Cordus matter: Part 3.3 Energy cycles within matter

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Abstract

The interaction of light with electrons is one of the fundamental perceptual realities of what we see. Yet that interaction is only partly understood. Cordus concepts are applied to develop a descriptive model of the mechanisms whereby photons are absorbed into electrons and emitted. From the Cordus perspective, the temperature of a body is primarily a measure of its phonons (lattice-vibrations). Cordus shows why entropy occurs, despite the individual mechanisms being reversible. An understanding of the mechanisms for entropy is relevant to the understanding of coherence, superfluidity and superconductivity. Cordus suggests that a failure to adequately conceptualise entropy leads to misapplication of coherence and ultimately to unreliability in the premise of superposition.

Keywords: absorbance; emission; photon; electron; entropy

1 Introduction

The starting focus of this set of papers was the behaviour of the photon, and the loci it takes. However the photon is only the specialist flight-mode of a larger energy cycle, which we term the life-cycle of the photon. The electron is the primary device for capturing and emitting these photons.

Photons generally start as energy within matter, are ejected, fly free for a while, and are then reabsorbed into other matter. Photons are therefore a way for matter to transfer energy to other matter. Thus light is a distribution and energy-rebalancing mechanism for matter. Photons do not exist as identifiable entities within matter: their energy is spread into it. There is therefore a life-cycle for the photon. Understanding this could help better understand the photon. This paper, which is part 3 in a series on matter, explores emission and absorbance of light from the perspective of the Cordus conjecture.

Also, there is the problem of entropy to deal with. Where does the inelasticity occur in the life-cycle of the photon? What is the relationship between photon and heat? Such questions on the interaction of light and matter are addressed by quantum electrodynamics (QED), but extension of the Cordus conjecture suggests other novel ways of looking at the problem.

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2 Cordus model for photon absorption

The mechanism for absorption of a photon into matter is uncertain. The general interpretation of physics is that photons are absorbed into electrons. Absorption is not an instant event - it requires some depth to the material and mass density is one of the factors though known to be non-linear (Beer-Lambert law). It is known that the process may be saturated, i.e. dependent on the light intensity - explained as atoms being excited into upper energy states quicker than they can decay. Also, the fine-structure constant is (among other things) a constant for the interaction between electrons and photons.

High energy photons (Compton scattering)

It is possible for the electron to absorb only part of the energy of the photon, and send the photon on its way with lower energy (hence frequency), as Compton scattering shows. In this effect a high energy photon, e.g. X-ray, collides with an electron, and bounces off. The photon exits with lower energy (lower frequency) on a deflected path, the change in frequency being related to the angular deflection of the exiting photon.[14] The electron is physically displaced and may be ejected from the atom. The effect, or at least the equations thereof, are based on the conservation of energy and momentum, and the assumption that the photon has momentum. The Compton effect is generally accepted as evidence for the particle nature of photons, and hence also quantum theory. In principle the process may be at least partially reversible, since the inverse also occurs, where low energy photons may be energised to higher frequencies by interaction with energetic electrons. The Compton effect only occurs for high-energy photons such as X-rays.

There are two output variables in the Compton effect: the angle of deflection and the frequency of the leaving photon. Though related by an equation, neither variable can be directly controlled. So what is the independent variable and how does the effect work? Cordus suggests that the photon cordus comes close to that of the electron; the frequencies are too asynchronous to readily permit their joining (absorption), however their hyff affect each other; the hyff exert forces between the cordi even if they are near misses; at comparable frequencies the second reactive end will experience a similar force to the first. Consequently both ends of the photon are deflected, rather than one just being delayed. The angular deflection occurs depending on the positional and angular alignment, and the phase differences between photon and electron cordi. If the electron is not quick enough to move, then it gives the energy back to the photon, which continues on a deflected path with no change in frequency.

[14] However it may be that the photon is not partly absorbed, but rather totally absorbed and a new photon emitted.

Mid energy interactions

Mid energy photons also interact with electrons, in the photoelectric effect. In this case the photon is absorbed completely, and the electron is moved to a higher orbital band, or emitted from the atom. The effect is dependent on the frequency (not the light intensity), and for a given substrate requires a minimum threshold frequency of the incident photons. Electrons appear to require a minimum quantum of energy to be released: any excess is converted to kinetic energy. Light intensity determines the number of electrons emitted (current), not their energy (voltage).

The Cordus explanation of absorption is as follows: the incoming photon comes close to the electron orbital; the hyff of the photon connect to those of the electron; the two fibrils join; the energy of the photon is added to that of the electron. If there is sufficient energy in the photon to make up the requirement for the next energy quantum shell, then the electron will appear at that higher position at its next frequency cycle. Now that the electron has more energy it will have faster frequency too, and shorter span, and can therefore dance around the slower moving electrons. However, with sufficient energy, the electron-to-nucleus bond is overloaded and the electron escapes entirely from the atom (photoelectric effect). If there is not enough to bridge the gap in the first place, or left-over energy, then it goes into heat, i.e. vibration of the lattice, or phonons.

Having absorbed a photon, the electron can also emit a new one, which does not have to be the same frequency. This gives rise to the effect we perceive as colour of an object. The absorption effect is dependent on frequency of the photon. If the incident light is 'white', i.e. made up of many frequencies, then photons of some frequencies may be absorbed and others left to transmit through. Thus a body may be opaque to some frequencies and transparent to others. If it is light, then the exit light has a particular colour corresponding to the frequencies not absorbed.

We therefore generally conclude that the energy of a photon can be partly changed, i.e. the quantum is not strictly fixed.[15] The hyff pump energy into and out of the cordus (photon or electron), as per the concept of *passing observation* (ref. ‘Cordus Conjecture’).

3 Recycling the energy: reversibility, elasticity, entropy

Energy from incoming photons is distributed into the receiving electron system in several ways: boosts the energy level of the electron (quantum shell-increment); ejection of the electron with kinetic energy;

[15] The term ‘quantum’ is a good one for the energy levels of the electron orbitals in an atom (see M.2.5) because these are set quantitative increments, albeit non-uniform. However the ‘quantum’ word has been indiscriminately, even if enthusiastically, applied to just about everything, and now confounds several effects. We use ‘quantum’ in the original sense of *set intervals*, and otherwise use the word ‘granular’ for fine-scaled discontinuous phenomena.

displacement of free electrons (plasmons); and vibrational strain between the electrons making up the inter-atomic bonds (phonons).

The latter energy fragment is distributed to the bulk by vibration, hence conduction or phonons. That vibration is diluted as it is spread to further atoms. While it is theoretically possible to reassemble the heat fragments and recreate the photon, e.g. the thermionic effect, this is impractical as a spontaneous event as the heat is spread too far away into the bulk of the matter.

Phonons, heat, and temperature

In thermodynamics, heat is the energy transferred from one body to another. The *nature* of that energy is generally left unspecified, so ‘heat’ has many meanings. The cordus perspective suggests that ‘heat’ can be differentiated into radiation heat, for which the mechanism is photon transfer, and conductive heat, which uses phonons. Thus what we perceive as conductive heat is the movement of phonon vibrations between atoms in a bulk, and *Temperature* is the measure of the severity of the phonons. This is why there is an absolute zero temperature: it is simply when all phonon motions cease. It is also why light does not have a ‘temperature’: light is different to phonons.

The concept of phonons is readily understandable as vibrations in the lattice of solids. However liquids, and especially gases, do not have crystalline structures, but they do have conductive heat, so how do phonons apply there? The cordus perspective is that the e-hyff are able to communicate force and thus move neighbouring atoms, even if they are not formally bonded together. This also results in the Brownian motion of gases. In a gas with many atoms (or molecules), the position of each atom is determined by the hyff (in different phases) from many other atoms, and this results in disorderly systems. This is not to say that the systems are inherently disorderly or probabilistic. Instead the underlying mechanics is deterministic, but the complexity rises so quickly with the number of participating atoms, that the system behaviour is practically disorderly because it is too difficult to predict.

From a Cordus perspective, temperature is phonons, i.e. the relative motion between atoms, transmitted through the electron bonds. However the frequency of the electron cordus is intrinsic energy, and is not the same as temperature. The two are different forms of energy.[16]

Thus higher temperature increases the number and magnitude of phonons, and thereby adds to the disorderly regime within the material. Phonons and electron-modes affect each other. Effectively a phonon is a temporary displacement of one RE mode of the electron from its preferred position. Energy can be transferred between phonons and electrons, and again between electrons and photons. Thus electrons are the mediator for both conductive heat (phonons) and radiation energy (photons), and can

[16] Hence in photovoltaic effect, the energy of the released electron is determined by the frequency of the incident photon, not the temperature of the substrate.

transfer energy between the two forms of energy, albeit with some dilution losses on the way. In summary temperature is a *matter* property determined by phonons. This also implies that the conventional term 'heat' is unhelpful as it fails to distinguish between multiple phenomena.

Entropy

Taken together, the implication is that an atom that has surplus energy can dispense it in five main forms: electron orbital change (including bonding), electron ejection, photon ejection, electron flow (plasmons), and phonon propagation. If phonons, then another atom some distance away receive some of the energy and will likewise use what it can and dispense with the rest. That remote atom might emit a photon for example. Even if that photon was sent straight back to the original atom (which is not generally the case), there would still be less energy in the feedback loop because of the phonon dilution in the bulk, and the time required for the photon flight. Thus the individual mechanisms are all reversible (elastic), but the system as a whole is not, and we suggest this is what creates entropy.

Both photons and phonons tend to be dispersed out into the surrounding space or material (respectively), and this dilution of the original energy is the primary mechanism for thermodynamic irreversibility and entropy. The geometric and micro-structural complexity of the matter accessible to the photons and phonons introduces so many dilution paths that it is extremely unlikely that the energy fragments will spontaneously recombine.

Geometric separation is another contributory factor: when the matter separates or radiates photons across space, then the dilution is further increased and the number of paths reduced by which the energy can come back together. The enormous radiative loss of photons from stars contributes to entropy, because that energy cannot realistically all be recovered after it has travelled billions of years and stopped in our eye, and even if it were reflected back it would be more billions of years to travel back.[17] In the meantime space expands, which adds to the delay. The expansion of space in the universe contributes to entropy.

Separation causes the photon to arrive late, the more so if it involves transmission through denser material. Thus the energy is not delivered at the time it might have been, but is instead postponed into the future, i.e. an arrow of time. If that postponement is indefinite, it takes energy out of the system. This is another barrier to recombining the original energy, and thus another contribution to entropy.

[17] As the next bracket of papers, 'Cordus in extremis' shows, that smoothing out of energy means that the fabric of the vacuum is relatively smooth, and the fabric determines time at the local sub-atomic level. Thus in a way entropy is linked to the consistency of the universe and the mechanisms whereby space and time operate.

4 Photon Emission

From the Cordus perspective, photon emission is a reversal of the absorption process. It starts with the electron being in an energised state due to other energy input. If there is an unfilled lower energy vacancy then the e-fibril is drawn to that space by the lack of hyff emanating from that location. At the next frequency cycle the RE switches its mode to terminate at that inner vacancy, and the electron now appears there. This releases a photon containing the surplus energy. The size of the energy fragment corresponds to the separation of the energy shells, and this is also associated with the frequency. Hence the frequency (wavelength) of the emitted light depends on the change in orbitals.

Assuming that multiple atoms in a material generally do not synchronise their electron frequencies, so each atom will emit a photon when it is appropriate for it to do so, and the resulting photons will not be in phase with each other, though they could be the same frequency.

Special case: stimulated emission

In stimulated emission, the incoming photon triggers an electron to drop energy level and emit another photon. The original photon survives: it engages with the electron only in passing. The new photon has the same kinetic properties: frequency, phase, polarisation, and also direction of travel. If there are other atoms in a similar state of readiness then they too may be triggered to release photons, and the cumulative effect is the laser.

The Cordus explanation is that the interactions are of the passing type: that the hyff attract (repel) the roving electron to align with the photon cordus, and then precipitate emission of the second photon. The alignment causes the second photon to have the same phase, polarisation, and direction of travel as the first. It is a dynamic, on-the-spot form of CoFS. It is presumed that for the passing interaction to have no consequence on the flight of the first photon, that the electron must require negligible energy to change states. In turn this means that the electron's surplus energy available to put into the second photon must closely match that of the incoming photon. Thus the composition of the medium determine its electron properties and thus frequency of emitted light. From a Cordus perspective, the second photon is not necessarily emitted from the same space as the incoming one: it may be offset laterally or axially.

5 Conclusions

The interaction of light with electrons is one of the fundamental perceptual realities of what we see. Yet that interaction is only partly understood. Applying the Cordus concept allows a better description of the mechanisms whereby photons are absorbed into electrons and emitted. The model also provides an explanation of how the irreversibility occurs in physical systems, because conventional physics tends to provide elastic interactions between atoms. From the Cordus perspective, the temperature of a body is primarily a measure of its phonons (lattice-vibrations). Cordus shows why entropy occurs, despite the individual mechanisms being reversible.

An understanding of the mechanisms for entropy is important in the next paper (part 4) which deals with special states of matter. It is shown that the conditions for superfluidity and superconductivity are effectively low-entropy states, where the phonon transmission is suppressed. This is also relevant to the understanding of coherence. Cordus suggests that a failure to adequately conceptualise entropy leads to misapplication of coherence and ultimately to unreliability in the fundamental premise of superposition that underpins quantum mechanics. The cordus re-conceptualisation of entropy might seem basic and almost self-evident in hindsight, but it is a core concept in understanding why QM does not scale up to the macroscopic world. It is the Achilles heel of Quantum mechanics.