Reading 1

Abstract

The experiment, Reading 1, is designed to demonstrate time-flow oscillations. Qualitative and quantitative measurements on the Reading 1 apparatus that would demonstrate such oscillations are described. A positive result in the experiment would support the hypothesis that genuinely random events do occur in the universe and would demonstrate that time travel is practical at the level of individual particles. Some standard physical work needs to be done to test the feasibility of constructing the Reading 1 apparatus.

Introduction

We hypothesise that the direction of time-flow oscillates in *oscillating time*, but that genuinely random events, being point-wise in time and generally irreversible, ratchet *elapsed time* into a forward direction.

If this hypothesis is correct then removing random events from an experimental apparatus might demonstrate the effects of time-flow oscillations.

However, the standard interpretation of physics does not admit any genuinely random events in the universe. Where probabilities arise in physical theories they are said to be the best available mathematical description in the face of our ignorance of the true, deterministic position and motion of particles. This ignorance is ultimately justified by appeal to Heisenberg's Uncertainty Principle. On the other hand, some physicists hold that physics *is* irreducibly random. Genuine randomness is essential to the experiment Reading 1, so a positive result in the experiment would support the hypothesis that genuinely random events do occur in the universe.

This argument about the nature of probability in physics is about the interpretation we put on the mathematics. No mathematical result, nor any physical theory, need be changed if we change our interpretation of the nature of physical probability. Though if we do alter our opinion, we might go on to hypothesise and find physical phenomena that would not otherwise come to mind.

On the assumption that quantum probabilities *are* genuinely random, one way to remove some of them is with the Casimir apparatus. The classical Casimir apparatus is composed of two, parallel, earthed, metal plates in a vacuum. With the plates very close together some virtual particles are excluded from the space between the plates, but continue to appear and disappear at random in the surrounding space. The larger density of particles outside the plates pushes the plates together with a very small force that has been measured. In Reading 1 we will *not* use this force, but instead exploit the absence of the excluded virtual particles in the Casimir cavity. That is, we will exploit the lower degree of randomness, not the lower pressure of virtual particles.

We propose to construct the Casimir apparatus using silicon lithography, because this technology is well developed and can construct devices at the small scale required. It will also be possible to integrate computing elements with the experimental devices, so that a single computer chip can run the experiment and collect data. Experiments can then be conducted in many configurations, and at relatively low cost, by placing many experimental devices on a single silicon chip. If the experiment is successful, a major step will also have been taken toward delivering the devices in a technologically exploitable form - as computer chips.

In theory one could test any particle in the Reading 1 apparatus, but if the experiment were successful with photons this would demonstrate the possibility of time travel and faster than light travel. Naturally, our experience of the universe leads us to be very sceptical about this possibility, but there are other, more plausible, reasons to develop the mathematics needed to predict the outcome of Reading 1.

One reason arises from the mathematical fact that oscillating time is incompatible with spacetime. Spacetime records the geometrical shape occupied by a particle in both space and time, but a particle in oscillating time can be both present and not present at a point in space at every instant in oscillating time. Hence it does not have one position at an instant in oscillating time, so its (single) position cannot be drawn in spacetime. This means that oscillating time is incompatible with general relativity as expressed in spacetime, but elapsed time *is* compatible, because elapsed time describes the position of points fixed in time by random events. Thus elapsed time is compatible with all existing physical theories. Oscillating time provides an internal structure to time that can be exploited to build mathematical models of other phenomena. If the mathematical properties of particles in oscillating time can be arranged so that general relativity emerges in elapsed time, then it is a simple matter to unify quantum physics and general relativity. This too, might seem like an implausible mathematical goal, but there is a still more plausible reason to explore the mathematics of Reading 1.

The Perspex machine unifies projective geometry and the Turing machine. It is interesting simply as a novel computing device and also because of its applications in robotics. The properties of the Perspex machine could be explored with any kind of computation, but it will do no harm to explore the mathematics of oscillating time. In fact, the mathematical model of oscillating and elapsed time described here arises from the way a Turing machine performs operations in projective space in the Perspex machine. That is, the Perspex machine is a mathematical model of the kinds of time discussed here and is well suited to simulating the physics of a universe where time has both oscillating and elapsed components.

Apparatus

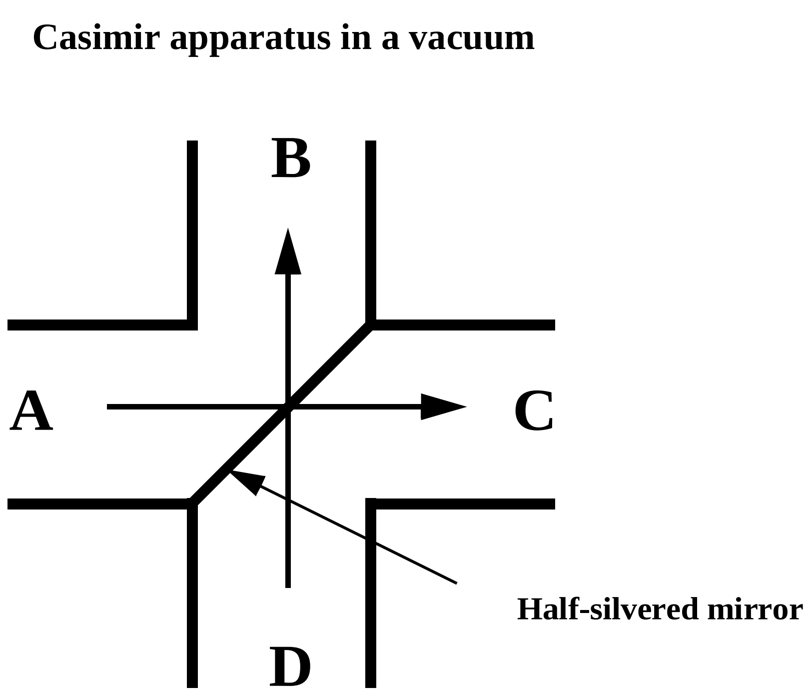

Figure 1: Intersecting, parallel, Casimir plates forming a cross, with a half-silvered mirror set diagonally across the intersection, and the paths of particles shown by arrows.

The classical Casimir apparatus is composed of two, parallel, earthed, metal plates in a vacuum. In Figure 1 two sets of Casimir plates intersect in a cross. The arms of the cross *A*, *B*, *C*, *D* are immersed in a vacuum. The walls of the cross are thick compared to the gap and are made of a conducting material. The arrows show the paths of beams from *A* to *C* and *D* to *B*. These are discussed below.

In the classical apparatus metal plates are used, but we expect that pure, doped, or gold-plated silicon will suffice. It would be sensible to compute what proportion of the Casimir effect is yielded by each of these materials.

If the experiment is to work then it is necessary to choose a particle for the beam and a separation of the plates such that the Casimir apparatus excludes some virtual particles with which the beam interacts. We hope that a sufficient reduction in the virtual particles will reveal time-oscillations, if any such exist.

The most irrefutable demonstration of temporal oscillations would be to show that particles move backwards in time within the apparatus. The simplest way to do this might be to show faster than light travel of photons, because any increase in the speed of photons demonstrates faster than light travel and this manifests as time travel.

It would be wise to compute the Casimir effect in the region of the intersection of the cross, and the mirror, in case changes in the optical density of the vacuum perturb the path of the beam of light in some way prejudicial to the experiment.

Experiment

Inject a pulse of laser light at *A*. When the beam hits the mirror it will bounce toward *B* if it hits silver, otherwise it will pass straight through to *C*. If the universe is deterministic and time were to run backwards then the light at *B* would hit the same piece of silver and would reflect to *A*. Similarly, light at *C* would pass through the same part of the mirror and retrace its path exactly, returning to *A*. Thus the history of the universe would be wound back by a reversal in time to where the light had not left *A*. Apart from the scattering of light at the mirror and in the walls of the apparatus, no light travels to *D* in either the forward or backward flow of time under a deterministic interpretation of physics.

Now suppose that the Perspex model of time holds. Photons from *A* strike the mirror and bounce toward *B* or pass straight through to *C*, as above. But suppose that time flow reverses so that the photons begin to retrace their paths from *B* toward the mirror and from *C* toward the mirror. We suppose that the Casimir effect prevents some of the photons being ratcheted into elapsed time in the arms of the cross, but that the position of the silver in the mirror is perturbed by virtual particles. Half the particles coming from *B* will return to *A*, but half will pass straight through the mirror to *D*. Similarly, half the particles coming from *C* will return to *A*, but half will reflect to *D*. Summing these two components, we see that half of the photons that are not ratcheted into elapsed time return to *A*, whereas half go to *D*. These photons at *D* are in addition to the photons that arrive by scattering and are all subject to a phase shift as computed below. Further, classical calculation of scattering would show what the intensity of illumination at *D* should be in the absence of time travelling photons, but it is unlikely that such calculations would be accurate enough to be helpful.

If this experiment is to give clear results it will be important to have very efficient photon detectors at *B* and *D* so that photons do not oscillate many times through the apparatus.

Even if an excess of photons is detected, or the systematic phase shift is found, it might be argued that this is an artefact of the construction of the apparatus. This may be countered by repeating the experiment by injecting the pulse of laser light at *C*. In this symmetrical version of the experiment all of the effects observed at *D* should now be observed at *C*. It is unlikely that a defect in manufacture could operate symmetrically in this way, thereby strengthening the interpretation that temporal oscillations are the cause of the predicted effects. Conversely, the phase calculations exploit an asymmetric mirror that is silvered on only one side, but this leads to a larger number of testable outcomes, making the experiment more falsifiable, and therefore stronger.

An irrefutable result would be to detect photons that have oscillated in time, before detecting those that have not oscillated in time. That is, when laser light is injected in a pulse at *A*, photons should be detected at *D* before those at *C*. It would be even clearer if photons were detected at *D* before being emitted at *A*. Again, the results should be checked by repeating the experiment in the symmetrical configuration with light injected at *C*.

Several devices could be strung together by passing the laser light along a long *A* to *C* arm with many *B* and *D* branches. Thus many different intensities of light could be tested on one chip. Many different configurations could also be tested by putting several of these long devices on one chip.

Phase Calculations

An asymmetric mirror, that is 'silvered' on only one side, is used to ensure that a negative phase retardation, $-\phi_1$, that is, a phase advancement, can be introduced which is incompatible with standard physics. If specular reflection at the mirror introduces a phase shift, ϕ_2, in the polarisation of the light, then up to four testable phase shifts are introduced, corresponding to the sum: $\pm\phi_1 \pm \phi_2$.

It is sensible to consider the properties of an asymmetric mirror, because these are easier to fabricate.

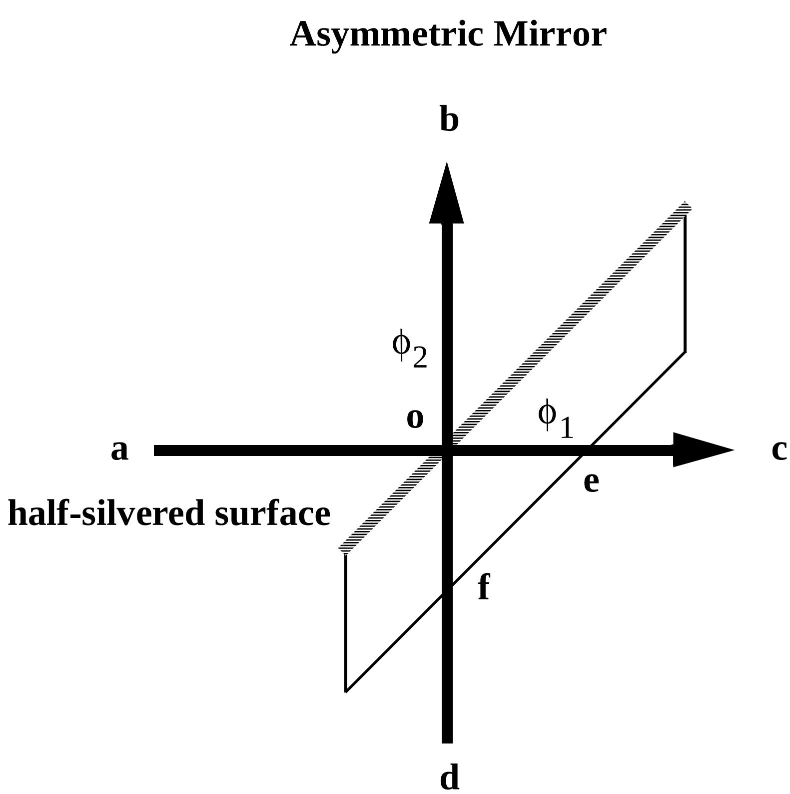

Figure 2: Asymmetric mirror with the paths of particles shown by arrows.

Figure 2 shows a half-silvered mirror where the 'silver' is applied only to the surface passing through the origin, *o*. The points *a, b, c, d* correspond, respectively, to points in the arms *A, B, C, D* of the apparatus shown in Figure 1. The ray *ac* intersects the unsilvered surface of the mirror at *e*. Similarly the ray *db* intersects the unsilvered surface at *f*. A ray of light passing from *o* to *e* in forward time is retarded by a phase ϕ_1. A ray of light specularly reflected at *o* from *a* to *b* in forward time has a phase shift ϕ_2 depending on the polarising properties of the surface of the mirror. In the simple case considered here, it is assumed that the bulk properties of the mirror are such that they preserve polarisation in a ray travelling through the mirror in either direction of time. This needs to be checked for silicon.

In oscillating time there are two paths by which particles emitted at *a* can arrive at *d*. Path 1 is *aobofd* and path 2 is *aoeceofd*. Similarly there are two paths by which particles emitted at *c* can arrive at *b*. Path 3 is *ceoaob* and path 4 is *ceofdfob*.

Table 1: Path 1 from A to D

Step	Effect	Phase Difference
ao		
oo	specular reflection in forward time	ϕ_2
ob		
bb	time reversal	
bo		
of	retardation in backward time	$-\phi_1$
fd		
Net Effect		$-\phi_1 + \phi_2$

Table 2: Path 2 from A to D

Step	Effect	Phase Difference
ao		
oe	retardation in forward time	ϕ_1
ec		
cc	time reversal	
ce		
eo	retardation in backward time	$-\phi_1$
oo	specular reflection in backward time	$-\phi_2$
of	retardation in backward time	$-\phi_1$
fd		
Net Effect		$-\phi_1 - \phi_2$

Thus light arriving in arm *D* that has passed through oscillating time on paths 1 and 2 will have a phase shifted by $-\phi_1 \pm \phi_2$ with respect to light at the source *A*. Therefore, we expect a local peak at these phases in the light that, on a conventional account of physics, arrives at *D* by scattering.

Table 3: Path 3 from C to B

Step	Effect	Phase Difference
ce		
eo	retardation in forward time	ϕ_1
oa		
aa	time reversal	
ao		
oo	specular reflection in backward time	$-\phi_2$
ob		
Net Effect		$\phi_1 - \phi_2$

Table 4: Path 4 from C to B

Step	Effect	Phase Difference
ce		
eo	retardation in forward time	ϕ_1
oo	specular reflection in forward time	ϕ_2
of	retardation in forward time	ϕ_1
fd		
dd	time reversal	
df		
fo	retardation in backward time	$-\phi_1$
ob		
Net Effect		$\phi_1 + \phi_2$

Thus light arriving in arm *B* that has passed through oscillating time on paths 3 and 4 will have a phase shifted by $\phi_1 \pm \phi_2$ with respect to light at the source *C*. Therefore, we expect a local peak at these phases in the light that, on a conventional account of physics, arrives at *B* by scattering.

Combining the results for light emitted from *A* and light emitted from *C* we see that up to four local peaks should appear in the phases of light arriving at *D* and *B*, respectively. These four peaks correspond to the sum $\pm\phi_1 \pm \phi_2$.

Things To Do

This list was first published on March 9^{th}, 2003. It will be updated as the work progresses.

1) Compute what proportion of the Casimir effect is yielded by pure, doped, or gold-plated silicon.

2) Choose a particle for the beam and a separation of the Casimir plates such that the plates exclude some virtual particles that would otherwise interact with the beam. (Photons of visible light are preferred, but photons in the microwave range might allow a larger apparatus to be built more easily than by using lithography.)

3) Compute the Casimir effect in the intersection of the cross in case changes in the (optical) density of the vacuum perturb the path of the beam (of light) in some way prejudicial to the experiment.

4) Compute quantitative predictions for Reading 1.

    4.1) Compute the excess intensity at *D*.

    4.2) Compute the phase of photons at *D*.
    Done 12^{th} March 2003.

    4.3) Compute the difference in arrival times at *C* and *D*.

5) Test the predictions (4) in the existing data of similar experiments.

6) Run specific Reading 1 experiments.

7) See if (6) supports the conclusion that the universe has random events.

8) See if (6) supports the conclusion that backward travel in time and faster than light communication are possible.

9) What are the polarising properties of silicon?

10) What are the polarising properties of half-silvered mirrors (beam splitters) that can be fabricated in silicon?