

Self similarity, in this case, means that the pattern of layers successively outwards would be as follows: A, AB, ABBA, ABBABAAB, and so forth.

"The effect might be applied for on-chip spectroscopy or on-chip 'color-sorters,'" says Ruwen Peng, one of the Nanjing researchers. "It might also be used for photon processing and information transport in optical communications and quantum computing." Peng and her associates, who published their results in the American Institute of Physics' journal Applied Physics Letters, expect that they can create trapped "rainbows" for light in many portions of the electromagnetic spectrum, including microwave, terahertz, infrared, and even visible.

More information: The article "'Rainbow' trapped in a self-similar coaxial optical waveguide" by Qing Hu, Jin-Zhu Zhao, Ru-Wen Peng, Feng Gao, Rui-Li Zhang, and Mu Wang was published online in the journal Applied Physics Letters in April, 2010. See: link.aip.org/link/APPLAB/v96/i16/p161101/s1

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