Bell Experiment Results Explained by Retrocausality: Implications for Quantum Cryptography, Quantum Computers and Action at a Distance

Austin J. Fearnley
Manchester
England
2 October 2022

Abstract

Recent papers by Fearnley [2022, 2021] show that Bell's Theorem is bypassed, rather than broken, by retrocausality using local hidden variables. Bell experiments can overcome the constraints of Bell's Inequalities and produce results (correlation coefficients) which are higher than can be achieved classically. Retrocausality allows apparent action at a distance and yet uses local hidden variables. Retrocausality enables there to be quantum cryptography as a rewarding field of research but renders quantum computers to be without proper foundation as there are no indeterminate spin states of particles.

Introduction

Fearnley [2022] shows that bell experiments can be explained by Malus' Law if retrocausality is assumed:

Bell + retrocausality —> Malus.

This allows the mathematics of a Bell experiment to follow very simply from Malus Law. The use of Malus's Law does not guarantee the local hidden variables are present in entangled particles but Fearnley [2021] shows an alternative mathematical derivation of the results of Bell Experiments. This method is from first principles and specifically does use local hidden variables and retrocausality of antiparticles moving backwards in time to bypass the Bell Inequalities.

My preon model throws light on how the spin +1 photon and spin -1 photon act as if they were particle and antiparticle in a bell experiment whereas photons may not otherwise appear to be antiparticles.

The paper explains some of the issues surrounding retrocausality and explores the implications for quantum cryptography and quantum computers.

Retrocausality and Bell's Theorem

BACKWARDS IN TIME ANTIPARTICLES AND ANTIPREONS

Retrocausality and superdeterminism are two leading contenders to resolve the EPR/Bell issues concerning action at a distance in quantum mechanics. Retrocausality caused by backwards in time antiparticles can certainly explain a bypassing of the Bell's Inequalities in a particle-at-a-time simulation of a Bell's Theorem experiment [Fearnley, 2022 and 2021].

Such backward effects for antiparticles can lead to assuming that antipreons, too, are necessarily travelling backwards in time. Whereas antiparticles are scarce in the universe, antipreons in my preon model are as prevalent as preons. Antiparticles are rarer than particles because of spontaneous symmetry breaking, which makes antiparticle rarity an emergent property which is not present at the deeper level of preons in my preon model [Fearnley, 2019]. For example, in a simple model of a hydrogen atom, ignoring gluons, there is one proton and one electron. The proton is made of two up quarks and one down quark with, say, one quark of each colour and a mix of chiral handedness . The totality of preons and antipreons contained is: 8 preons and 8 antipreons. Gluons and photons in my preon model also each individually contain an equal number of preons and antipreons because they are electrically neutral.

THE PREONS AND ANTIPREONS THAT CARRY INTRINSIC SPIN

In a Bell experiment concerning the EPR issue, the important property under testing is the intrinsic particle spin. For a LH electron, the spin of -0.5 is carried by the A preon, n my preon model. But, for an electron with a RH form, its spin of +0.5 is carried by the B preon. Spin for the positron or anti-electron is carried by antipreons A' and B' for RH and LH forms respectively. That means that the spin for an electron is carried forwards in time by preons but the spin for a positron is carried backwards in time by antipreons.

In a photon with spin +1, the spin is carried equally by two B preons. For the spin -1 photon, the spin is carried only by two B' antipreons. So the spin -1 photon acts with an antiparticle role in a Bell experiment as the spin is carried backwards in time even though the photon electric charge is neutral.

Photons, like gluons, are massless and are neutral electrically, and they each have two preons plus two antipreons: either BBC'C' or B'B'CC: which are spin +1 and -1 respectively. A photon is known to travel entirely through space and not at all through time in its own frame. But a photon does travel through time in the frame of an observer say at 'rest' on a beach in a deckchair. About eight minutes from the surface of the sun to the earth.

All elementary particles of the standard model contain at least one preon and one antipreon. Therefore all elementary particles contain at least one forwards in time preon and one backwards in time preon. These are equivalent to advanced and retarded waves proposed by Feynman and wheeler which were necessary in order to build QED. This means that a photon is not travelling through time in its own frame 'on average' but that its 'average' is a counterbalancing mix of preons travelling forwards in time (two B preons for spin +1) and backwards in time (two C' antipreons) simultaneously. Similarly, although an electron travels forwards in time as a whole, one of its four preons is travelling backwards in time. Likewise, an anti-electron or positron is travelling mostly backwards in time but one-quarter of it is travelling forwards in time, in my preon model.

LOCAL ACTION VERSUS ACTION AT A DISTANCE

Action at a distance is generally accepted to be somehow true because of the breaking of Bell's Inequalities in a Bell experiment. Retrocausality, however, allows both views to be true simultaneously. Local action applied in a reverse time direction leads to an apparent 'action' at a distance for forwards-in-time observers. So both 'actions' are true.

RETROCAUSALITY AND INSTANT MESSAGING

In a Bell Experiment, a measurement on an antiparticle (a positron or a spin -1 photon) instantly, via backwards in time local action, causes the spin state of a remote partner particle to be known, assuming that the particle measurement is made along the same polarisation angle setting of the detector as for the antiparticle measurement. 'Action' is too strong a word for these effects under retrocausality assumptions. When the particle pair is created at the oven, the polarisations of both particles, that is, their hidden variables, are already fixed and are opposites. The spin outcome of the particle at a later measurement follows deterministically from the particle polarisation as it left the oven. There is no true 'action' at distance merely a revelation to a human observer's mind as in the Bertlmann's socks situation, which is explainable classically. The indeterminate entangled spin states of quantum mechanics are a sign only of observer ignorance of the particles' polarisations and not of the fundamental nature of two-particle spin states.

REMOTE SIGNALLING AND QUANTUM CRYPTOGRAPHY

Although retrocausal local action allows apparent faster than light action at a distance, there are no instantaneous changes of spin state occurring. The observer knowledge of remote spin states can however change instantly and can be very useful for cryptographic messaging. This is equivalent to instantaneous changes of contestant knowledge in the Monty Hall 'paradox'.

QUANTUM COMPUTING

Quantum mechanics entanglement of particles is not genuine in the sense that particles have fixed polarisations states (in between interactions) and therefore the spin states are not in an indeterminate, entangled flux. This lack of spin entanglement undermines the prospects of making quantum computers vastly superior to classical computers. But, as entangled states are not actually indeterminate because Bell Experiments can be explained by retrocausality plus local hidden variables, can a quantum computer work based on indeterminate states existing only in the mind of its operator, rather than existing in the hardware of the computer?

Discussion

KALUZA-KLEIN DIMENSION CONTAINING ORIGIN AND HOME OF ELECTRIC FIELDS

The Kaluza-klein fifth dimension is where the content of electric fields may dwell. It is a spatial dimension. Yablon [2018] has re-modelled this fifth dimension, using covariant formulae and Dirac equations, to be a time dimension. My own naive view is that such an extra dimension or dimensions is at least a 4D spacetime block which, because of electric contents moving relative to our spacetime at speed c, can only yield measurements to us as +/- 1. This can be interpreted as electric contents moving either forwards or backwards in KK time, where KK's arrow of time is taken to be not orthogonal to our universal arrow of time.

ELECTRIC CHARGE IS COMPLETELY DEPENDENT ON QCD COLOUR CHARGE

In my preon model, electric charge is entirely dependent on colour charge [Fearnley, 2017]. This means that the KK fifth dimension in my preon model is composed of three independent 4D 'colour charge' spacetimes. So a red or anti-red quality implies a red charge moving in the red dimensions, either forwards or backwards in red time. Unfortunately, redness can be a property of both a negatively charged down quark and a positively charged up quark. This is because the true connection is only revealed at the level of preons. A red quark has an assembly of preons and a {red + green + blue} combination would provide a block of negative charge within the quark. So the quark charge does not show the underlying charge relationship between colour charge and electric charge.

ZIG-ZAG RETROCAUSAL PATHS?

Oliver Costa de Beauregard had the idea of a zig-zag path through time for retrocausality. This is not the case for my model as preons always travel forwards in time whereas antipreons always travel backwards in time. The influence of an entangled antiparticle can be felt by its partner particle apparently instantly but only because that influence is transmitted locally in a reverse time direction.

HOW CAN A PARTICLE BE LOCAL IF IT HAS FORWARDS AND BACKWARDS COMPONENTS WITHIN IT?

Visualise this analogously as the particle being an 'engagement' ring through which the preons' advanced and retarded fields pass through freely and frictionlessly. The ring is where the particle is located (were it to be measured) even though the preon fields have opposite time directions.

RETROCAUSALITY AND THE BLOCK UNIVERSE

Forwards and backwards in time fields with a common origin, also known as entangled pairs, may be important in creating spacetime. A block universe derived from deterministic rules following a fixed set of initial states, seems to rule out human free will. Advanced and retarded fields in preons do not challenge that view. The past, present and future are all fixed deterministically. Our written history is not undergoing revision simply because antiparticles are travelling backwards in time. They are not travelling backwards undoing our history. They are already part of our history. Confusion may arise because entangled particles have been supposed to be in a mixed or indeterminate spin state. If this were true then there might be scope to undo the past, but retrocausality can resolve the bell paradox using retrocausal hidden (and constant) variables. There is no indeterminacy in the particles. The past is already fixed and the future will be fixed deterministically, with all that means, unfortunately or fortunately, for human lack of free will. In an interaction, preons are counted in and the same preons are counted out at every particle interaction. All preons are required to be where they are in spacetime and there is no scope for using some anti-preons to undermine the past spacetime structure. They are part of history and that history is not fluid.

BLACK HOLE MODEL OF A UNIVERSE

In one interpretation, the inwards dimension of a Black Hole is its time dimension. Inwards is not a linear vector but could be described by the sign of a trivector, say +1 to differentiate it from outwards, or -1. In geometric algebra the sign of the overall trivector is arbitrary and

does not affect the physical outcomes within, yet it still needs to be chosen and remain fixed throughout the calculations. This seems to rule out having two time dimensions within one calculation of geometric algebra, which would apparently not cope with antiparticles travelling backwards in time. But the one time direction of inwards can lead to opposing locally linear time direction vectors if particles from the two opposite edges of the BH were to face and approach one another. They would be particles and antiparticles relative to one another. If it were possible for a particle to travel completely through the BH it could travel along one time vector until it then travelled backwards in the time of the opposing time vector. It could then emerge having taken zero time to pass through the BH, and emerging travelling backwards in BH entry time (which is not the time dimension of the outer universe).

The time dimension in the Black Hole universe model could originally have been a spatial dimension subsequently compactified by our 3D space passing through it at speed c. The compactified dimension would then yield only +1 or -1 quantised measurements: time going forwards ('+') or backwards ('-') would represent matter going forwards or backwards in the original spatial dimension.

CAN ONE ACCESS OPPOSING TIME DIRECTIONS IN A CLOSED UNIVERSE?

The meeting of opposing time dimensions would not seem to be possible in the Penrose CCC model of a cyclical universe as the universe would end at a node before meeting an opposing time direction. The time direction of the universe is associated with rising entropy. Rising entropy is in turn associated with conversion of bosons into fermions. Fermions need their own space because of Pauli's exclusion principle, so increasing the number of fermions drives the expansion of space. A CCC node has all matter in the form of bosons. In one sense one could expect that turning fermions back into bosons for the end of CCC cycle should require travelling backwards in time but that is not what happens in the CCC model. The CCC explanation is, however, plausible to me in light of the behaviour of metrics where the underlying raw data tend to a Guttman pattern as would occur for space in extreme expansion [Fearnley, 2016]. Retrocausality would be better served by a model where opposing time directions could meet, frictionlessly and independently, with unitarity, like ships passing in the night.

My preons are in a particle model. Likewise are hexarks. But the septarks stem from fields. In fact those fields are string dimensions or universes with their own spacetimes travelling at speed c. Our only access to them is quantised measurements of +1 or -1. Either along their time dimensions or against them. For example, red or anti-red; spin + or spin -.

MASSES OF PARTICLES ARE ALWAYS POSITIVE EVEN WHEN BACKWARDS IN TIME.

In my preon model, mass is associated with inert or net neutral-charge blocks of preon plus antipreon. For example the block A A' would provide mass. The spin +1 photon is BBC'C' which has no mass giving component. A Left-handed electron such as ACAA' does have a mass component. Higher generations contain more preons, and more neutral blocks, than lower generations and are more likely to have greater masses, though there is no simple relationship. In my model, the z boson (BBC'C'AA'AA') is a second generation photon and the neutral blocks give it mass. The extra preons allow the z boson to participate in second generation interactions. No preons are destroyed in interactions and it is important for particles to provide or absorb all the preons in the interactions for whatever generations are involved. The gluons form a third and maybe also a fourth generation photon. Gluons have many preons and participate in short range interactions which is typical of massive particles yet they have no mass. The extra preons in higher generations allow for more complex behaviour so the photon and z are neutral with respect to colour charge, but the extra C and C' preons in the gluons allow for complex net colour charges to exist in the gluons.

PREONS ARE CONSERVED IN ALL PARTICLE INTERACTIONS

Preons are conserved. Matter is not created from nothing. Annihilation interactions do not destroy preons. Universes are not created from nothing nor are they annihilated into nothingness.

CHOICE OF DETECTOR SETTINGS IS IRRELEVANT IN A RETROCAUSAL EXPLANATION OF BELL.

Fearnley [2022] explains how the Bell Inequalities are bypassed in a Bell Experiment. The explanation assumes retrocausality via antiparticles travelling backwards in time. The Bell result is then subject to resolution using the 200 year old Malus's Law. It is very clear that Malus's Law requires only an input of like-polarised photons. Alice and Bob's detector settings provide these polarised antiparticle beams. Retrocausality means that the incoming antiparticles are outside the normal interpretation of the usual paths of antiparticles. Alice and Bob's detector settings completely control the beam intensities in the retrocausal Bell experiment. The original antiparticle polarisation vectors are completely irrelevant. The particular detector settings are irrelevant as any settings will give the desired Bell result. The settings can be decided using far galaxies if desired but settings are irrelevant as any setting will work.

CAN THE PAST BE UNDONE USING RETROCAUSALITY?

Retrocausality in this paper is only about revealing the nature of particle spins at their interactions. This is in a deterministic block universe with no free will. There is no communication of messages from present to past nor present to future. There is no changing the past and undoing history. Action at a distance is misleading as there is no genuine 'action' involved, only a suddenly revealed knowledge of the spin at a distance. This is genuinely a Bertlmann's socks situation or a Monty Hall situation where information about a distant object travels faster than light but only in the mind of an observer. The distant object already had its property of spin before measurement. The + or - spin outcome of measurement though is not possessed by the particle. Instead, the particle possesses a spin polarisation vector which is more complicated than a 0/1 quantum number and the measurement result also depends on the detector polarisation vector. 'Vector' is also too simple to explain the particle polarisation property at a given instant as that vector only describes the average state of the particle over time.

Advanced and retarded fields are a sign that particle interactions require successful 'handshakes' between past and future particles before they interact. If a lone antiparticle was somehow sent backwards in time it would need to complete a successful handshake with a particle in the past before it could interact with it. This seems feasible from the point of view of a whole antiparticle, but what of the constituent preons of that particle? These preons all fit into the current spacetime region of the antiparticle so there are other preon 'handshakes' that would also need to be undone in order to allow the antiparticle to be free. This freedom does not seem likely.

ARE BACKWARDS-IN-TIME ANTIPARTICLES ESSENTIAL TO ACTION AT A DISTANCE?

In Fearnley [2021] models of particle spin for electrons and photons were made. These models were used to provide results for a Bell experiment using retrocausality. The electron model had electron spin, by analogy, like the spin of a gyroscope. A spinning gyroscope on a table surface was analogous to an electron spin in the |up> state. The actual spin vector was variable over time and upwards was only its average spin vector over time. For two electron spins to be identical for establishment of entanglement status they would need to both be |up> but in addition their spin vectors at any instant would need to be identical. This is equivalent to their phases being aligned. Such spin-aligned particles could be used to provide enhanced Bell correlations, in this case positive correlations. I understand that photon pair production using optically-active media does produce entangled photon pairs with exactly opposite spin vectors. These are, in my preon model, for spin purposes a photon plus an

antiphoton where the photon has spin -1 and the antiphoton has spin +1 (see section 'THE PREONS AND ANTIPREONS THAT CARRY INTRINSIC SPIN').

Summary

The main conclusions about retrocausal local hidden variables are:

Entangled pairs of particles do not have indeterminate spin states. Indeterminacy is not needed to explain the results of Bell Experiments when retrocausality is the explanation.

Instant messaging is possible because of retrocausality but the only entity that travels faster than light is information in the minds of observers. As in a Monty Hall situation.

Retrocausality cannot alter the past. So the past is secure and the future is also secure and fixed in a deterministic universe.

Quantum computers cannot use indeterministic spin states of particles as they do not exist within entanglement. But maybe such computers could work using entangled states in human minds operating such computers. A long shot, though perhaps possible.

My preon model throws light, at least for me, as to how antiphotons can represent antiparticles travelling backwards in time. In my preon model a spin -1 photon is composed of four preons B'B'CC where the spin is carried entirely in the two B'B' anti-preons travelling backwards in time. The two CC preons are travelling forwards in time. The photon average stance is not to travel through time in its own frame, but that is just its average stance. The spin -1 B'B'CC photon acts like an antiparticle for the purpose of its spin content which is travelling backwards in time.

Although there are few antiparticles in our midst, at the preon level there are equal numbers of preons and anti-preons in our locality. This makes retrocausality important in the structure of spacetime.

References

Bell's Theorem and Retrocausality. Fearnley, A. J. (2022) https://vixra.org/abs/2205.0140

Antiparticles and the Nature of Space. Fearnley, A. J. (2021) https://vixra.org/abs/2101.0179

Malus's Law and Bell's Theorem with Local Hidden Variables. Fearnley, A. J. (2020) https://vixra.org/abs/2006.0160

A Comparison of Bell's Theorem and Malus's Law: Action-at-a-Distance is not Required in Order to Explain Results of Bell's Theorem Experiments. Fearnley, A. J. (2019) https://vixra.org/abs/1908.0348

Leptoquarks and Charged Higgs Using Preon Model #9. Fearnley, A. J. (2019) viXra:1907.0038

Theory of Fermion Masses, Mixing, Lagrangian Potentials and Weak Beta Decays, based on Higgs Bosons arising from the Scalar Fields of a Kaluza Klein Theory with Five-Dimensional General Covariance Provided by Dirac's Quantum Theory of the Electron. Yablon, J. R. (2018) Researchgate. DOI: 10.13140/RG.2.2.10103.68007

Correlation of – Cos ϑ Between Measurements in a Bell's Inequality Experiment Simulation Calculated Using Local Hidden Variables. Fearnley, A. J. (2017) https://vixra.org/abs/1610.0327

Hexark and Preon Model #8 and the Unification of Forces: a Summary. Fearnley, A. J. (2017) viXra:1709.0021

Pseudo-Random Data Testing The Scales Used In Rasch Pairs Analysis/ Adaptive Comparative Judgement. Fearnley, A. J. (2016) https://vixra.org/abs/1609.0329

Time As a Geometric Property of Space. Chappell, Hartnett, Iannella, Iqbal and Abbott. (2016) Front. Phys., 17 November 2016. https://doi.org/10.3389/fphy.2016.00044

Austin J. Fearnley

2 October 2022