

INTERPRETATIONS AT QUANTUM LEVEL IN THE PHENOMENA THAT ACCOMPANY THE LASER BEAM PROCESSING

Țițu Mihail Aurel ¹, Oprean Constantin ², Mărginean Ion ³, Moldovan Alexandru ⁴, Predescu Adrian Bogorin ⁵

¹"Lucian Blaga" University of Sibiu, titu.mihail@gmail.com

²"Lucian Blaga" University of Sibiu, presedinte@ulbsibiu.ro

³"Lucian Blaga" University of Sibiu, ion.marginean@ulbsibiu.ro

⁴"Lucian Blaga" University of Sibiu, salaul2001@yahoo.com

⁵"Lucian Blaga" University of Sibiu, adrian_bogorin@yahoo.com

ABSTRACT: In the classical studies of the photo-electrical effects, the leap of electrons on a superior energetic level and their coming back on the previous level are represented by straight lines whose extension pass through the centre of the atomic nucleus, allowing the assumption that their passing from one energetic level to another is done instantaneously and outside time, purely formal, taking the shortest way, even though it is said that those electrons are found in rotation movement around the nucleus with speeds close to the speed of light. Practically, those electrons are represented as changing their movement direction at a straight angle, at such speeds, even though they do not have a zero mass. In the explications afferent to these phenomena extrapolations are made from the quantitative aspects (easily expressed by figures) to qualitative aspects and the explication that the density of energy absorbed being very high, high temperature is obtained, is reached and further on, the temperature explains everything, including ionizations and the occurrence of luminous radiations. We want to conclude that the new effects that occur when using the intense photonic beams (with high powers and focused on small surfaces) are the results of some new phenomena, cumulative and integrative, that occur only under the conditions of "astronomical" numbers of photons that act on the same small portion of matter. Currently, it is admitted that any conclusive experiment enclosing photonic effects, also constitute contribution to the solving of the photon's nature and of the atom's complex and, still enigmatical on certain parts, configuration.

KEY WORDS: photo-electrical effects, atomic nucleus, photonic beams, photons, electrons.

1. INTRODUCTION

In the classical studies of the photo-electrical effects, the leap of electrons on a superior energetic level and their coming back on the previous level are represented by straight lines whose extension pass through the centre of the atomic nucleus, allowing the assumption that their passing from one energetic level to another is done instantaneously and outside time, purely formal, taking the shortest way, even though it is said that those electrons are found in rotation movement around the nucleus with speeds close to the speed of light. Practically, those electrons are represented as changing their movement direction at a straight angle, at such speeds, even though they do not have a zero mass.

Enigmatical is also the fact that, even though at low energetic densities of the photonic beams using wave lengths bigger than 1 microns, specific to the infrared spectrum, no ionization of atoms and no interactions with the free electrons are noticed, but with extremely high energetic concentrations of controlled photon (that can only be obtained with lasers), new phenomena occur, intense luminous phenomena, including profound ionizations of atoms and very high temperatures.

In the explications afferent to these phenomena extrapolations are made from the quantitative aspects (easily expressed by figures) to qualitative aspects and the explication that the density of energy absorbed being very high, high temperature is obtained, is reached and further on, the temperature explains everything, including ionizations and the occurrence of luminous radiations.

The essence of such explanatory extrapolations would be the following: at the moment of the photons' impact with the surface of the matter energy transfer occurs, transfer which leads to the increase of the material's temperature, materialized in its heating, the formation of the melting, the evaporation and dislocation of the substance.

About how one passes from phenomena, that at low energetic concentrations have almost imperceptible effects, and at extremely high concentrations have new and impressive effects, explanatory substitutions are done attributed to the magic laser and enormous concentrations. Between these two situations described there is no phenomenological continuity, but a qualitative discontinuity, with a threshold which is surpassed through any other explications without describing the chain of phenomena that produce the useful final effects,

such as cutting and holing, easy to notice and measure.

We want to conclude that the new effects that occur when using the intense photonic beams (with high powers and focused on small surfaces) are the results of some new phenomena, cumulative and integrative, that occur only under the conditions of “astronomical” numbers of photons that act on the same small portion of matter. Currently, it is admitted that any conclusive experiment enclosing photonic effects, also constitute contribution to the solving of the photon’s nature and of the atom’s complex and, still enigmatical on certain parts, configuration.

2. GENERAL CONSIDERATIONS

The laws of the photo-electric effect established by experiment could not be explained with the help of the wave-like theory. Albert Einstein explained them in 1905 based on the quantum hypothesis, hypothesis introduced by Max Planck in 1900. Max Planck explained the microscopic mechanism of emitting the thermal radiation based on the hypothesis that the microscopic electro-magnet oscillators emit energy in discrete quantities. These discrete portions of energy were called quantum (ϵ) and they carry energy equal to $h\nu$ thus, it depends on the frequency of the radiation emitted or absorbed.

3. THE CASE OF THE SINGULAR SPONTANEOUS PHOTONIC LEAP CONVENTIONALLY REPRESENTED

As representative and typical product of knowledge, the laser was predicted to have, from its earliest existing days, very special usages, yet reality surpassed even the most enthusiastic expectations through its quality performances obtained in the laser based technologies, through the completely new applications and through the contributions to the study of mater and energy.

The fact that even though at low energetic densities of the photonic beams using wave lengths bigger than 1 micron, specific to the infrared spectrum, one cannot observe neither ionizations of the atoms, nor interactions with the free electrons seems enigmatic, but at extremely high energetic concentrations of controlled photons (which can be obtained only with lasers) in the technological processing with lasers, new phenomena occur, including profound ionisations of the atoms and very high temperatures.

About how one moves from phenomena with no effects to low energetic levels, and at extremely high energetic concentrations they have new and impressive effects, explanatory substitutions are

made, attributed to the magical laser and the enormous concentrations. Between these two described situations there is no phenomenological continuity, but a qualitative discontinuity, with a threshold, which is surpassed through any other explanations, without describing the causes that produce every effect.

Some of the hypothesis in literature, in which such phenomena are described as succinct as possible, analyse the actions of the radiation on mater starting from:

- the action of the surface electromagnetic waves (UES) on the path of the free electrons between two successive clashes;
- the action of the electrical component of the electro-magnetic field represented by the photonic radiation, in a given example – at a concentrated power of 10^9 W/cm^2 , it reaches 10^9 V/cm – this field would be stronger than the field that connects the exterior electrons in most of the atoms;
- the assumption that in such an intense field “the atoms or molecules can interact in a strange and unpredictable manner. From here resulting the utility of the laser beams for different scientific researches, for the study of the crystal field and of the inter- or even intra-atomic connections”.

It can be proven that the photon with a wave length bigger than 300 nm (immediately after the ultraviolet, including the visible, toward the distant infrared), it does not produce the effects (that can be easily seen macroscopically) through its action on the path of the free electron, at a singular photon-electron interaction, but through other kinds of interactions.

In order to prove the hypothesis according to which the electrons that do not gravitate around an atom or ion, it does not even interact with the visible radiation (with photons more energetic than the infrared radiation), we have conceived and done a relatively simple, yet conclusive experiment.

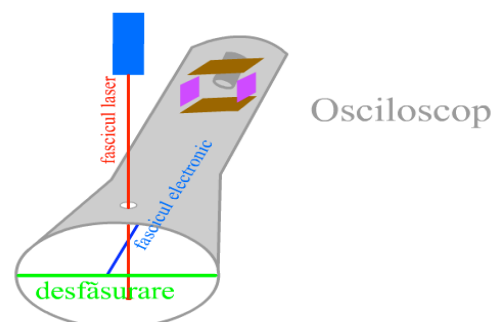


Figure 1. Oscilloscope. Capture in Romanian language from modelling software

We have created an opening through the superior part of the metal screen of an oscilloscope with conventional electronic beam with electrostatic deviation, according to Figure 1, and we have sent vertically, downwards, a red light laser beam through that respective opening, so that the electrons beam in its scanning to intersect with the laser light beam. If the laser radiation photons would interact with the electronic beam's electrons, then one could have observed on the phosphorescent screen a defocusing or a deviation of the spot. The result (the expected one) was that no observable effect, of defocusing or deviation of the oscilloscope's spots occurred, as interaction between the two beams that intersected with a high or low frequency (modifiable from the frequency of the horizontal development of the oscilloscope). It is worth mentioning that the electrons from the electronic beam's composition of the oscilloscope were free in their movement, because they did not belong neither to the atoms, nor the ions, being accelerated by a voltage of 5 kilovolts. The result of this experiment was expected, having as argument the incontestable reality that the laser beams, even with $\lambda = 10.6$ microns process very well even the ideal insulators (the ones that do not have free electrons);

We underline the fact that the photon (considered non-energetic) of the visible or infrared radiation can have an action only on the electrons found on the orbits of the atoms or ions and they do not act on the electrons found outside the atoms or ions.

4. THE CASE OF THE SINGULAR SPONTANEOUS PHOTONIC SUB-LEAP ON AN ATOMIC SUB-LEVEL

For an easier follow up of the phenomena, in the following hypothesis, we are using description in successive steps.

We assert as first hypothesis that the action of the photons on the electrons belonging to atoms or ions become concrete not only as leaps from one energetic level to another, according to the conventional photo-electric effect, but also under the form of partial sub-leaps, on temporal and transitory sub-levels, the electrons coming back to the initial states, with effects described in the following steps. Comparatively, giving in the classical description of the photo-electric effect, according to Figure 2, at the absorption of one photon the energetic leap of the peripheral electron occurs from the fundamental level E1 on the next level E2, where it stays for approximately ten nanoseconds, after which the electron comes back on the fundamental level E1,

with the emission of a photon identical with the one absorbed.

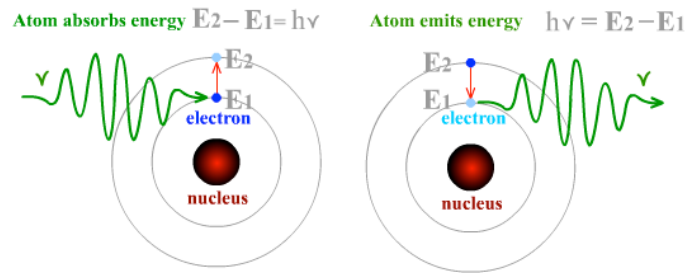


Figure 2. Change of direction of the electron

If the atom, according to Figure 3, absorbs a less energetic photon, with a wave length bigger than the one necessary for the complete leap E1-E2, for example an infrared radiation photon, a sub-leap is going to take place on the intermediary and transitory level E1,2 and the electron's come-back on the fundamental level E1, the atom is going to emit an infrared photon identical to the one absorbed, having the energy corresponding to the come-back from the sub-level reached through the sub-leap that was made.

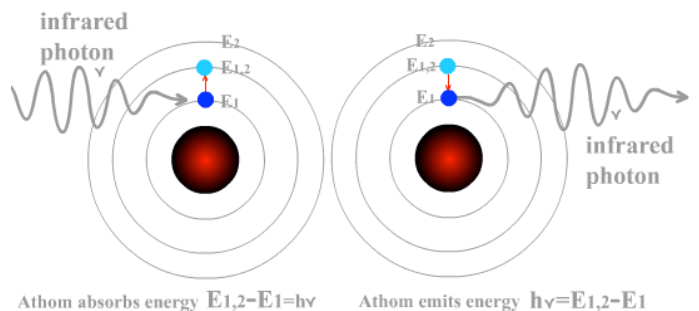


Figure 3. Singular spontaneous quantum under leap

Within the energetic belt, the electron can cumulate the energy of the successive photons, which arrive one after the other in a repetition time (t_r) shorter than the normal come-back time of the electron from the superior level (occupied through leaping) on the former inferior level ($t_r < t_s$) under the conditions in which the photons are in an extremely high number in the time unit (as in the case of the powerful laser beams, focused on a material target). In this manner, through the succession of the transitory leaps of the electrons, under the action of the incidental laser beams, on raising sub-levels inside the belt in which they are found, they manage a few successive climbs towards higher energies, without managing to come back on the basic level due to the new leaps they are forced to climb by other incidental photons, according to Figure 3 and especially due to the film 25, Film – From photon to plasma.

5. THE CASE OF THE HYPOTHESIS OF THE CUMULATIVE SUCCESSIVE LEAPS OF THE SAME ELECTRON

5.1 SUCCESSIVE ENERGETIC LEAPS

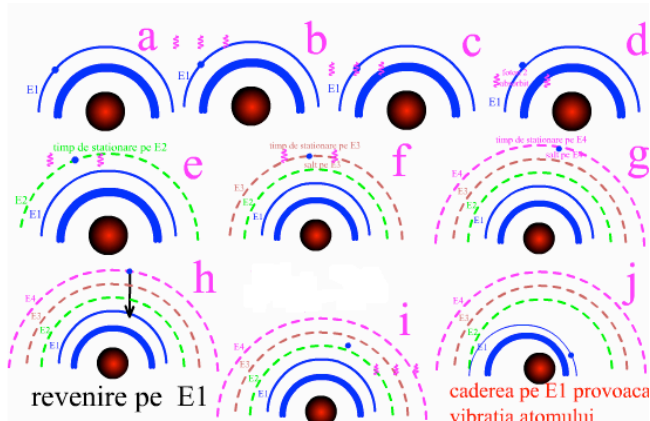


Figure 4. Successive energetic leaps. Capture in Romanian language from modelling software

In the specialised literature, room is left for such a hypothesis: “the allowed areas that are called <<the Brillouin areas>> are made out of very close levels of energy, constituting almost continuous belts”. Meaning not continuous, but almost continuous.

After a number of climbing leaps towards higher energies, such electrons, step by step accumulating additional energies, becoming more and more unstable on the new levels, come back right on the basic, fundamental level giving out the accumulated energy (through a few successive leaps) under the form of an infrared or even luminous radiation photon, phenomenon observed at the laser processing.

It is to be assumed that only those photons that coincide in phase and in space with the rotation of the electron on the orbital’s trajectory can be absorbed, successively and cumulatively increasing the radius of the orb, in the reduced limits, of the energy belts (even if discretely). Such photons that coincide with the rotation of the electrons, practically resonate temporarily with the respective electrons while the other photons, non-resonating, have no influence. Such resonance is possible only if the number of events (favourable and non-favourable) is high enough as for the favourable ones to be sufficient. We called favourable those photon incomings that coincide, in phase, with the localization of the electron on the trajectory at a certain time and non-favourable all the rest.

The successive absorption of several photons by the same electron has a small effect at one single leap, but with distinct and concrete meaning: the very little, discrete increase of the energetic level of the electron in its energetic belt (regardless which one);

After a number of successive transitory increases, with very little of the electron’s energetic level, after a pause in which it was not lifted up by another incidental photon, the electron comes back on the basic level but giving out the energy cumulated under the form of an infrared or luminous radiation photon, example: $h\nu = E_4 - E_1$ (the electron vibrating coming back to the base) after it has climbed a few steps interpreted as sub-levels as presented in Figure 4 and the film 26. The vibrating come-back, specific to all excited atoms (as the fall of a rubber ball), it is transmitted to the entire electronic cloud of that particular atom, which it deforms also vibrating (it produces over it a deforming oscillation amortized in time). Even though the laser radiation is coherent, all other aspects that follow the impact of the photons with the material target are non-coherent.

5.2 THE HYPOTHESIS OF THE CUMULATIVE LEAPS

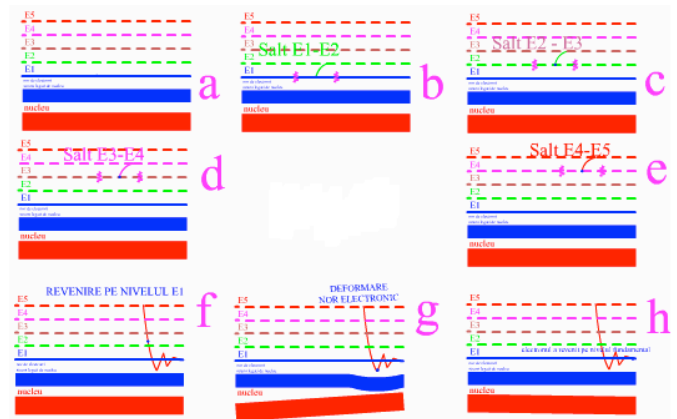


Figure 5. Hypothesis of the cumulative leaps. Capture in Romanian language from modelling software

One can interpret that the electrons found on orbits and which have made successive leaps towards superior energetic sub-levels, under the impact of the incidental photons (in a sufficiently large number) have accomplished a first integration of a part of the beam’s energy under the form of increasing successive leaps (before coming back to the basic level).

5.3 THE PHENOMENOLOGICAL INTERPRETATION OF MELTING BY PHOTONIC RADIATION

Together with the come-back on the fundamental level of the electrons successively lifted up, come-back which has a vibrating character (constituting the emission of the infrared or visible photon locally produced and characterizing the difference of energies in the given example: $h\nu = E_4 - E_1$), the electron gives away to the atom the energy it holds temporarily, vibrating deforming the rest of the atom’s electronic cloud. After a number of vibrate

deformations of the electronic cloud, produced by the leaps and come-backs of the electrons found in its compositions, under the incidence of the crowd of photons of the incidental beam which have produced increasing successive leaps, followed by come-backs on their base levels through falls of a few levels, the electronic cloud holds an induced vibration, which constitutes a second integration.

5.4 THE MELTING WITH PHOTONS

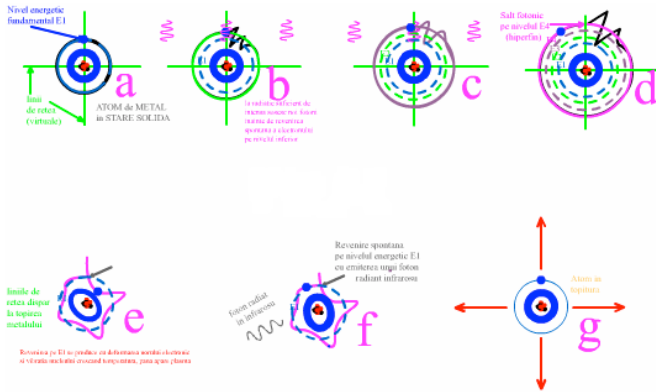


Figure 6. Melting with photons. Capture in Romanian language from modelling software

This second integration has cumulated, according to Figure 5 and the film 25, Film – From photon to plasma, the energy of those electrons, which have been energized by the incidental processing beam’s photons and it is under the form of the electronic cloud’s vibration around an average position, vibration that is called (in literature) optical phonon.

The vibration of the electronic cloud influences the atom’s nucleus (which has a mass two thousand times bigger than the electronic cloud). Practically, the nucleus integrates in time the deformations of the electronic cloud, under the form of its own vibration, of a lower frequency and characterizing the temperature of the material. If the vibration has the amplitude bigger than the sides of the crystal networks, the network structure disappears and the material is considered to be melted or vaporized.

The vibration of the atomic nucleus, by cumulating the energies of the electronic cloud’s deformations around it (done in a high number) constitutes a third integration of the energy received by the material to be processed from the laser photon beam.

6. CONCLUSIONS

Synthetizing, the energy of the laser beam which is focused on the material to be processed is taken by the material in four phases: a) from photons – to the electrons increasingly successively lifted up; b) from the electrons that come back vibrating on the basic level – to the electronic cloud which becomes deformed after several lifted up and then brought back electrons; c) from the electronic cloud – to the atom’s nucleus which vibrates after several deformations of the electronic cloud around it; d) from the singular vibrating atom – to the local crowd of vibrating atoms of the material exposed to the photonic beam, through acoustic phonons and through the thermal agitation of the plasma which is born locally, plasma generated through profound ionizations having as cause the temperature obtained locally through the previous phases and not directly, the photonic radiation, it acting through the intermediates which have become induced phenomena having radiation as cause: 1) lifted up and brought back electrons; 2) optical phonons – as deformations of the electronic clouds – 3) acoustic phonons – as deformations and oscillations that propagate from one place of the crystal network to another – and 4) temperature – as vibration of the atoms’ nucleuses and network’s ions, vibration whose amplitude represents their own local temperature.

7. REFERENCES

1. Mahan, G.D, *Fizica sistemelor cu multe particule*, Editura Tehnică, București,(1993).
2. Marinescu, N.I, Nanu, D., Lăcătuș, E., Popa, I., Marinescu, R., Savastru, R.*Procese de prelucrare cu fascicule și jeturi*. Editura INOE, București, (2000).
3. Nanu, A. (coordonator), *Tratat de tehnologii neconvenționale*, Editura Augusta, Timișoara, (2003).
4. Ursu, I., Mihăilescu, I.N., Prokhorov, A.M., Konov, V.I. *Interacțiunea radiației laser cu metalele*, Editura Academiei,(1986).