Erasing history? Temporal cloaks adjust light's throttle to hide an event in time

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Researchers from Cornell University in Ithaca, N.Y., have demonstrated for the first time that it's possible to cloak a singular event in time, creating what has been described as a "history editor." In a feat of Einstein-inspired physics, Moti Fridman and his colleagues sent a beam of light traveling down an optical fiber and through a pair of so-called "time lenses." Between these two lenses, the researchers were able to briefly create a small bubble, or gap, in the flow of light. During that fleetingly brief moment, lasting only the tiniest fraction of a second, the gap functioned like a temporal hole, concealing the fact that a brief burst of light ever occurred.

The team will present their findings at the Optical Society's (OSA) Annual Meeting, Frontiers in Optics (FiO) 2011, taking place in San Jose, Calif. next week.

Their ingenious system, which is the first physical demonstration of a phenomenon originally described theoretically a year ago by Martin McCall and his colleagues at Imperial College London in the Journal of Optics, relies on the ability to use short intense pulses of light to alter the speed of light as it travels through optical materials, in this case an optical fiber. (In a vacuum, light maintains its predetermined speed limit of 180,000 miles per second.) As the beam passes through a split-time lens (a silicon device originally designed to speed up data transfer), it accelerates near the center and slows down along the edges, causing it to balloon out toward the edges, leaving a dead zone around which the light waves curve. A similar lens a little farther along the path produces the

exact but opposite velocity adjustments, resetting the speeds and reproducing the original shape and appearance of the light rays.

To test the performance of their temporal cloak, the researchers created pulses of light directly between the two lenses. The pulses repeated like clockwork at a rate of 41 kilohertz. When the cloak was off, the researchers were able to detect a steady beat. By switching on the temporal cloak, which was synchronized with the light pulses, all signs that these events ever took place were erased from the data stream.

Unlike spatial optical cloaking, which typically requires the use of metamaterials (specially created materials engineered to have specific optical properties), the temporal cloak designed by the researchers relies more on the fundamental properties of light and how it behaves under highly constrained space and time conditions. The area affected by the temporal cloak is a mere 6 millimeters long and can last only 20 trillionths of a second. The length of the cloaked area and the length of time it is able to function are tightly constrained—primarily by the extreme velocity of light. Cloaking for a longer duration would create turbulence in the system, essentially pulling back the curtain and hinting that an event had occurred. Also, to achieve any measurable macroscopic effects, an experiment of planetary and even interplanetary scales would be necessary.

More information: FiO presentation FMI3, "Demonstration of Temporal Cloaking," by Moti Fridman et al. is at 4:45 p.m. on Monday, Oct. 17. http://www.frontiersinoptics.com/

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