THE TONY CHADWICK PRIZE WINNING ESSAY

QUANTUM REALITY

by Trevor Pitts

Physicists insist that time must behave identically in their equations, either backwards or forwards. Supposedly, universal laws acting on identical constituents of matter somehow find the dispersed, precise atomic components of a rotted corpse, reassemble and re-animate it to then proceed backwards through life to be sucked back into the womb. Even the usual example of a glass breaking by falling of the table neglects the need to reverse gravitational attraction, resulting in the break-up of the Earth and the explosion of the Sun. This crude version of symmetry is essentially infinitely absurd, requiring huge numbers of particles to do impossible things for 15 billion years. A method of eradicating this nonsense was recently submitted for publication by the author. In my Symmetrical Time Hypothesis (STH), time is more like the space dimensions, which extend on all sides of the origin, the Big Bang. Time extends equally before and after the origin, expanding outward into the same space as ours, but the negative equivalent of the present is twice the age of the universe in the past. The Hypothesis is falsifiable, explains various strange cosmological observations, and makes predictions. The hypothesised antiuniverse on the other side of the Big Bang is populated by antimatter, (in accordance with the Feynman-Stueckelberg Interpretation of Quantum Electrodynamics) and everything runs backwards in time. The inhabitants won't notice, because time still expands outward from the origin, the same as space and time do here. They do not inhabit a reversed cinema film of here, but their and our physicists can calculate backwards in peace. The present is no longer bizarre and unique, it is simply the furthest point along the time axis that has been reached since the Big Bang started the simultaneous expansion of space and time, exactly symmetrical with the antipresent.

We are now free to consider our universe without a prejudice against the reality of the present moment, understanding that the discussion also applies to the antiuniverse. Nothing in Relativity prevents the slicing (foliating) of space-time in order to provide a preferred plane of simultaneity equidistant in time from the origin, throughout the universe. Nothing prevents our choice of the present as this plane. Nothing prevents this chosen plane moving outward from the origin as space-time expands. Even Relativity, however, can provide only a part of the present since vast differences on the microscopic level are equally consistent with relativity. For example, Hitler's brain in 1932 could be full of the *Mein Kampf* plans, or a plan to convert to Judaism and lead a crusade against the inhabitants of the British Mandate in Palestine. Einstein could tell the difference, but Einstein's theory could not.

If Einstein cannot halt the march of the present, can his rivals Schrödinger, Heisenberg and the other Quantum theorists? Quantum theory has deep problems with the present moment, if we assume there is only one present moment, not a near infinity of rapidly diverging alternative presents. Even if we accept this 'many worlds' version, there is nothing in Quantum Theory that pins down any part of any of the many worlds as a version of now. So we can dismiss this

version as not merely ugly but useless for this discussion. We can arrive at the present via a 'collapse' of the wave function into one particular solution out of a wide variety of alternatives. Physicists are deeply sceptical of this process. The most principled objection to the collapse of the wave function is based on the fact that the wave equation is symmetrical in time, so why should a progressive evolution in time and one-way collapse occur? The STH removes this objection, as the wave equations can run backwards and collapse backwards in the antiuniverse. Since we are no longer afraid of Einstein, why not ask what happens if we collapse the only complete wave equation, that of the whole universe? We form a simultaneity plane, a preferred now, across the whole of the universe. Quantum interactions are instantaneous, regardless of distance, so everything happens at once, everywhere. Relativity is not violated, since the past and future cones in Minkowsi space-time have zero volume at the instant of the present, so that relativity cannot absolutely determine the present.

Quantum Electrodynamics is the most successful and most exact theory in the history of science, so exact that an archer could hit a bullseye on the moon, if blessed with equal accuracy and enough range. In QED we arrive at the calculated values by summing the totality of the routes to an effect in such a way that every route contributes but the more 'reasonable' routes contribute most. So putting Einstein and Schrödinger together, what is the picture? The worldlines of the totality of the past, including random events, relativistic effects, chaos, self-limiting criticality (e.g. earthquakes, sandpile collapse), the decisions of living entities, and the relevant divergence in the universal superposition of states, are summed and a part of the universal wave equation becomes the next moment of reality. Roger Penrose's 'U-process', the continuing evolution of the wave equation is the framework in which his 'R-process', the reduction of the quantum state vector (collapse of the wave function), is embedded and formed. The processes are not antithetical, they are simultaneous, a part of one another. To repeat, a part of the wave function becomes reality. Some of the wave function continues in the 'U-process' and interacts with the new reality to create the next moment.

If we imagine an awesome superposition of states of all the possible initial conditions of all the possible universes after the Planck time, surely no-one will begrudge us an original collapse into the initial conditions here in our universe. The front of simultaneity created by this reduction of this Meta-universal state vector then propagates outward in time throughout the expanding space, now filled with all the mass-energy we have to play with. Let us call this front 'Quantum Reality' or Reality for short. Its thickness along the time axis is at least the Planck length. In the STH, Reality is a continuing collapse of the universal wave function. It is a front of creation, the only moment of time, the same moment as the Beginning. It can be seen that this is consistent with Occam's Razor, since we have asked only that the universe should have once firmed into Reality. We need ask no more of the wave equation.

Behind this front in, for example, our particular place the solidly determinist Einstein 'block time' is left for the delectation of distant observers, who can do nothing to change it. THEIR perception of the precise part of OUR past that they are observing will, however, shift radically with small changes in their velocity. All that they see, of course, is a pattern of waves crawling

across the universe at the speed of light. The distant observers will eventually be changed by the pattern and all will appear as Einstein calculated. The pattern is included in the universal superposition of states until some part of it interacts with some aspect of distant Reality. In our particular part of space then, 'the moving finger writes and having writ, moves on'. Omar Khayyam would continue: 'nor all your piety nor wit, shall lure it back to cancel so much as half a line, nor all your tears wash out one word of it'.

Perhaps at this point we should consider the Wheeler-De Witt solutions to Einstein's field equations. If these indeed produce a frozen universe with no time, we cannot reconcile Einstein and Schrödinger after all. Apparently, the solutions depend on the total energy of the universe being exactly zero, gravitational energy being given a negative sign. This may have made some sense in the days of the closed (Big Crunch) or asymptotically flat (expansion stops at infinite time) universe models. Now, fortunately, we have observations indicating not only that expansion will continue forever but that the pace of expansion is increasing. So there is a shortage of gravity. It has also been argued that the zero-point energy of the vacuum may exert the required repulsive effect, increasing as the amount of space increases. In this case, why should the total energy of space-time be zero? Surely more vacuum means more zero point energy? That the universe should have zero or even a fixed positive total energy, is a pleasant thought, but pleasant thoughts have had a high attrition rate in science.

In the Quantum Reality (QR) picture there is no past or future. Outside the present is an unimaginable nullity, a void without even a vacuum. As reality continues to solidify it appears that we are moving onward in time in a 3D universe where everything is being diluted by increasing space. Since only about a billionth of the universe is not radiation, and since the bigger the space the more rarely radiation interacts with matter or other radiation, all except a billionth part of the universe is now in a superposition of states. The future is open, but it is a narrow opening. The QR view of free will is very subtle. The future depends on our decisions, which are based on all prior events, but we are a nexus through which the future is determined. For an example where free will might lie, if there is any, imagine a scuba diver. Like all of us at all times, the diver's brain is bathed in mood altering hormones and active chemicals of many types and effects. When divers hyperventilate due to fear and/or too much exertion the fall in carbon dioxide in the blood triggers a cascade of chemical and mental events. Without a great effort at calmness and deep breathing, the result is a runaway feedback effect: panic. Panic is the cause of most deaths among divers. You either master your emotions or you die. Anyone who has experienced this will conclude that his fate is in his own hands.

Less dramatically, perhaps we may concede that a mobile autonomous decision maker of our type effectively has free will if the present allows him to determine his future. Perhaps if we are fully aware of the moment and not daydreaming or gripped by greed, lust, fear, etc., we can integrate our needs and desires in more desirable ways, grasp our part of the wave function and turn the outcome to a better result. Perhaps there are profound religious and motivational consequences if we wholeheartedly accept that now is all there is. In the way that artists have

used skill and creativity within the constraints of convention to produce beauty we can use the constraints of circumstance to do the same with life.

Perhaps the more cogent objections to determinist theories lie not in the future with free will, but in the past, at the Big Bang. Science aims to produce complex outcomes by simple laws acting upon particles which within each type, are indistinguishable. An absolute determinism of the Einstein type seems to require every quark that appeared soon after the origin to have an immense script to tell it where to be, forever. We need our quark soup to be a little stirred, to produce inhomogeneities from which galaxies can form, but each quark must be identical. The idea of a quark version of alphabet soup near the Big Bang is deeply repellent. A more conventional way to phrase this is to object to extremely detailed boundary conditions at the origin. There is also an objection in the indefinite future in that more and more events seem to be a consequence of various complexity theories, e.g. chaos, and there are also known evolutionary mechanisms which select randomly generated changes to dominate the future composition of species, human cultures, or economic arrangements. Such mechanisms work to amplify any tiny amount of randomness or quantum uncertainty to an overwhelming scale over billions of years. Einstein's extreme determinism can therefore afford not a single undetermined event in the whole history of the cosmos. Einstein is of course absolutely right if we confine ourselves to all that we can measure, the past, since Reality always obeyed Relativity. Indeed it is illuminating to reflect that physicists complain that the present does not drop out of their equations. Quantum Theory and Relativity purport to be valid for the whole of time. How can we expect now or last Tuesday to drop out of such constructs?

In conclusion, now is a moveable feast and we find it by observation, then put the right numbers in the universal equations.