Explaining Results of Stern Gerlach Apparatus Experiments with Gyroscopic Motion

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Abstract

Gyroscopic motion is used to explain why it is that there is maintenance of same or opposite axis of rotation orientation, by electron particles produced as a pair. Important for answering two important questions. 1/ Why can pairs of particles separated by large distances act as if they are coordinating their responses to tests? The proposed answer making faster than light communication between particles unnecessary. It also explains the strange semi permanence of propensity to give particular state outcomes for a repeated same test, that is lost when there is an intermediate different test ; Answering the question. Two famous examples of supposed quantum strangeness.

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Georgina Woodward 2020

Why it is that there is maintenance of same or opposite axis of rotation orientation, by electron particles produced as a pair, is important for answering two important questions. 1/ Why can pairs of particles separated by large distances act as if they are coordinating their responses to tests? The answer discussed in this paper has explanatory power that makes faster than light communication between particles unnecessary. It also explains the strange semi permanence of propensity to give particular state outcome; Answering the question; 2/ Why do particles given the same test as previously act so that it seems the output state is fixed (as if resulting from a property of the particle), yet if tested at a different angle (as ascertained by many such tests) the outcome state is seemingly random, as if it is not related to a fixed property of the particle. Two famous examples of supposed quantum strangeness.

Weightless rotating gyroscopes are stable. They maintain their axes of rotation unless acted upon by twisting forces. They are not resting on a support, so do not loose energy via friction. Conducting gyroscopes align themselves with a magnetic field [Ref.1]. If exposed to same magnetic environment to which it is already aligned it will not change its axis of rotation. If a different magnetic environment is encountered it will respond individually to the forces it encounters. This may be a useful model of an electron in a Stern Gerlach apparatus. The gyroscopes don't need to communicate to co-ordinate keeping their correlation or to loose it. It is proposed that their stability in some circumstances, and sensitivity in others is a consequence of their gyroscopic nature. This un-spokifies spooky action at a distance.

Behaviours of gyroscopes.

1. In the absence of twisting forces, a gyroscope's axis will always point in whatever direction it was pointing when it started spinning. Once spinning they are stable, resisting motion around their spin axis. Relevant to temporary maintenance of output state if same test orientation is repeated. And maintenance of the appearance of 'entangled pair' orientation correlation or anti-correlation. I.e. they do not spontaneously loose their relation when treated the same. This can be demonstrated with pairs of gyroscopes floating freely in space craft.

2. The separation of the pair gyroscopes does not affect their relationship- (so long as they do not

collide!) Compare this with electron particle pair members given huge separation, maintaining the 偃ppearance僁f 'entanglement'.
Push it unsupported in space it maintains its orientation and moves across the cabin. (It does not show 'circling' precession as it would if on a support of any kind on Earth.)
3. A twist is needed for it to change orientation. Compare this with gyroscopic electrons in SG apparatus, exposed to same and different field orientations.

Assumptions.
a. the electron particles of a pair are produced with opposite gyroscopic spin orientation.
b. Their orientation is either aligned with the magnetic field individually encountered OR that magnetic field acts as a local environment exerting a twist. So its orientation adjusts accordingly.
Evidence for that [Ref. 1]: 偗The magnet is de-energized and the axis of the gyroscope is set at an angle 40-50¸ to the direction of the field, and the gyroscope is then set in motion. The magnetic field is then turned on, and the axis is seen to change its position until it is parallel to the magnetic field偪 偭emonstration with conducting gyroscope in a magnetic field偪K N Baranskiĭ
° 1968 American Institute of Physics Soviet Physics Uspekhi, Volume 11, Number 2

Electron particles are produced as pairs, for use with Stern Gerlach apparatus.
They have been called anti-correlated. Meaning by that, they are opposite in some way; now in this paper, presuming opposite gyroscopic rotation.
Each has an affinity with the rotation it was produced with, that is sensitive to magnetic field orientation. This is corroborated by experimental outcomes. That will be discussed.
Important for apparent behaviour in experiments, that has led to argument of quantum entanglement, is that the electron particles produced from the source share a relation that is same spatial x,y,z orientation of axis of rotation relative to each other, but opposite directions of that orientation, meaning they are anti parallel to each other.

Let偣call the particle pairs twins, and because they are opposites, twin/anti-twin pairs. (T/At). We do not know which is the twin and which the anti, the abbreviation applies to both possibilities.
[To try and more clearly differentiate particles and output bit results. Bit names will not be used for particles.]

Using the right hand rule

To imagine T/At pair; We do not know which is which but do know they have opposite rotation. Using Right hand rule (Rhr) as an aid: Take your right hand and make a fist, with thumb pointing skywards. The curl of the fingers is anticlockwise. To get the opposite turn hand over so thumb points to the ground, curl of fingers is clockwise. Curl gives direction of turn of rotation thumb orientation gives flow of movement. That flow can be thought of as a component of motion that needs to be combined with the velocity through the apparatus.

If they are like gyroscopes rotating electrons keep their orientation until acted upon by forces that twist the axis of rotation. They can encounter forces that act on both particles so they remain anti-parallel, take up parallel directions of orientation or loose that sameness or similarity of orientation. As will be elucidated later. Each particle adjusts to the local environment it encounters.

The two rotations have opposite preference of orientation in the same orientation of field. One appearing to be South seeking and the other North seeking.

The relation between clockwise or anticlockwise rotation it was produced with and magnetic field orientation alignment is maintained. If the field direction is altered the particle adjusts to it.

If the field is inverted the particle inverts maintaining their relationship. Such as North magnet on top is changed to North down below, A clockwise rotation, down flow, South seeking, electron does not fail to respond and just become clockwise, down flow, North seeking, electron particle. It inverts and remains South seeking.

They also do not become the other kind of particle by spontaneous inversion of axis of rotation.

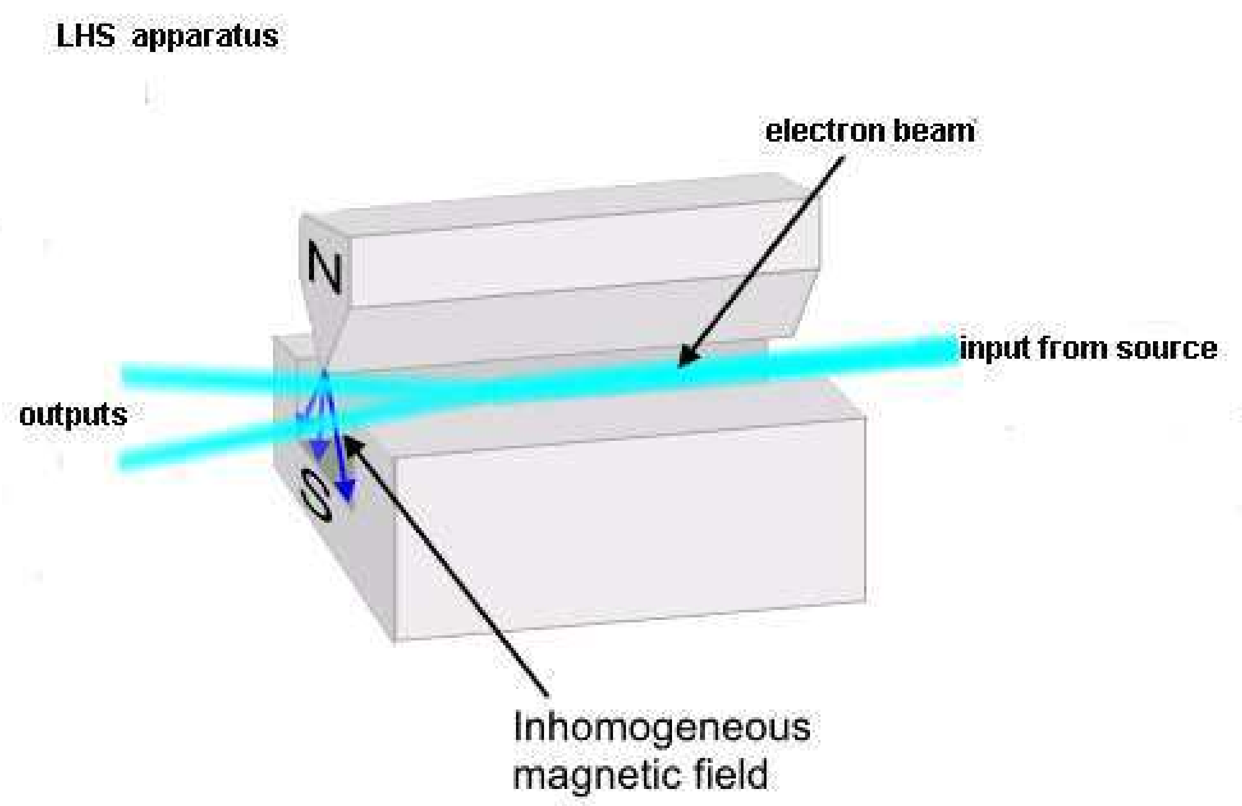
This behaviour suggests, together with the results of sequential tests on electron particles using same and different fields, semi /temporary permanence of axis of rotation preference, and hence flow direction.

Experiment 1

Electron particle pair Stern Gerlach experiments

Two Stern Gerlach apparatus, set up facing each other, so each receives one particle of T/At pairs. Left hand side apparatus (LHS) has vertically aligned magnets with the North Up top, South Down below. The right hand side apparatus (RHS) magnets are oriented so that the difference between angle on LHS and RHS is; 0 degrees,180 degrees and 90 degrees, in separate trials.

Apparatus for electron particle pair Stern Gerlach experiments



<u>0 degrees difference in apparatus angle. North magnet top. T/At pair.</u>

As they were produced as opposites they have different preference of orientation in the same direction of field; such as North magnet pole above/top. They will each adjust to the field they encounter.

It can now be understood that the produced pair enter the same field orientation (lets say North top South bottom) in each apparatus but because of their different relationship with it one will align parallel to the field, the other anti-parallel. Applying (Rhr) one 偃wants偶o move up the other down.

One of the many possible adjustments that could happen is both particles invert to achieve their preferred relation with the field.

The other extreme is they are already perfectly parallel and anti-parallel to the field and do not need to adjust their orientation. In all cases the twin/anti-twin relation is maintained. Applying the right hand rule, (N)up: (S)down or (N)down: (S)up

If (N) bit is named White and (S) is named Black; all bit pairs can be expected to be either BW or WB. In practice some pairs will not be T/At pairs but two singleton electrons, which can account for a few BB and WW results shy of 100% BW and WB, anticorreleted theoretical outcome.

Treated with the same magnetic environment they respond to the forces individually encountered, maintaining a pair of different rotations, being called T/At relationship, with no discrimination of which particle is which by experimenter or thinker.

<u>180 degrees LHS N top, RHS S top T/At pair</u>

LHS same as for 0 degrees. Lets assume for ease that no adjustment is needed and (as we have to chose one of the options for discussion) The LHS particle has antiCl. Turn (rotation) giving by Right hand rule (N) up flow.

The partner finds the opposite field orientation S top. Reminder; With N top this particle, the opposite, with Cl. Rotation, would be (S) down So it maintains its preferred relation with field by inverting. Now by RH rule it is now turning antiCl. Flow (S) up. The bits are matching, up. But although the bits are deemed identical, the magnetic polarity involved in production is different.

We know that if one of the apparatus is turned 180 degrees bit outcomes are instead correlated. This would happen if a particle with its own rotation had been produced and entering the apparatus encounters a field it can align with in its preferred manner if it turns over. Regarding the relationship of particle to apparatus it meets; turned over field and turned over particle is the same as neither turned over, relatively.

Stern Gerlach apparatus test of a T/At particle pair. If the magnets of the left hand side apparatus are left alone. The right hand apparatus偔magnets are turned 180 degrees. In this example of 180 degree difference each particle of a pair is experiencing the field direction n-s differently, whereas for 0 degrees even though the apparatus are facing each other n-s field orientation is the same. The particles align with the field they individually encounter. The opposite field direction causes an opposite (from what it would have been without field direction reversal of up/down direction of motion. But interestingly maintains the same apparent North or South seeking behaviour). All that is required is that the particle align its axis of rotation with n-s field direction. {Applies to all tests} 0 degrees and 180 are not comparable situation as for 0 both apparatus have the same n-s field direction.

If that is true for turning one magnet pair 180 degrees, it must also be true for moving both magnet pairs to get 180 degrees difference. Same outcome expected, all correlated, if instead of moving one magnet pair by 180 degrees, magnet pairs each side were adjusted by 90 degrees in opposite directions. From 0 degree start to give the 180 difference of angle.. If the particles entering their own sides of the apparatus both find a field direction that puts them in the antithesis of their preferred orientation both will turnover to align how they want to. As both do this they keep T/At relationship (remember we do not know which is which just that they are opposites). The individuals respond to their own environment. Due to the duel turning over, the relationships of particles to field within the apparatus become the same as if neither fields nor particles were turned, relatively.

In this case the LHS apparatus is not staying where is was but moved 90 degrees orthogonal. RHS moved 90 degrees orthogonal in opposite direction. Instead of one 180 degree inversion of RH particle there are two 1/2 of 180 turns in opposite directions. Giving both with orthogonal orientation compared to the starting orientations. If N is moved around and down from N Up to N Towards, and S is moved from S Down to S Away, North seeking / South seeking T/At pairs will have axes of rotation parallel.

Some Geometry

If 0 and 180 degree difference in direction of a vertical field gives parallel/ anti-parallel alignment of electron傷axis of rotation, and for 180 degrees parallel /parallel (a vertical field for simplification of explanation -every variation can not be discussed here); for comparison, consider two particles T/At drawn as tops with central axis of rotation as a stick running vertically through the middle. Drawn thus they represent vertical field alignment. Colour top and bottom of each differently (not representing a permanent property, just a visual aid). To align with the 90 degree field the axis of at least one particle must turn to align with the Towards (viewer)-Away (from viewer) z axis, as looked at as a diagram.

90 degrees difference in rotation of apparatus

If the test apparatus are at 90 degrees to each other, that is midway between producing a correlated result as for 180 degrees difference in rotation of apparatus and an anti-correlated result, as for 0 degrees difference in rotation of apparatus. It could go either way. And that is uncorrelated. Whether that is special or not depends on how it is thought about. It looks random, no special relationship shown by that. And yet it is precisely between correlated and anti-correlated and that is special.

Experiencing different field orientations the particle pair can not maintain opposite axes of rotation orientation. At 90 degrees difference of orientation of analyzers AT LEAST one of the particles will experience a change that gives a different orientation of axis of rotation from the partner. It can not keep the same orientation as the other even if they both move. They can neither have parallel or anti-parallel axes of rotation relative to each other. As the axes have to be orthogonal.

The axes of rotation have only two direction options, affecting bit outcomes, each side when aligning with the magnetic field. At 90 degrees there are as many ways of evolving into a situation where the outcome bit states are the same (as they are for 180 degree of angle difference between sides) as there are for them being opposite (as they are for 0 degree of angle difference between sides).

Illustration

Using the right hand rule

LHS : V axis orientation and particle flow NU, gives V(y) W bit

LHS : V axis orientation and particle flow S D, gives V(y) B bit.

RHS : Z axis orientation and particle flow S A, gives O (z) B bit

RHS : Z axis orientation and particle flow N T, gives O (z)W bit

Bit combinations

VW:OW different orientation origins (V:O) but matching bit names (W:W)

VB:OB different orientation origins (V:O) but matching bit names (B:B)

VW:OB different orientation origins (V:O) and different bit names (W:B)

VB:OW different orientation origins (V:O) and different bit names (B:W)

Being exactly half way between the 0 and 180 degree difference in magnet orientations an equal mix of the 4 possibilities is expected statistically, as there is no bias towards more like 0 degrees or more like 180 degrees.

Magnetic field orientations, electron axle of gyroscopic rotation (also giving flow direction) and output bits

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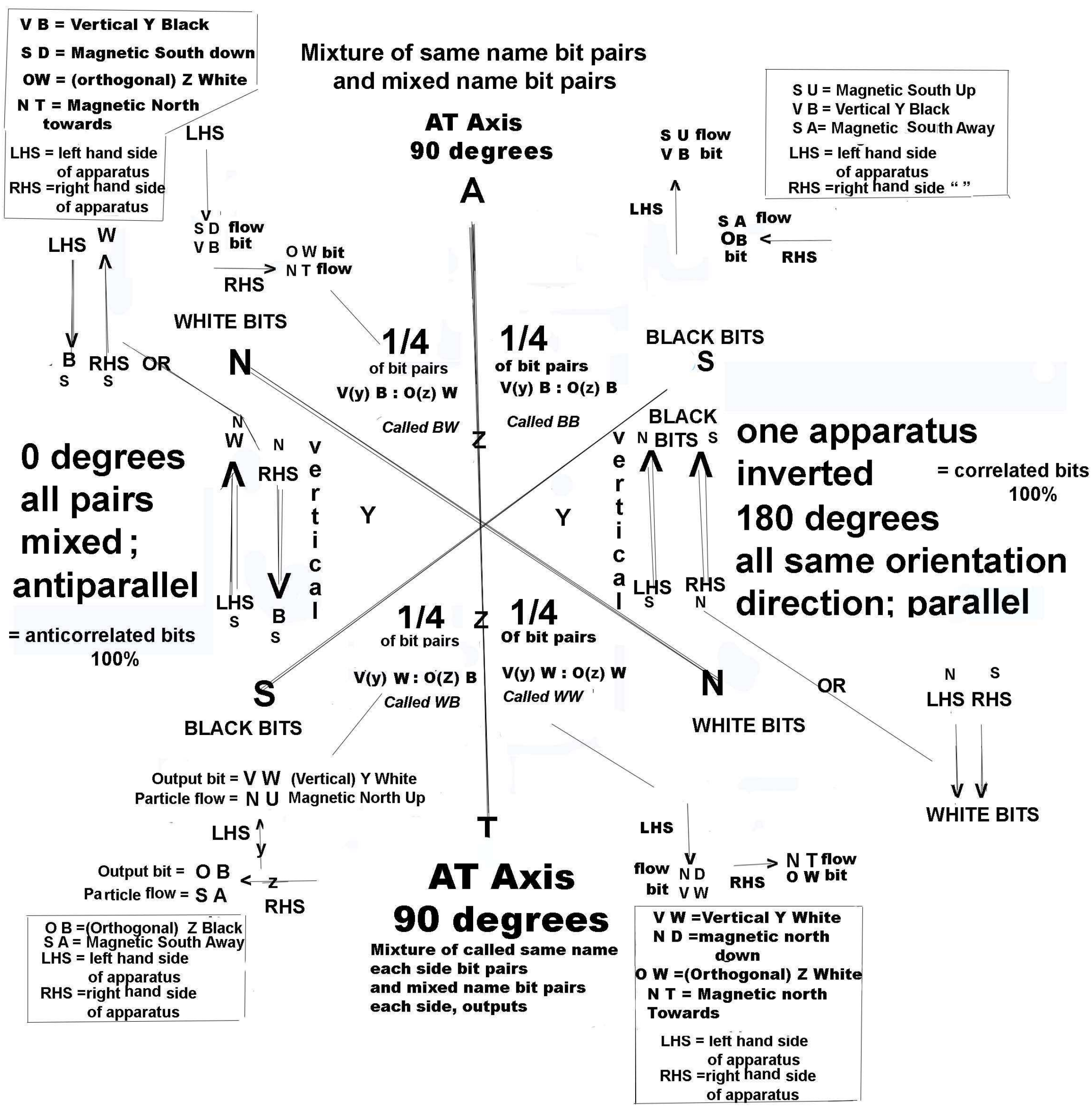
N = North magnetic polarity

S= South magnetic polarity



AT= AWAY TOWARDS AXIS, Z spatial orientation compared to Y spatial orientation of 0 and 180 difference of orientation of magnets, between sides of the experiment degree ;vertical orientations of magnetic field

AT 90 degrees is half way between sides having same orientation of vertical field,0 degrees and oppposite orientations of vertical magnetic field. Also between 100% anticorrelated and 100% correlated bits

Experiment 2

Sequential Stern Gerlach experiments [Ref. 2]

Using 2 different orientations of apparatus rotation around direction of input electron flight. The vertical apparatus shall be called a Colour box, which outputs White and Black named bits from its exit ports. The orthogonal apparatus will be called a Hardness box that outputs Hard and Soft named bits.

Random electrons enter the first box, a Colour box, from the source. Half of the electrons exit the White port. Half of the electrons exit the Black port. Electrons from the White exit port, if put though another Colour box will be output 100% White. Electrons from the Black exit port, if put though another Colour box will be output 100% Black; Indicating a preserved characteristic.

If instead the electrons exiting the Colour ports are put through a Hardness box, the electrons from either port produce half Hard and half Soft output bits. This shows no correlation between Colour and Hardness.

If the electrons entering the hardness box are 100% white, they exit 50% hard and 50% Soft. If either 50% output electrons are put into another Colour box they come out 50% White (25% of original total electrons) and 50% Black (25% of original total electrons); indicating that the formerly preserved characteristic associated with 偓olour偄utput has not persisted beyond the second box of different orientation.

偪ardness偁nd 偓olour偁ave never been measured simultaneously. That is to be expected if the Colour and Hardness bits result in part from gyroscopic rotation. A gyroscope can not be rotating about two differently oriented axes of rotation at the same time. (The other part is local magnetic field orientation and direction, not inherent in the particle.)

To take up a new orientation or spatial direction of axis of rotation the former has to be relinquished.

Analysis

For vertical colour box and orthogonal hardness box.

The electrons in the first colour box are sorted according to temporary preference of alignment in that field Up/North>>>White bits, OR Down/South >>>Black bits. Having not yet met the orthogonal field they have no preferred direction (of the two possible) alignment in it.

White exiting electrons enter the Hardness box. They meet a field which is half way between the vertical field they have left and 180 degrees rotation of the field, reversing its direction. Having just two ways to align, they align from Vertical North Up aligned to either orthogonal South (Away) (pole would be the opposite if 180 degree rotation of field was completed), producing a soft bit, OR orthogonal North (Towards) producing a Hard bit.

The electrons respond individually to the orthogonal field as they encounter it and take up one of the two directions of axis of rotation corresponding to that local field encounter. Only two directions because aligning axis of rotation parallel or anti-parallel to the field is how a gyroscope behaves.

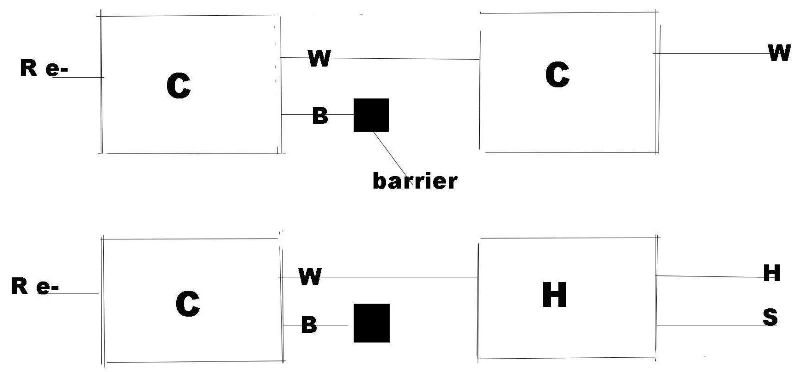
Having later taken up preferred direction of alignment in the hardness box, that will give Hard and Soft bit outcomes, the elections no longer have a preferred direction of alignment in the Colour box. The Colour box僫magnetic field is 90 degrees to the Hardness box magnetic field. Half way between unchanged and inverted at 180 degrees. Experimental results show that there is equal probability of the axis of rotation taking either of the two possible orientations. Showing Colour is not a permanently preserved property. Using another Hardness box will show that Hardness is not a permanently preserved property either.

Relating box outputs to electrons axis orientation designations used for experiment 1.

There is uncertain recovery of outcome preference after intermediate different orientation test. Electrons that gave one kind of Hardness bit outcome are selected for another Colour test. If Orthogonal Hard bits are produced from North Towards axis orientation and Orthogonal Soft is obtained from South Away axis orientation: If the electrons giving the just Hard outputs are selected, their axes of rotation must not remember former orientation at last Colour test, in order to give both Colour bit outcomes. The two different bit outcomes indicate two orientations of axes within the vertical field; North up and South down; obtained from different directions of alteration to achieve alignment. All resulting in the necessary orientation change. Overall there is no energy saving benefit of one direction of movement to reach alignment. Or difference in resistance to movement favouring one direction of change. As that would give more of one outcome Colour bit than the other. Indicating North or South seeking flow can vary according to circumstance, the relation of gyroscopic spin to local magnetic field direction, and is not a fixed identity or property of the electron particles.

<u>Simplified diagram of sequential tests.</u>

R e- = random electrons in (from source).

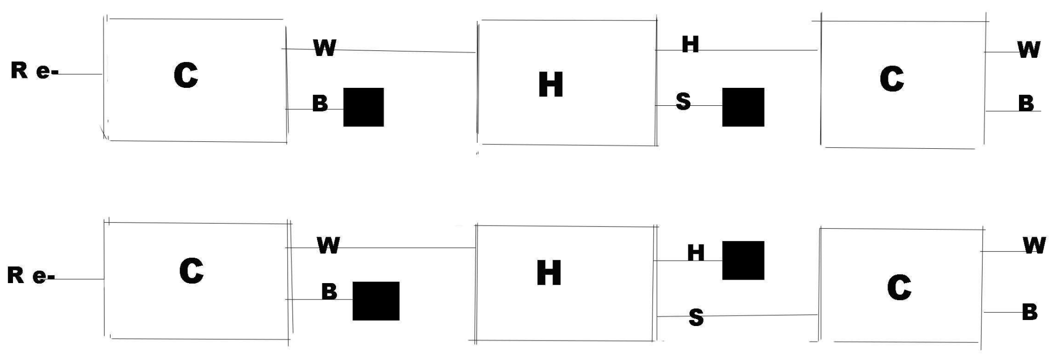


1

Shows output bit type *is preserved* when same test is repeated. Same would be found if black output was re-tested instead.

2

Shows there is *no correlation* between colour and hardness. Same would be found if black output was used instead.



3 The last two tests sequences shown indicate that the sole output bit type *is not preserved* after exposure to a differrent test (orientation of apparataus).

Simplified diagram

The boxes are diferent orientations of Stern Gerlach apparatus may be oriented at 90 degrees to each other.

Or three different orientations at 0, 120, and 240 degrees, Colour, Hardness and Whimsy, will lead to the three conclusions shown here.

Mirrors used to deflect electron beams do not change the axis of rotation orientation of the electrons or alter their clockwise or anticlockwise rotation. that is what is expected if the electrons are aacting as weightless gyroscopes.

Bell儇inequalities

The results are not what would be expected for a fixed property, the usual classical assumption. Change of orientation of apparatus is altering output bit states away from expectation, for classical proportions of a population of fixed properties.

An electron with axis of rotation oriented in the x direction does not have an axis of rotation oriented in the y or z direction. An electron with axis of rotation oriented in the y direction does not have an axis of rotation in the z or in the x directions. An electron with an axis of rotation in the z direction does not have either an axis of rotation in the x or in the y direction. For this reason the Venn diagram often drawn to show 3 different properties shared among a population does not apply. The characteristic the electrons have is their rotation, which of the two, clockwise or anticlockwise conveying North or South seeking propensity. The direction x, y, z of the axis of rotation is a result of the relation between the clockwise or anticlockwise rotation of a particle and the external field orientation in three dimensional space and its direction (which is not inherent in the particle). Bell's inequalities don't apply. That being the case for electron paraticles, it may be possile to extend the argument to other kinds of particle.

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Experimental validation of principle

The gyroscopes don't need to communicate to co-ordinate keeping their correlation or to loose it. This un-spokifies spooky action at a distance, at least for electrons..

The 偓ot so spooky semblance of action at a distance of the gyroscopes can be demonstrated either by using big magnets and tiny macroscopic gyroscopes in a weightless or micro gravity environment. Use of a vacuum or low pressure environment could more accurately simulate the environment within the Stern Gerlach apparatus. The gyroscopes could be set up so the gyroscopes have neural buoyancy in a liquid- though energy loss due to resistance of the liquid may be a problem.

There may need to be adjustment to comply with convention, spin being opposite to current turn rather than same as in this illustration. I will leave that decision to the scientific community. Relevant is whether gyroscopic spin ought to be considered a form of current (which by convention moves opposite to the movement of electrons, or should this kind of rotation movement be considered as something completely different, to which convention does not apply.)

Appendix

Relevance to formation of chiral molecules?

The particles are produced as a pair with opposite rotation. (Electron pairs in an atom are likely to have this relationship, canceling out each other僫angular momentum.) They do not change from one type to the other but keep their own rotation in relation field orientation. Temporarily preserved clockwise or anticlockwise rotation at the level of sub atomic particles may be relevant to the puzzle of why there are chiral molecules (molecules with handedness).

What about silver atoms? An idea

How about picturing the atom, like a drone swarm of gyroscopes? Each particle is individual but the whole atom is held together in its form by the attraction of electrons to the nucleus and mutual repulsion of electrons, except for electron pairs with opposite axis of rotation orientation, That allowing a figure of eight dance composed of the two different rotations, which gives stable proximity rather than repulsion and a canceling out of angular momentum.

The gyroscopic spins of the paired electrons will balance and cancel out any movement that would occur with just one. Depending on relative orientation of that single electron, parallel or anti- parallel to the magnetic field encountered, (it will adjust if necessary to be one of those options.) if the atom ensemble is considered weightless, as gravity is minuscule at this scale com All the electrons are paired thus, except for the lone outer one. Its rotation combined with the environmental field will give a force acting on the electron (rhr). The weightless atom will move with the singleton outer electron. Moving with the flow of the electron.

References

[1] 偣Demonstration with conducting gyroscope in a magnetic field偘K N Baranskiΐ 1968

American Institute of Physics Soviet Physics Uspekhi, Volume 11, Number 2

[2] MIT OpenCourseWare 8.04 Quantum Physics I, Spring 2013 via YouTube
https://youtu.be/lZ3bPUKo5zc
Instructor: Allan Adams In this lecture, Prof. Adams discusses a series of thought experiments involving "box apparatus" to illustrate the concepts of uncertainty and superposition, which are central to quantum mechanics. License: Creative Commons BY-NC-SA

Thanks;
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