

# Correspondence

## *To See the Light Is to See the Invisible*

Information about our environment comes to us mainly by means of light. Light reveals structure and other properties of matter, but light *per se* is invisible. It is important to remember this. It limits what we can really know about light.

### Observing Light

We try to find information about light by observing its effects on matter (electrons). This gives only partial information. For instance: By observing the current from a detector we can get information about light absorbed by electrons, but not about light absorbed by atoms or reflected away.

The output current from a detector consists of discrete electrons. Therefore, we cannot decide whether quantization existed in the propagating light or just arose in the detector. If we instead integrate the current from a radiation detector over a long time period (as we do when we study black-body radiation) we cannot decide if a frequency distribution is caused by radiation *per se*, or by the matter that is producing or detecting the radiation.

The only way to find information that is valid for light *per se* is to perturb the light in a point that is separated from the emission point as well as from the detection point. All experiments of this kind demonstrate light to be a wave motion. The double slit experiment is such a test, and it informs us about how light behaves during transmission.

Two equally strong waves of opposite phase add up to zero. This indicates some kind of symmetry between emission and absorption. Assuming quantized emission should imply quantized absorption too. However, reasons of symmetry do not imply quantized *transmission* of light.

### The Ether

Electric, magnetic and gravitational forces are physical realities, and so are electromagnetic waves. The owner of these properties is something real that we call ether (unfortunately denied). The ether does the 'waving'. The existence of an ether means that emission and absorption can be considered as electron/ether interactions, rather than as electron/light interactions. Therefore the energy absorbed by an electron is not *necessarily* transferred by the light. The fact that, when switched on, light affects electrons *instantaneously* supports the idea of an electron/ether interaction.

### Quantization

In Newton's era, light was described as propagating without time delay. This was a result of technical inability to measure the time delay. In other words: Light speed was by necessity infinite in the model, but this was not explicitly stated as a physical fact.

We find a modern parallel to this situation in quantum processes. The time for such a process is shorter than any measurable time, and is therefore *approximated* by the value zero. Quantiza-

tion is consequently a mathematical necessity, but we can never prove any process time to be *exactly* zero. Although we cannot avoid quantization in the model, it can be misleading to consider quantization to be a physical fact. In other words: Quantization is mathematically a step function, but in a physical process, a small - but finite - process time is definitely possible.

### Planck's Relation

Planck's relation is derived from studies of thermal radiation. Planck's relation states proportionality between a change of an electron's atom-related energy and the frequency of its rotation around the nucleus involved. The frequency of radiation produced is a consequence of electron's orbital states. Planck's constant contains information about the electron-to-nucleus relation, not about light. Quantization is demonstrated for *matter*, not for light.

### The Photoelectric Effect

In 1905 Einstein predicted — with the help of Planck's relation and an additive constant — linearity between energy of emitted electrons and frequency of light illuminating the emitting surface. This was called the photoelectric effect, and is a resonance phenomenon where other vibrations interfere with the motion of electrons. Einstein's predicted linearity was later verified empirically, and motivated his Nobel Prize in physics.

However, in the same paper [1] Einstein also concluded his light-quantum hypothesis. His chain of reasoning was long and complex, and raises many questions:

- Can adiabatic compression be extended from matter to light?
- Can the entropy concept be extended from matter to light?
- Can black-body emission be enclosed between non-emitting surfaces?

There are weak links in the reasoning. An exponential dependency in Wien's (not Planck's) law is identified as a sign of *entropy of radiation*. Perhaps a better interpretation is *entropy of matter (electrons), observable in radiation*. We must remember that observation of light involves absorption by atoms. Variations of black-body radiation with higher frequencies could emanate from the behavior of the matter rather than of the light itself. Therefore we cannot conclude from this variation that light is quantized during transmission.

### Black-Body Radiation

Planck's law about the frequency distribution of black-body radiation is a mathematical unification of two laws — one valid for lower frequencies, and the other for higher frequencies. This demonstrates a kind of dualism, which has been interpreted as a dualism between the wave concept and the particle concept. An alternative interpretation of this dualism is as an atom/electron dualism. At lower frequencies, the dominant oscillators are atoms in a crystalline structure undergoing thermal vibrations, and radiating in proportion to absolute temperature (Rayleigh's law).

They are partitioning kinetic energy with circulating lighter electrons that generate radiation only when they are changing energy state. Radiation from electrons is therefore concentrated in wave-packets of very short duration. This creates a particle-like behavior for higher frequencies.

Average content of kinetic energy in electrons is proportional to their frequency of oscillation in combination with the probability of occupying a certain energy state. An exponential function of energy describes this probability. This constitutes Wien's law, describing how electron's contribution dominates at higher frequencies. Therefore Planck's law of radiation can be considered to be an effect of two kinds of material objects in interaction.

In stable orbits, the electrons do not generate radiation. This can perhaps depend on the fact that they are synchronized in pairs that generate in opposite phase.

### The Compton Effect

The Compton effect demonstrates a possible — but not necessary — particle interpretation of radiation (X-rays). The wave interpretation is not automatically excluded. The effect of a wave on an electron can be concentrated in a short time period and thereby *imitate* the effect of a particle. (The process time is approximated by zero.)

In the interpretation of the Compton effect it is stated that most electrons are almost free. However, the Compton effect is not demonstrated for *most* electrons, but for an *enormously* small part of the electrons. These electrons have already a high kinetic energy, which is transferred from orbital to translational velocity. The probability for this event is extremely small. However, the probability for the reverse process is very high. These fast electrons are therefore very soon captured by other atoms.

As a consequence of this, the Compton effect can be described as two processes: an absorption, shortly followed by an emission of radiation at a somewhat longer wavelength. This shift in wavelength supports the idea of a *two step* process. This means that the Compton effect can be united with the wave model for packets of X-rays (not containing any particles). This is in agreement with Compton's earlier interpretation — before Einstein got the Nobel Prize. The extremely short time between emission and absorption means that generated wave packets do not have time to spread out very much. This creates a particle-like effect, but it does not prove particle structure.

### Crookes' Radiometer

In 1853 William Crookes invented what he called a radiometer. It is a small 'windmill' with vanes — black on one side and white on the other. It is enclosed in an evacuated glass bowl. When illuminated, it rotates.

Because the black surface moves *away* from the light source, the radiometer's behavior cannot be explained by the massive-particle model of light. The wave model combined with a light/electron interaction will not work either, because the light does not contain enough energy. Instead we should use the wave model and an ether/electron interaction. The energy that by interference is transferred from ether to electrons is further transferred from electrons to atoms. The black surface absorbs most energy and rotates away from the light source, in agreement with observation.

### Conclusions

The black-body radiation law, the photoelectric effect, Compton effect, and Crookes' radiometer can all be united with a wave model of electromagnetic radiation without particle structure. *Light-quanta are illusions caused by the discreteness of electrons and the invisibility of light.*

Planck's constant provides information about an electron's relation to an atomic nucleus, but implies nothing about light. His constant implies 'quantization' in matter, and consequently in emission as well as in absorption of light, but not during light transmission.

The ether is a physical reality. Quantization is a mathematical necessity and does not prove zero process time.

The constancy in light speed demonstrates this speed to be a property of an ether.

### Remarks

The fact that *light* is not quantized at the Planck level does not exclude the possibility that the *ether* could be quantized at a lower level. The ether could, for instance, be constituted of undetectable neutrinos. A velocity vector could be defined as an average value of many neutrino velocities, and thereby define the velocity of an ether.

The fact that *moving* electrons demonstrate a wavelike behavior in some experiments can also be explained by an ether/electron interaction. A ship moving in water can serve as a metaphor for this idea.

### Reference

- [1] A. Einstein, "On the Electrodynamics of Moving Bodies", *Ann. phys.* **17**, 891-921 (1905); reprinted in *The Collected Papers of Albert Einstein*, Vol. 2, pp. 140-171 (Princeton University Press, Princeton, 1989).

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