BIG Discovery ~ Speed of Light Not So Constant After All

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SHIFTING SPEEDS, even in vacuum conditions, light can move slower than its maximum speed depending on the structure of its pulses. The finding could be important for physicists studying extremely short light pulses. (Photo by Jeff Keyzer/FLICKR)

Light doesn't always travel at the speed of light. A new experiment reveals that focusing or manipulating the structure of light pulses reduces their speed, even in vacuum conditions.

A paper reporting the research, posted online at arXiv.org and accepted for publication, describes hard experimental evidence that the speed of light, one of the most important constants in physics, should be thought of as a limit rather than an invariable rate for light zipping through a vacuum.

“It’s very impressive work,” says Robert Boyd, an optical physicist at the University of Rochester in New York. “It’s the sort of thing that’s so obvious, you wonder why you didn’t think of it first.”

Researchers led by optical physicist Miles Padgett at the University of Glasgow demonstrated the effect by racing photons that were identical except for their structure. The structured light consistently arrived a tad late. Though the effect is not recognizable in everyday life and in most technological applications, the new research highlights a fundamental and previously unappreciated subtlety in the behavior of light.

The speed of light in a vacuum, usually denoted c, is a fundamental constant central to much of physics, particularly Einstein’s theory of relativity. While measuring c was once considered an important experimental problem, it is now simply specified to be 299,792,458 meters per second, as the meter itself is defined in terms of light’s vacuum speed. Generally if light is not traveling at c it is because it is moving through a material. For example, light slows down when passing through glass or water.

Padgett and his team wondered if there were fundamental factors that could change the speed of light in a vacuum. Previous studies had hinted that the structure of light could play a role. Physics textbooks idealize light as plane waves, in which the fronts of each wave move in parallel, much like ocean waves approaching a straight shoreline. But while light can usually be approximated as plane waves, its structure is actually more complicated. For instance, light can converge upon a point after passing through a lens. Lasers can shape light into concentrated or even bull’s-eye–shaped beams.

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