Diffraction One After Another and with Intermediate Imagery

Helmut Nieke

Abstract

It is experimentally shown that 1st: Diffraction one after another with light of the diffraction-figure of a half-plane shows other results at the following slit than with uninfluenced light. 2nd : If in the image of a double-slit one image of a single slit is masked, so the diffraction-figure shows nevertheless the fringes of double-slit, if the light runs a sufficient long way before the intermediate optic (order decimetre). The photon gets information of the slit that it did not pass itself.

I. Diffraction following one after another

According figure 1 the light source was imaged at a small pinhole-diaphragm. With that a half-plane is parallel illuminated and its diffraction-figure illuminated an oblique standing slit. By this way obtained diffraction-figure was photographically registered. The small pinhole diaphragm D caused that as well the diffraction-figure of half-plane appears sharply as also definite superpositions of both diffraction figures was possible in high.

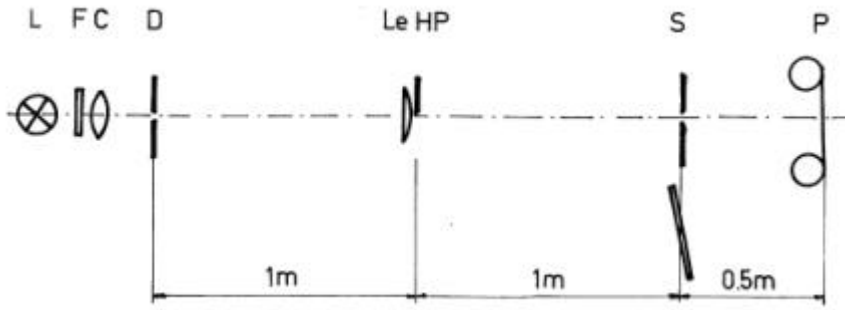


Figure 1. Experimental arrangement for diffraction following one after another. L - light-source, a super-pressure mercury-lamp HBO 100; F -green-filter; C - condenser; D - pinhole-diaphragm, a spinning nozzle 50 µm; Le. - lens f' = 1 m; HP - half-plane, a razor-blade; S - slit 0.3 mm, 10° towards HP oblique; P - photo-film in a miniature-camera without optic.

Figure 2 shows the diffraction-figure as result of two diffraction's following one after another. While the shadow-sided diffraction-figure appears practically normal, the figure light-sided (light- and shadow- seen from the half-plane) is specifically influenced by the superposed diffraction-figure of half-plane. The shadow-sided diffraction-figure of half-plane shows a continuous slope and the light-sided intensity oscillated with light-sided narrower intervals. The resulting diffraction is not modulated only by brightness but the diffraction-figure of half-plane influenced the deflection of light at second diffraction. At top of figure 2 the first maximum of half-plane comes on the oblique standing slit, under them the second and third maximum are still to distinguish incontestably. The modulation of brightness and convex baggy falls together in locality. The serpentine line of the light-sided diffraction-fringes shows that diffraction-angles are dependent on the preceding diffraction.

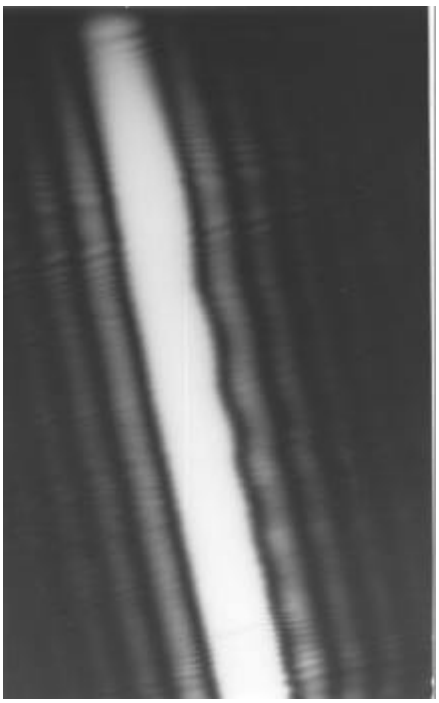


Figure 2. Experimental results with the arrangement of figure 1. The direction of light- and shadow-side is fixed by the half-plane. Enlargement of a negative at which the exposure-time was fitted to the higher orders.

II. Discussion of these experiments

The experiments with diffraction one after another show that bent and not influenced photons behaves differently in following diffraction. By photographically registration are pointed out photons. Generally it is known that the spaces of outer diffraction-fringes grow linear with distance. But this is no case in diffraction-figures of half-plane or inner diffraction-fringes of slit. Fresnel [1] examined the dependence of distance of fringe-spaces in diffraction-figures of half-planes with divergent up to parallel light. He found that spaces of these fringes grow for example in parallel incident light only with the root of distance. Newton [2] III observation 10 and query 3 inferred out of the transition from inner to outer fringes at triangular-slit that light-particles have to move eel-like. Then Nieke [3], [4], and [5] found that shadow-sided bent light has to be shadow-sided displaced for this light seems to come from the slit-jaws. All these observations hint at the fact that after diffraction photons by no means have to run rectilinear, they can run in a crooked curve. If these photons suffer renewed a diffraction, so is comprehend that they do not behave as normal photons.

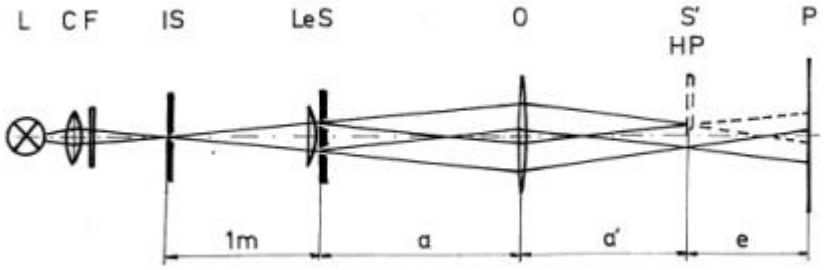


Figure 3. Experimental arrangement for double-slit with intermediate imagery with indicated optical path. L - light-source, a super-pressure mercury-lamp HBO 100; C - condenser; F - green-filter; IS -illumination slit; Le - lens f' 1 m; S - double-slit; O - telescope-objective f'= 60 cm, diameter 10 cm, a best-form lens; S' - the image of the double-slit, HP - half-plane, a razor-blade on a carriage with a micrometer-screw; P - photographic film.

III. Masking of one image of a double-slit

If one slit of a double-slit is masked, so only the diffraction-figure of one slit is visible and no more the diffraction-figure of double-slit. This fact is long known and often discussed. The experiments of this section show results that originated from masking of the image of one slit in the image at an intermediate imagery of double-slit.

The light-source was imaged by a condenser at the illumination-slit accordingly to figure 3, the lens Le caused parallel illumination for double-slit. In the distance a the telescope objective O stood for intermediate imagery. This objective must have a large diameter.

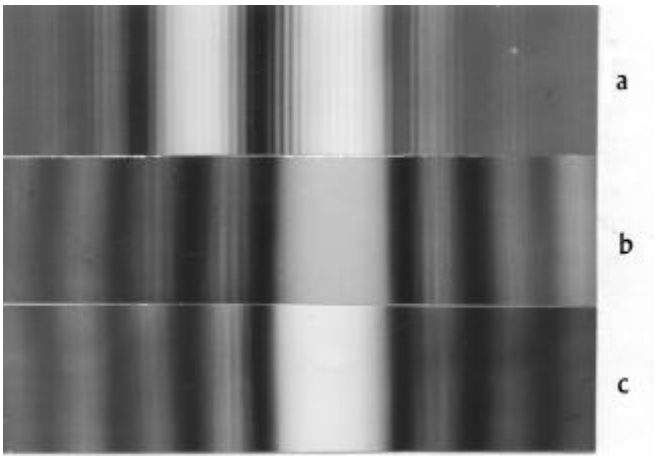


Figure 4. Experimental results of masking one image of the double-slit in the arrangement figure 3. With -a = a' = 1.2 m, e = 1 m, IS - 0.15 mm, S - single slit-width 0.25 mm and 1.5 mm intermediate piece.

a: diffraction-figure of double-slit,
b: one image of single slit masked
c: half-plane HP masked till the middle of both slit images.

It was established that at least the sixth order of the diffraction figure of a single slit has to pass the lens O to get for this case a satisfied image. This objective causes the imagery of the double-slit. At the place of image of double-slit S' was set adjustable a razor-blade with a micrometer-crew on a carriage as masking plane. It is to bring up great care for placing the half-plane exactly in the image plane. Besides with ground-glass focusing can be adjusted to the disappearance of inner fringes by observation with a magnifier with cross-wires.

Whether the focusing is correct one will perceive at pushing forward the half-plane. By correct focusing all fringes of a slit disappear simultaneously and with other adjustment's one after another.

First in figure 4 the scale-ratio was chosen to -1. With a focal-length f' = 0.6 m and -a = a' = 1.2 m was used a relative small double-slit.Figure 4a shows the diffraction-figure of double-slit figure 4 b the diffraction-figure with one masked image of a single slit what is controllable unequivocally in the photo. Figure 4 c shows the diffraction-figure when the half-plane masked up to middle of both slit images. Figure 4 shows the sought effect: Also with masked image of one single slit, the diffraction-figure of the double-slit originated in a satisfactory measure. It is interesting that the spacing of fringes of double-slit in figure 4 b and c do not agree exactly with these in figure 4a.

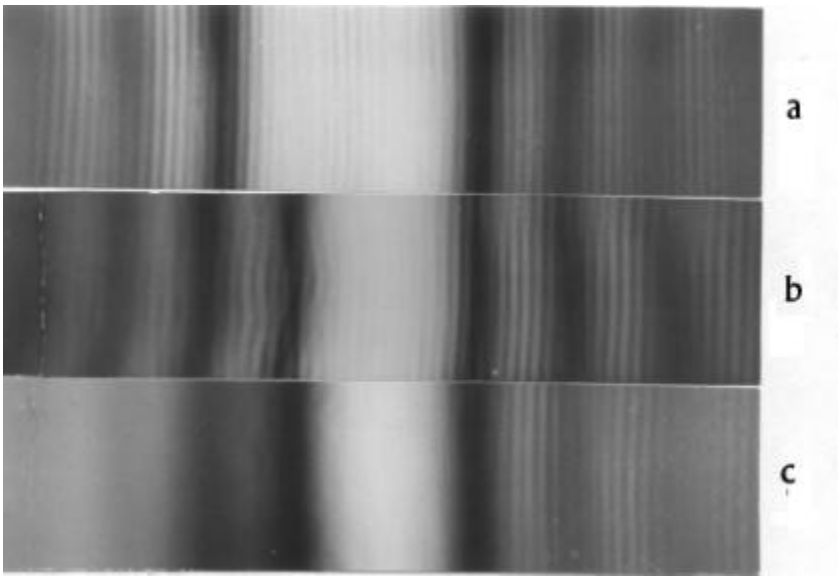


Figure 5. Experimental results of masking one image of the double-slit with a = -8 m, a' = 0.63 m, e = 0.3 m, IS = 0.04 mm, S - double-slit, single slit width 1 mm and 5 mm intermediate piece.
a: diffraction-figure of double-slit,
b: one image of single slit masked,
c: half-plane HP masked till the middle of both slit images.

If the distance a is chosen larger, the results will be more favourable. It is proved that the distance a must be chosen larger, an equal large a' brought not the same effect. Figure 5 a shows the diffraction figure in 8 m distance to the imaging lens. In figure 5 b one single slit image was masked what is here also to control unobjection- ably. In figure 5c the half-plane stood in middle of both slit images. Here is manifested that with a masked image of one single slit the fringes of double-slit are still present.

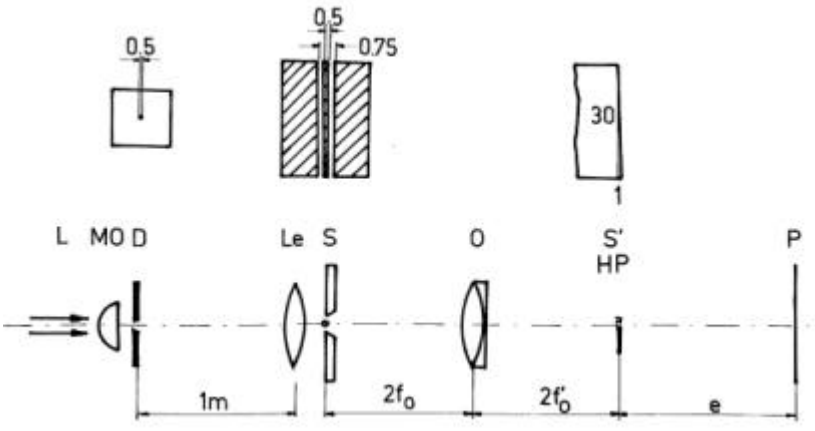


Figure 6. Experimental arrangement for the diffraction experiments at double-slit with intermediate imagery by oblique masked slit image. L - helium-neon laser HNA 188; MO - microscope objective; D - pinhole-diaphragm diameter 50 µm; Le - lens f' = 1 m ; S - double-slit, a precision-slit 0.75 mm open with a axis-steel Ø 0.5 mm as intermediate piece; O - photographic lens with different focal-length; S' - image of the double-slit S; HP - in the plane S' placed half-plane 1 : 30 oblique to S'; P -photo-plate.

A ground-glass placed between light-source and illumination-slit did not change the positive effect, just the mercury lamp could be exchanged by a filament-lamp.

IV. Oblique masking of the image of double-slit

An oblique masking of one image of the double-slit established indeed no unequivocal proof for the sought effect but that permits a review. The half-plane HP stood oblique to the image of the double-slit according to figure 6, so that as well the whole diffraction-figure as that of one slit image appeared simultaneously in plane P at the photoplate. The focal-

length of the photographic lens O was changed, whereby the distance was so varied that intermediate image ensured in the scale - ratio -1 : 1. For intervals in diffraction figures is authoritative the distance from slit, resp. here slit image. If this distance is constant so the diffraction-figures appear with the same intervals without respect of the foregoing intermediate imagery.

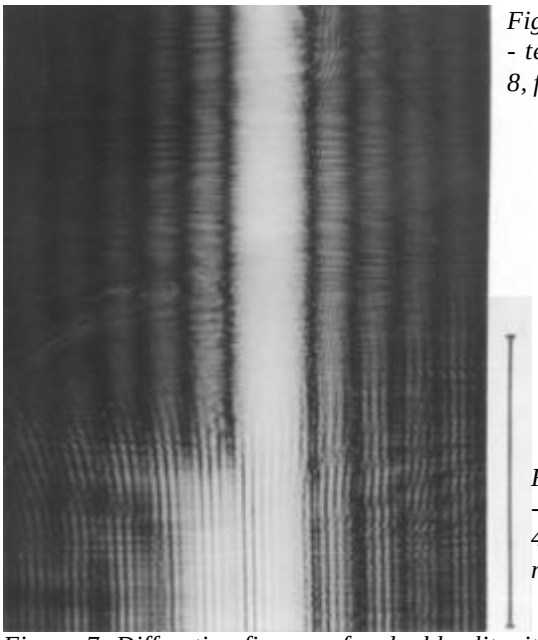


Figure 7a: O - tessar 1 : 2 8, f' = 50 mm,

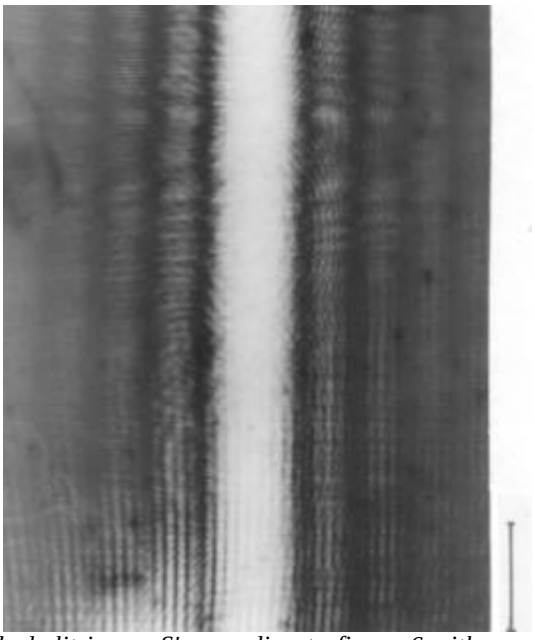
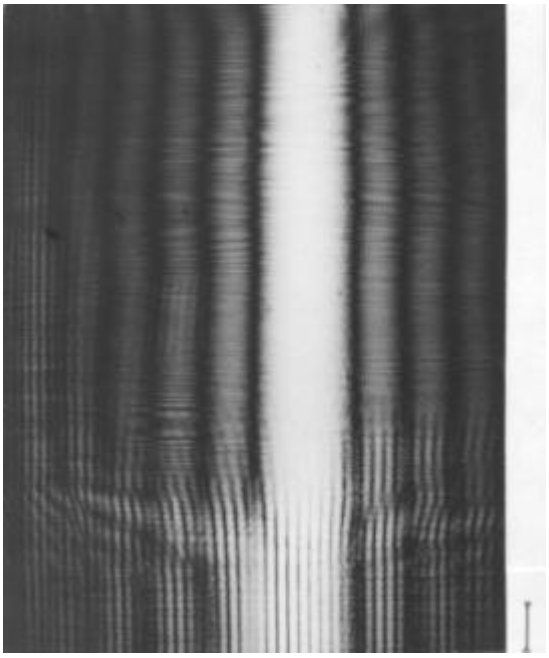


Figure 7b: O - tessar 1 : 4.5, f' = 135 mm,

Figure 7. Diffraction-figures of a double-slit with oblique masked slit image S' according to figure 6 with e = const. = 640 mm, besides every photo is drawn up the relative vertical ratio scale e/f_O.
Figure 7c: O - achromat 1 : 8, f' = 320 mm.



However, for length of fringes and intervals between both zeroth orders of single slits, the image-side focus of lens O is the centre of projection because it was illuminated with parallel light. The scale-ratio for that results in e/f'_O, these values change with variation of focal-length of the photo-lens O.

The below parts of figure 7 a, b, and c show the undisturbed diffraction-figure of the double-slit; the upper parts show the diffraction-figure of one single slit. Between them the result of masking of an increasing part of the image of the double-slit is visible. In figure 7 the distance e was kept constantly and therefore the intervals of fringes appear approximately constant. Thereby the vertical scale-ratio become very differently. The scale-ratio e/f'_O is drawn beside every fig 7 a, b, and c. So the vertical scale-ratio in this figures is proportional 12.8 : 4.75 : 2. With a small focal-length in figure 7 a the diffraction figure of double-slit reaches hardly over the masking-position of one single slit. At larger focal-length it is manifested that especially at higher orders of the diffraction-fringes of single slits the diffraction-figure of double-slit reaches over the masking position of one single slit. In the

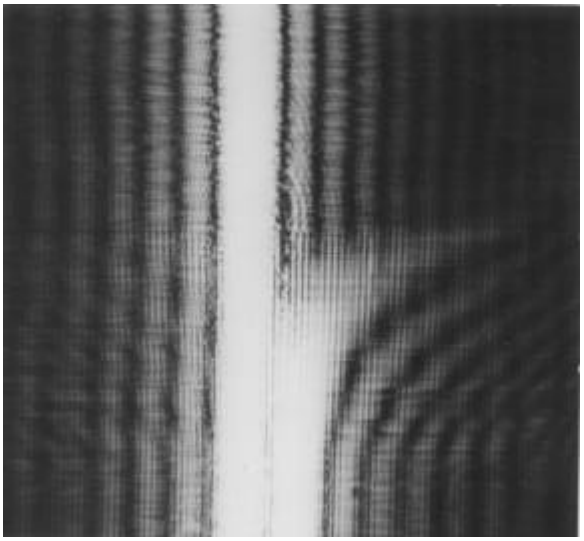


Figure 8a: O - tessar 1: 4.5, f' = 135 mm,

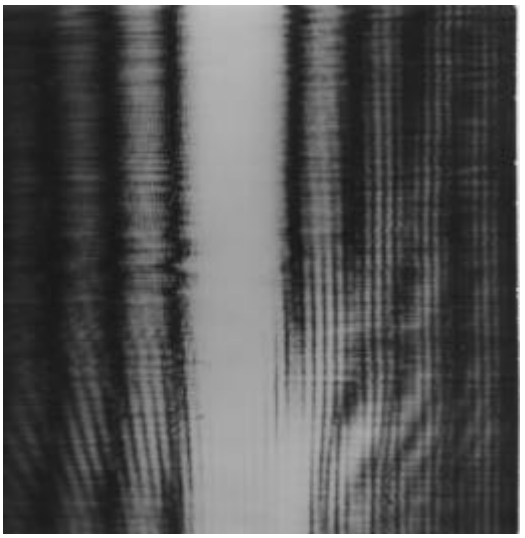


Figure 8 b: O - achromat 1 : 7, f' = 400 mm.

Figure 8. Diffraction-figures of a double-slit with oblique masked slit image S' according to figure 6 with e/f' = constant.

most favourable case the diffraction figure of double-slit reaches nearly that position where the image of second slit is masked too.

It is also possible to hold constant the vertical scale-ratio and in figure 8 is to see that with longer focal-length of intermediate optics and therefore a longer distance a. In figure 8 b the diffraction-figures of double-slit reach over the masking position of one single slit. Here the diffraction figures have different intervals.

Conventional light-sources and lasers gave the same results.

V. Discussion of the experiments with the double-slit

For the wave-hypothesis the diffraction at double-slit was no problem, this was explainable with Young's principle, indeed, at the double-slit this principle was developed above all. When the quantum-nature of light was discovered many discussions were carried on, for a photon can only pass one slit and so at that time they were standing helplessly opposite this interference-figure. Experiments with coincidence-detectors instead observation or photos in double-slit or interference-apparatus result by change of path-length in one path a periodical change of coincidences; consequently no more what is known 150 years ago: The interferences are shifting.

The experiments with masked image of a double-slit show that a photon can receive the information of a slit which it did not pass itself, if the photon runs a sufficient long way from diffraction to the intermediate optic. Here is to think of ideas of Broglie [6] about the photon and its lead- or guidance-wave; nevertheless, wave is to replace by field, what Born [7] already corrected, because wave is too special. The field of photon passes then also the slit which the photon does not pass and return to its photon whereby the photon gets information about the slit which it does not pass itself.

References

[1] A. Fresnel, Oeuvres Complétes I. Paris 1866;
Abhandlungen über die Beugung des Lichtes. Ostwalds Klassiker Nr. 215, Engelmann, Leipzig 1926.

[2] I. Newton, Opticks, or a Treatise of the Reflexions, Refractions Inflexions and Colours of Light. London 1704;
Opera quae exstant omnis, Tom IV, London 1782;
Optics, reprint, Bruxelles 1966;
Optik II + III, Übers. W. Abendroth, Ostwald's Klassiker Nr. 97, Engelmannn, Leipzig 1898;
Neuauflage Bd. 96/97, Vieweg, Braunschweig 1983;
Optique, Trad. J. P. Macat 1787; Bourgois, Paris 1989.

[3] H. Nieke, Newtons Beugungsexperimente und ihre Weiterführung. Halle 1997, Comp. Print 1, Arbeit 1
(vorhanden in vielen Deutschen Universitätsbibliotheken)
Newton’s Diffraction Experiments and their Continuation. Halle 1997, comp. print 3, paper 1
(available in some university libraries)

[4] As [3], paper 2.

[5] As [3], paper 3.

[6] L. de Broglie, La physique quantique restera-t-elle indéterministe? Gauthier-Villars Paris 1953;
Phys. Bl. **19** (1953) 488, 541.

[7] M. Born, Physik im Wandel meiner Zeit. Vieweg, Braunschweig u. Akademie-Verlag, Berlin 1958, S. 35.
Physics in my Generation. Pergamon, London 1959.