KINEMATICS Units 4 & 5

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& New York Times September 22, 2011 by Dennis Overbye . Send Dr Cise an e-mail on how you used this application. Thanks!

Tiny Neutrinos May Have Broken Cosmic Speed Limit(9/22/11)

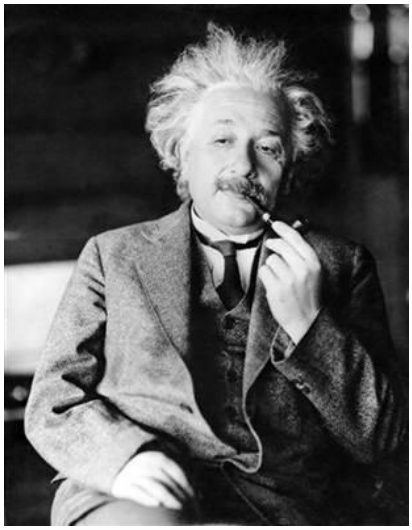
The physics world is abuzz with news that a group of European physicists plans to announce Friday that it has clocked a burst of subatomic particles known **as neutrinos breaking the cosmic speed limit — the speed of light** — that was set by Albert Einstein in 1905.

If true, it is a result that would change the world. But that "if" is enormous.

Even before the European physicists had presented their results — in a paper that appeared on the physics Web site arXiv.org on Thursday night and in a seminar at CERN, the European Center for Nuclear Research, on Friday — a chorus of physicists had risen up on blogs and elsewhere arguing that it was way too soon to give up on Einstein and that there was probably some experimental error. Incredible claims require incredible evidence.

"These guys have done their level best, but before throwing Einstein on the bonfire, you would like to see an independent experiment," said John Ellis, a CERN theorist who has published work on the speeds of the ghostly particles known as neutrinos.

According to scientists familiar with the paper, the neutrinos raced from a particle accelerator at CERN outside Geneva, **where they were created, to a cavern underneath Gran Sasso in Italy, a distance of about 450 miles(730,000 m), about 60 nanoseconds faster than it would take a light beam(c = 299,792,458 m/s). That amounts to a *speed greater than light by about 0.0025 percent* (2.5 parts in a hundred thousand).** Even this small deviation would open up the possibility of time travel and play havoc with longstanding notions of cause and effect**. Einstein himself — the author of modern physics, whose theory of relativity established the speed of light as the ultimate limit** — said that if you could send a message faster than light, "You could send a telegram to the past."



INRODUCTION: **NANOSECOND = 10^{-9}** s . **QUESTIONS:** (a) Find the time for light to go 450 miles(730,000 m)? (b) What is the time it took the neutino's to go 450 miles? (c) At what speed were the neutrino's traveling at? (d) How many m/s faster were the neutrinos than speed of light? (e) Show the speed of the neutrinos is 0.0025 % faster than the speed of light?

ANSWERS: (a) 0.002435017 s (b) 0.002434947 s (c) 299,799,955 m/s (d) 7,497 m/s (e) Show the speed increase is ~ 0.0025 % more than Light.