Cordus Conjecture: Part 1.3 Explanation of fringes

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Abstract

The cordus concept is shown to be able to explain wave behaviour in gaps, and fringes in the double slit device. This is useful because one of the enigmas of the double-slit device is that single photons form fringe patterns. Cordus explains fringes in terms of force lines called hyperfine fibrils (hyff) and their interaction with the edges of the light path. This also explains beam divergence and near-field effects. The results show that it is conceptually possible to create a solution for fringes based on a particuloid interpretation of light, without using the concept of interference. The biggest difference between Wave theory and the cordus explanation is their interpretation of the mechanism for fringes. Wave theory explains fringes as 'interference': two separate waves of light differing by full (half) fractions of wavelengths and thus constructively (destructively) interfering. From the Cordus perspective photons do not actually interfere or add together, and 'interference' is only a convenient analogy. The Cordus explanation is that fringes are caused instead by interaction of the photon hyff with opaque edges. This bracket of papers therefore offers a resolution of wave-particle duality by anticipating the internal cordus structure of the photon and the associated cordus mechanics. From this perspective wave and particle behaviours are simply the different output behaviours that the internal system shows depending on how it is measured. Thus Cordus offers a deeper mechanics that subsumes both quantum mechanics and wave theory. Surprisingly, Cordus suggests that the next deeper level of reality is deterministic.

Keywords: wave-particle duality; wave theory; quantum mechanics; double slit; fringe; interference
Revision 1

1 Introduction

One of the enigmas of the double-slit device is that single photons form fringe patterns, given enough of them. That light waves should do so is expected, but the puzzling part is what makes individual photons do so given that the usual mechanism of interference is unavailable.

In this paper the cordus concept is expanded to explain wave behaviour in gaps, and fringes in the double slit device. This paper is part 3 in a bracket of three. The first part describes the fundamental cordus concepts. i.e. the

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proposed internal structure of the photon. The second part solves the apparent path-dilemmas in the double-slit device, and also interferometers.

2 Wave theory explanation of interference

The Wave theory explanation is that the fringes, e.g. in a gap, form due to interference based on phase difference along different optical paths:

- each point on the surviving wave-front after the obstacle becomes a point source and radiates its own secondary wave
- these points are separated in space
- the distances from central and edge points to the screen is therefore different
- this difference will be a full (half) wavelength at some locations on the screen and therefore cause constructive (destructive) interference there
- Consequently the secondary waves interfere to produce lighter and darker regions.

The explanation rests on frequency and phase shifts arising from geometric path differences.

Limitations in Wave Theory

Optical Wave theory sufficiently explains the behaviour of beams of light. However it does not explain why multiple separate single photons should also form fringes. Also, the concept of 'destructive interference' is difficult to reconcile from an energy perspective. How do two photons destroy each other and leave no residue? With water waves, the peak of one wave A can be higher where that of B is lower. Peak A is above the mean water level and therefore has positive potential energy, whereas peak B has negative. When they meet, the energy excess in A exactly balances the deficit in B and a flat piece of water results. No energy is lost: the mean water height is the same.

Destructive interference in light is usually explained similarly, by the electric fields cancelling. That of course does not explain the observed interference of individual photons that were never in the same place at the same time. Furthermore, the wave explanation suggests that the effect should be seen more often, but the reality is that photons do not observably interfere with each other, despite their vast quantity in the world.

Existing attempts at reconciling wave and particle behaviour have tended to preserve Wave theory and make the particle behave like a wave by 'interfering' with itself through a 'virtual' particle. The virtual particle is not detectable and therefore metaphysical, and this is where weirdness arises.

What is frequency?

Frequency is a core mechanism in the Wave theory description of fringes. It is strange that wave theory is so highly dependent on the concept of frequency, yet cannot explain how frequency arises. In other wave phenomena such as water waves, the frequency corresponds to a physical motion of water molecules. What is the comparable phenomenon in light? The standard wave theory answer is that it is the frequency of oscillation of the electric and magnetic fields. However this is not entirely satisfactory as it still does not answer the question, nor explain why the fields reverse polarity.

Another paradox with wave theory is that many phenomena in optics are dependent on the wavelength λ, but the dimensions of the experiment are in the transverse direction. For example, the presence and strength of fringes depend on the diameter of the aperture or width of the gap. This is curious, because wavelength is an axial dimension, whereas gap width is transverse geometry, i.e. the two measurements are perpendicular. If anything one would expect amplitude to be involved since it is a transverse measurement. Strangely, amplitude does not feature in the wave theory descriptors of optical effects, but wavelength does.

Nor can the particle view explain frequency: it hardly even needs the concept, other than as a measure of energy. Thus neither wave nor particle perspectives explain the mystery of Frequency. Consequently, a model that bridges the wave-particle duality and invokes internal variables will inevitably have to reconceptualise 'frequency'.

3 Cordus solution

The Cordus approach developed up to here can make sense of the photon path dilemmas, but not of the fringes. The next lemmas show how it can be extended to solve this, by proposing internal variables for the photon. A companion paper (ref. 'Cordus matter') shows why Bell's theorem is not a constraint.

Lemma L.4 Internal and external variables of the photon

This lemma asserts that the cordus has internal physical variables, that manifest as variables that can be measured (external variables).

L.4.1 The orientation of the cordus is variable.

L.4.1.1 The cordus may be inclined in pitch, roll, and yaw around the optical centre line of the photon path.

L.4.1.2 The cordus may rotate around the optical centre line.

L.4.1.3 The above internal variables manifest externally as polarisation states (V.1.2). For example Circular polarisation is a transverse cordus with roll angular velocity, and is therefore handed.

L.4.2 The cordus vibrates, or oscillates.

L.4.2.1 This corresponds to the frequency of the photon and its energy (V.1.1).

L.4.2.2 The nature of the vibration is left temporarily unspecified: oscillation or rotation motion; vibration of the fibril in radial or axial displacement; reciprocation of parts. Refer

C.1, in part 1.1 where the dashed lines in Figure 2 represent the frequency component. See also lemma 9.

L.4.2.3 This vibration generates electromagnetic fields (V.1.3), though the mechanism is left unspecified at this point.

This provides a physical mechanism for frequency among other external variables of the photon. Though vague, it is nonetheless sufficient to proceed, and is further developed later.

The explanation of fringes also needs a mechanism to explain the width of the cordus, and how it is affected by frequency, hence the next lemma.

Lemma L.5 Span length

The distance between the reactive ends (Span) may vary.

L.5.1 The Span is plastic. It may be stretched or shrunk. (Nothing yet suggests it has elastic recoil).

L.5.2 The Span may be changed by the external optical environment, e.g. by sending the reactive ends along different paths. When thus forced by the environment, the Span may be large: at least of the order of metres. In other situations the Span may be small.

L.5.3 For newly created and unconstrained photons the natural tendency is for the Span to be small and inversely related to the frequency. The greater the frequency the shorter the Span. Thus shorter wavelengths have shorter spans.

L.5.4 The Span varies randomly by quantum amounts.

L.5.4.1 For convenience it is assumed that the Span can take one of only three changed states: increase, stay the same, or decrease.

L.5.4.2 The size of the quantum increment/decrement (delta) is related to the frequency of the photon. Delta span is inversely proportional to frequency: high frequency photons (short wavelength) have smaller spans (L.5.3) and smaller delta span.

L.5.4.3 The changes in Span length do not affect the polarisation or energy of the photon.

L.5.4.4 The mechanism for span fluctuation is not specified. The present working model tentatively assumes it is the resistance to growth of the hyff (see later).

L.5.5 The change in Span occurs at the same time as the frequency oscillations i.e. synchronised.

L.5.6 Span changes apply symmetrically.

From the Cordus perspective span and frequency are the main variables for optical fringe effects. Wavelength is thus a proxy variable for frequency and velocity.

4 Wave behaviour in single gaps: diffraction

Diffraction can mean several things, but here refers to the spreading of a light wave (i.e. breaking into pieces) through a single optical path, (e.g. a single slit, aperture, or round the edge of an object), with subsequent fringes.

A single slit will cause diffraction; which appears as a central region of high intensity, with fringes to each side. The observed reality is that narrower gaps produce fewer but more pronounced fringes. The distance from the gap to the screen (far field) needs to be many wavelengths, which implies that the angular effect is small and in need of magnification.

In searching for a candidate theory for quantum frequency, we noted that the fringe pattern is independent of the thickness of the opaque barrier: thin and thick layers are equally effective. This suggests that the diffraction effect is governed not by the depth or composition of the material but simply by the existence of an opaque 2D frontal-plane. If so, this means that the angular deflection of the photon (diffraction) occurs at the 2D surface, not in the bulk of the barrier. However there are two problems: First, the individual photon does not have an obvious mechanism to create its own angular deflection: common sense has it that it either passes cleanly through the gap, or slams into the barrier and is no more. If it does not touch the barrier, how can it be affected by it? Secondly, there is no obvious mechanism to break the angular deflection into angular quanta and hence fringes. This is where the electromagnetic field is recruited as a ranged-variable, consistent with the *passing observation*.

Lemma L.6 Cordus hyff for the photon

This lemma accepts the L.1 conjecture that reciprocal motion of some type occurs, corresponding to frequency, and then couples the frequency to the electromagnetic field, as follows:

L.6.1 The energy in the cordus oscillates from one reactive end to the other, at a rate given by the frequency.

L.6.2 The oscillation causes structural transience: the reactive ends deconstruct and reconstruct. The energy is shuttled between them by the fibril. That central fibril is a permanent feature of the cordus in flight, unlike the transient hyff (see below).

L.6.3 The reactive end has a dynamic electromagnetic (EM) field around it. For simplicity consider primarily the electric field here. The field is transient and linked to the frequency.

L.6.4 The field is made of hyperfine fibrils (hyff) that extend like hairy fluff from the reactive end, and these carry the EM field and force. The hyperfine fibrils collapse and grow as the reactive ends deconstruct and reconstruct (C.1.5 and C.1.6 hyff photon model).[4] Thus the electric field is emitted and then retracted.

L.6.5 A hyff is attached at one end to a reactive end, and extends outwards from that base. It can make a temporary bond to other matter, in which case it exerts a tensile or repulsive force, or pumps energy into/out of the photon.

[4] The number of hyff per photon does not need to be specified here. A companion paper (Cordus Optics) suggests that the photon probably has only one hyff at each reactive end, in the radial direction.

L.6.6 A hyff exerts a transient force linked to the frequency. The oscillation of energy along the cordus results in the extension of hyff followed by their withdrawal, and the collapse of any force. This also accommodates the reversal in the observed field.

L.6.7 A hyperfine fibril that engages with matter can exert force on the photon without necessarily terminating the photon.

L.6.8 The trajectory and dynamic properties of the photon can be influenced by interaction with matter at a distance, the hyff being the coupling mechanism. This corresponds to *passing* observation, i.e. such observation affects the dynamic properties of the photon through the coupling.

L.6.9 The photon hyff have a range which is potentially infinite but practically not, as they have decreasing chance of being in the outer range, see also L.6.16. The range of the hyff is not the frequency. Instead frequency is the refresh-rate of the fibril and hyff.

L.6.10 The hyff have stepped (quantum) force increments. The mechanism for this is not certain. One candidate is that the hyff extend stepwise outwards, and another is that the hyff force itself is quantised. Another is that it is simply the number of hyff renewal pulses (hyffons, see 'Cordus in extremis') that manage to get an engagement with the edge in passing. This is an open question. Nonetheless the assumption is that the frequency state of the hyff at the RE at the time of engagement with the gap determines the force.

L.6.11 Higher frequency gives finer force increments.

L.6.12 The force exerted by a hyff is greater at shorter ranges.

L.6.13 The timing of the frequency events for the two reactive ends is not prescribed here. It could be alternate (the current working model), simultaneous, or the general case of disjoint (variable phase difference between ends).

L.6.14 Taking these assumptions together, the force exerted by an anchored hyff comes in quanta that are stronger at shorter range. The force corresponds to the angular deflection of the reactive end, or retardation (phase delay). The force may be attractive or repulsive.

L.6.15 The communication across the fibril is practically instantaneous.

L.6.16 The growth of the electromagnetic hyff (e-hyff) is at the speed of light in the medium. (This may also imply that higher frequency photons have shorter-range hyff).

L.6.17 The reactive ends fade in and out of existence at the ends of the span. The 'particle' nature is in the reactive ends, and in turn these exist as hyff.

It may be convenient to think of photon hyff as equivalent to fields, e.g. the evanescent field, or oscillating electric dipoles. The hyff also replace the concept of virtual particles in QM. At the same time it provides a simple means to explain frequency, which is otherwise a problematic concept for both wave and particle perspectives. In a companion paper the hyff concept is used to explain fields more generally, e.g. how a charged particle exerts a force at a distance.

Explanation of gap fringes

The Cordus explanation for diffraction in *gaps* is that the photon cordus is diffracted (bent) by set angular amounts, by its interaction with the opaque material surrounding the gap. The hyff become engaged with the (thin) surface opaque material and thus exert a quantised force that retards the one reactive end and bends its trajectory, causing fringes at set intervals. The other reactive end is not affected as much (unless it is close to its own wall) as the span is plastic.

However that is not the whole story: if only one reactive end of a cordus goes on a bent trajectory, then the other straight-ahead reactive end will always ground on the back-plane first, because it is the shorter path, see point D' in Figure 1.

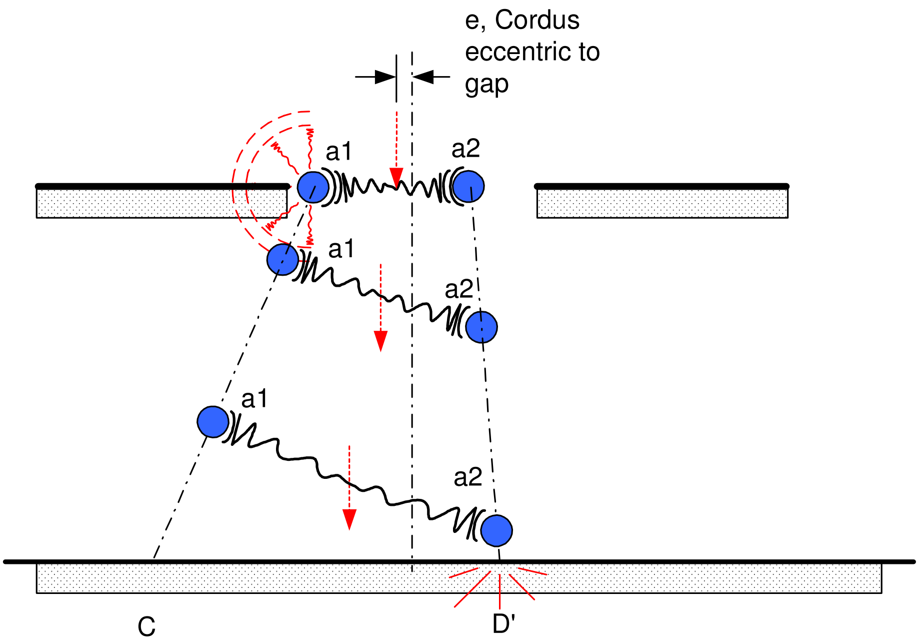

Figure 1: Path of eccentric cordus through a gap. The grazing reactive end is delayed and angularly deflected more than the medial RE which is further from its edge.

For fringes in gaps it is important that the cordus is delayed equally at *both* reactive ends. This requires that the incident photon be concentric with the gap, so that its reactive ends are equidistant from the gap edges, and both are delayed the same. This stretches the span to form symmetrical fringes, see E and E' in Figure 2. The figure shows a simultaneous frequency model (L.6.13), though it is presumed that the effect would also operate for the more general case of disjoint frequency providing that the frequency was sufficiently high that both reactive ends had an opportunity to sense the edge.

Ironically, non-concentric photons ground closer to the centreline of the gap than concentric photons. So any deviations cause central rather than peripheral loading. This is consistent with the observation that the central fringe is wider and brighter than those further out.

Those cordi with span such that a reactive end closely grazes the edge will have greater hyff force, and therefore be bent more. Cordi that are far from the edge of the gap will be bent only a little. Thus multiple photons sent through the gap will bend differently depending on their location relative to the wall, blurring the fringes.

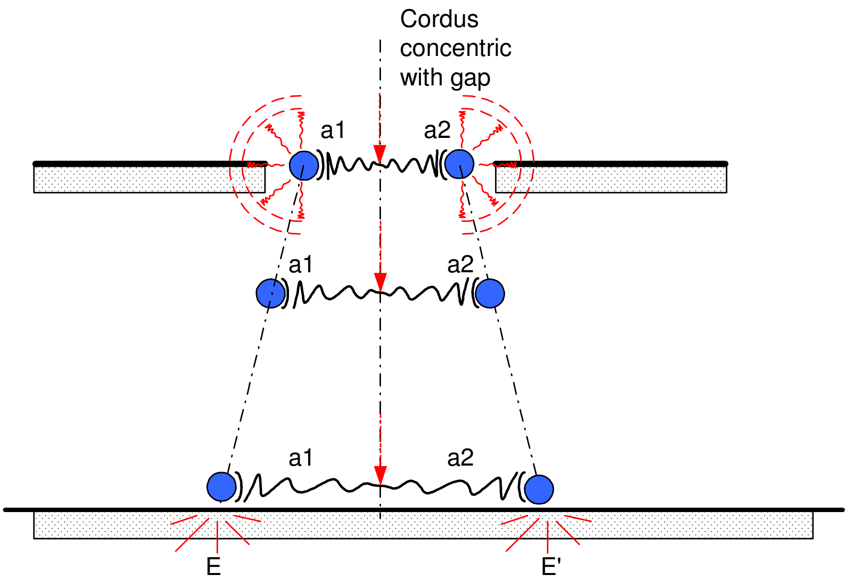

Figure 2: A concentric cordus is equally affected at both reactive ends, and thus the angular deflections are equal. One of the paths will ground first, and the fringe will start to be built up there.

Gap width

The observed reality is that *narrow gaps produce fewer but more pronounced fringes* whereas wide gaps produce many fine fringes. The Cordus explanation is that narrower gaps admit smaller-span cordi, which means fewer quantum states for span width (L.5.4) hence fewer quantum angular deflection outcomes. The eccentricity is predicted not to be the major effect, instead it simply degrades fringe quality.

In all cases the incident photons need to have the same frequency and polarisation. Distinct fringes do not appear in decoherent light, e.g. sunlight, because the different cordi diffract differently and smudge the fringes.

Apertures and Airy pattern

Circular apertures form circular fringes or Airy patterns. For example fringes appear at the output of a Sagnac[5] or Mach-Zehnder interferometer when the output beam is focussed by a lens. The lens is necessary: without

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5 The Sagnac interferometer is arranged in a ring, with one path clockwise and the other anti. A circular interference fringe may be visible at the output detector. The optical explanation is that the light beam splits into the two separate paths, and these subsequently interfere at the output. The (say) clockwise path encounters 2+2k phase shift, whereas the anticlockwise 1.5 +2k phase shift. Therefore there is a half wavelength difference between the two exit beams, and this creates the interference. Rotation of the device causes a further change in timing, and this is evident in the fringes.

The Cordus explanation is that some photons are split down both paths, and delayed differently. The fringes are formed by the aperture effect. When the device is rotated the delay is changed, and this changes the timing of REs past the aperture edges, hence changing the fringes.

it the fringes do not appear. The Cordus explanation is the same for the gaps considered above: an edge interaction effect for axially-concentric photons, that causes quantised angular deflection, which appear as fringes. Thus fringes are an artefact of the lens, and more specifically an effect caused by the edges of the aperture.

Beam divergence

A laser beam will spread, the divergence from the central axis being $\theta=\lambda/(\pi.w)$ where w is the beam waist (approximated by the aperture). Thus larger aperture beams spread less, as do shorter wavelength. This is typically explained as a diffraction effect, though the mechanism is incompletely understood.

Cordus provides several candidate explanations. First a possible mechanism for spread in a vacuum: the span fluctuates randomly (L.5), but cannot go negative, and therefore over time some extreme cases tend to move to larger spans. The span, and span increment, are inversely related to the frequency (L.5), so high frequency (tight λ) photons grow their span from a smaller base and therefore more slowly.

In air or a transparent medium, the mechanism for gaps may be involved, i.e. diffraction, and refraction, with one RE being delayed by an interaction with matter but not the other, hence bending the overall cordus trajectory.

For the aperture effect, the starting span cannot be larger than the aperture w. Whether or not the cordi are symmetrical and span the entire beam aperture is a second matter. Assuming that they do not, then the above spread mechanisms can also move a RE towards the centreline, so the average spread is less. According to this explanation it is not the aperture per se that is important, but the degree of concentricity of the photons with the centreline: it is predicted that greater concentricity will show greater divergence, and the tendency to fringes.

5 Fringes in the Double-slit device

The explanation of conventional optical wave theory is that the incoming light is a wave that passes through both slits, and the residual waves interfere with each other constructively (light regions) and destructively (dark lines). The interference is explained as due to the phase shift in wave-length, a difference of half a wavelength ($\lambda/2$) causing destruction of the wave. The explanation is adequate for most situations where there is a beam of many particles. However it does not explain the behaviour of a single particle, which also ends up in a fringe location even if there is only one particle in the device at the time.

The quantum mechanics (QM) explanation is that the particle is a wave-packet and thus can pass through both slots, interfere with itself on the other side, and collapse in one of the fringe locations. Alternatively, that the particle has a twin 'virtual' particle that takes the other slit and then interferes with the real particle.

The Cordus explanation is a straightforward application of the single gap model, with two additions. First is that the short span cordi are barred entry by the medulla. Thus the device imposes an upper and lower filter on the range of spans admitted.

The second is that diffraction occurs at both lateral and medial edges of the gaps. Lateral diffraction is identical to gaps, and shown in Figure 3. Symmetrical lateral fringes form.

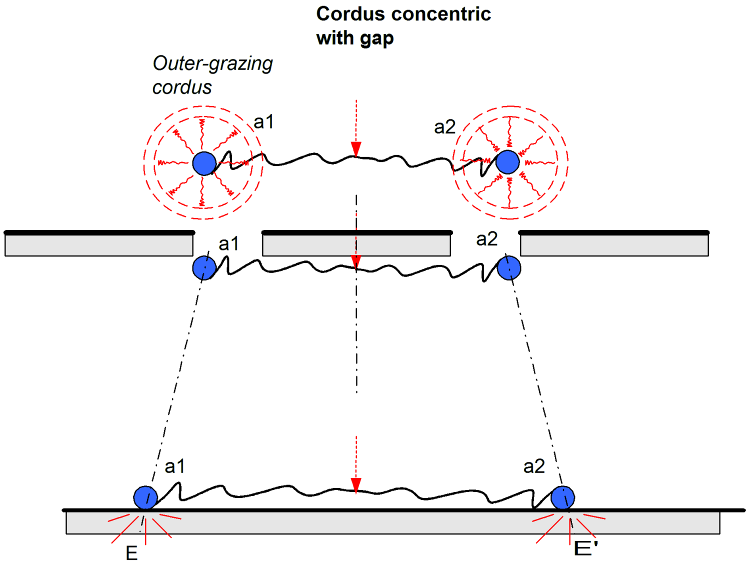

Figure 3: An Outer grazing cordus is deflected away from the midline by an angular quantum.

Medial diffraction also occurs, in which the reactive ends are both angularly deflected inwards, forming fringes as shown in Figure 4.

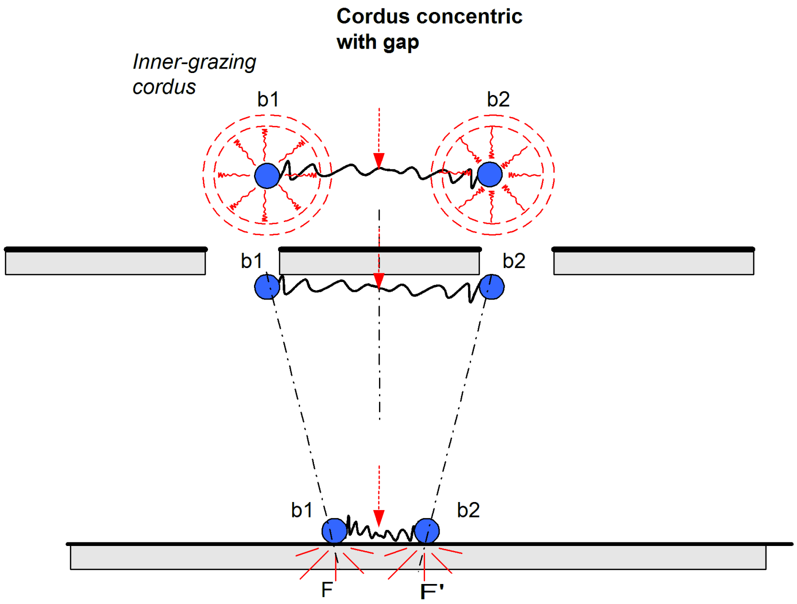

Figure 4: An Inner grazing cordus is deflected towards the midline by an angular quantum.

For a concentric photon, the deflection paths are symmetrical. For a beam of many such photons, each will be deflected differently according to its span. However the deflections are arranged in angular quanta dependent on the frequency. A single photon will therefore collapse to one of the fringe locations. A whole beam of them will do likewise, but to a variety of fringes, the visible fringes being the sum of the collapse of many individual cordi. Non-concentric photons will diffract differently on each side, and not form fringes but instead tend to collapse medially.

Photon path cross-over

The paths for the smallest span cordi will take them medially, and cause cross-over. The cross-over of the path itself is not perceived as a problem in the Cordus interpretation, but it will confuse the fringe picture. This is consistent with the experimental results, and corresponds to the near-field. A screen too close to the slits, as in Figure 5, will therefore intercept a number of cross-over cordi, so the fringes will be indistinct.

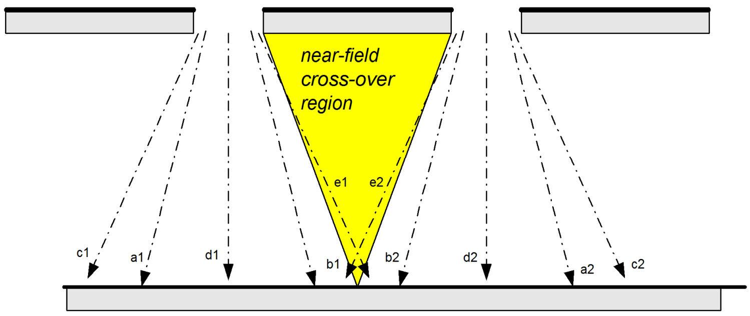

Figure 5: Concentric photon cordi of various span will take different paths a1-a2, b1-b2, etc., and form fringes. Some of the cross-over cordi (shaded area)will mix with other fringes, at least in the near-field.

The problem dissipates in the far-field, because for small slit pitch w and large screen distance q, the cordus paths are parallel for similar bunches (same angular deflection $\phi_{c1} = \phi_{e2}$), thus p_{ce} = slit pitch w. This is shown in Figure 6 with the c1/e2 bunch. Thus the bunch will consolidate to one fringe that will be at least w wide. For the fringes to be distinct from each other it is necessary that w be less than the fringe pitch q.tan($\Delta\phi_f$) where $\Delta\phi_f$ is the angular quantum, and this requires a sufficiently large screen distance q.

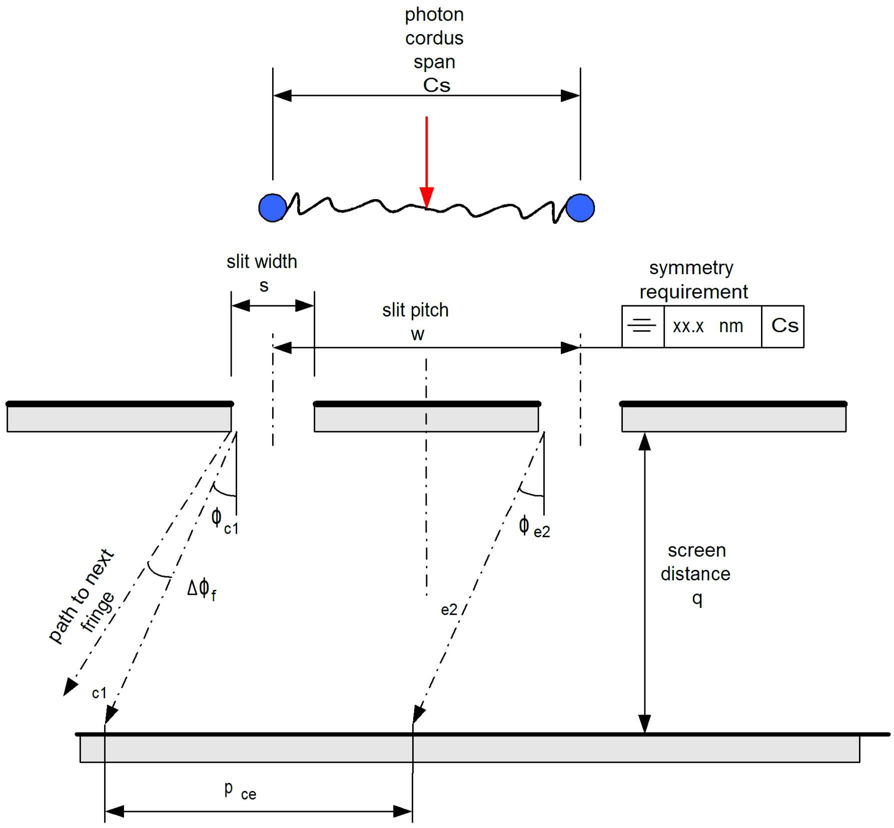

Figure 6: Geometry for far-field. A tolerance frame is included to emphasise the necessity for the span to be closely symmetrical with the slots.

The Cordus conjecture thus provides a very different explanation to the optical wave theory and QM. Cordus does not require destructive interference of photons, nor wave packets or virtual particles.

Why then should wave theory be such a good explanation for the double-slit, at least for beams of light? From the Cordus perspective this is because the hyff, being the EM field, are wave-like and the same mathematics apply.

Curiously, Cordus offers an explanation for another effect that is not readily explained by either wave theory or QM: the reason why fringes do not always appear. It is known empirically that the concentricity of the incident beam on the slits is important, and indeed such an effect is required by Cordus. By comparison neither wave theory nor QM explain why the symmetry requirement should exist: with both those theories waves/particles take all available paths, and symmetry issues should not arise as they do.

Thus the Cordus model explains both single photon and beam behaviour. Together with the earlier work on the path dilemma, this concludes the conceptual explanation of the double-slit device.

6 Discussion

This paper has expanded the cordus concept to explain wave behaviour in gaps, and fringes in the double slit device. This is useful because one of the enigmas of the double-slit device is that single photons form fringe patterns. Cordus explains fringes in terms of force lines called hyperfine fibrils (hyff) and their interaction with the edges of the light path. This also explains beam divergence and near-field effects. The significance of this is that it shows it is conceptually possible to create a solution for fringes based on a particuloid interpretation of light, without using the concept of interference. This means that the Cordus solution has coherence over a wider range than simply the path-ambiguity problems.

Comparison with Wave theory

The biggest difference between Wave theory and the cordus explanation is their interpretation of the mechanism for fringes. Wave theory explains fringes as 'interference': two separate waves of light differing by full (half) fractions of wavelengths and thus constructively (destructively) interfering. From the Cordus perspective photons do not actually interfere or add together, and 'interference' is only a convenient analogy. The Cordus explanation is that fringes are caused instead by interaction of the photon hyff with opaque edges.

This suggests a test. If Wave theory is correct, coherence is not essential and it should be possible to construct an interference pattern from two independent light sources, e.g. one into each slit of the double-slit experiment. The light sources need not be synchronised nor even exactly the same frequency: according to WT, interference fringes should nonetheless form, though not necessarily static. Cordus predicts that the outcome will be two independent gap-fringes (which is not the same as interference fringes). If interference fringes cannot be achieved then it suggests that light is not fundamentally a wave, but only shows wave-like behaviour.

Any truly integrative solution should be capable of explaining conventional optics too, and companion papers shows how cordus is applicable to optical effects (ref. 'Cordus optics').

Limitations

Cordus is a thought-experiment that challenges fixed ways of thinking. It asks the awkward questions, 'Is there really no better way of thinking about photons other than 1D points, mathematical wave-functions, or electromagnetic waves? Is there really no deeper integration?' Cordus is a purposely audacious idea: it explores new ways of thinking, and therefore deliberately puts forward tentative explanations to stimulate new thinking. We don't believe the particular design variant developed in this set of papers is necessarily the only or the final solution, and we are open to the possibility that it could be wrong in places. Thus the working model presented here is simply a conceptual model to be critically evaluated.

The treatment of these topics is primarily conceptual and descriptive, and the cordus mechanics only lightly sketched out. It is a conceptual model, not so much a full theory with all the details worked out. Effectively we are proposing internal variables for the photon: a 'hidden-variable' solution. Therein lies a potential problem: the general interpretation within physics is that such solutions are expressly prohibited by Bell's theorem. However that is not an issue as a companion paper refutes Bell's theorem (Ref. ‘Cordus Matter’).

Not all quantum and optical effects have been considered here, nor are the quantitative cordus mechanics worked out. However, sufficient of the idea has been sketched out to allow the concept to be evaluated. Open questions are the mechanics of the fibril (how is the invisible connection maintained between the REs?) and the mechanism for quantum hyff forces.

7 Conclusions

Outcomes: what has been achieved?

The Cordus explanation for the double-slit is that the photon cordus really does pass through both slits. It can subsequently collapse at one of the detectors and thereby appear to have taken only that path. This concept explains the dilemma of single-photon behaviour. It also explains fringe formation from single photons in gaps and slits. Path dilemmas in interferometers are also solvable from the cordus perspective.

That concludes the original purpose, which was to explore whether there could be a deeper mechanics that explains wave-particle duality. The Cordus conjecture does away with much of the weirdness of wave-particle duality: there is no need for virtual particles, superposition, observer dilemmas, pilot waves, intelligent photons, or parallel universes. A simple deterministic, unintelligent photon with a dual existence is all that is required.

Quis es tu, photon? What is the photon?

The answer to that question, from the Cordus perspective, is that the photon is a cordus with two reactive ends, with a physical gap between them, held together with a fibril. The reactive ends may be energised to various degrees, and in turn consist of hyff force lines. The energy shuttles between the ends, and this also means that the particuloid does not exist continuously at one location, but at two, and oscillates between them at a frequency, see Figure 7.

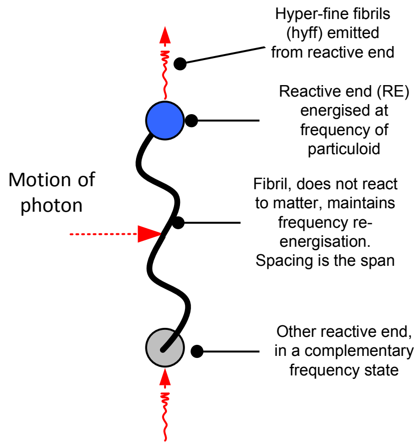

Figure 7: Cordus model of the photon

How do Quantum mechanics and Wave theory fit in?

From the cordus perspective both conventional theories, quantum mechanics and wave theory, are mathematical simplifications of a deeper mechanics. Those theories represent the *output behaviour* of the inner system. The weirdness of conventional wave-particle duality is not because the photon is fundamentally weird, but because the existing conceptual frameworks are inadequate: their mathematics are sufficient for forward propagation of effect (prediction), but give unreliable results when used for backward inference of causality (explanation).

Comments on the bracket of 'Cordus Conjecture' papers as a whole

Wave theory and quantum mechanics are functionally adequate theories on their own, and powerful in their ability to predict how beams of light and individual photons, respectively, will behave in a given situation. However, despite their mathematical sophistication, they are incongruous explanations of reality when wave and particle behaviours occur in the same situation, e.g. the double-slit device. In these situations their explanations are weird, which suggests that the models of causality are incomplete. The problem has been that wave theory and quantum mechanics are just so good, that it has been difficult to see what the deeper mechanics could be, especially as Bell's theorem seems to prohibit solutions with hidden variables.

Resolution of wave-particle duality

This bracket of papers offers a resolution of wave-particle duality by anticipating the internal cordus structure of the photon and the associated cordus mechanics. From this perspective wave and particle behaviours are simply the different output behaviours that the internal system shows depending on how it is measured. The duality and the apparent incongruity of Quantum mechanics and Wave theory are resolved: the conflict no longer exists at the deeper level.

Thus Cordus offers a deeper mechanics that subsumes both quantum mechanics and wave theory. This bracket shows how it resolves wave-particle duality, and other papers extend it to other enigmatic effects, as well as the mundane. Perhaps surprisingly, Cordus is also simpler and more coherent across a wider range of phenomena than quantum mechanics or wave theory on their own. Even more surprising, and unexpectedly contrary to the prevailing probabilistic paradigm of Quantum mechanics, Cordus suggests that the next deeper level of reality is deterministic.

The current bracket of papers has described the method and developed some of the basic cordus concepts, and applied them to path dilemmas and fringes. Other brackets of papers apply the Cordus concept to optical effects (ref. 'Cordus Optics'), matter (ref. 'Cordus matter'), and fields (ref. 'Cordus in extremis'), and each of those have several parts.