Near-Field Optics with Regard to Newton’s Diffraction-Experiments

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Abstract
The phenomenons of diffraction are new built up with regard to Newton's and newly diffraction experiments. By photons with structure and field diffraction is described as change of direction in consequence of interaction of the photon with its asymmetric returning field with use of vortex-dynamics By strong fade out, interaction or origin in smallest particles, can originate photons with an incomplete field. These photons can not interfere with its field and so are not to obey Abbe's formula for resolving power. But every photon completed soon its field and so was near-field optics possible only in shortest distances, as experiments show too.

I. Introduction

In the literature are discussed two methods of near-field optics which should permit a resolution up to nano-meter. 1st: As aperture-SNOM (scanning near-field optical microscopy) with sources of light or objects faded out by small holes, stimulation of fine tips, or detectors of atomic dimension. 2nd: The irradiation of tip-plasma of STM (scanning tunnelling microscope) with laser-radiation. The method 2 is described as more promising. Abbe’s formula gives the limit of resolving power Δs of a microscope to

$$\Delta s = \lambda / A, \quad (1)$$

where A the aperture of microscope and λ the so called wavelength of light. This is founded with diffraction at the object in the microscope. But in near-field optics this resolution should be excelled by orders. For that purpose at first the history of diffraction has to be rolled up at the beginning and first then shall be considered the near-field optics.

II. Historical sight of diffraction by Newton

The first proof of diffraction originated by Grimaldi. From him is known 'Grimaldi's luminous edge' (which covered the light-source). Newton [1] reported extensively in the IIIrd book of his opticks about diffraction. Here is interesting the observation 5 where he proved that bent light comes only out of the near surroundings of edge (order of some 1/100 mm); and observation 10, where he proved at the triangular-slit that in short distances and large slit-widths first originate the inner (within and outside the shadow-limits) diffraction-fringes of slit. The inner fringes correspond to diffraction of half-plane with the edges as half-planes (inside shadow-limits disproportionate diffraction-fringes and outside continuous slope). First in large distances or in small slit-width d originate the outer diffraction-fringes, which are described off about 1850 as sole diffraction-fringes at the slit. At parallel incidence light inner diffraction-fringes of slit are to find in distances

$$e < d^2 / \lambda , \quad (2)$$

in larger distances originate only outer diffraction-fringes. Newton not only asserted but proved with the above termed observations that light never can be a wave, but he could not give a theory of diffraction. With punctiform particles of light, quanta of light or photons Newton's mechanics could not found a deflexion perpendicular to propagation direction.

Fresnel [2] had on the contrary the conception of Huygens and Young that light should be a wave. Also Fresnel placed careful experiments to diffraction, but he communicated they only if they correspond sufficiently to his theory, at slit he restricted the communication of outer diffraction-fringes which originate in large distances. The well known formula for outer diffraction-fringes which is only valid in large distances

$$\sin \alpha = n\, d / \lambda , \quad (3)$$

with n as running term for order of minimum and d as slit-width, was extrapolated to the distance nought, therefore to the slit-plane. From this was concluded: The slit limits a wave-front and every point of this wave-front will be a starting-point of a new sphere-wave. From Newton's observation 10 follows that this extrapolation is inadmissible because in short distances originate inner diffraction-fringes. This extrapolation is wrong too, Newton had already proved with observation 5 for bent light comes only out of the near surroundings of edges, what

Young (false) limited to the edge and also Fresnel confirmed this explicitly in his first paper about diffraction. The acceptation that light is consisting of waves was building up on an inadmissible and wrong extrapolation and all with that placed calculations are only valid formally and sufficiently for large distances.

Already Mach [3] had shown that all diffraction and interference experiments prove only the periodicity of light and not the wave. Periodicity is not only possible in swinging but also in rotation. The here stated phenomena in short distances still have nothing to do with near-field optics, to this are to fulfil particular conditions.

III. Continuation of diffraction experiments

By Nieke [4] Newton's diffraction experiments are continued in a schlieren-apparatus by Abbe which allow to divide bent and not sufficient bent light. Newton's observation 5 and 10 are confirmed and continued. By masking of orders in a schlieren-apparatus could be shown the attachment of their two places in the image of slit (but not within orders). By Nieke [5] Babinet's principle for diffraction-fringes at slit and hindrance are shown inner and outer diffraction-fringes as edge-symmetric exchanged and only in special cases the diffraction-figures are equal. Nieke [6] proved the so called coherence condition as a geometrical condition (angle to light-source less than to interval of diffraction-fringes). Nieke [7] showed that diffractions one after another are distinguished by such with non influenced light. Farther is proved by Nieke [7] that at masking of an image of one slit of a double-slit after intermediate imaging nevertheless appeared the diffraction-figure of double-slit if before the intermediate optic is a distance greater than decimetre. Also the diffraction of half-plane originated by Nieke [5] not directly behind the half-plane but by visible light and parallel incident radiation complete first in distances e off about 50 mm, general off about

$$e > 10^5 \lambda \,. \qquad (4)$$

Smekal demanded a diminution of frequency of photons after a diffraction, what Nieke [8] confirmed experimentally at small slits.

IV. Interpretation of Newton’s and the continued experiments

By Nieke [9] was tried to interpret these experiments. To that was combined: Heisenberg's model of photon (side by side fermion and antifermion), Dirac's interference of photon with itself, Broglie’s guidance-field (not -wave!), and Sommerfeld's unconscious proof of the possibility that Schrödinger-equation can be a formula of vortex-dynamics (Schrödinger's-equation and vortex-dynamics are dependent on first differential-quotient to time). It was concluded that photons have the structure of vortex-pair with returning field. Then diffraction is discussed as change of direction as result of asymmetrically hindered field and the interaction with its photon according vortex-dynamics (theorem of centre of gravity in vortex-dynamics). According to that inner diffraction-fringes of slit originate if only field is returned which passed near the edges. Returns also field to the photon which passed the whole slit, so the photon receives information of the whole slit, and so generate the diffraction-figure of outer diffraction-fringes. Accordingly the inadmissible and wrong extrapolation had respected only a part-aspect, one has not to use the notion light but only field finds backwards to its photon, which passed near the edge, first in large distances. These here in short distances described phenomena are no phenomena of near-field optics, they relate to phenomena in order smaller distances.

The interpretations of diffraction with including Newton s diffraction experiments are to summarize: Light has an electromagnetic field. Light consists of photons, consequently every photon must have an electromagnetic field. The electromagnetic field runs out permanently from the photon and runs normally back to the photon. Is the field asymmetrically hindered, so causes the interaction of photon with its returning field a swinging, therefore a change of direction. At diffraction in narrow slits the loss of field is demonstrable as diminution of frequency.

Then Nieke [9] described the emission of photon as transition of stimulation-energy with a dipole-moment during the life-time ~ 10^{-8} s at visible light as transition of energy of oscillating in electromagnetic vortex-energy as photon. In this time of ~ 10^6 periods the photon is a photon in 'status nascendi’ and no 'virtual photon', and there takes place no quantum jump but the photon is building up in a half-periodic way. There are new statements for interpretation of diffraction which are to respect in near-field optics too.

Well, perhaps somebody would be saying that for a time the wave (and therefore also the dualism) was necessary for interpretation. With punctiform particle of light, quanta of light or photons could be given no other physical possibility. The non-existence of ether especially the missing of drag force did not be sufficient to finish the era of wave. But since about 1960 a structure of elementary particles was acknowledged, however a self-interaction of elementary particle with its field has to become accepted (Chew [10]). But now the wave is superfluous and misleading.

V. Diffraction and quantum theory

Bohr established his quantum-theory on the dualism of wave and particle and exclusive probability in quantum-processes at which diffraction by Fresnel served as model. The proof of wave by Fresnel, so also the wave in dualism, is already marked as an inadmissible and wrong extrapolation. Hund [11] wrote (translated): „However, the foundation of quantum-theory on dualism of wave and particle is a prejudiced point of view, and you should remain aware of this." Newton's observation 5 proves for diffraction that for bent light can be make statements of locality, therefore here are possible exceeded statements above probability. Diffraction is to connect with consideration of Newton's difraction experiments with it are to examine new also the foundations of Copenhagen interpretation.

In his original paper Heisenberg [12] founded his uncertainty relation 1st with commutation relation, error of p and q, and the Compton-effect, 2nd the angle-deflect in diffraction and Brogli's relation, and 3rd corresponding to Dirac-Jordan's theory with the 'value' of matrices at observation in direction of their main-axes.

Heisenberg [13] derived his uncertainty relation out of the 'simplest laws of optics', namely the formula (1) in the form:

$$\sin \alpha \sim d / \lambda \qquad (5)$$

with d = slit-width. With the sign ~ he had respected the breadth of order. Heisenberg described here the diffraction at slit with electrons. By Broglie is $\lambda = h / p$, the alteration of impulse p to screen $p = (h \sin \alpha)/ \lambda$ (the impulse has to deliver up to slit or grating). And with $\Delta q = d$ you will get the well known Heisenberg's uncertainty relation:

$$\Delta p \, \Delta q \sim h \qquad (6)$$

With introduction of the impulse to screen Heisenberg respected formally diffraction and avoided an extrapolation to the distance nought. But simultaneously the validity of formula (1) is carried over on that of formula (6), that is in large distances.

If Heisenberg used on basis of 'Copenhagen's mind of quantum-theory' the dualism of wave and particle, so he had accepted with the wave the inadmissible and wrong extrapolation. But Heisenberg needed this concept of wave for justify the use of Fourier-theorem which he quoted as 'a general mathematic proposition says' with it he could built up a wave-packet of any form, namely every partial monotonous function. For every experimental result is partial monotonous, so Heisenberg thought that to him can happen nothing. With consideration of Newton's diffraction experiments is to deny the wave and thereby loses the use of Fourier-theorem its universal establishment.

Nieke [14] criticized already that a particle with structure is not to mark with two statements as locality and impulse or a pair canonical conjugated variables as Heisenberg's uncertainty relation presupposed. Heisenberg's uncertainty relation should be applicable only to punctiform particles, and such particles do not exist.

For diffraction at grating with light Heisenberg showed reverse that out of uncertainty relation follows the formula of diffraction at grating. For grating results the formula (1) if for minimum at slit is placed maximum at grating and d = grating-constant. For diffraction at grating is to remark: as in section 2 is described, bent light comes only out of a sphere less than 0.1 mm (dependent of aperture) from every edge. At a slit-width less than 0.1 mm overlap the spheres out of bent light is coming or seams to come. In gratings the grating-constant is normally essentially less than 0.1 mm and at so there appears no inner diffraction-fringes.

With this the formula (1) at gratings does not obtain unlimited validity. It is to notice that every photon can only pass one grating-slit and its field also all the others grating-slits. Therefore Abbe's equation and Heisenberg's uncertainty relation get the same limit, namely the extension of photon with its field, what is dependent from the so called wavelength. For interpretation of diffraction general, interference, and also near-field optics, however, the experiments at slit by Newton [1] and the continuations experiments are unconditionally to respect.

VI. Inferences from diffraction for near-field optics

For the in section 1 as aperture-SNOM designated method Raether[15] gave a first introduction, of course with focal point in detection of plasmons. This method used for example Fischer and PohI [16] and reported by Marti and Krausch [17]. Here is still to denote the method of photo-mapping where photo-lacquer is laid on the surface, exposed and scanned later, both with scanning-method with narrow diaphragm, from above or below in thin layers.

To the method aperture-SNOM is to remark that by Nieke [4] shadow-side bent light appear shadow-side displaced (but always less than 0.1 mm), this light seems to come from the slit-yaws. Perhaps already Newton and Young had observed this, but not reported because that seems impossible for them. But to spectroscopicans was known long since that slit-images always are broaden. That now can be established with the shadow-side displace of shadow-side bent light. Already at imagery with 10 mm focus distance by Nieke [4] the effect was essential smaller. How far this effect is noticeable in near-field optics is to test. This effect excluded in any case the use of near-field optics in larger or also in before as short distance denoted distances. For settle of effective diameter of small holes is to compare with Nieke [18].

In the same way is to test if the photons, originated in 'status nascendi', have at once their complete field or if that is building up first on the further way. If this was the case so the origin of photons by fluorescence at tips and small particles makes possible near-field optics.

For the in section 1 as method 2 denoted STM with laser radiation is to accept an interaction of laser-light with the electrons which later cause the tunnel-effect. If light has by Nieke [8] a diminished frequency after passing a narrow slit, so should be accepted this also after interaction with small particles. With electrons already this is known as Compton-effect. The Compton-effect is according to interpret: A photon which hits an electron central or eccentric will be turned as result of impact-process. After this turn only a part of field finds back to the photon, the photon looses so a part of its field, with which it looses energy and according the formula $E = h f$ the frequency f has to be less to preserve stability. The energy of the fieldwhich does not return to its photon, can used for the electron as kinetic energy. In contrary to the photon, the electron is only stable with one (inner) energy. What is demonstrable in Compton-effect with X-rays, should be possible here already with laser-light and can be used in near-field optics.

With the method 2 once are influenced electrons by photons which; cause later the tunnel-effect in the object. Arnold and Krieger [19] or Völker, Krieger and Walter [20] showed that also difference-frequencies are provable (as modulation) in the tunnel-current, if is irradiated with two lasers with different frequencies. Otherwise photons are deflected by electrons of the tip-plasma, generated by fluorescence at tip, plasmons or objects, new generated through the tunnel-current (electro-luminescence), which are pointed out by photo-detectors. This is shown for instance by Berndt u. o. [21], Berndt [22], by Fischer, Döring and Pohl [23] in reflection. Here the energy of radiation has to be sufficient for stimulation. By Dickmann and Jersch [24] materials of tip can be let carry over or off to the object, what by Schimmel and Fuchs [25] is possible also without radiation.

If a photon has lost its field or a part of it so the photon has to form a field continuously new. By Newton [1] the light runs eel-like, by Nieke [6] the photon completed its field on its further way. Huygens' principle was so partially authorized, the photon emits running a field, but the field does not run away but returns if possible to its photon. After interaction with an electron, according Compton-effect, the photon has lost a part of its field, it is a 'nude photon'. However, the photon forms a field renewed which corresponds to its remained energy and new frequency. It is only short-time a nude photon in near-field where it can not interfere with its field because it has not one. The near-field optics presupposes accordingly photons with an incomplete field which can not interfere normally.

The presuppositions for near-field optics can be summarized: The field of photons is not only hindered asymmetrical in return as in diffraction, but in near-field optics the field has to miss whole or partial. Either the field can not return to its photon, it has lost its field, or the field is not yet ready built up. Therefore the photon can not interfere as usual with its field. Possible this is by extreme fade out, interaction at smallest particles like Compton-effect, or by new formation of photons. For photons send out runningly a field, so the photon is building up new its field, the phase of near-field optics is narrowly and temporally limited.

VII. Comparison with the sound-field

Marti a. Krausch [17] compared near-field optics with phenomena in sound where also appear near-field effects which direct to a higher resolution. But between sound and light are fundamental differences. With our present knowledge sound bases in gaseous medium on periodic stimulations but then on impact-processes. The single gas-molecules move locally only little in propagation-direction till it hits the next molecule. At central impact they can pass down their energy, at eccentric impact only a part of energy is delivered and it results a change of direction. These changes of direction feign to do a Huygens' principle and cause at sound a diffraction as deflection. An interference of one molecule with itself in the form of interaction of molecule with ist field not known in sound. At limitation and periodic stimulation result diffractions which are only restrictively comparable with diffraction of light. If sound comes out of a very small source so have in short distance took place only few impacts and deviations from the original direction hardly make a difference, there exists also in sound a near-field with different properties.

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