

Trial for Interpretation of Newton's Diffraction Experiments

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Abstract

With combination of Heisenberg's structure of photons, Dirac's interference of photon with itself, Broglie's guidance-field, and Sommerfeld's unconscious proof that the Schrödinger-equation can be a formula of vortex-dynamics, a work-hypothesis for diffraction is formed. With interaction of photons with structure of electromagnetic vortex pairs and its field is tried to establish the diffraction as change of direction as result of hindered returning field according vortex-dynamics. With it Newton's diffraction experiments are explicable and the usual inadmissible and wrong extrapolation on the slit-plane is superfluous.

I. Historical development of diffractions experiments

Newton [1] and Fresnel [2] presented diffraction experiments which Nieke [3] has verified. Newton communicated his measurements also there where he could not explain it. Where Fresnel communicated the measurements, his statements agree with verifications. But exact there where his theory of border-line cases did no more sufficiently fulfil the measurements, he broke off his communications without hint at this deviation. It is not necessary that everyone checks up these experiments over Fresnel's statements but it is sufficient to examine the extrapolation of the well-known formula for outer fringes of slit in large distances to the distance nought or to the slit-plane as inadmissible and wrong. This is discussed by Nieke [3] and results out of Newton [1] III observation 5 and 10.

Newton [1] III observation 10 showed at triangular-slit the transformation from inner to outer (in- and out-side of shadow-limits) diffraction-fringes, which could explain neither Fresnel nor the wave-theory. In short distances inner diffraction-fringes originate which do not obey the presupposed formula of outer diffraction-fringes, but the diffraction with edges as half-plane. Then Newton [1] III observation 5 showed that bent light comes only out of a narrow surroundings of edge. But according above extrapolation bent light should come from the whole slit. These both facts, which could not described by wave-theory, influenced off 1850 textbook authors to conceal Newton's diffraction experiments and to limit diffraction on the both border-line cases: diffraction at half-plane in not to short distances and diffraction at slit with outer fringes in very great distances. So a misleading theory was introduced. This was only possible for Newton and his follower could not establish diffraction with (punctiform) light-particles for Newton's mechanics did not gave a possibility. Nieke [4] to [8] continued Newton's diffraction experiments.

II. Historical foundations of the theory of diffraction

As about 1900 the particle-structure of light was proved, true Newton was given right, for he asserted that light never can be a wave. But nothing in the fact altered that with (punctiform) light-particles, light-quanta or photons diffraction was not to explain. So both, wave and particle, were tried to unit philosophically with help of Hegel's dialectic with thesis -antithesis - synthesis in the dualism of wave and particle.

Supporters of dualism of wave and particle considered the wave resp. the magnitude $|\Psi|^2$ as probability to meet a particle in a volume-element. Born [9] is valued as founder of this interpretation. Bohr [10] and [11] used this interpretation and he carried on the dualism as complementary double-view of reality.

Most of authors, especially modern ones, content with description the dualism of wave and particle as fact. For example here is quoted Feynman [12] (translated): „Newton thought that light consisted out of particles, but then was discovered that it be a wave. However, later was found that in fact light behaved sometimes as a particle. ... In reality it behaved neither the one nor the other. Give we up. We say: It is as neither of both.“

By Broglie [13] the wave as guidance-wave leads the photon corresponding the probability to meet a photon. Already Born [14] corrected guidance-wave in the general term guidance- or leading-field.

The other extreme is the consistent refusal of dualism. The prominentest representative of this group was Einstein [15], who demanded a fusion of wave and particle. In a letter [16] to Schrödinger he wrote (translated): „Heisenberg-Bohr's quieting philosophy- or religion? - is so finely concocted that it delivers to the believers in the meantime a soft resting pillow of that he is not so easily to scare.“

Particulars about the discussion between Einstein and Bohr are reported by Jammer [17] and Bunge [18]. Hund [19] wrote (translated): „However, the foundation of quantum-theory on the dualism of wave and particle is a prejudiced standpoint, and one would be aware of that.“ Already Mach [20] had shown that all diffraction and interference experiments proof only the periodicity of light and not the wave, what is easy to verify.

Feynman [12] was right when he wrote that light is neither wave nor (punctiform) particle. His inference: „Give we up“; however, this is bad. Right were: „We do not give up but try whilst we consider real the complete appearance and not only simple border-line cases“. This is done in this paper.

III. Statements for structure of photons

In the last section was shown that no diffraction was to explain with photons as mass-points. For off about 1960 e.g. by Hofstadter [21] was supposed a structure for elementary-particles so should this be possible for photons and electrons too. For structure of photons are discussed two statements:

a. The linear polarized photon as basis

Heisenberg [22] gave as structure of the linear polarized photon laying side by side fermion and antifermion with opposite spin. Hughston [23] denoted this as twistor-pair and by Broglie [24] the photon is composed out of two half-photons with opposite spin.

b. The circular polarized photon as basis

Christiansen [25], Shewandow [26] and similar already Nowak [27] used the circular polarized photon as basis. The electrical field-vector is rotating perpendicular to propagation-direction with the frequency f , the E-vector describes a screw. By this model for a linear polarized photon has to combine a right- and a left-photon by pairs so that theresultant vector remains in a plane. So Levitt [28] considered the linear polarized photon as double-spiral. Deutsch [29] and Lennan [30] connected this model with rotating charges what among others Canals-Frau [31] discussed. But charges are never shown in a photon.

By the model b with circular polarized photon as basis the transformation of a circular polarized photon e.g. by a quarter-wave-plate in a linear polarized photon is improbable with an added photon. Therefore is favoured the variant a with linear polarized photon as basis. The linear polarized photon has in both models the same structure. By going out from the linear polarized photon as basis, circular polarized light originated by rotation of the whole photon around the propagation-direction.

Hunter a. Wadlinger [32] considered the photon as oscillatory two-divided state of electromagnetic field that is delimited as solitron but they kept the denotation 'wavicle'. Honig [33] used the field of radiation by Hertz but considered only 1/2 period as field of the photon that he marked as toroidal vortex.

For Heisenberg advocated the Copenhagen-interpretation, therefore the indescription in quantum-processes, so he put under his model no descriptive interpretation. Uhlenbeck a. Goudsmith [34] interpreted the spin as angular-momentum. But with rotating rigid bodies the spin could not be calculated rightly, therefore in Heisenberg-Bohr's quantum-theory the spin was considered as a formal spin quantum-number.

Marshall [35] discussed locality and non-locality in optics. With knowledge of Newton's diffraction experiments with localisation of bent light was shown a hint for locality.

IV. Work-hypothesis for a conceptual model of photons

Since Maxwell light has uncontested an electromagnetic field. Since the beginning of our century light consisted uncontestedly of photons and so every photon must have an electromagnetic field. Maxwell's equations demand from variable fields that the rotor of one field-component is equal the temporal change of the other component. From this ensues that always this field has to be a vortex-field. ByHertz [36] from the dipole-field loosen in every half-period a closed electromagnetic field-line from the radiation-field.

For elucidation of these questions are to consult electro- and vortex-dynamics. The best exhibition about vortex-dynamics gave Sommerfeld [37]. He wrote (translated): „It is a very peculiar

dynamics we got to know here. It deviate in decisive points from the dynamic of mass-points. Already the lex prima by Newton is altered here. The isolated, therefore force-free vortex persists in the state of rest. To a uniform rectilinear movement it is only able in union with a second vortex of equal strength and opposite direction of rotation or in influence of a fixed wall. ... Still remarkably is the difference in lex secunda. The outer influence, which goes out from a second vortex, appointed here not the acceleration but the velocity.“ Both vortices move (it is also to say that they reciprocal drive forward) with the velocity v (perpendicular to the vortex-axis) with vortex-strength μ (= half of circulation) and space a of vortices:

$$v = \mu / 2 \pi a. \quad (1)$$

Two vortices of same strength and opposite rotation are named as vortex-pair. Such a vortex-pair has the symmetry of a photon. A rotation to 180° around the propagation-direction yields the same symmetry of a vortex-pair as light by the same direction of polarization.

For the case that vortex-strengths are not equal, Sommerfeld [37] wrote (translated): „Two straight vortex-threads with strength as pleasure describe circles around their common centre of gravity.“ In the case of opposite rotation of vortices the centre of gravity is laying outside of connection-line of single centres of gravity. The sentence of centre of gravity yields:

$$v_1 \mu_1 = v_2 \mu_2, \quad (2)$$

therefore different v_1 and v_2 cause a swinging as change of direction. An asymmetry of vortex-strengths of a (nearly) vortex-pair would cause an alteration of direction according equation (2).

As above reported Heisenberg [22] offered for the model of photon side by side laying fermion and antifermion with opposite spins. If the from Heisenberg advocated indescription in quantum-processes is given up, so results for the photon the structure of a vortex-pair. Helmholtz [38] showed the analogy of vortex- and electro-dynamics what Sommerfeld [39] reported in modern form. In transformation to electromagnetic in vacuum is to consider no friction.

For introduction of vortex-dynamics in Heisenberg's model of photon there is still a farther argument. As above reported, Sommerfeld [36] showed that in vortex-dynamics the outer influence determined velocity and not acceleration. Sommerfeld [40] described as essential difference between classical- and Schrödinger-wave-equation besides factors only the appearance of the first derivation to time in the Schrödinger-equation and the second in classical wave-equation. For that are the classical wave-equation (I.1.5) in [40] with u in right-angled coordinates, a the velocity of phases of light and Δ the Laplace-differential-operator:

$$\Delta u = 1 / a^2 \cdot \delta^2 u / \delta t^2 \quad (3)$$

with

$$\Delta u = \delta^2 u / \delta x^2 + \delta^2 u / \delta y^2 + \delta^2 u / \delta z^2$$

is to compare with the space-temporal wave-equation by Schrödinger (I.6.9a) in [40]

$$\Delta u - 2 m V h^2 u + 2 i m h^{-1} \cdot \delta u / \delta t = 0 \quad (4)$$

at which here the force can have a potential V which can be time dependent, and m as mass.

In connection to this Sommerfeld called attention that (I.1.5) is of the type of swing-equation with acceleration and equation (I.5.9) is of the type of diffusion-equation with velocity.

If still the vortex was marked by the imaginary coordinate so one fulfils the Schrödinger-equation, Ψ to multiply with the conjugate complex value. For the sentence of Sommerfeld [37] (translated): „Only in union with a second vortex of same strength and opposite rotation“, therefore a vortex-pair is formed.

By Sommerfeld [37] was concluded that the context is different between local and temporal alteration of mass-points and vortices.

By Sommerfeld [40] was concluded that the context is different between local and temporal alternation of classical and Schrödinger wave-equation.

Out of the same temporal dependence is to concluded that the Schrödinger-equation can be a formula of vortex-dynamics. This is unequivocal with $V = 0$ in (4). As work-hypothesis ensued the model of photon: The photon has the structure of an electromagnetic vortex-pair. From the photon

goes out running an electromagnetic field above all in front and returned normally to its photon. That was a new formulation of a principle of Huygens'. Hönl, Maue, a. Westphal [41] reported about an in front directed wave as vectorial Huygens'-principle. Einstein [15] demanded a needle-radiation.

For Schrödinger has shown that his equation is equivalent to Heisenberg's matrix, so Heisenberg had performed besides his dissertation unconsciously a contribution for vortex-dynamics.

V. Interpretation of the experiments with photons with structure

From the photon started running an electromagnetic field. The photon forms a source and for the field runs back to its photon it is also a sink for the own field. For field has the effect of a phase so it could exceed or underlie the velocity of light. The field of photon is a part of photon. If field is hindered asymmetrically so that it can not return or only retarded, the photon executed a swinging according equation (2) till it is again symmetrized. As alteration of direction and not as extinction this could correspond to Young's or Huygens-Fresnel's principle. Here the interaction of photon with its field could cause diffraction.

The diffraction at the triangular-slit, reported by Nieke [3], is to describe: Is to the photon, which passed near the edge, only asymmetrical field returned which passed near the edge, so the photon has only information of the near edge and executed that turn or swing which belongs to this disturbance of symmetry. This should give the inner diffraction-fringes of slit which corresponds to the diffraction-figure of half-plane at this edge. If on the farther way parts of field, which passed the other half of slit, returned to the photon so gets the photon information of the whole slit and executes a turn or swing which belongs to the outer diffraction-fringes of slit.

The results in the schlieren-apparatus by Nieke [4] directed to the origin of bent photons, for all photons which are not sufficiently bent are masked by schlieren-diaphragma. In Abbe's schlieren-apparatus the slit is imaged as double-stripes with a dark strip at the places of edges. The breadth of one double-stripe was maximal 0.1 mm and is dependent of the aperture of objective for imaging. In the schlieren-apparatus takes place an imagery of slit with bent light, at which this light is rectilinearly to follow backward. So for shadow-sided bent photons a shadow-sided displacing is to suppose for they can not come from the slit-jaws as shown by Nieke [3], [4] and [5]. This displacing would be conditioned first by hinder of field by the edge and then by returning of field-parts which passed the edge in some distance.

If in diffraction one after another by Nieke [7] the photons were not again symmetrized for not all the field is returned, so the photons react differently on the following diffraction for they react still on missing or returning field of the first diffraction.

At masking of one image in the image of double-slit by Nieke [7] not only returned the field of single slit but also field which passed the other single slit. If the field run a sufficient long way (order dm) between double-slit and imaging optic, then the photon has got information of both slits of double-slit. No more diffraction-fringes of the masked single-slit image are to see but diffraction-fringes of double-slit.

Nieke [8] showed that light has partial a diminishing frequency after diffraction what is demonstrable with small slit-widths. If a part of the field of a photon can not return to the photon, so a diminishing of frequency or energy is self-evident if the field is a part of photon.

Not self-evident shines that in great distances light-side diffracted light behave as the shadow-sided bent light: It run into the same order as shown in the masking-experiments of Nieke [4]. Because the field of photons have passed the whole slit, this symmetry is understandable. This was finally the statement of Young which caused him to Young's principle, even if he supposed falsely that bent light goes out only from edges.

Carnal a. Mlynek [42] reported that also atoms and elementary-particles show diffraction. Because uncontested atoms have a structure so it should be possible to explain diffraction by their structure.

The interference of photon with itself by Dirac [43] should have found an obvious interpretation by interaction of photon with its field. If this field is asymmetrically hindered so can result a deflection and therefore a diffraction. Also the demand of Einstein [15] for a fusion of wave and particle is fulfilled with it.

The capitulation of Feynman [12]: „Give we up“ prolonged only the life-time of the inadmissible and wrong extrapolation and their taking over by Bohr in the Copenhagen interpretation. Not to capitulate brought in this paper a new interpretation of diffraction.

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