Re: How can light travel without losing energy?

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- *From*: Einar Andreas Rødland <e.a.rodland@xxxxxxxxxxxxxx>
- *Date*: Sat, 24 Sep 2005 03:34:28 +0000 (UTC)

Nick Maclaren wrote:

> In article <dgc05igtd1@xxxxxxxxxxxxx>,
> Einar Andreas Rødland <e.a.rodland@xxxxxxxxxxxxxx> wrote:
>
> Not one worth bothering with. What I am saying is that, IF that aspect
> of quantum mechanics is correct, THEN there will almost certainly be
> some interaction between light and "the active vacuum". I am then ALSO
> saying that such an interaction has so far unknown properties, and so
> MIGHT produce a similar reduction in energy to the reduction in velocity
> when light enters a medium of higher refractive index.

Electromagnetic waves, i.e. light, interact with charged particles so as to effectively slow the wave down by a factor. However, it doesn't lose any energy on this.

In order to lose energy, either the energy must go somewhere else or disappear. If it was to go somewhere else, e.g. be absorbed, it would seem reasonable that this should give some observable effect as the absorbed energy piles up, particularly around radiating bodies where the effect should be the strongest. If it was to downright disappear, it would require that energy not be conserved, which seems contrary to what we otherwise observe.

Another problem with photons losing energy in this manner is, if you think of a photon as a coherent wave, that in order to interact with something without changing its direction, it depends on interactions taking place over a sufficiently large region as to remain a coherent wave after the interactions. You may thing of the photon as being absorbed by charged particles and then reemitted shortly after, but where the reemitted wave is undirected (moves out from the particle as a spherical wave). When you sum all the reemitted waves for all the different particles, you get positive interference in the original direction of the wave, whereas in the other directions the spherical waves cancel out...except if the particles are in a regular crystal structure, that is. However, if the light changes frequency (i.e. energy), you will not get consistent positive interference in any direction.

As a thought experiment illustrating the above, imagine you send a laser beam. You can then count the number of waves (i.e. wave tops) being sent (frequency*time). You can also count the number of waves received. If the frequency of the light is reduced, the number of waves must have changed. This is problematic since it means that there is a phase shift that increases over time; or, alternatively, if a light pulse consisting of a specific number of waves is sent, that a pulse with a different number of waves is received.

> I am NOT saying that is likely and NOT proposing a theory − what I am saying is that it can't be said to be IMPOSSIBLE unless its opponents can explain why it is.

Well, nothing can ever be proved impossible (except in mathematics). However, the above arguments (and a number of other arguments I suspect) show that in order to obtain a general red−shift as observed would require throwing away some very successful and well−tested assumptions, and require some very strange phenomena.

From my impression of theoretical physicists, I suspect a number of them have actually tried various approaches discarding even the successful and well−tested assumptions; however, so far none seem to have come up with anything remotely competitive.

> Not at all. What I am saying is the dogma is the claim that it is known that the physical laws and constants were volatile during the Big Bang and thereafter froze completely solidly, so that they were thereafter invariant for all time (until the Big Bong, if any, when the universe implodes).

I know the "volatility of physical laws" during the early stages Big Bang is often used in popular explanations, but I hardly think physicists think of it in those terms. Quite the contrary, the aim is to find physical laws that do not change, or they would not be considered fundamental laws. The case now is that there are separate theories covering different aspects of physics, each with great success in their separate domains, and where most phenomena are dominated by one of these and can therefore be explained without the need of a unified theory. However, understanding the early stages of the Big Bang requires understanding how these different aspects work together: e.g. what happens when gravitation becomes so extreme that it is heavily influenced by quantum mechanical effects.

The existing theories−−−general relativity, electro−weak and strong interactions−−−are well tested under conditions we have access to. That gives some idea how extreme conditions must be before they no longer give accurate results, and better (e.g. unified) theories are needed. I don't

know the details of what has been done on this, though: only have some vague memories and impressions from what I've read.

Of course, we might be extremely unlucky in that laws as we know them only apply in our neighborhood of the universe. But if that was the case, it would be rather surprising that most observations can still be explained quite easily by the same fundamental laws.

> Actually, no. What I am stating is that the proofs of Hubble's theory depend on those assumptions. Where physicists follow the rigorous standards of the better pure mathematicians and say:
>
> > Assuming hypotheses X, Y and Z, we show that ....
>
> I am happy. There is nothing wrong with assuming that physical laws and constants are invariant, provided that you admit that you are doing so without conclusive proof and that your conclusions are void if it turns out not to be the case.

I'm not following you on this. Pure mathematicians make statements about mathematical objects, not about reality.

In physics, the axioms are those specifying the fundamental theories of physics, and the fundamental question is what set of axioms describes nature...or describes it better. That questions cannot be answered from within the axiomatic system. To ask for proof (in the mathematical sense) that the axioms are true is thus rather pointless.

Einar

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