A Demonstration that an Electron Must Consist of a Ring Vortex Pair with Greater than 7 Sigma Certainty, Alongside an Explanation of Electromagnetism

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Abstract

Several properties of subatomic particles have been deduced through experimentation. Extending this picture further is the Schrodinger wave equation and a recent video of an electron compiled from pulses of light. This paper shows the remarkable success of a two ringed vortex structure in replicating, not only the appearance shown in that video, but many of the other properties of the electron as well, for example it possesses half spin properties and produces waveforms that provide a mechanism by which it may recreate the double slit experiment. The study finds extraordinary and extensive correlations between two ringed vortex behaviours and those of an electron and proves that they are the same at above the 7 sigma level. The model uses axiomatic mathematics to provide classical physics explanations for many quantum effects as well as a potential mechanism for the production of electromagnetism, and consequently represents a significant step forward in the field of physics.

Introduction

Since 1867 vortices have been proposed as potential models for atomic and subatomic structures. Lord Kelvin famously suggested that atoms might be knotted ring vortices whose distinct configurations represent the different chemical elements of the periodic table [1]. Since then single vortex models have been suggested as representations of electrons.[2][3]

Ring vortices only need a fragmented, moving and friction free background of virtual particles or simply broken areas of space time to exist and to persist indefinitely. Einstein commented to Lorentz in 1919 that space itself must have additional properties of some kind, "It would have been more correct if I had limited myself, in my earlier publications, to emphasizing only the non-existence of an aether velocity,

instead of arguing the total non-existence of the aether, for I can see that with the word aether we say nothing else than that space has to be viewed as a carrier of physical qualities."[4] In this context it should be borne in mind that should the wake of a particle be turbulent, as it is with ring vortices, a collective velocity of aether, an aether drift, might not be able to establish itself due to that rotational dissipation of any overall movement of the aether in which it is present. According to Robert Laughlin the current experimentally derived understanding is that space is far from a void, and is filled with "stuff" that exhibits properties more akin to a medium.[5]

Vortices can exhibit an unexpectedly wide range of properties: thin vortices can slice through each other and repair themselves afterwards; some can, upon intersection, merge briefly before splitting again having exchanged energy in a manner reminiscent of Feynman diagrams; a head on collision can result in the disintegration of the larger vortices into smaller temporary vortices, whilst some vortices, colliding at an angle, have shown simple deflections. Naturally the velocity, the medium and the diameter of the vortex rings all influence the outcome of such interactions.

The physical structure proposed here for an electron is of two leapfrogging ring vortices, called in this paper a colinked vortice or CLV. This structure appears to be unique in that it has an extraordinary number of favourable characteristics which will be described below. Aside from those it is the only form which approximately aligns with the Schrödinger wave equation in terms of its properties.[6] This fact alone necessitates an investigation as it shows an explanation of quantum behaviour in the simpler terms of classical physics.

Figure 1 shows a section of the continuous looping exhibited by ring vortices

Helmholtz showed that CLVs self-sustain in a frictionless medium.[7] CLVs are the only structures that can absorb energy from their surroundings to gain the ceaseless energy necessary to continuously emit waves. At first sight they sit outside the laws of entropy, but as they are not in the super atomic realm the realm where friction exists and where the 4th law of thermodynamics was designed to be applied, it is, perhaps, not a significant case of entropy reversal in that it cannot be extended to imply a general breakdown of the law.

Method

In this study a combination of logic, comparative analysis and axiomatic proof are employed to investigate the properties of CLVs and electrons. Logical arguments are used to establish that the fundamental characteristics of the electron can be exhibited by a CLV, a comparative approach highlights the rarity of the similitude of the two entities and axiomatic proofs offer exclusion proofs indicating that a CLV is the only viable option. These methods provide a robust framework for proving their equivalence as will be seen in due course.

Results

Proof 1

Here we can see the standing wave momentum pattern of an electron wave packet (EWP) imaged by Mauritsson et al. [8]
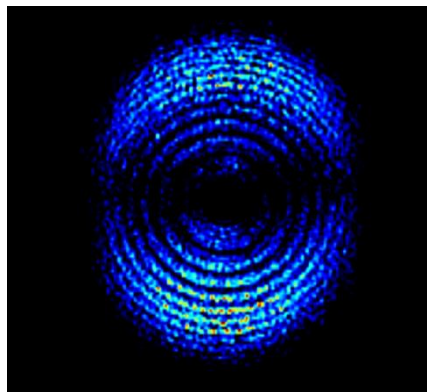

Figure 2 Shows the momentum distribution of an electron wave packet. [8]

This is a still from a video which shows that these waveform shapes do not expand or contract radially. This indicates that they are standing waves. Standing waves are formed from the addition of an outgoing wave with a return wave of the same periodicity which add and subtract in such a manner as to give the impression of a wave with no movement.

In the production of this phenomenon energy must be used to create the waves. The CLV is unique in having the ability to absorb energy from its environment and focus it into waves: any other kind of solid would require a supply of energy to endlessly cause movement to create the waveform effects. With limited dimensions the sole production method which is consistent with the law of the conservation energy is via the CLVs; any other shape either a ball, string or a sheet form would require some endless

supply of energy for the movement and, as none is available, the colinked pair is proven to be the correct particle through the logic of exclusion.

In mathematical terms this can be expressed many ways such as the set-theoretic formulation:

If we have a finite set of S possibilities, and we show that all but one element in x $\in$ S are invalid, then the last remaining element must be valid:

$$S = \{x_1, x_2, ..., a_n\}, \ P(x_i) \text{ is false for } i = 1, \cdots, n-1 \Rightarrow P(x_n) \text{ must be true.}$$

Proof 2

Axiom 1. In this space time model as above all types of force must stem from one phenomenon only: that which changes momentum:

$$F = dp/dt$$

That is to say all forces stem from the effects of collision and the effects stemming from that such as the Bernoulli effect and the force of pressure. All forces must be condensed down to these fundamentals for arguments to remain rational and understood in physical terms. Every effect must have a rational cause or the argument becomes irrational.

Axiom 2. All matter must be made from volumes of dimension as there is no other unit of building material available, and indeed it is employed as the building block in many fundamental theories as will be known to readers.

For all particles aside from vortices a hard shell or body is required. This hardness denotes some kind of cohesive force. As there is no available cohesive force that would logically affect small areas of space (we are stuck with the logical forces outlined above) and not others, a ring vortex is the only valid form for particles as it needs no shell, or inexplicable binding force.

This also aligns with the observation that no cohesive properties of dimension have been observed or perhaps even suggested.

Confirmation of Proof 2 comes from Bose Einstein condensates where vortices are the only object-like forms which persist.

Proof / Strong indication 3

If Proof 1 and 2 are ignored, some kind of engine has to exist made out of 3 dimensional space for the waveform motion to be produced in some sort of solid particle. In other words there has to be some variety of cause for the waveform effect. Such devices on a sub-atomic scale are unlikely due to the unimaginable material and method of their construction. No energy producing devices have been suggested presumably on this basis.

Proof 4

Axiom 1: There is no energy signature at the centre of Figure 1 so the particle part of an electron must be ring shaped.

Axiom 2: A ring shape must pulse to produce self-similar waveforms shown in Figure 2.

By exclusion the electron must be a CLV as it is the only shape which fulfils axiom 1 and axiom 2 above.

It could not be clearer, within the confines of normal space time, that an electron must be a CLV. It then follows that a CLV must be able to replicate the behaviour of an electron in various contexts, such as the electron slit experiment. Consequently the proof can be checked and verified through checking whether these behaviours are plausible.

Predictions

The Magnetic Monopole characteristic is a little like a fingerprint for the identification of an electron and we have a fairly good match of those fingerprints here. It should be borne in mind that the lines in magnetic field patterns are artificially created with iron filings: the lines illustrate the direction and, collectively, express the density of the field.
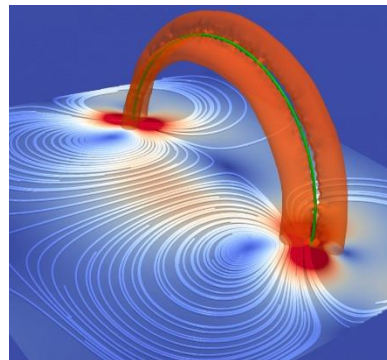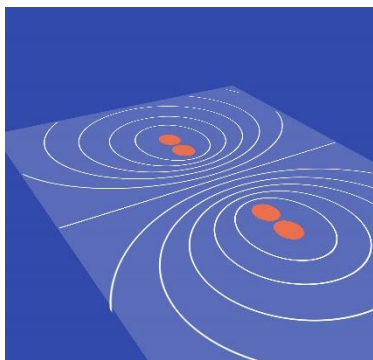

Figure 3 shows the classical pattern of the magnetic field, and Figure 4 shows the flows around the colinked vortex at a single instant in a normal fluid. Image by Makoto Tsubota, OMU [9]

In the above Figure 3 represents the magnetic field diagram around an electron and Figure 3 represents the flow of a normal fluid around a CLV at a single instant. It can be imagined that Figure 4 averages out to Figure 3 over a period of time as the lobes of flow in Figure 4 are swept around in a circular motion.

Also due to the directionality of the flow the CLVs correctly predict the polar nature of the field around an electron.

The CLVs also predict magnetic attraction and repulsion; CLVs repel with opposite spin signs confusingly producing alike poles being placed together and vice versa.[10] [11] In that assertion CLVs have to be approximated to single vortices due to a shortage of references on this issue.

Half-spin is a property very rarely observed outside the quantum arena. Here it is predicted that one ring at a time is rotated through the rotational force of the surrounding medium, the inner ring being sheltered by the outer ring. Consequently if one ring is rotated 180° before the other reaches the outside of the body and receives a similar rotation. There has been 360° of rotation which has resulted in a half spin of the entire body.

The spin is also quantized; the stability of CLV is only coherent when both rings have been turned 180 degrees. Turning just one of the rings to any degree would destabilize the system.

The *Schrödinger equation* The linear nature of the Schrödinger equation explains electron behaviour in atomic, molecular, and solid-state contexts.[12] Yet, theoretical advancements and innovative experiments have revealed situations in which nonlinear dynamics appear. Ideas that include self-interaction or background-field connections add nonlinear elements and address quantum measurement issues.[13]

The nonlinear Schrödinger equation (NLSE), widely used in modelling Bose-Einstein condensates, supports vortex dynamics that mirror classical leapfrogging while incorporating quantized circulation.[14] The nonlinear term governs vortex interactions and enables stable leapfrogging cycles—phenomena not present in the linear case in that particular medium, but an Einstein Bose condensate is not representational of a fractured model of space. Indeed linear characteristics appear in low-mass gas-like environments. As g reduces, linearity increases in leapfrogging ring vortex pair behaviour.[15,16] This implies that the same Schrodinger equation variations can describe both the electron and a CLV which is of benefit to this model.

This is an ongoing area of research where it is clear that the mathematical description of both the electron and CLV's are developing. Whilst the exact situation is not clear it can be said that the real and model behaviour could be equivalent especially given the low mass gas like qualities of the medium in which the CLV's are moving.

Entanglement is a well-documented quantum phenomenon. It is also observed in Bose-Einstein condensates, where particles assume identical quantum states due to wavefunction overlap.[17] A similar mechanism applies to CLVS, which, by their very nature, are dynamically coupled systems with overlapping wavefunctions. [18]

The *electron slit experiment* is theoretically replicated by the CLVs. They throw out pressure waves in advance of themselves as the vector of movement of the rings in the forward direction exceeds the overall speed of the whole CLV. As can be seen in Figure 4 if the body of the electron goes through the top slit the waveform, with which it interferes, has a much greater distance to travel and therefore only works if it is thrown out with this extra velocity. This of course is impossible phenomena for the vast majority of randomly chosen shapes. The electron could, also, theoretically carry a wave packet which is inexplicably distended in space, but as some electron slit experiments have been performed with a 0.25nm slit separation the "wave packet" would have to be, perhaps, inexplicably distended for the interference to take place.[19]
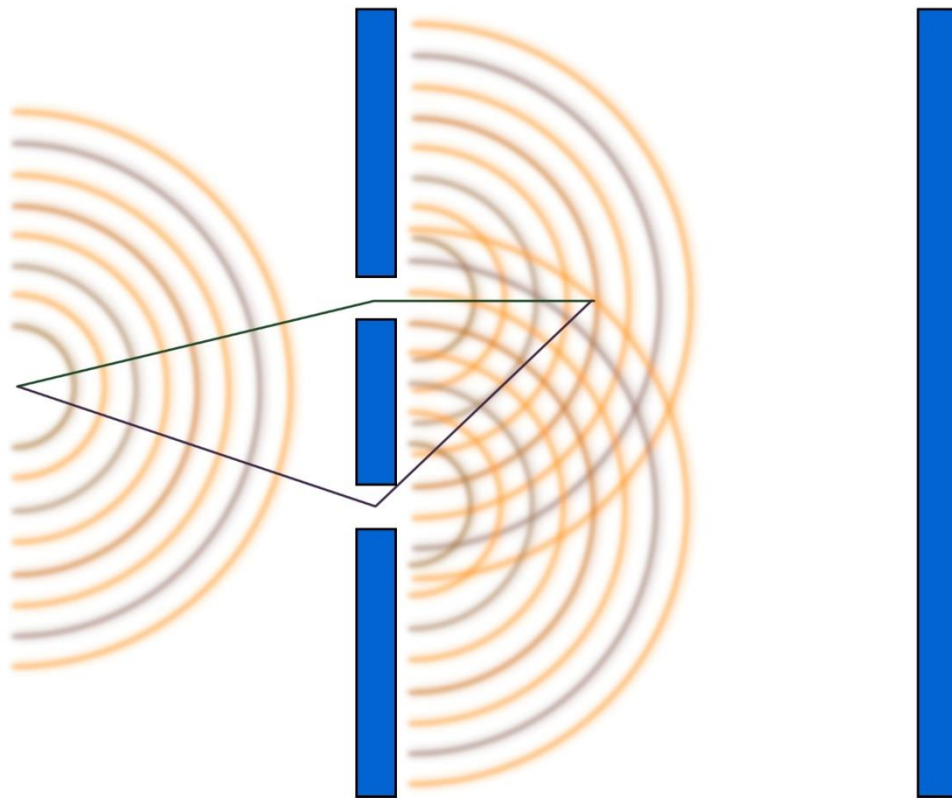
Figure 4 shows the path of an electron and its interference waveform in a double slit experiment.

The *Mauritsson Image*, figure 1, of an electron might be explained by a CLV. The explanation proposed here is that the bow wave adds to the outgoing wave and an incoming wave, or waves from other electrons with which it is entangled, produce the phenomena of the rings as shown in the video.
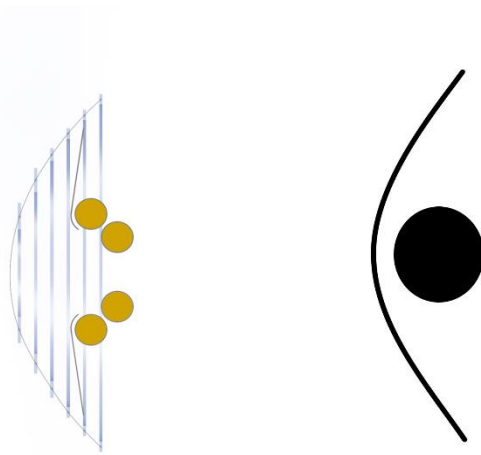
Figure 5 shows the interference of outgoing, incoming and bow wave. Actual diameter data is taken from the Mauritsson electron image. This diameter data is combined with an added separation spacing between the ring to create figure 5. The sweeping shock wave edges (approximated) and the bow wave of the entire body are shown. In Figure 6 a tracing of an actual bow wave.[20]

The data is for the widths in Figures 5 is taken from Mauritsson et al[8] and consequently has a small margin of error due to the diffuse nature of the original images. Figure 6 is adapted from a paper by Bedarev et al [20] which also demonstrates how bow shocks become more curved at lower speeds and shows the effects of dual cylinders on the shape of shock waves which when close together approximate to that of a single cylinder as shown.

No exact replication of a shock wave was sought here, presumably the manipulation of various parameters an extremely or exact approximation of the shape of the Mauritsson wave might be created, but as this would require arbitrarily manipulating figures it was not seen as something that would valuably add to a proof at this stage. It is only necessary to note that the proposed model could be commensurate with the video created by Mauritson et al.

Photon Emission by electrons is observed when electrons experience acceleration. That a photon might be a ring vortex of some type has been suggested elsewhere.[21,22]

The mechanism by which any other body may give birth to another particle, within logic and reason, may appear to be confounding, but this phenomenon arises naturally with vortices. Though there are no real world examples of vortices shedding self-similar vortices under acceleration, probably due to the difficulty of the experiment, vortex production from an accelerating curved surface in normal fluids has been shown.[23]

The above reasoning indicates a distinct prediction here for the CLV: if photons are produced by this model, then logically the photons are vortices in either single or double form. Here, due to the nature of a photon having a frequency, a double vortex is appears to be the necessary choice.

Looking at this idea briefly, a few plausible and shared characteristics, can be noted. If CLVs can temporarily link with each other to form two pairs, this aligns with photon absorption by electrons around atoms, also explaining how they might share energy with an electron. It is known that single ring vortices can temporarily link, it is also known that systems of more than two vortices can form, so conceptually the mechanism for photon behaviour around an electron is known. And at this stage it is simply necessary to check this aspect, that there is a rational mechanism so that, as a prediction, it remains logical.

One of the other properties of thin CLVs is that if they can approximate to single vortices when the two rings are thin, closely spaced and their leapfrogging is fast relative to their translational speeds, there are indications of a fixed relationship with their speed through the medium and the two properties of their radiuses and their circulation strengths.[22] The speed is independent of its frequency.[26] This is mirrors photon behaviour. Slow photons do not and cannot exist in free space, an unusual characteristic that is not shared by any other form, but is a characteristic of a thin ring vortex.

$$U = \Gamma/4\pi R(\ln(8R/a) - 0.25)$$

where:

- U is the self-induced velocity, its natural velocity through a medium
- Γ is the circulation,
- R is the radius of the ring,
- a is the radius of the core.

Thin vortices have the ability to cut through each other and mend themselves and thin vortices tend to deform around objects rather than collide, again this echoes the behaviour of photons at normal energies. The also often avoid mass transference, giving the impression of masslessness.

Electromagnetic Forces. A further implication arising from the model, in the context of the electron slit model, is that the deflection of the electron is caused by the deflection of the particle by its collision with the waveform which that has travelled via the other slit. Ergo the waveform has to be identified as a force carrier, therefore, given that it appears to be the only emission from the electron, it is conjectured to be the sole carrier of electromagnetic force. Why then does this only act on other electrons? The answer is likely to be to do with the scale of the electron relative to the wave size, just as small lapping waves cannot move a cargo container, they can impart motion to objects of a similar wavelength. Into this has to be added gyroscopic inertia allowing other vortices or combinations thereof to remain unaffected. Hence the idea of electric current arises from two observations: the CLVs constantly move and will naturally disperse into an area with a low density of other CLVs under the same principles as gas diffusion. Furthermore when a group of electrons move in the same direction, due to the directionality

of their cumulative wavefronts, a net wavefront force in the direction of their travel is produced, this maybe weak but strong enough to change the direction of travel of other electrons, and, in addition, due to their average alignment in travelling in a direction their magnetic fields would line up and could add together to produce an overall electromagnetic field with the correct alignment.

Dirac's Zitterbewegung seems to be very close to the energy system exhibited by the CLV's rotational energy. The oscillatory exchange between positive and negative energy components in the Dirac wavefunction echoes the kinetic and potential energy of the two vortices interacting; both phenomena can be described by Hamiltonian systems with periodic solutions in that the Dirac equation yields oscillatory solutions for free particles and in the same can be stated for CLV'S.

As Dr Inés Urdaneta notes in discussing zitterbewegung: "It's all about the fluid dynamics and circulation". This observation hints at the possibility that quantum phenomena such as zitterbewegung might be understood through fluid-dynamical analogies, a perspective aligned with some hydrodynamic interpretations of quantum mechanics and this paper.[27]

The Size of an Electron determined by high energy electron scattering experiments may be wrong according to this model. One aspect to bear in mind here is that the electron possesses a form of gyroscopic inertia: a coherent internal motion or angular momentum that resists the twisting of the whole body of the electron during an interaction, in other words a deflection may not necessarily take place even when an "impact", or more correctly the interaction of quasi gaseous bodies, has taken place. The nature of vortices and the substance of their composition allows localized deformations and partial overlap during close encounters to be permitted and may cause minimal effective force on the body allowing the electron to retain its overall trajectory.

Discussion

Solely looking at 4 proofs, it appears to be relatively certain that CLVs are the only candidate for the representation of an electron within the realms of a standard space time framework.

Further to this the CLV model was put to the test to see if, corresponding to the electron, the CLV has the potential to predict the bizarre and at times inexplicable behaviours of an electron. The predictions were briefly viewed to check that they were within the realm of the possible, retaining a reasoned cause and effect logic, to move from incomprehensible to the world of intuitively correct physical laws.

Table 1 summarises the ability of CLVs to closely reproduce electron behaviour

Phenomena replicated	Likely / Definite	Possible	Not Possible
Magnetic field pattern	x		
Magnetic Attraction / Repulsion	x		
Half Spin	x		
Spin quantization	x		
Schrodinger WE		x	
Entanglement	x		
Electron slit	x		
Mauritsson et al		x	
Photon Emission		x	
Constant photon speed	x		
Electron-Photon linking	x		
Electromagnetism		x	

No prediction for CLV behaviour was found to be beyond the realms of reason. Even if a very rough guess of a 1 in 10 to 1in 100 chance is given for a random object to exhibit any of the characteristics, it seems the chance of a CLV exhibiting all facets randomly is between 10^{12} and 10^{120} to one, which produces a high confidence interval that an electron is indeed a CLV.

The table is quite useful for testing other shapes or ideas. For example, if any simple geometric shape is posited as the shape of an electron, it fails all 12 tests to provide a clear answer to that suggestion.

$E = mc2 = VvDk$, where V = volume, v = average speed, D = density and k = a constant where there is no relative motion between the body and the viewer.

Conclusion

A robust set of proofs that electrons are CLVs has been presented. Interestingly the model can be investigated further using virtual computer modelling; that is to say a test CLV could be constructed which could then be put in various situations to see if the predictions are mathematically accurate. A

wide degree of accurately predicted behaviours would allow for the behaviour of electrons to be studied in a virtual context.

It is also interesting to see how the equivalence of mass and energy can be explained with this model without abstraction, in a clear mechanistic and natural manner, in other words as a concept sitting clearly within the bounds of simple Newtonian thinking.

It is the view of the author that further investigations should be made. As everything has a frequency it is logical to formulate the idea that everything is moving; therefore as everything is moving and sustained in its motion it is necessary within 3+1 space for them to be vortices. So within this framework the author recommends modelling electrons to see if they behave correctly within the magnetic wells of a much larger proton vortex structure. Inter baryonic forces might be explained by Bernoulli forces and as has been found in BECs vortex rings may be attracted or repelled by energy gradients, as if it were a quasiparticle moving in an effective potential the mechanism of gravity might also be deduced from this work. No great leap of the imagination into the unknown is needed to formulate interesting extensions based upon this foundation.

It is an astounding feature of the CLV shown in this paper that it has been able to unlock the mysterious qualities of the electron. The qualities of half spin and magnetism have appeared to be agonisingly abstract. This model replaces the apparently inexplicable realm with a rational realm, a realm where forces are explained and phenomena are easily understood.

1. Thomson, W. 4. On Vortex Atoms. *Proc. R. Soc. Edinb.* **6**, 94–105 (1869).

2. Osmera Senior, P. *et al.* Ring models of atoms, molecules and nanomaterials. *Adv. Mater. Lett.* **10**, 248–252 (2019).

3. Butto, N. Electron Shape and Structure: A New Vortex Theory. *JHEPGC* **06**, 340–352 (2020).

4. Einstein, A. Einstein letter to Lorentz. (1919).

5. Laughlin, R. B. *A Different Universe: Reinventing Physics from the Bottom Down*. (Basic Books, New York, 2005).

6. Caplan, R. M., Talley, J. D., Carretero-González, R. & Kevrekidis, P. G. Scattering and leapfrogging of vortex rings in a superfluid. *Physics of Fluids* **26**, 097101 (2014).

7. Helmholtz, H. LXIII. On Integrals of the hydrodynamical equations, which express vortex-motion. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science* **33**, 485–512 (1867).

8. Mauritsson, J. *et al.* Coherent Electron Scattering Captured by an Attosecond Quantum Stroboscope. *Phys. Rev. Lett.* **100**, 073003 (2008).

9. Tang, Y. *et al.* Imaging quantized vortex rings in superfluid helium to evaluate quantum dissipation. *Nat Commun* **14**, 2941 (2023).

10. Yao, J. & Hussain, F. Polarized vortex reconnection. *Journal of Fluid Mechanics* **922**, A19 (2021).

11. Helical spin textures in dipolar Bose-Einstein condensates | Phys. Rev. A. https://journals.aps.org/pra/abstract/10.1103/PhysRevA.82.053616.

12. Popelier, P. *Solving the Schrödinger Equation: Has Everything Been Tried?* (IMPERIAL COLLEGE PRESS, 2011). doi:10.1142/p780.

13. Czachor, M. Nonlocal-looking equations can make nonlinear quantum dynamics local. *Phys. Rev. A* **57**, 4122–4129 (1998).

14. Caplan, R. M., Talley, J. D., Carretero-González, R. & Kevrekidis, P. G. Scattering and leapfrogging of vortex rings in a superfluid. *Physics of Fluids* **26**, 097101 (2014).

15. Jerrard, R. L. & Smets, D. Leapfrogging vortex rings for the three dimensional Gross-Pitaevskii equation. Preprint at https://doi.org/10.48550/arXiv.1606.05103 (2016).

16. Borisov, A. V., Kilin, A. A. & Mamaev, I. S. The dynamics of vortex rings: Leapfrogging, choreographies and the stability problem. *Regul. Chaot. Dyn.* **18**, 33–62 (2013).

17. Sørensen, A., Duan, L.-M., Cirac, J. I. & Zoller, P. Many-particle entanglement with Bose–Einstein condensates. *Nature* **409**, 63–66 (2001).

18. Lo Gullo, N., McEndoo, S., Busch, T. & Paternostro, M. Vortex entanglement in Bose-Einstein condensates coupled to Laguerre-Gauss beams. *Phys. Rev. A* **81**, 053625 (2010).

19. Furuya, K., Ninomiya, Y., Machida, N. & Miyamoto, Y. Young's Double-Slit Interference Observation of Hot Electrons in Semiconductors. *Phys. Rev. Lett.* **91**, 216803 (2003).

20. Bedarev, I. A., Fedorov, A. V. & Fomin, V. M. Numerical analysis of the flow around a system of bodies behind the shock wave. *Combust Explos Shock Waves* **48**, 446–454 (2012).

21. Wan, C., Cao, Q., Chen, J., Chong, A. & Zhan, Q. Toroidal vortices of light. *Nat. Photon.* **16**, 519–522 (2022).

22. Drori, L. *et al.* Quantum vortices of strongly interacting photons. *Science* **381**, 193–198 (2023).

23. Magarvey, R. H. & MacLatchy, C. S. VORTICES IN SPHERE WAKES. *Can. J. Phys.* **43**, 1649–1656 (1965).

24. The velocity of a vortex ring with a thin core of elliptical cross section. *Proc. R. Soc. Lond. A* **370**, 407–415 (1980).

25. Moore, D. W. & Stuart, J. T. The velocity of a vortex ring with a thin core of elliptical cross section. *Proceedings of the Royal Society of London. A. Mathematical and Physical Sciences* **370**, 407–415 (1997).

26. The effect of compressibility on the speed of propagation of a vortex ring. *Proc. R. Soc. Lond. A* **397**, 87–97 (1985).

27. Santos, I. U. The *zitterbewegung* electron puzzle. *phys essays* **36**, 299–335 (2023).