Antiparticles and the nature of space

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Abstract

Fearnley (2020, Ref. 2) shows that if positrons, the antiparticles of electrons, travel backwards in time then the Bell's Theorem experiment correlation result (Wikipedia, Ref. 5) can be achieved using classical physics calculations. This would involve a mundane bypassing of the Bell Inequalities instead of a spooky breaking of them. Fearnley (Aug. 2018, Ref. 7 and July 2018, Ref.8) and Farnes (Dec. 2018, Ref. 9) show that particles with negative mass can explain gravitationally both dark energy and dark matter. The current paper brings together these two models in one place and gives an antiparticle with negative mass and also travelling backwards in time. In this paper the idea is raised of a specialised type of space to be the environment of antiparticles, where the space occupied by antiparticles is an opposite-handed (geometric algebra) space to the space occupied by particles. The universe as a whole occupies the same handedness of space as does particles. Time runs backwards in the space of antiparticles compared with the direction of time for the universe and for particles.

Introduction

A paper by James M. Chappell et al: *Time As a Geometric Property of Space* (2016, Ref. 1) has time as a dependent scalar dimension within a geometric algebra description of space. This generally fits with my own view that the direction of time is equivalent to the sign of the trivector, which is a pseudoscalar; either + or – being the sign of ε_{ijk} in geometric algebra. Time thereby being the direction of torsion in a trivector or volume of space as described by geometric algebra.

Negative time

A trivector volume in geometric algebra can have orientation + or -. My model assumes that the two trivector orientations correspond to two opposite directions of time. One direction is the positive time direction of particles and of the macroscopic arrow of time corresponding to an increase of entropy. The other, opposite, direction is the direction of time for antiparticles. To achieve this, the universe as a whole must have the + trivector space wrapping around everything. Within the universe, particles have their own + trivector spaces while antiparticles have their own - trivector spaces. There is nothing absolute for the nature of time about the + overall - trivector. If the universe had an overall - trivector space rather than a + space, we would not be able to detect any difference arising from this change in how time passes for us. Antiparticles in such a universe would have + trivector spaces. What is important is the relative time directions of two spaces where one space is embedded in the other.

Thus if we represent a + time direction of outer space wrapped around a - time direction of inner space as [+(-)], then the four possible pairings are: [+(+))], [+(-)], [-(-)] and [-(+)].

The symbols [+(+))] and [+(-)] could represent time for particles and antiparticles respectively in our universe. However, [-(-)] and [-(+)] could equally well represent time for particles and antiparticles respectively in our universe. What is important is the use of the same sign (as has the universe) for particles and the opposite sign for antiparticles. We have no way of knowing the sign direction of time in our universe, and that sign would only be important if there were a sign of an even further-out space, denoted by '{}', wrapping around out universe, such as {-[+(-)]}. Whatever the sign of the time direction of our universe, we see it as our direction of increasing time because we and all macroscopic bodies are made from particles (rather than antiparticles) for which the laws of thermodynamics apply to increase entropy.

Negative mass

Papers from Farnes (2018, Ref. 9) and Fearnley (2018, Refs. 7 and 8) associate dark matter and dark energy with effects of negative mass. These papers use Newton's Laws simply with –m being substituted directly into those laws when the mass is negative. This results in negative masses accelerating one another away from each other gravitationally; positive masses accelerating negative masses towards themselves; and, negative masses accelerating positive masses away from themselves. The first effect of –m on –m results in dark energy with the space between galaxies expanding continuously. The second effect of +m (active source) on –m (passive source) results in a dark matter halo of negative mass surrounding galaxies. The third effect of -m (active source) on +m (passive source) results in galaxies holding generally their compactness as the universe expands. Distances within galaxies do not expand as quickly as distances between galaxies. In both authors' papers, movements of masses are simulated, though in my paper the simulation is only in one dimension and is non-relativistic.

It should not be assumed that an antiparticle has positive mass merely because it falls under gravity to earth. Both positive and negative masses would fall to earth because positive masses attract negative masses as well as attracting positive masses.

Feynman and Stuckleberg (Refs. 11, 12 and 15) have both pronounced on properties of antiparticles. It is generally accepted that a positron can be viewed as an electron moving backwards in time, but only as a mathematical contrivance. My view is that a positron is an electron moving backwards in time and that it is a mathematical contrivance, and a physical necessity, that observations on it can only be made from a forwards-in-time point of view (by macroscopic instruments and observers). So the backwardness is real while the forwardness viewpoint is merely the best we can do to observe an antiparticle.

Newton's Laws ensure that antiparticles with negative mass cannot form massive macroscopic bodies, so there will be no antiparticle planets, stars or galaxies in our universe. Particles can form such macroscopic bodies because particles have the same arrow of time as does our universe and hence have positive masses. But there is nothing absolute in what is a particle or antiparticle. If our universe had had a reversed time direction then our particles would have been antiparticles and vice versa. Returning to the Feynman idea of a positron being an electron travelling backwards in time, then both particles and antiparticles have intrinsically, or actual, positive mass in whatever actual time direction they are travelling. Negative mass only arises in the inside of the macroscopic universe which, along with its macroscopic observers, cannot cope with observing the antiparticle travelling backwards in time. So negative mass is an observer effect rather than the intrinsic sign of a mass. Here, the universe is treated as an observer which is travelling in the opposite time direction to the antiparticles.

Direction of causality for particles, antiparticles and the universe

Antiparticles travelling backwards in time could be said to have used the communication or conspiracy loophole to Break Bell's Inequalities. The Bell's Inequalities are, however, irrelevant to the retrocausal physics of a Bell's Theorem. The details of a Bell's Theorem experiment using retrocausality (because of antiparticles travelling backwards in time) are given in Fearnley (Ref. 2). It may be seen that measurements on antiparticles travelling backwards in time are made when those antiparticles were not entangled. This means that entanglement is not responsible for the Bell's Theorem correlation of $-\cos\theta$. Instead, polarisation plays the key role in achieving $-\cos\theta$ in a retrocausal explanation.

At a measurement, an antiparticle becomes polarised after (but remember that 'after' is in the antiparticle's backwards time frame) that measurement in or against the spin or polarisation direction of the detector. Positrons arriving (backwards in relation to the macroscopic time direction) at the source are hence arriving polarised or aligned in the spin directions of Alice's or Bob's detectors. At the particle pair creation event at the source, the partner electron is created with opposite spin and polarisation to the positron which effectively transfers the exact spin and polarisation of the positron to the partner electron.

This means that (say) Alice measures partner electrons pre-polarised at an angle θ to her detector's setting. This makes a Bell's theorem experiment very similar to a Malus's law experiment, and the intensities from a Malus experiment correspond exactly with a Bell correlation of $-\cos\theta$. Full details of the straightforward mathematics of this retrocausal derivation of the Bell correlation are given in Fearnley (Ref. 2).

The macroscopic arrow of time is not compromised

Time's direction is above defined for microscopic antiparticles relative (and opposite to) to the enveloping universe's arrow of time. The arrow of time for an antiparticle *needs* the universe's arrow of time to function properly in relation to it. There is no threat to the universal arrow of time in this definition of a particle's arrow of time. Similarly, in a geometric algebra calculation, the trivector orientation for the whole calculation needs to be set as having a + or – sign, and there is a standard usage of one of the signs for the environment of the whole calculation. (Though time plays no role in the normal usage of geometric algebra.) Retrocausality is normally ruled out as a possibility because the universal arrow of time is seen as being compromised by antiparticles travelling in the opposite time direction. I do not have that same view. In fact, there is very little to consider in a positron's retrocausality. A positron changes spin and changes its weak isospin at every interaction where a photon is emitted or absorbed. There is a toggling back and to from spin +0.5 and weak isospin +0.5 to spin -0.5 and weak isospin zero at every positron interaction. It is impossible to prove whether the causality is in one direction or the other as so little can possibly vary. There is actually a little more scope in a series of such toggling of properties. An incoming particle has its polarisation angle changed at a measurement to that of the measuring device's polarisation setting. With retrocausality, the polarisation angle of a positron would appear to an observer to have the polarisation angle of the measurement device *before* it was actually measured. It is not possible to detect the polarisation angle as adding a new measurement in an extra, or test, interaction merely confounds what is to be measured. This really means that the polarisation of an antiparticle is unknown at a measurement. When Alice measures a positron in a Bell's Theorem experiment, the polarisation angle of the incoming positron is unknown, which is as good as it being an unpolarised particle. Bell's experiment uses a pair of particles which are assumed to have equal and opposite orientations but in a retrocausal explanation the pair of particles do not have a relationship with each other at the instants of the two measurements. So the Bell Inequalities are not applicable to the result.

There are no zig zags backwards and forwards in time for a particle or an antiparticle

Another difficulty assumed to occur with a retrocausal explanation is that zig zags occur for a particle zigzagging forwards and backwards in time. This does not occur in my model. Entities travelling forwards in time never travel backwards in time and, vice versa, entities travelling backwards in time never travel forwards in time. This also is true in my preon model (Fearnley, 2019, Ref. 10) where Standard Model elementary particles are composed of preons and their antiparticles or antipreons which travel always forwards and always backwards, respectively, in time.

Conclusions

A paper by Chappell et al (Ref. 1) equates the arrow of time to a dependent scalar dimension within a geometric algebra description of space. Time thereby being the direction of torsion in a trivector or volume of space as described by geometric algebra. A trivector can have opposite signs leading to my suggestion that particles have one sign while antiparticles have the opposite sign. This fits in with my paper (Ref. 2) having antiparticles travelling backwards in time, which allows a Bell's Theorem experiment to be simulated using retrocausality without breaking the Bell Inequalities and yet resulting in the $-\cos\theta$ correlation coefficient result which is equivalent to the CHSH S statistic being 2.8 which exceeds the classical bound of 2.0. In my retrocausal simulation, this bound is bypassed rather than exceeded. Bell's Theorem is of course true and very important in making one look for the true way in which nature operates to bypass the Bell Inequalities and retain a classical explanation.

Papers from Farnes (Ref. 9) and Fearnley (Refs. 7 and 8) associate dark matter and dark energy with effects of negative mass. A particle has positive mass moving forwards in universal time. An antiparticle has positive mass moving backwards in universal time. The universe must view the antiparticle as if it were a particle moving through positive universal time with negative mass and opposite charge (both QED and QCD) and opposite spin and weak isospin. This explains the macroscopic effects of Dark Matter and Dark Energy as a 'real' effect of 'apparent' negative masses. But, for a Bell's Theorem experiment, the actual time direction of a positron is backwards in universal time and the microscopic causation direction of the positron's change in polarisation angles at interactions is backwards in time corresponding to the positron inhabiting a microscopic space having a trivector with a reverse sign to that of particles and also that of the macroscopic universe.

These ideas do suggest an answer to the question of where are the antiparticles in the universe. Particles can form macroscopic bodies because their outer universe has the same trivector sign as them. To look for a region of space with a predominance of antiparticles, we need to find that part of the space of the outer universe which has the opposite trivector sign to our particles. But if and when we find it, our particles would have to be re-classified as antiparticles and our macroscopic forms could therefore no longer exist, and so we are unlikely to find a zone with a predominance of antiparticles.

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Appendix

Queries about the nature of time and space which represent 'further work required'

My assumptions have previously been, and still are for the nearby universe, that paths through time of a Standard Model particle never reverse their time directions. The prospect of a closed group such as S^3 representing the space of the universe, and time being a trivector property of space, raises the prospect of a Mobius-like (Ref. 14) structure of space so that the universal time direction may gradually change, but only on a universal scale. This closed structure may be relevant to the closed property of Unitary, where nothing is lost at an interaction of particles.

My preon model (Refs. 10 and 16) has sub-particles (preons) and anti-particle versions of these. Every individual Standard Model particle in this model is a combination of both preons and antipreons. If antipreons are travelling backwards in time, then all Standard Model particles are travelling BOTH backwards and forwards in time. This is also true for mesons, which are composite, not elementary, particles. This implies that all particles have no free will as their future preon paths are locked in to the past paths of their antipreons.

But what is this time, however, for preons? My preon model has electric charge as an aggregate of an equal amount of all three QCD colour charges. Also, my model assumes many multidimensions for QCD colour. In the red dimensions, matter may be travelling in the + or - red time direction. Preons are travelling in at least three separate time directions of colour dimensions R, G and B. This is in addition to the preons also travelling either for or against the universal arrow of time. It is possible that the fifth dimension of the Kaluza-Klein model should be replaced by three QCD coloured time dimensions, which if aggregated become a single, compactified QED time dimension (Yablon, 2018, Ref. 17). Multiple time directions do complicate finding a definition of what is an antiparticle: for example there may be a separate universe which is a QCD universal-red (say) spacetime which is just as important as our spacetime. This red-universe is not the version of a multiverse partner resulting from the measurement problem, and such measurement-problem universe-splitting multiverses are not required by my retrocausal model which re-introduces a classical explanation for a Bell's Theorem experimental result.

My preon model has multidimensions which are compactified dimensions on the lines of those in string theory. A preon model is similar to Supersymmetry (SUSY) in that aggregations and re-aggregations (at particle interactions) of preons form a method of transformation between boson and fermions (Ref. 10). My preon model does not, however, call for the existence of SUSY superpartners. Despite this complexity at a sub-elementary particle level, I see my preon model as compatible with classical-like interpretations of Standard Model particles of the kind which bypass Bell's Inequalities. (Ref. 2)