# HEISENBERG'S UNCERTAINTIES AND THE SUBMICROSCOPIC CONCEPT. DIFFRACTION OF PHOTONS

11th INTERNATIONAL CONFERENCE
ON SQUEEZED STATES AND UNCERTAINTY RELATIONS,
Olomouc, 22-26 June 2006

Volodymyr Krasnoholovets

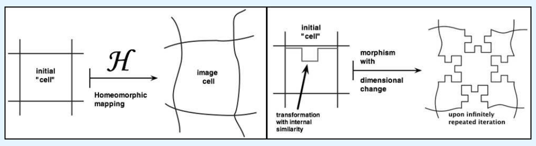
Indra Scientific SA, Brussels, Belgium     e-mail : v_kras@yahoo.com

11th INTERNATIONAL CONFERENCE
ON SQUEEZED STATES AND UNCERTAINTY RELATIONS,
Olomouc, 22-26 June 2006

http://inerton.kiev.ua     http://inerton.org     http://inerton.wikidot.com

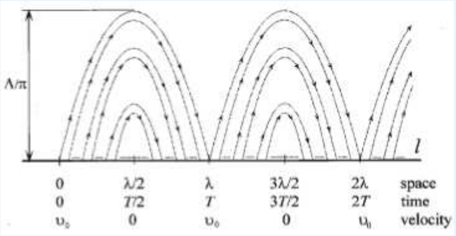
## 1. THE STRUCTURE OF PHYSICAL SPACE [1]. SUBMICROSCOPIC MECHANICS [2]

A physical space is derived from the mathematical space constructed as a mathematical lattice of topological balls. This lattice of balls has been referred to as a ***tessel-lattice***, in which balls are found in a degenerate state and their characteristics are such mathematical parameters as length, surface, volume and fractality.



The size of a ball in the tessel-lattice was associated with the Planck's size $l_{\mathrm{P}} = \sqrt{\hbar G / c^3} \sim 10^{-35}$ m. The removal of degeneracy results in local phase transitions in the tessel-lattice, which creates "solid" physical matter. So matter (mass, charge and canonical particle) is immediately generated by space and has to be described by the same characteristics as the balls from which matter is formed.

A particle appears as a local fractal volumetric deformation in the tessel-lattice, i.e. a fractal volumetric deformation of a cell of the tessel-lattice. Excitations, which move together with the particle in the tessel-lattice, were called ***inertons:*** they transfer fragments of the particle's mass and are responsible for inertial properties of the particle. The amplitude of inerton cloud: $\Lambda = \lambda_{\text{de Br.}} c/\upsilon$ where $\lambda_{\text{de Br.}}$ is the particle's de Broglie wavelength; $c$ and $\upsilon$ are the velocity of light and the particle, respectively. The value of $\Lambda$ in expression (1) determines the amplitude of the particle's inerton cloud, which spreads in transverse directions around the particle; along the particle's path it spreads up to the distance $\lambda_{\text{de Br.}}/2$.



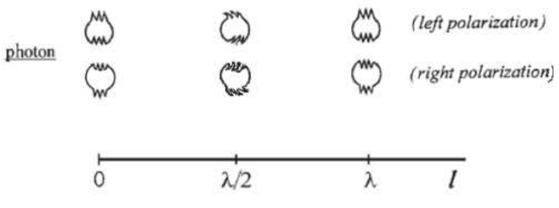
The behaviour of a canonical particle obeys submicroscopic deterministic mechanics [2] developed in the tessel-lattice. Its results in complete agreement with the results predicted by conventional probabilistic quantum mechanics developed on the atomic scale in an abstract phase space.

Acoustic excitations in condensed media, for example, phonons, have also to be surrounded by their inerton clouds.

## 2. THE STRUCTURE OF THE PHOTON [3]

The photon appears as a polarisation state of the surface of the inerton. These two fundamental quasi-particles of space can exist only in the state of motion. We can draw the appropriate picture of the photon as follows: the mass (local deformation) of the migrating photon oscillates, periodically transforming to the state that can be described as the tension of the cell. The geometry of the surface of the photon oscillates between the state of normal needles (electric polarisation) and the state of combed needles (magnetic polarisation).

Profile and streamlines of the irregular wave
The electrical polarisation, when needles are normal to the spherical surface, appears with the interval of $\lambda$. Needles are periodically combed, which physically means the appearance of the magnetic field in the present point. If needles are combed towards the direction of motion of the photon, the photon can be called right-polarised. If needles are combed in the reverse direction of the motion of the



Structure of the photon. The electrical polarisation, when needles are normal to the spherical surface, appears with the interval of $\lambda$. Needles are periodically combed, which physically means the appearance of the magnetic field in the present point. If needles are combed towards the direction of motion of the photon, the photon can be called right-polarised. If needles are combed in the reverse direction of the motion of the photon, the photon can be called left-polarised.

In quantum physics, quanta of light attribute phase and coherence similar to the waves of the classical theory – because de Broglie and Schroedinger showed that particles possess wave properties, namely, particles obey relationships $E = h\nu$ and $\lambda_{\text{de Br.}} = h/(m\upsilon)$ and obey the wave equation for the *Ψ*-function. Thus, the problem of diffraction was resolved by introducing an undetermined notion of "wave-particle". But how to understand this "monster" called the wave-particle duality?

## 3. VERIFICATION OF THE WAVE-PARTICLE DUALITY NOTION

Panarella's review paper

E. Panarella, Nonlinear behavior of light at very low intensities: The "photon clump" model, in *Quantum Uncertainties: Recent and future experiments and interpretations*. Eds.: W. M. Honig, D. W. Kraft and E. Panarella (*Proceedings of NATO, NATO ASI Series, Series B: Physcis* **162**, New York, and London, USA: Plenum, 1987), pp.105-167.

Is dedicated to the experimental testing of the wave-particle duality notion for photons.

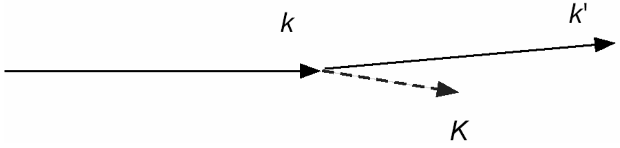
Panarella notes that with a flux (generated by an optical laser) of around $10^{10}$ statistically independent photons/sec in the interferometer, a clear diffraction pattern is recorded on the oscilloscope. At a photon flux of around $10^{8}$ photons/sec, no clear diffraction pattern appears. The further decrease of the intensity shows an increase of nonlinearity in the behaviour of photons. Moreover, a flux in the interferometer of $10^{4}$ photons/sec shows that we deal with a single particle phenomenon – no diffraction at all. Analysing the experiments of previous researchers who dealt with fluxes of only tens of photons per second, Panarella rightly intimated that they were unable unambiguously to determine whether their sources of light produced individual/single photons or the sources produced packets of photons.

Panarella concludes: "The series of experiments reported here on the detection of diffraction patterns from a laser source at different low light intensities confirms the wave nature of collections of photons but tends to dispute it, or not provide a clear proof of it, for single photons".

## 4. INERTONS AS THE REASON FOR THE DIFFRACTION PHENOMENON

Before reaching the target photons pass through the interferometer, which includes a series of details (lenses, mirrors, etc. and a foil(s) with a pinhole), we have to concentrate on some of its peculiarities, because they cause the photons to interfere.

In a transparent substance photons with wave number *k* scatter by the structural non-homogeneities producing non-equilibrium acoustic excitations with wave numbers *K* close to those of photons.



If $\omega$ is the cyclic frequency of an incident photon then the cyclic frequency of the acoustic excitation (phonon) is

$$\Omega \cong \frac{2\upsilon_{\text{sound}}\,\omega n}{c}\sin\frac{\varphi}{2} = 4\pi\frac{\upsilon_{\text{sound}}\,n}{\lambda}\sin\frac{\varphi}{2}$$

where $\lambda$ is the wavelength of the photon, $\upsilon_{\text{sound}}$ is the sound velocity of the substance and $n$ its refraction index. $\varphi$ is the angle between the initial and scattered photons, which can be treated as very small for glass, $\varphi << 1$, and hence the direction of motion of a produced acoustic phonon is practically parallel to that of the photon.

The lifetime of generated acoustic excitations $\tau$ is about $10^{-11}$ s in a metal*) and $10^{-10}$ to $10^{-8}$ s in semiconductors and dielectrics**). This means that in a short time $\tau$, non-equilibrium phonons decay.

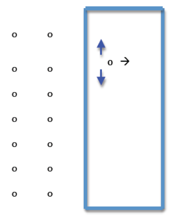
---

*) R. Truell, C. Elbaum, and B. B. Chick, *Ultrasonic methods in solid state physics* (Academy Press, New York, London, 1969), Sections 35-38.

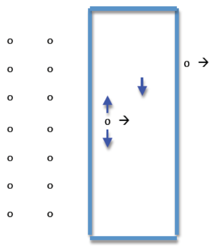
**) J. W. Trucker and V. W. Rampton, *Microwave ultrasonics in solid state physics* (North-Holland Publ.Co., Amsterdam, 1972).
Sh. Tamura, Spontaneous decay rates of LA phonons in quasi-isotropic solids, *Phys. Rev. B* **31**, No. 4, 2574-2577 (1985).
W. E. Born, J. L. Patel, and W. L. Schairch. Transport of phonons into diffusive media, *Phys. Rev. B* **20**, No. 12, 5394-5397 (1979).
*Phonon scattering in condensed matter*, Ed.: W. Eisenmeger, K. Lasman, and S. Dottinger (Springer, Berlin, 1984).

Let us apply submicroscopic mechanics developed for free particles to vibrating atoms as well. This means that in a solid we may use expression $\Lambda = \lambda_{\text{de Br.}} c/\upsilon$ not only for atoms but also for phonons.

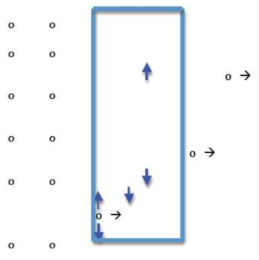
Hence non-equilibrium phonons produced by incident photons have to generate inertons in the environment space. During a short time, the phonons gradually release generated inertons in transverse directions to the phonon's wave vector ***K***. This means that these inertons move almost perpendicular to the beam of photons and hence can tangibly affect the photon trajectories.



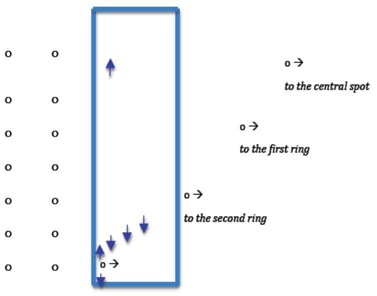
The first photon enters the interferometer. The photon creates the acoustical excitation that in turn generates its cloud of inertons in transverse directions



The first photon leaves the interferometer. The following photon just entered the interferometer; the photon creates the appropriate acoustic excitation, which generates a cloud of inertons, and inertons generated by the previous photon are approaching the path of the second photon.



The two photons have already left the interferometer: the second one has experienced a sideways action through the inertons of the first photon. The third photon just enters the interferometer; it experiences sideways action through inertons generated by the two previous photons (through the respective decayed phonons).



The three photons have already left the interferometer and the fourth photon that has entered the interferometer undergoes sideways action from three flows of inertons generated by the previous photons. The three first photons follow their own trajectories: 1) the first one, which has not been affected by inertons, follows to the centre of the target; 2) the second photon, which was influenced by the first photon (through inertons of the appropriate phonon), is going to form the first ring of the Airy diffraction pattern; 3) the third photon, which underwent the influence of the double flow of inertons (from the two first photons), is deflected to forming the third ring of the Airy pattern, and so on…

The lifetime of non-equilibrium phonons for dielectrics, as mentioned above, varies from $10^{-10}$ s to $10^{-8}$ s. If the inequality $t \geq \tau$ holds, the second photon will arrive to the interferometer at the moment when inertons generated by the first photon will already be absent there. Therefore, the second photon does not experience a transverse action and will continue to follow its path to the central peak on the target. The inequality holds for the case of the lowest intensity of photons, $N_3 \approx 10^4$ photons/sec, namely, $t_3 > \tau$. Hence the mechanism described is capable to account for Panarella's experiments in which the diffraction fringe was absent.

## REFERENCES

[1] M. Bounias and V. Krasnoholovets, Scanning the structure of ill-known spaces: Part 1,2,3. *Kybernetes: The Int. J. Systems and Cybernetics* **32**, no. 7/8, 945-1020 (2003) http://arXiv.org/abs/physics/0211096 http://arXiv.org/abs/physics/0212004 http://arXiv.org/abs/physics/0301049

[2] V. Krasnoholovets, Submicroscopic deterministic quantum mechanics, *Int. J. Computing Anticipatory Systems* **11**, 164-179 (2002) http://arXiv.org/abs/quant-ph/0109012

[3] V. Krasnoholovets, On the theory of the anomalous photoelectric effect stemming from a substructure of matter waves, *Indian Journal of Theoretical Physics* **49**, no. 1, 1-32 (2001) http://arXiv.org/abs/quant-ph/9906091

V. Krasnoholovets, On the notion of the photon, *Ann. Fond. L. de Broglie* **27**, no. 1, 93-100 (2002) http://arXiv.org/abs/quant-ph/0202170

V. Krasnoholovets, On the nature of the electric charge, *Hadronic J. Supplement* **18**, no. 4, pp. 425-456 (2003) http://arXiv.org/abs/physics/0501132