The ‘Photon’ Fiasco

Is physical action at a distance instantaneous or time-delayed? The answer relativity theory gives is, *both*.

This presents an intellectual challenge, for how can action at a distance possibly be conceived as *both* instantaneous *and* time-delayed? The two are surely contradictory.

Well, in relativistic physics, distant interaction definitely *is* both instantaneous and time-delayed. The theory states that for anything travelling at the speed of light *c* (that is, 300,000 kilometres per second), the time the object it takes, in itself, by its own ‘clocks’ and other time-processes, is zero. In other words, in its own intrinsic or ‘proper’ time, the object covers the distance *instantly*. It is there as soon as it starts out.

But, of course, no material particle can travel at that speed. If it did, its mass would be infinite, and an infinite mass cannot be accelerated – it would take an infinite amount of energy to do so. So no material object can travel either at or faster than the automatically un-exceedable speed-limit, *c* – except *light*, that is. The ultimate particle of light, the light-quantum, or 'photon', allegedly travels at precisely that speed, never more and never less. Logically, then, the 'photon' cannot be a material particle. Moreover, in its own time, travelling (allegedly) at speed *c*, the time at which it 'leaves' its source and the time at which it 'arrives' are identical. In what sense, then can the 'photon' be realistically conceived as a material particle?

Well, logically, it can't. There have been all sorts of contrived attempts to preserve the 'photon' concept in the face of this contradiction, but every one of them fails. The fact, then, remains, that there is no material particle called the ‘photon’ and *c* cannot really be a ‘speed’ – not of any real object, at any rate.

What else, then can *c* be if not a speed? The answer that has been given, by at least three scientists [1], is that *c* is no more than a distance-time *conversion factor*, or *dimensional constant*. As Herman Bondi puts it:

> Any attempt to measure the velocity of light is . . . not an attempt at measuring the velocity of light but an attempt at ascertaining the length of the standard metre in Paris in terms of time-units.

Now this change in conception does not affect the *mathematics* of Relativity in the least How can it, since *c* has the same value and dimensions in both interpretations. that is, 300,000 kilometres to the second. What this conceptual flipover does is simply to remove the seeming contradiction between instantaneous and time-delayed distant interaction which has remained the running sore of controversy between the followers of Niels Bohr and Albert Einstein, respectively, over the so-called ‘EPR paradox’. Logically, this situation is like the dispute, between the Lilliputians and their neighbours, in the book *Gulliver's Travels*, by Jonathan Swift, over whether a soft-boiled egg should be cracked on the top (the small end) or the bottom (the bigger

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[1] These are: G. N. Lewis ('Light Waves and Corpuscles', *Nature*, 117, 256 (1926)); H. Bondi, *Assumption and Myth in Physical Theory*: Cambridge University Press, 1965. p.28 and N. V. Pope (unpublished, 1954 See websites www.vivpope.co.uk ; www.vivpope.org ; www.poams.org).

end). The logical answer, of course, is that in the EPR controversy as in the Lilliputian one, *both* choices are equally valid.

So, how can it be the case that in Relativity, distant light-interaction can be both instantaneous *and* time-delayed? This has always been the intellectual challenge presented by Einstein's Theory of Relativity ever since its inception, creating the situation that is veritably Lilliputian. The fact, however, is that an action may be *both instantaneous* ***and*** *time-delayed* without any contradiction. For instance, in what the film-maker calls 'action' there are both instantaneous and time-sequenced *components* of that action. The *instantaneous* component is the connection between, say, a pair of objects in the still frame, or 'still' – such as, for instance, an arrow in an archer's bow – and the time component is the *sequence* between that frame and the next in which the arrow is in the target or – in a faster film – somewhere in between. These photographic 'stills' are analogous to the proper-time *instantaneous* quantum connections in a light-interaction, and the *time-sequence* in 'quantum jumps' between those stills is analogous to the delayed observer-time or viewer time between those instantaneous connections in the running of the film.

In quantum physics, this is the way in which physical phenomena occur, much like in a movie but, of course, in a very much more fine-grained way and in an altogether faster sequence-time, namely, at the constant space-time rate *c*. The instantaneous quantum connections and the time-sequences of these instantaneous connections, far from being contradictory, are actually complementary. Realising this is the intellectual 'trick' in understanding not only relativistic and quantum physics but also the complete logical inter-dependency of the two.

All this is really simple. What 'queers the pitch' is the concept of the light quantum as a travelling particle called the 'photon'. This makes trying to understand quantum relativity like trying to fathom how a movie works in terms of something having to 'travel' between the stills to create the phenomenon of motion. This is because we usually think of a movie as an illusion created by a film camera taking sequences of pictures which are no more than chunks out of what is really continuous motion [2]. With this concept of underlying continuity stuck in our minds we can scarcely contemplate the inverse of that concept, which is that on the ultimate quantum level of physical analysis, it is the 'chunks' that are the reality and the continuity the illusion.

Clearly, not everyone can manage that conceptual flipover, which is evidently why both relativity and quantum theory have for so long remained notoriously obscure. But, surely, now that there is plainly no excuse for continued mystification in that regard, it is high time that these two historically antagonistic theories were allowed naturally to merge and become incorporated into ordinary commonsense

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[2] This is the so-called **phi phenomenon**. In simplest form, the phi phenomenon can be demonstrated by successively turning two adjacent lights on and off, given appropriate temporal and spatial relations between the two... [Online Encyclopedia Britannica.]