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arizona.edu/~jscotti/NOT.faked and pirlwww.lpl.arizona.edu/~scotti/NOT.faked/FOX.html.

—*James V. Scotti*

James V. Scotti is an astronomer at the Lunar & Planetary Laboratory at the University of Arizona in Tucson.

Richard Wiseman Tries to Tune into Ever-Elusive ESP

On December 7, 2000, the "Museum of the Unknown" in London, England, hosted "The World's Largest ESP Experiment," the brainchild of Richard Wiseman. The museum was the venue for a day-long series of ten half-hour ESP trials. Members of the public were asked to psychically transmit a series of images they viewed on a projection screen to a "receiver" who sat in the "ganzfeld state" (a mode of sensory isolation) 200 yards away in a nearby building, 19 stories above street level.

Wiseman was leading what CNN.com Europe described as "a sort of brain-wave blitzkrieg," getting crowds of "senders" cooperate as psychic messengers. "By boosting the signal, by having lots of senders," Wiseman told a British ITN television reporter, "you'd expect that maybe you can achieve spectacular results and that's what we're trying to find out today."

In another experiment that day, while thirty people sat in a room concentrating on the projected images of gophers and other assorted objects, a sequestered receiver relaxes in the "ganzfeld" state: she reclines with ping-pong ball hemispheres taped to her eyes, listening to white noise and bathing in soft, red light. Her goal is to empty her mind for ten minutes, then focus on any psychic impressions that might be emanating from the people back at the room in the museum.

If the battery of trials had yielded six or more hits out of ten, Wiseman would conclude that the results hint at some phenomenon other than chance. Speaking to a reporter from the ITN Network in the United Kingdom, Wiseman described the goals of the tests he had set up:

"It's very difficult to tell ESP from chance. I mean, we could do a hundred trials. They could all be hits. It could still be chance. But what we're looking at is saying, 'Well look, if it goes to 100 to one, if it goes to 200 to one, that doesn't feel so much like chance, that feels like something else going on.' And that's really how we're measuring things."

The results of the experiment—two hits out of ten—failed to find any evidence of a psychic message transmission.

—*Kevin Christopher*

Faster than Light? Well, Yes and No

Perhaps you saw the headline from *The Sunday Times* (London) on June 4, 2000: "Eureka! Scientists break speed of light." Or perhaps you caught mention on radio or television about research by Dr. Lijun Wang (of the NEC Research Institute in New Jersey) involving violations of one of the most important rules of physics, namely that nothing can exceed the speed of light. Several other "superluminal" experiments have made the news this last year. What you won't always hear is that the experiments don't disprove Einstein, and that causality has not been violated.

Salon.com carried an excellent analysis by Chris Colin (8/3/2000), who got to the bottom of the Wang story. After the initial excitement and confusion, it had turned out that, "Far from challenging fundamental rules of nature, the team developed a method of manipulating the wavelengths of a beam of light, thereby altering the way it arrives at its destination. Because short wavelengths become longer and long ones become shorter, the natural fanning outward that marks a light pulse is eliminated; consequently the shape of the pulse at its destination appears the same as at its origin. This effect, called anomalous dispersion, had never been produced in a transparent medium [until Wang]. . . . The light didn't speed up, but rather the peak of its pulse shifted, thereby changing its intensity."

In light of what the Wang experiment did—and didn't—show, it's amusing to note the reaction of physicist Russ Humphreys, a young-Earth creationist from New Mexico. Humphreys wrote on the new "speed of light" experiments for the Answers in Genesis web site (www.answersingenesis.org), focusing on Wang's article in the journal *Nature* (Vol. 406, pp. 277–279). Humphreys wrote "The most puzzling thing to me is how the authors appear to deny the obvious implications of their data. They imply that their results do not suggest that information could be transmitted faster than the speed of light in vacuum, and yet the nearly-raw data in their figure 4 says [*sic*] just the opposite." Humphreys goes on to say "The newspapers actually got that point right. This raises the possibility of transmitting information 'backwards' in time. That would be astonishing!" In other words, creation physicist Humphreys, like the *Times*, completely misunderstood the Wang research. Causality violation wouldn't bother Humphreys anyway; he also writes ". . . for millennia the Bible has been transmitting detailed information to us about the future. I haven't noticed the world collapsing into non-causal chaos quite yet!"

Recently, New Mexicans for Science and Reason (NMSR) heard Dr. Mohammed Mojahedi, of the University of New Mexico Physics Department, speaking on his "superluminal" research. Mojahedi works at the University of New Mexico's Center for High Tech Materials (CHTM), and his group's fascinating experiment was reported in the October 2000 issue of *Physical Review E*. In Mojahedi's work, pulses have been measured as traveling faster than the speed of light in vacuum, some 300 million meters per second.

In Mojahedi's experiment, a beam of

microwaves was split into two, and the path lengths for the two beams calibrated. Then, a special array of plastic window panes was inserted into one of the beams. One might expect that the array of windows might slow down the pulse, delaying the arrival of that beam. But just the opposite happened. Mojahedi's group consistently measured the window-path beam's main pulse as arriving half of a billionth of a second before the pulse from the vacuum-path beam; for the small distances involved on the lab table, this amounted to a speed of 2.38 times the speed of light!

The effect is due to quantum tunneling effects in the window materials, dielectric photonic crystals. Mojahedi exploited a curious property called Evanescent Mode Propagation to achieve his surprising results.

But how surprising were the results? Was Einstein causality violated? Mojahedi said "No." The faster-than-light-speed ("superluminal") propagation was observed only for the main part of the pulse signal. This is the large-amplitude part of the pulse that is easy to measure. It's much harder to measure the very beginning of the signal—the "forerunner" or "precursor"—because those signals have very small amplitudes. Yet the forerunner signals are the ones that obey the cosmic speed limit of the universe, the speed of light.

Mojahedi used an analogy involving race cars. The forerunner signals correspond to the sharp front edge of the race cars, while the main section of the race cars, containing the driver, correspond to the main pulse of the signals. In both the "normal" and "superluminal" paths, the forerunner signals arrive at the same time—both travel at the speed of light, no faster. (See points labeled A and A^1 on the diagrams.) However, the main pulse is accelerated in the photonic crystals, with the result that it arrives earlier in the superluminal path (going through the special windows) than through the vacuum path. (See points labeled B and B^1 on the diagrams.)

The figure shows signals like the ones Mojahedi's group measured. The Sommerfeld forerunner signals arrive at the same time for both the normal path (A, top) and "superluminal" path (A^1, bottom). The Brillouin forerunners arrive next, with the superluminal path's signal winning that race by a small amount. The main envelope of the superluminal pulse arrives earlier (B^1) than the envelope for the normal pulse (B). And so the velocity of the forerunner pulse does not exceed that of light, but the "group velocity" (for the main pulse envelope) does.

Mojahedi described how his work challenges some of the earlier thinking in this field, such as comments by Borne and Wolfe, and Brillouin, that superluminal group velocities had no physical significance or meaning. Does this work suggest that faster-than-light communications might be possible? Unfortunately, no. While the superluminal pulse (B^1) might arrive before its vacuum counterpart (B), it will never precede the arrival of its precursor (A^1). That would be like the driver of the race car reaching a point before the leading edge of the car does. However, the work may hold promise for speeding up detection of pulses in applications such as computing.

With other interesting experiments being conducted, such as slowing light down to a crawl inside a special medium, the speed of light continues to be an entertaining subject. Rumors of the demise of Einstein and causality are still a bit premature.

—David Thomas

Dave Thomas, a physicist, is president of the New Mexicans for Science and Reason and a SKEPTICAL INQUIRER *consulting editor.* □