Slow down, intellectual works

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A dialogue between SE., science enthusiast, EE., electronics engineer, and TP., theoretical physicist.

EE. Hey, you who always complain that everything is going faster and faster, did you see this news in the paper: physicists have managed to slow down light until it moves at less than 100 km/h! A car would overtake it...

SE. Wait, are you serious?

EE. Yes, it was in the very renowned scientific journal Nature, on January 25.

SE. But I don't understand: for nearly a century, we've been bombarded with the idea that light always travels at the same speed, which Einstein made a cornerstone of his theory of relativity...

EE. Listen, I'm just an engineer and not a physicist; for fundamental questions, you need to ask a real theoretician. Besides, here comes P. right now.

TP. I can confirm the information, which is nothing earth-shattering. Light only has «its» speed, those famous 300,000 km/s, when it propagates in a vacuum. In a transparent medium, it goes slower; in glass, for example, its speed is only 200,000 km/s.

SE. Maybe, but slowing it down to 30 meters per second, don't tell me that's commonplace!

EE. In fact, this phenomenon is observed in a very particular medium, a condensate of sodium atoms at a temperature close to absolute zero, which exhibits quite special quantum properties.

TP. It's indeed an impressive technical feat, but it doesn't call into question the foundations of physics at all. The same goes for many supposedly revolutionary discoveries presented by the media.

SE. Exactly: what about that other news item, which also made the headlines a few months ago, according to which phenomena «faster than light» had been demonstrated? There at least, Einstein must have turned in his grave? He did say that nothing could go faster than light?

TP. Sorry to disappoint your legitimate appetite for novelty again, but, even if it's little known, including among many physicists, the speed of light is not an absolute limit! According to Einstein's relativity, no material body, nor any information, can indeed propagate faster than...

SE. ...light, that's what I said, and what these experiments contradict, right?

TP. You're interrupting too quickly. I was going to tell you that there are phenomena that don't fall into these categories subject to the speed limit.

SE. How??? But what could propagate without carrying mass, energy, or information?

TP. A «phenomenon», precisely, in the etymological sense—an appearance. I'm sure the electronics engineer sees what I mean.

EE. Yes, of course! The phase of a wave, for example?

TP. Let's not intimidate our friend with technical notions like phase velocity. There are simpler examples. Imagine a twinkling Christmas garland, or a display board on which news scrolls,

with bulbs lighting up one after the other. Nothing prevents these bulbs from lighting up successively at as high a speed as you want!

SE. Yet, it's light that's propagating on this garland or screen?

EE. No, no... The light goes from the bulbs to your eyes—at its normal speed always. The phenomenon of the bulbs lighting up, on the other hand, is not luminous, and its speed is predetermined by the delay between two successive bulbs, which you can set as you wish. Similarly, the movement of a light point on a TV or computer screen could very well be faster than light.

TP. And perhaps the most amusing example: the speed of an shadow's movement is not limited by any physical principle. Imagine, for example, a streetlamp casting the shadow of a passerby on a wall; the farther the wall is, the faster the shadow moves on it, and in principle, it could go faster than light. Various superluminal astrophysical effects have been understood in this framework, as have the laboratory experiments you were alluding to, which are more spectacular than profound.

SE. Here I am both completely excited by this revelation—the shadow that can go faster than light!—and at the same time quite disappointed. In my resistance to the generalized acceleration of the world, I was counting on physicists to set an impassable barrier. Ultimately, nature is like highways: the posted speed limits are cheerfully violated. Physical laws are not much better respected than laws in general!

TP. At least when they are poorly formulated. But in any case, this speed limit is so great (300,000 km/s), that it is practically infinite on our scale, and hardly matters in everyday life.

EE. Excuse me, but that's not entirely true anymore. Modern technology now implements processes so fast that Einstein's limit is starting to make its effects felt. For example, there are electronic devices that work on the picosecond scale (a millionth of a millionth of a second)... During such a duration, electromagnetic waves travel less than a millimeter. Travel times therefore start to count, and future optical computers will have to take them into account, and minimize the lengths of connections.

SE. And those noticeable delays, of a fraction of a second, that one perceives in intercontinental telephone communications, aren't they also due to this limitation?

EE. In general, it's rather the operating times of relays on the line that come into play, but you're right in principle: for example, a communication that goes through a geostationary satellite, at 36,000 kilometers from Earth, would require a few tenths of a second, which can be noticeable. And let's not even talk about communications with interplanetary probes, which can take several hours.

TP. As for the Universe itself, it takes light billions of years to cross it. On those scales, light doesn't go so fast!

SE. Still, this idea of a speed limit, even if it only applies to the effective transport of mass or information, is really hard to swallow! What would prevent a rocket, once it reaches the speed of light, from accelerating further and going faster?

TP. But simply the fact that it can't reach that speed! It is unsurpassable because it is unattainable. The closer you get to it, the more a body's inertia, its resistance to acceleration, increases—indefinitely.

SE. So, it's a bit like a horizon, on a hypothetical flat Earth anyway: you can see that line, in a defined direction, but it's at infinity and therefore unattainable.

TP. Exactly, and besides, physicists often use another way to measure speed, valid for very high values, in the domain of Einsteinian relativity. This new quantity, which they have named «rapidity», tends toward infinity when the usual speed tends toward the speed limit. In other words, the speed of light, while numerically finite, can be considered conceptually infinite, which dispels or at least attenuates the usual paradoxes.

EE. Yes, but there's another question that intrigues me: why this privilege given to light that would make its speed a universal standard? Isn't it that the old mythical dimension of light as an essential cosmic agent continues to mark science? Einstein bases his theory on the analysis of communications by light signals. But if we used another method, wouldn't we change our representation of space and time?

TP. The usual presentations of relativity do indeed fall short on this point, you're right. In truth, we know today that the speed limit has a much deeper meaning, and that it is a general characteristic of space-time, independent of the fact, after all contingent, that it is also the speed of light. It would be better to call it, for example, the «Einstein constant.«In fact, the theory of relativity governs all physical phenomena, nuclear as well as luminous, for example.

SE. All this is getting really complicated and I'm afraid I'll get lost. Ultimately, in relation to my ordinary human concerns, I wonder if physics has anything to say to me. Can its subtle variations on the concept of speed enlighten me when I'm trying to understand why everything is going so fast around me?

TP. Not sure, indeed. You know, a science, especially one as formalized as physics, needs to exercise its full intellectual power by operating in a narrowly circumscribed field, and most problems, whether philosophical or political, find little illumination in these disciplines whose field of validity is by nature very limited.

EE. I find you too pessimistic. Perhaps it is precisely by showing us the difficulty of thinking that science plays one of its most useful roles, even outside its own domains. Sticking to the notion of speed, you've shown us well how physics demonstrates the need to detail and diversify its meanings if we don't want to hold discourses so general about «the» speed that they lose all relevance.

SE. Yes, let's not think too fast! Perhaps the paths of reflection should be better signposted: «slow down, works».