Superposition of Interference and Diffraction

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Abstract

In a Mach-Zehender interferometer is shown that the diffraction figure of a half-plane does not superpose with the interference figure of the half-plane undisturbedly. This is reduced because photons of the diffraction figure of half-plane do not go rectilinearly. The same fact is shown with Newton's rings where likewise diffraction and interference do not superpose undisturbedly. Whereas in scattering the superposition could not be examined, it was discussed why the common scattering figure can not originate in an usual interference apparatus

I. Introduction

Nieke [1] showed in diffraction following one after another with the diffraction-figure of half-plane at the following slit, that this caused a changed diffraction-figure. It is near to hand to examine also the superposition of diffraction and interference.

Instruments for interference demand always a beam-splitter. This beam-splitting can be realized with the following arrangements:

a. Reflection - refraction (Newton's rings, Lummer-Gehrcke-plate)
b. Semi-reflecting (for example Michelson's interferometer)
c. Double imagery (tilted mirrors, divided lens)
d. Partial masking with diffraction (slit, double-slit, grating)
e. Scattering (little particles, dusting plate, ground-glass)

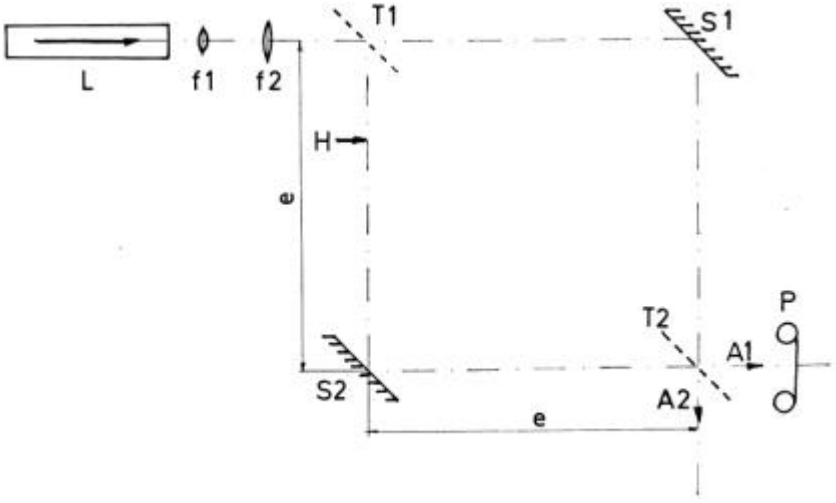

Figure 1: Mach-Zehender Interferometer (Leybold Didaktik). L - He-Ne-laser; f1, f2 - lens for beam-enlarging, parallel setting; T1, T2 -beam-splitters; H - in some photos place of half-plane or scattering-plate; e - distance 16.5 cm; S1, S2 - mirrors; Al, A2 - outlets, as positive and negative; P - corpus of a single-lens miniature-reflex camera.

Without beam-splitting interference is only possible with two mode- and phase-stabilized lasers at which are to set high demands for stabilization.

II. Experiments with diffraction in an interference-apparatus

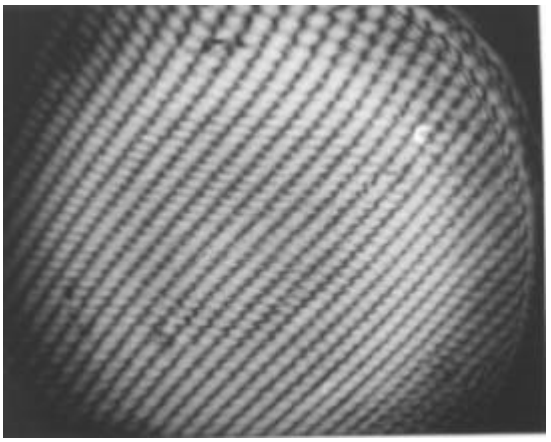

Figure 2. Interference-figure of the interferometer according to figure 1

For this purpose was used a Mach-Zehender interferometer. Michelson's interferometer is unfit for there the same way is running by light there and back and so conditions are complicated. In Mach-Zehender's interferometer by figure 1 diffraction only once ensues in one way and is dividedly to observe. At the place H in figure 1 was brought in a half-plane as at figure 3 and 4.

Figure 2 shows the undisturbed interference-figure of the interferometer accordingly to figure 1. The figure 3 demonstrates the diffraction-figure in one way of interferometer, the other way of light was masked. Figure 4 shows the superposition of diffraction- and interference-figure. As by Nieke [1] the figures exert an influence on another.

With design was used for diffraction a half-

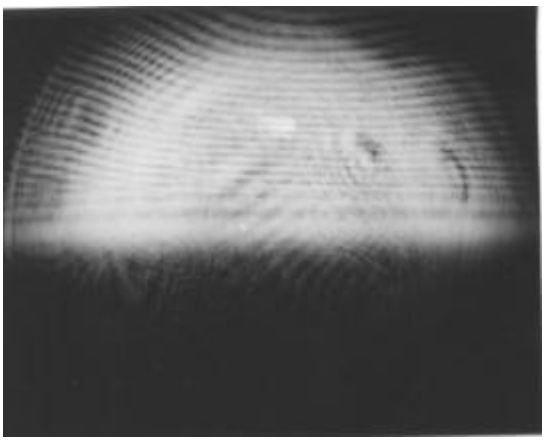

Figure 3. Diffraction-figure of a half-plane in H and masked other way of light.

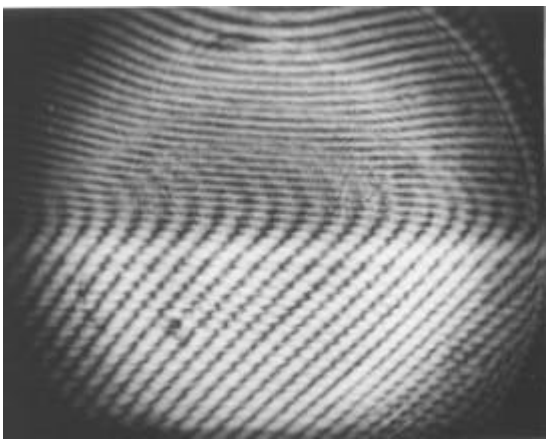

Figure 4. Superposition of diffraction and interference.

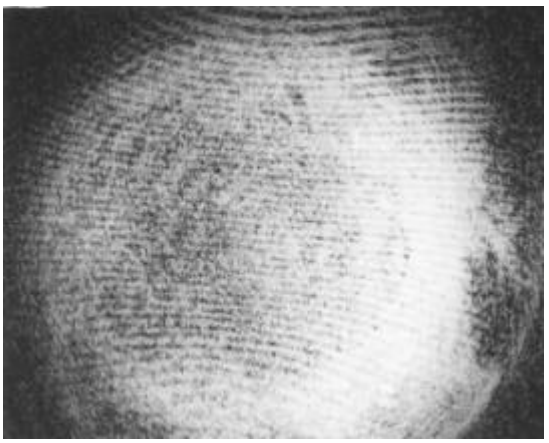

Figure 5. Undisturbed interference-figure with a limpid object-plane in H of figure 1, new adjusted

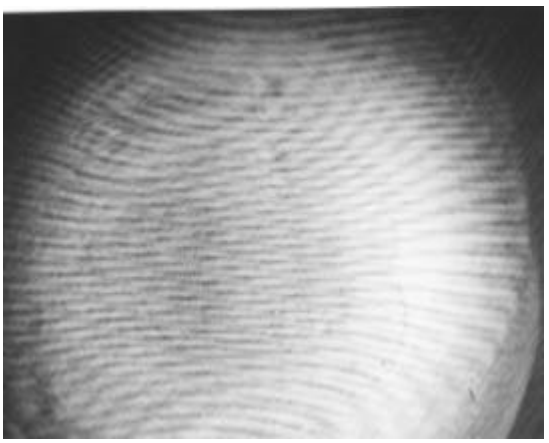

Figure 6. Scattering-figure with spores of ground-pine on an object plane in H, the other way of light was masked.

plane, for already Fresnel [2] found that for example in parallel illumination the (unequal) intervals of diffraction-fringes only increase proportional to root of distance. Bent photons can not run rectilinearly and so it is to expect a disturbed superposition.

III. Experiments with scattering in a interference apparatus

Honig [3] reported about a performance which Martini delivered on a congress. He reported about the insertion of a transparent plast-disk in one way of an interferometer and then of different behaviour in smallest intensity if the disk rotated. With a photon-counter he maintained to have shown a non-linear behaviour at smallest intensities.

Figure 7. Whole-result with scattering-figure superposed of interference-figure.

Figure 8. As figure 7, but the object-plane with spores of ground-pine moved additionally.

Indeed, here only the influence of scattering on the figure of interference is interesting. But already Nieke [5] critiqued non-linearity of photon-counting as unreliable, for the used absorption-filter could alter the interference angle-condition by scattering.

Nieke [4] had shown that the appearances of stripes at Mach's rotating disk are a physical phenomenon. He discussed this as diffraction at rotating edges.

It was ascertained that an insertion of a transparent plast-disk or a ground-glass in one way of interference-apparatus originates nomore interferences (what not excluded a counting of photons). For this examination was chosen an arrangement with a smaller scattering, as usual was used an object-plate covered with spores of ground pine (lycopodium). This plate was brought in a way of

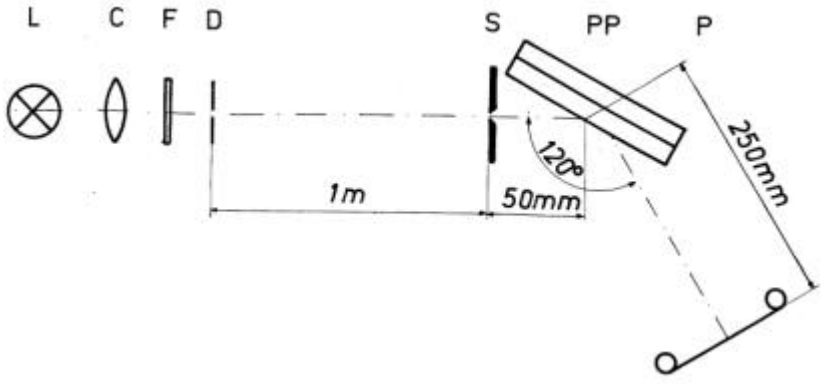

Figure 9. Experimental arrangement for examination of Newton's rings with illumination of diffraction-rings in reflection-position. L -light-source, a mercury-super-pressure lamp HBO 100; C - condenser; F - green-filter; D - circular-opening ~ 0.1 mm; S - variable slit; PP - plane-parallel plates that show Newton's rings; P - photo-film.

interferometer at the place H of figure 1. Figure 5 showed the undisturbed interference-figure in the aperture figure 1, where the limpid part of object-plate was standing in the way of light path. In figure 6 the resting object-plate was covered with spores of ground-pin and the other way of light was masked, thus only scattering is shown. The figure 7 shows

the whole result, both ways are open. There are to see only points of spores. In figure 8 the plate with spores of ground-pine was moved additionally.

IV. Experiments with diffraction and Newton's rings

In a schlieren-apparatus according Abbe, as used by Nieke [6], a plate-pair, which shows Newton's rings as well in transmission as in reflection, shows behind the schlieren-diaphragm neither a noticeable brightens nor an interference-figure. The same result was to show with Köster's double-prism. Out of these experiments is to conclude that by experiments of equal thickness ensued no demonstrable change of direction.

At ready mounted pairs of plates for demonstration of Newton's rings is to test whether the inside surfaces are bedewed with an immersion medium. With that the black spot can be demonstrated with plates of moderate quality but this disturbs in schlieren-apparatus.

Figure 9 shows the arrangement: two plates, showing Newton's rings, were illuminated with the diffraction figure of a wide slit, causing at this distances inner fringes. Figure 10 shows a clutter of the diffraction- and interference-figure, Newton's rings run in the photo from left below to right above and they show disturbed superposition at spots where minima of diffraction and minima of Newton's rings meet another. These places in figure 10 are marked by arrows. An illumination with outer fringes (narrow slit) shows not this appearance.

V. Discussion of this interference experiments

If one asks the question: „Where remains the light when the one outlet of an interference-apparatus appears dark?“ So is to remark: In Newton’s rings or in Mach-Zehender's interferometer are always one way bright, if the other is dark (reflection-transmission). The ways A1 and A2 of figure 1 are like negative and positive. The light is not vanished or has extinguished itself but the photon took one way, the field both ways. On the second beam-splitter (2 outlets!) ever the difference of phase of photon and field decided which way the photon has to take. At Michelson's interferometer is to remark that the second way is reflected return to the light-source.

Newton [8] described interferences of his rings that light-particles have 'fits' (real fit and no

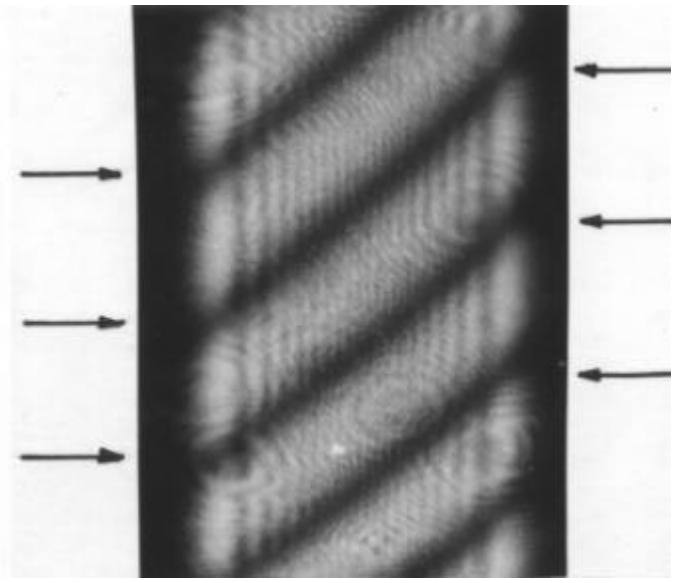

Figure 10. Parts of Newton's rings after Figure 9, illuminated with a slit-width of S with 2 mm. Arrows - cf. text.

caprice) lat. 'vices' as periodical changing disposition of reflection and refraction. It is light to verify that the Mach-Zehender interferometer is an apart pulled plate-pair for Newton's plate-pair. By Broglie - wave replaced through field - diffraction can be interpreted as inter-action of photon with its field corresponding difference of way-length of photon and field. As by Broglie [9] the photon can only use one way the field all possible ways.

In addition to diffraction by change of direction of photons, unconditionally there has to be the already by Newton demanded effect of periodical influence of reflection and refraction in interference without change of direction, indifferent if this is instantaneous explicable or not.

If arrangements with interferences of equal thickness show interferences and no deflexions of photons are demonstrable, so remains as only possibility the change of parts of reflection and refraction by periodical quality of photon and field. The 'fits' did not were a hypothesis nor an attempt of explanation but a description of the fact, that interferences of equal thickness appear without deflexion. Already Mach [10] showed that interference proves the periodicity of light and not the wave.

The interference-figure of Newton's rings remains catching up directly behind the plates as also in large distances, it changes similarly in convergent or divergent bundle of rays, the sharpest imagery is to obtain by setting on the last beam-splitter. The diffraction-figure of a slit is also to catch up, but in a schlieren-apparatus it shows defined lighten, that is a change of direction, as well diffraction-figures have not to be similar (cf. Nieke [7] with inner and outer fringes).

VI. Discussion of scattering experiments

For scattering at irregular particles usually used spores of ground-pine as for example Pohl [11] described with dusty mirror and irregular circular-openings. The there described scattering-figures are only visible if a small plane is illuminated and this is project on a large plane. In an usual interference-apparatus this scattering-figure is not to obtain, but only as in figure 6 scatter-particle are to see as points. Well, interferences are to show also in divergent light but this demand a special greater apparatus where light is lead convergent to H and then off H with scatter-plate divergent. This could be attempt.

Then is to quote Laue [12] who reported at irregularly arranged scattering-particle about a refuse of classical wave-theory.
He reported also about radial fringes that do not correspond to the theory, also Nieke [6] found star-like scattering-fringes. Laue[13] wrote (translated): „... for experiment and theory on this place are passed without took cognizance each other.“ In this paper he put against one another without to give a solution.

According Laue the so called wave-optics failed in scattering-figures but wave-optics failed also in Newton's diffraction experiments (Nieke [6] and [14]). With Fourier's theorem every piecemeal monotonous function is to perform approximately, so Fresnel could give solutions for specific cases. In case of need with help of an arbitrarily introduced phase-jump only because deviation of wave-theory with experimental results. Laue [12] wrote (translated): „We see in this a refute of classical wave-theory, which has proved true at all interference- and diffraction-appearances so excellently.“ Here Laue respected only the formal mathematical application of Fourier-theorem and not Newton's diffraction experiments ([8] book III observation 5 and 10 and Nieke [14]). Here Laue is nowhere quoted, exact so like Laue [15] did not quoted in his hand-hook article about diffraction Newton's diffraction experiments.

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