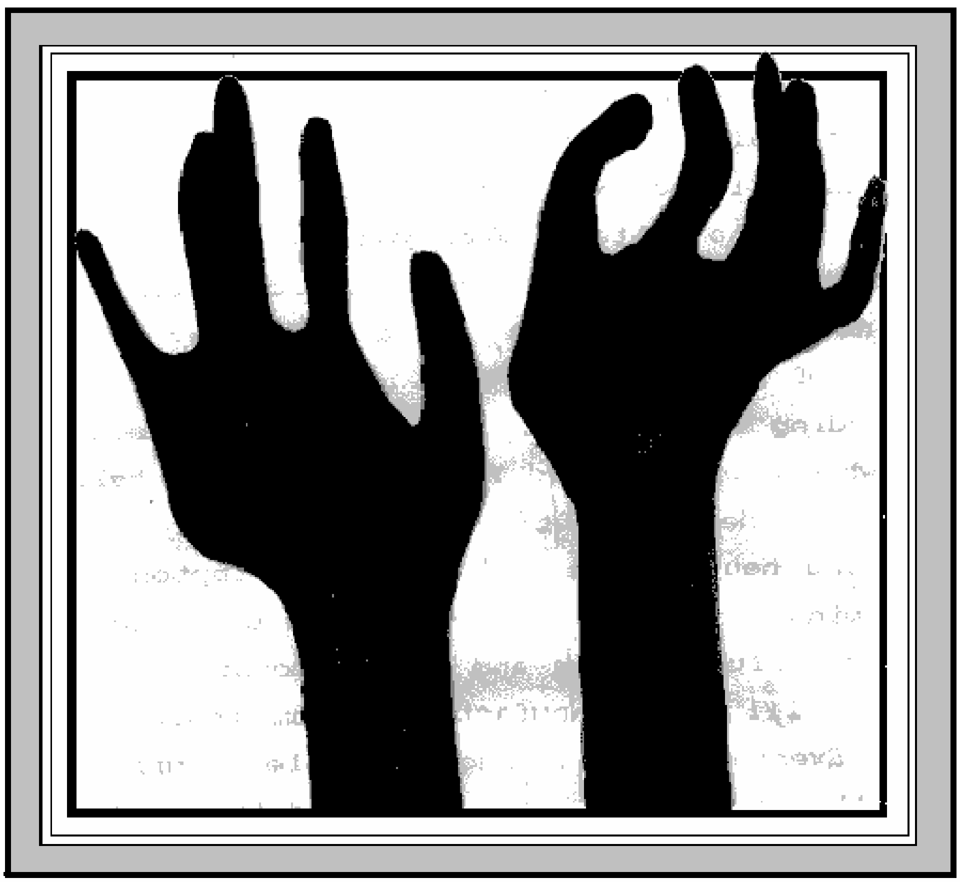
Stage 1

There is a Problem

Who is as the wise man? and who
knoweth the interpretation of a thing?
The Preacher



Please help!

WITHIN US ALL THERE IS A NATURAL DESIRE TO KNOW. Given this curiosity, questions arise for the creative mind to answer. Usually these are straightforward questions concerning the immediate requirements of life, but sometimes profound questions surface, deep answers to which are not immediately forthcoming. Who am I? Where did I come from? What is the purpose of life? Is there life after death?

Christian theology says you are a child of God with an indestructible soul which survives bodily death, and that the purpose of life is to do the will of God. But who is God, and what is his will? What is the soul?

Biological science answers such questions in a very different way. It says you are a biological organism which has developed through your lifetime from a single cell that encoded information from your parents' cells on how to unfold and grow into a potential parent yourself. According to bioscience, this reproduction *is* the purpose of life which has gradually developed from a primeval molecular soup by a process of blind evolution through natural selection by the survival of the fittest. When you die, you, as a conscious thinking individual, are totally extinguished along with your body: you are no more. But what *exactly* is a molecule? And what is the true explanation of MIND?

According to modern astrophysical science, a *molecule* is made of atoms whose nuclei were created from hydrogen and helium nuclei inside stars during their natural evolutionary process. Hydrogen nuclei (protons) and neutrons came from a quark-lepton fireball in the first second of the evolution of the universe. Within a few minutes some deuterium, helium and small amounts of lithium and beryllium nuclei were manufactured from these protons and neutrons. Eventually the nuclei cooled sufficiently to combine with electrons to form atoms and these atoms clumped together to form galaxies and then further coagulated into stars which exploded and coagulated again and again. As for the *mind*, psychological science considers it to be an epiphenomenon of the brain; a spontaneous emergent property of the exceedingly complex neural network. But what *exactly* are quarks and leptons? And how could *consciousness* appear from a physical conglomeration, however complex?

Answers to questions themselves give rise to questions and they to more. Is there no end to questions? Even an onion which has many layers has a heart that somehow accounts for its characteristics. What explains Nature herself? Can there be such a question which, if answered, would answer all questions? There is a perennial problem in science. Ignorance.

For Christian theology the problem is yet more serious than this. Adam sinned against God and thence mankind needs redemption before he can 'see the light'. In a story about Jesus, the redeemer, no man cast the first stone on the woman because all of them, in effect, acknowledged their sinful nature. There is a problem just being human? Sin.

Physics, the most fundamental science, traditionally concerns itself with what is objective reality. The word 'physics' comes from $\phi\upsilon\sigma\iota\kappa\alpha$ meaning *things of nature*. In its highest traditional expression, physics looks for basic constituents, elementary particles, in terms of which the entire objective world can be explained. But even if it is completely successful and proves beyond doubt that everything we see around us is made ultimately of quarks and leptons, there still remains the question: why do these particular elementary particles exist and not different ones?

Cosmology is that branch of physics which attempts to explain why anything at all exists in the first place. The universe is observed to be uniformly expanding. Projecting backwards in time, apparently the whole universe started about fifteen billion years ago from a dense small point. But why did it start? Whence existence? There is a problem. Existence.

If there is more than a certain 'critical' amount of matter in the universe then current cosmology says that the whole universe will stop expanding and begin to contract, returning to the small dense point. Everything in the universe will return to its original state. Biological life will return to mere molecules, molecules to atoms, atoms to a quark-lepton fireball. Quickly, that too will be snuffed out in a black hole singularity. Everything biological, chemical and even physical, will die and return to its pre-elemental nature to be described *without any* temporal or spacial or structural characteristics.

Even given the fact that some of a parent's traits survive genetically in their children, in some sense representing immortality, nevertheless their children's children's children's ..... children will ultimately surely die in a biological sense, and then in a chemical, and then a physical sense, in the ultimate fate of the universe as a whole. There is a blatant problem. Death.

In our day people think little about death. Few have sufficient faith in traditional religion to feel totally confident about an indestructible soul. Most seem to take it for granted that death will be the end: at death consciousness will fade to nothing, leaving nothing of the life that was; no perpetuation in spirit, no heaven, nor hell, nor reincarnation.

To kick a brick is sufficient evidence of materialism for materialists. But materialism is an outdated philosophy. It is too superficial to be of any real value in delivering meaningful answers to serious questions about the experience and nature of self-death. Unless a deeper philosophy is furnished and quickly becomes accepted by people at large, society will crumble, as societies have before, because it will have no essential optimism for the long term future and no selfless motivation to seek after pure truth.

In this particular period of history, when rapid change is all around us, there is another problem; violent conflict. In other words, look, it really is getting VERY DANGEREOUS NOW!

❶ Questions: Can there be an end to suffering?

"LIFE IS SUFFERING" said Gautama Buddha around 500 BC. Why did he say that? Was it because so many people in the world happen to find themselves in appalling circumstances? Was it because we all suffer life's tribulations at some time or another. Or was it because most humans, however well off, always seem to want a bigger house or a better car or just more fun and more money? It is not often that you hear of someone giving away most of their money just because they feel they have too much. By equating value with money, everyone, almost by definition, wants more.

Life sometimes does seem to be a struggle to earn a living, eke out an existence, compete with whatever elements. Stop eating! If that is no problem then it will be in a week. Stop breathing! If that is no problem then it will be in a minute. In fact, if we don't continually keep our life support systems running then we are just one moment from death. What a responsibility! Perhaps it is as well that we are generally unconscious of these functions, otherwise we might forget, mishandle or play with the vital controls. Who has the patience to keep their heart ticking faultlessly for a hundred years? One would be well advised to master self control before approaching such powers. Is this why we suffer; deep rooted fear?

Perhaps Buddha was referring to the anxieties we sometimes inflict upon ourselves when we ask pessimistic "what if ...?" questions. Anyone with a comfortable life can spoil their contentment by dwelling on a lamentable past or on negative future possibilities. Either we have a life of real problems and difficulties or else we are apt to invent or imagine them. Either way we suffer.

Is it possible to be truly and constantly *ecstatic* then? Anything less than ecstasy involves a degree of suffering. Faced with the ultimate prospect of death, and an intermediate likely prospect of some pain, it is hard to see how *total ecstasy* is achievable. Only by some way managing to escape the grip of death does it seem possible to cast off suffering entirely. Until then we are stuck with problems of one sort or another.

On the intellectual level, there is a problem unless one has a completely unified credible satisfactory explanation for *everything*. Once religion assumed this rôle. Now science provides astonishingly concise and beautiful alternative explanations of very many natural phenomena. Theoretical physicists are currently expressing the view that the final explanation of everything might soon be found. Unless they reject all the following concepts as superficial, they ought to be able to present their theory in a way which shows how these concepts fit into the general scheme: truth, goodness, beauty; faith, hope, charity; peace, love, courage; honesty, humility, dignity, virtue; happiness, enchantment, joy; wisdom, prudence, understanding; zeal, loyalty, devotion; purpose, meaning, responsibility, justice; grace, charm, value; wonder, awe, amazement, astonishment, rapture; righteousness, holiness, divinity. Any unified *theory of everything* that mentions none of these notions is completely missing the human dimension unless they can be explicitly reconstructed. Otherwise they might as well all be totally disregarded as being of no fundamental consequence whatsoever.

As there is no largest number, so there is no final question. (What is the number after that one?...) Even if there was a general theory that accounted for everything, unless it was totally understood *intuitively* one could still ask of it any number of difficult questions reflecting different specific conditions in this chaotic world.

Scientific method itself is sometimes considered as a meta-theory which can be applied to yield answers (theories), and that it is about to yield the final answer to the most fundamental of questions. But scientific method does not only involve verification of a theory by testing against observations. This could be conceived as a mechanical process. It involves the difficult creative act of induction of generalities from particulars.

Remember Bob Hope said: “He who generalises generally lies!” Inventing accurate new theories is NOT easy. The criteria for accepting a scientific theory involve gauging the veracity and surprising novelty of predictions, measuring the simplicity, elegance, economy and beauty of a theory, and weighing the value, import, content and generality of an explanation. Are not these teleological, ethical and aesthetic measures doomed to be outside the scope of any scientific theory? What then is their status in a scientific theory of everything? What indeed are the limits of science?

According to *quantum* philosophy, the characteristics of physical phenomena are fundamentally defined by the questions we ask. The way an observation is made determines the concepts that can be meaningfully applied to the resulting observed phenomenon. Thus the rôle of the inquisitor actually takes on an active significance. It is through questions that we can find out about the world. Indeed it is through active questions that the world takes on specific shape and size and structure. Generally, in order to ask a question of a scientific theory, an apparatus must be carefully set up in order to ask the question of nature. In quantum philosophy the interaction between apparatus and nature is so intrinsic that the properties ascribed to nature can not be extricated from those of the apparatus. Nature does not present herself for an inspection of her absolute appearance but rather changes her very heart according to the intentions of the inquisitor.

According to Buddha, the enlightened, or aware, or undeluded one, liberation from suffering is to be achieved by higher states of consciousness, leading ultimately to nirvana where one is finally freed from the cycle of birth and rebirth. In quantum philosophy the interaction relating observer to observed is so intimate that no clear division can be maintained between the two during the moment of observation. During this moment the seer and the seen are one. The mind is expanded by becoming aware of the object. The body is expanded by becoming ontologically one with it.

A sound theory that is not understood is full of conceptual difficulties and paradoxes. When the theory is assimilated, the paradigm shift involved reflects a general alteration and expansion of consciousness. A unified theory of everything, if understood fully and intimately, ought to end in enlightenment whereby all problems are immediately soluble and one is thereby freed from all material and intellectual suffering.

What would you do if you discovered that a mere thimble-full of the chemical methylenedioxymethamphetamine (MDMA) could make you feel ecstatically happy for a year without any loss of control whatsoever? Would you want others to be ecstatic when you’re not? Is the psychic atmosphere against it? If Popeye was right about the power of spinach, it would be totally illegal, but the army would eat it.

❷ Existence: What is matter, is it real?

SIR ISAAC NEWTON'S CLASSICAL MECHANICS of 1687 and James Clerk Maxwell's classical electromagnetism of 1873 are without doubt *tremendous theoretical and practical successes*. By the year 1899 many physicists believed that physics had just about reached a successful final conclusion, only a few odd peripheral problems remaining to be cleared up.

One such problem is called the *ultraviolet catastrophe*. Classical theory predicts that far more high frequency radiation should be emitted from a very hot object than is actually observed. Around 1900 Max Planck discovered that he could correctly account for the observed distribution of frequencies by making the radical assumption that energy exchange between matter and radiation takes place by way of a discrete indivisible *quantum* of radiation whose *energy is directly proportional to the frequency* of the radiation. The absolute universal constant of proportionality is now called Planck's constant and equals a thousandth of a trillionth of a trillionth of the action associated with a mass of one gram moving at a velocity of one centimetre per second over a distance of one centimetre. (A billion is here defined as a thousand million, and a trillion is a thousand billion.)

In 1905 Albert Einstein used Planck's linear relationship between energy and frequency to explain another outstanding problem called the *photoelectric effect* in which light falling on a metal releases electrons whose kinetic energy is observed to be independent of the intensity of the incident light. Einstein postulated that light consists of particles, now called *photons*, whose energy is Planck's constant times their classical frequency. This explained why the energy of the released electrons should be limited by the frequency, not the intensity, of the incident photons.

Another question which classical theory could not answer concerned the *stability of atoms*. An atom was considered to be composed of very light electrons encircling the relatively heavy nucleus which had been discovered by Ernest Rutherford in 1911. But no known mechanism could stop the electrons from emitting radiation and spiralling into the nucleus. In 1913 Niels Bohr postulated that in an atom, electron energy can only take on discrete values. Jumps from one energy level to another could then only take place by the emission or absorption of photons whose frequency is given by the Planck relationship as being directly proportional to the energy difference between the two levels. This new picture of the atom could then explain, amongst other things, the origin of the spectral lines characteristic of each atom.

Although Planck's relationship was proving successful, it did not constitute a theory but rather was regarded as an *ad hoc* hypothesis to be coupled onto classical physics. A major step towards the totally new theory of quantum mechanics came in 1923 when Lewis de Broglie proposed that matter has wave-like properties in a counter-analogous way to Einstein's proposal that light has particle-like properties. Knowing from special relativity that *mass is a form of energy*, and from Planck that *energy comes in quanta of a proportionate frequency*, de Broglie simply derived the explicit *linear relationship between mass and frequency*.

Erwin Schrödinger in 1926 developed de Broglie's proposal into a *wave equation for matter*. This equation, together with a probabilistic interpretation of the matter wave given by Max Born in the same year, constituted a radical and revolutionary new fundamental theory called *wave mechanics*. Born realized that the square of the modulus of the complex wave function governed by the Schrödinger equation of motion gives a measure of the *probability* of finding a particle at a given position and time.

Working from a very different perspective, Werner Heisenberg pursued a deeper explanation than Bohr's of the origin of the spectral lines of atoms. Sticking closely only to those quantities that are in principle physically observable, like frequency and intensity rather than hypothetical electron orbits or trajectories, he developed in 1925 a theory wherein physical (i.e. measurable) quantities are represented by matrices. The fact that matrices generally do not commute with one another under multiplication led Heisenberg to his famous *uncertainty principle*. It states that physical quantities represented by non-commuting matrices, such as is the case for position and momentum, cannot both at once be measured exactly, but can be simultaneously specified only up to a certain LIMIT equal to Planck's exceedingly small constant of proportionality. In classical physics this limit is presumed to be zero.

In 1926, Schrödinger proved that his wave mechanics and Heisenberg's *matrix mechanics* are EQUIVALENT theories. They came to be known as *quantum mechanics*. Despite its highly technical historical origins, quantum mechanics turns out to be such a profoundly radical theory that it modifies *all* previous understanding of the nature of the physical world. When a fundamental scientific theory tampers with everyone's cherished preconceptions then a conceptual revolution, a paradigm shift, a transformation of consciousness is underway which is very likely to have powerful unforeseen implications world-wide.

Schrödinger's equation almost immediately led to a good basic mathematical understanding of the reason for the periodicity of the periodic table of chemical elements, now called atoms, which had been constructed by Dimitri Mendeléeff in 1869. It also gave a quantitative account of chemical bonding. This led to rapid advances in chemistry and then to advances in molecular biology. Another domain in which quantum mechanics proves to be of enormous value is in the study of solids in the crystalline state. Out of this particular application of quantum mechanics has come microelectronics with, in particular, its replacement of electronic valves by microelectronic transistors. Another major area of study which has been transformed by quantum ideas is the physics of the atomic nucleus to be discussed in Stage 2.

Quantum Ontology

Let us outline some of the major *conceptual* difficulties of quantum mechanics. In so far as these difficulties conflict with our world view, our world view will probably have to change.

In ancient Greece, Democritus argued that reality consists of atoms moving in a void, or vacuum. This is the view which Newton supported and which is still largely prevalent today. The relatively recent success of the Rutherford-Bohr model of the atom in 1913 and the particle language adopted by present day elementary 'particle' physicists has given weight to the common misconception that quantum philosophy basically agrees with Democritus. (Actually, even the concept of a vacuum is quantized in quantum field theory.)

Contrary to Democritean atomism, Parmenides argued that reality is a solid homogeneous plenum without void. Space is like a jelly. Ripples within the jelly account for matter in motion. This view has much in common with Maxwell's approach to electromagnetic phenomena as well as Schrödinger's own interpretation of wave mechanics.

Parmenides and Democritus flatly CONTRADICT one another. The two ontologies, or theories of being, are mutually exclusive. So what does quantum mechanics tell us? It says that if you set up an experiment designed to produce an interference pattern, a signature of WAVES, then this can be done with photons or electrons or, in principle, *any material object* such as whole atoms or molecules or even tennis balls or stars. If on the other hand you set up another experiment designed to identify precise location, a signature of PARTICLES, then this can be done with photons or electrons or *any material object*, even sound waves (phonons) or radio waves (photons) as well as tennis balls and stars. But classical understanding calls for a *monistic* ontology; waves *or* particles not both mutually exclusive concepts. So what IS reality?

At this point Heisenberg's approach should be recalled. In his construction of matrix mechanics he only gave credit to those physical quantities which are actually observable. If, for example, you assume that an electron IS a particle which goes one way *or* the other round an obstacle then the resulting interference pattern leads to an ontological contradiction because only waves can interfere. On the other hand, if you supply equipment to observe which way round the electron actually goes, and this can always be done, then you *necessarily* loose the conditions required for interference, and so destroy the pattern thus avoiding manifest conflict between wave and particle natures. It is in quantum principle not possible to show which way the electron goes *and* at the same time demonstrate the wave interference pattern. In this way quantum mechanics just manages to avoid a direct ontological contradiction. Thus quantum theory loosens the usual strangle-hold of any universal absolute ontology. Everyone sees it differently. Everyone has it different!

Treating everything as interfering Schrödinger waves works in theory until one actually looks at the spacio-temporal position of some particular thing. At that moment all semblance of a spread out wave in continuous space disappears and one observes a localised object at a definite place. To avoid a dilemma, Heisenberg concluded that in describing nature one is NOT obliged to fill in a picture of the *interphenomenon*, or *noumenon*, particularly in a situation where observing that noumenon necessarily alters the original phenomenon itself. Indeed, an attempt to cling to a simple model of what is happening 'behind the scenes' of a quantum phenomenon always leads to an ontological contradiction in circumstances where verifying by observation the validity of the ontological model of the noumenon would destroy the original observed phenomenon.

Anything that is in principle not demonstrable should be disallowed as part of the ontological description of nature. For example, any attempt to demonstrate that electrons follow definite trajectories round the nucleus of an atom will fail because using X-rays, which are needed to identify the location sufficiently, transfers to the electron a quantum of energy of a definite amount directly proportional to the high frequency of X-rays, thus *significantly* affecting any trajectory which the electron might hypothetically have had. Quantum philosophy prevents one from conceiving an atom as a nucleus surrounded by orbiting electrons, like solid planets round a star. Instead one is forced to the conclusion that INTERPHENOMENA ARE NOT OBJECTIVE. This does not mean that nothing can be said about noumena. Quantum mechanics says a great deal about that in terms of the Schrödinger wave. But noumena can't be fully understood in ordinary classical terms, only in quantum terms.

As an illustration which demonstrates that noumena behind phenomena cannot be accorded a simple classical ontology, consider the simple case of a dim source of light which releases a single photon. Corresponding to this will be a Schrödinger-type wave spreading out at the speed of light in every possible direction. If the photon is detected with a photomultiplier some distance away then immediately the Schrödinger wave must change its configuration to become zero everywhere except at the location of the photomultiplier, having been as it were transformed by the Heisenberg matrix representing the position measurement. This instantaneous change of the wave over a considerable volume cannot simply be physical without violating the tenet of special relativity that no information can travel faster than light.

Einstein was VERY UNHAPPY about this non-local aspect of the Schrödinger wave. In order to demonstrate what he regarded as an unacceptable consequence of the theory as presented by Bohr and Heisenberg, he, Boris Podolski and Nathen Rosen devised in 1935 what has come to be called the EPR thought-experiment.

Einstein felt that if an object could have its properties predicted with certainty without its being disturbed in any way then one was justified in regarding these properties as belonging to the object itself, prior to and independent of any observation. This sounds eminently reasonable. Consider, for example, a particle which spontaneously splits into two equal mass parts. If one part is found to have a certain momentum then the other will certainly be found to have, by conservation of momentum, an equal and opposite momentum. If on the other hand the position of one particle is measured precisely then the position of the other can be predicted with certainty by quantum mechanics. This suggests that particles actually *have* precise positions and momenta simultaneously even though Heisenberg's uncertainty principle says that quantum mechanics cannot simultaneously specify both precisely.

This argument led Einstein to propose that quantum mechanics is a statistical approximation to a deeper theory in much the same way that classical statistical mechanics is an indispensable approximation to classical mechanics for describing large numbers of particles in, for example, thermodynamic considerations. There has been much effort expended in trying to discover this hypothetical deeper theory, now called generically a *hidden variable theory*. However it was shown in 1964 by John Bell that any theory which preserves the classical *separability* of the two component particles described above AND restores classical *determinism* AND reproduces the *predictions of quantum mechanics*, will lead to certain restrictions on the results of a series of Einstein-Podolski-Rosen type measurements. A number of different experiments have now shown that these restrictions are violated which means that *there are no hidden variables* of the kind believed by Einstein.

The quantum philosophical resolution of the conceptual difficulty rests on the conclusion: *interphenomena are not objective*. It is incorrect to visualise the situation in terms of particles flying off in opposite directions. Rather there is a Schrödinger wave propagating outwards and this wave encapsulates all the *entangled* correlations between potential observations. When an observation is made the wave immediately changes form over the entire volume. This non-local behaviour ties the observer to the observed yet more intimately than Newtonian physics does. Newton's conception of gravity involves *action at a distance* which implies instantaneous non-local transfer of information. That is quite an attachment. However relativistic theory does not allow such instantaneous transfer of information. The new intimate quantum relationship between interacting entities is sometimes called *passion at a distance*. Quantum stuff hardly even has properties of its own.

It is difficult to make the necessary conceptual leap from ontological monism to ontological-cum-epistemological holism which quantum rationally invokes dramatic instantaneous large scale change behind the face of modest observation, but this is what quantum reality demands. The most subtle observation can have an almost omnipresent significance over a huge spacial range, especially when prior interactions of the observed object are taken into account. We might have thought that we knew what brute matter was, but now it seems more alive than dead.

❸ Knowledge: What is mind, is it rational?

THE COMMON SENSE NOTION OF PROBABILITY refers implicitly to some contingent lack of knowledge which makes certainty unavailable. It is therefore natural to think that the Schrödinger wave is merely an incomplete expression of what is known about a physical situation, making non-local changes in the wave merely *changes of knowledge*. But the Born interpretation of the wave function as giving a measure of the probability of observing a specific outcome can not support an understanding purely based on what is known rather than what is the case.

Quantum Epistemology

Quantum probability does not reflect a lack of knowledge in the usual sense because once the wave function has been specified completely then nothing more can be said about the state of the world. There are no hidden variables to discover: no relevant information is left out. And yet predictions may still only be expressed as probabilities. The fundamental indeterminism of quantum mechanics leads to probabilistic predictions. Since we have been used to thinking in terms of deterministic mechanical theories, any mention of probability naturally implies ignorance. However in indeterministic quantum mechanics IGNORANCE IS THEORETICAL. That is, the theory itself implies necessary ignorance. Ignorance is rational. Statistics can be deep; quantum statistics.

Consider electrons passing by an obstacle and producing an interference pattern on the far side. The pattern can be built up slowly on a photographic plate by sending one electron at a time. If this classically indivisible material particle with its classically indivisible electric charge goes *either* round one side *or* round the other side of the obstacle then NO interference could possibly occur. Only if the electron wave goes round *both* ways, and then interferes with itself, can the pattern be produced. If the wave solely expressed knowledge and not reality then how could a real interference pattern appear? *No local deterministic hidden variable theory can account for such phenomena.*

Bohr devised a new word to describe the situation encountered in quantum mechanics relevant to two observables related by the uncertainty principle. When one describes a phenomenon in quantum mechanics certain words are naturally involved in the description; for example position or time. Other words, which are not simultaneously applicable according to the uncertainty principle, such as wavelength and frequency, Bohr called *complementary*. Complementary measurements must be represented by matrices in matrix mechanics (or differential operators in wave mechanics) which do not commute. The complementarity relation has often been compared to the relationship between yin and yang in Chinese philosophy because of the essential unity beyond yin-yang duality (☯). Ordinary vocabulary seems to split into two sets of complementary words and each word seems to hold something of the essence of its complement. Further than this basic duality, angular momentum seems to exemplify a *trinity* or three fold entanglement and there are other examples of more complicated entanglements or *contextuality*.

It is often supposed that the conceptual difficulties of quantum mechanics refer primarily to the prediction of the *future* and that retrodiction of the *past* can be freed of the restrictions of the uncertainty principle, leading, for example, to a complete reconstruction of the historical path of a particle. However, in 1931 Einstein, Richard Tolman and Podolski showed that such retrodiction of the past can lead to prediction of the future which violates the restrictions of the uncertainty principle. They concluded that the principles of quantum mechanics actually involve an uncertainty in the description of *past* events analogous to the uncertainty in the prediction of future events. This forcefully tells us what we already intuitively know: *now* is a very special window on the world, alone in giving certainty. There is nothing so special about 'now' in classical or relativistic physics.

Quantum mechanics applies to microscopic objects. It also applies to larger objects such as crystals, superconductors and superfluids. Indeed, there is every reason to suppose that quantum mechanics applies to all objects no matter what their size or function. In particular quantum mechanical description can be given of a measuring instrument itself. The purpose of a quantum measuring instrument is to magnify microscopic possibilities into quantitative macroscopic possibilities. Although not deterministic, quantum mechanics is causal with regard to the propagation of possibilities. Thus the Schrödinger equation can be used to show how the wave describing the microscopic set of possibilities can be amplified into a wave describing a corresponding set of macroscopic possibilities of the measuring instrument.

Look at a revealing example of this macroquantum mechanics. Schrödinger *imagined* putting his poor cat into an opaque sound-proof box. The cat is connected to an electrocuting device which is triggered if a single photon hits a photomultiplier that has been placed behind a semi-silvered mirror. A single photon is directed towards the mirror. On hitting the mirror the Schrödinger wave splits into two components, one which goes through the mirror and one which is reflected by the mirror. These two components represent the two possible phenomenal outcomes, the 50% chance that the photon has passed through and the 50% chance that it was reflected by the mirror, in classical thinking. The wave component passing through the mirror hits the photomultiplier and is amplified into a wave triggering the electrocuting device which then kills the cat. The wave component not passing through the mirror does not hit the photomultiplier and leaves the cat unharmed.

At the end of this unpleasant imaginary experiment one is left with a box, the contents of which are described quantum mechanically by a Schrödinger wave made up of two distinct components. Classically the two possibilities, a box containing a dead cat and a box containing a live cat, are mutually exclusive. One presumes that one possibility is actually the case in fact and the other is actually not, but one just *does not know* which is the case until one looks.

Quantum mechanically, probability is not interpreted as mere lack of knowledge but, because of the experimental and theoretical evidence of interference of classical possibilities, probability has to be given epistemological *and* ontological significance. We know that when we look we shall see a cat which is either dead or alive and not in any sense both, and that a consistent classical history will follow too. Similarly we know that when we look at an electron wave, however complex, we shall see only an integral charged electron of a particular mass at some particular place. For both the electron and the cat the uncertainty involved is of the same quantum mechanical quality and must be given ontological as well as epistemological weight. In other words, we can't regard the cat as being *either* dead *or* alive in reality but we just don't know which. We have to accept that the cat is in a *superposition* of live and dead states or *superstate* or noumenal state.

Common sense tells us that if the cat is found alive then it has been alive all the time, the electric shock machine did not work and the photon did not pass the mirror. Such retrodiction is allowed, but not before the cat is observed. In quantum sense, prior to observation, ignorance is theoretical, interphenomena are not objective, the past and the future are both superstates. Sleep is a myth.

Even if we are prepared to grant that the cat, as well as everything else that we are *necessarily ignorant of*, is in a noumenal as opposed to phenomenal state, what does the cat herself think? If she suffered the electric shock then she can think no more, but if she did not receive the shock then presumably she has, in some sense, verified to herself that she is not in a paradoxical noumenal state but in a simple phenomenal live state.

This conceptual obstacle was expressed most acutely by Eugene Wigner in 1961. He imagined a friend had already looked in the box to discover the state of the cat. Wigner realised that he must describe his friend as being in a noumenal state too. After hearing about the fate of the cat Wigner therefore asks his friend the presumed superfluous rhetorical question, "Just before I asked you about the cat you were in a noumenal state. What was it like?" His friend replies, "No. I was in a definite phenomenal state and the cat too has been in a definite live state, at least ever since *I* looked at it."

One would be justified in arguing that in this case there obviously are 'hidden' (classical) variables which we have not taken into account such as the temperature of the cat. However the account is still valid in (quantum) principle because it is theoretically possible to organise the experiment in such a way that, by suitable screening, it is impossible to know what happened to the cat, and then also impossible to know what the friend saw. In this circumstance the particular life or death information has to be given in terms of a noumenal superposed state. Much more can be said about other secondary matters, but as regards the simple life or death situation a superposed noumenal state embodies the complete quantum description. Likewise the pointer reading on a measuring instrument is the significant datum. This too is in a noumenal state unless being actually read in which case it is phenomenal. That is, it is in a definite unsuperposed quantum state as regards the observation in question. As regards a complementary observation, however, the state is again a superposition.

In terms of Schrödinger waves, at the semi-silvered mirror the wave divides into two components which remain a distinct non-interfering superposition of two spiky waves thereafter until the state is observed. But did the photomultiplier *observe* and so *collapse* the superstate into one definite state, or did the cat, or did the friend, or did Wigner himself? There can be no question of an ordinary classical explanation of this collapse because that would invoke deterministic hidden variables which would necessarily be *non-local* making the notion of explanation unlike that expected of a mechanical understanding anyway. For this reason the notion of a dynamical collapse is too realistic and therefore unhelpful.

Quantum mechanics applies to biological matter as well as atoms and elementary particles. Wigner is therefore obliged to describe the photomultiplier, the cat AND his friend as noumenal until observed by *himself*. He is not treating himself as a physical object to be included in an objective account of the physical situation, rather his consciousness of the external world is the terminal link in the chain wherein the world is not so much confronted hypothetically as directly and actually. Probability is not a notion needed to describe an immediate conscious experience in the way that it is required to describe potential, or latent, or 'would-be', experiences. However, exactly this argument which satisfies Wigner that the buck stops here, in his mind, also satisfies his friend. Is Wigner therefore plain wrong to describe his friend as noumenal?

For Eugene, before discovering the fate of the cat, the cat is in a noumenal state. For his friend, the cat is not. The conclusion to be drawn from this is that *ontology itself is relative to the conscious observer*. We are quite familiar with the notion that *knowledge* is relative to the conscious observer. Now it is necessary to extend this relativity to *being*, so that what can be said to BE is not absolute but relative to consciousness. Mass is a form of energy. Energy is complementary to time. Therefore the concepts of material reality and passage of time cannot both together be applied with impunity.

The quantum wave function or superstate or noumenal state of a system accommodates the complete description of the system. It incorporates everything that can be known about the system. It has both ontological and epistemological force. It is not just a statement of knowledge and it is not a simple statement of being. The quantum state is of a different order of reality, which intimately unites knowledge and being, as well as ignorance and nothingness.

Consider hypothetically some object behind your head. You take it to still be the thing you perceived it to be a moment ago. However, it will by now have interacted with something which itself was in a superposed noumenal state. This puts that object in a noumenal state too, and hence you in a state of relative ignorance about it. The thing is now neither known for sure nor is it even something definite. It's not phenomenal, it's entirely noumenal. Indeed *only* those things of which you are currently directly aware are not noumenal: they are the only true phenomena. Turn round. Look at the object. Now it's phenomenal, definite, certain, if it's still there.

In terms of wave mechanics, the thing which you are looking at can be represented by a sharp spikey wave implying relative certainty of something, position for example. As soon as the thing is not in conscious focus, waves from the surroundings splash against the spikes turning them into flatter distributions representing things which are in quantum principle less than certain, less than real, but more than impossible, more than mere ideas.

Of course in science everyone has to agree at the end of the day about what the world is like. When dealing with actions which are large with respect to Planck's constant then the familiar concepts of classical mechanics become meaningfully applicable in practice and so large objects can usually be taken as definite, even when not being scrutinized. But when instruments magnify quantum possibilities, what ensures that everyone experiences a consistent world? In 1957 Hugh Everett III offered a quantum mechanical proof that everyone would agree when they confer about the state of the world even though different observers can have had different noumenal histories.

It is by looking at the world that we obtain our sense of rationality. Classical physics can appear as the epitome of reason because it coincides so well with what we have come to regard as giving a reasonable and rational explanation. The concepts of classical physics constitute such an entrenched paradigm, a paradigm which might even be physically wired into our brains, that we forget that the concept of rationality itself is ultimately determined by the nature of the world and not just by pure abstract thinking. When the world is given a new quantum form of explanation, with it comes a new paradigm of rationality.

Ontology and epistemology, while clear and distinct concepts in Aritotelian and Newtonian physics, are intimately yoked together in quantum physics. This union causes such a change of perspective that possibly no one has yet succeeded in achieving a clear understanding of it. Omniscience can no longer mean knowing all about everything in the obvious classical sense because *ignorance is theoretical*. And reality is not ultimately brick-like because *interphenomena are not objective*. Classical understanding kept mind and matter distinct. Quantum understanding makes their acquaintance.