Speed of Light Not so Constant After All

Required Annotations		Student-Created Annotations		Summary / Questions / Reflection	

Comprehension	**New: omni = everywhere, all; spec = see || Previous (to find): -ist; con (x2);**	Comments

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, almost **omnipresecent** 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.

The researchers produced pairs of photons and sent them on different paths toward a detector. One photon zipped straight through a fiber. The other photon went through a pair of devices that manipulated the structure of the light and then switched it back. Had structure not mattered, the two photons would have arrived at the same time. But that didn't happen. Measurements revealed that the structured light consistently arrived several micrometers late per meter of distance traveled.

"I'm not surprised the effect exists," Boyd says. "But it's surprising that the effect is so large and **robust**."

Greg Gbur, an optical physicist at the University of North Carolina at Charlotte, says the findings won't change the way physicists look at the **aura** **emanating** from a lamp or flashlight. But he says the speed corrections could be important for physicists studying extremely short light pulses.

Questions

1. How is the speed of light incorporated into Einstein's theory of relativity?
2. How did scientists alter one beam of light in the experiment?
3. List three ways in which Hamilton's diagnosis is ironic.