1.

Cosmic Mind

All the choir of heaven and furniture of earth, in a word all those bodies which compose the mighty frame of the world, have not any substance without the mind . . . . so long as they are not actually perceived by me, or do not exist in my mind, or that of any other created spirit, they must either have no existence at all, or else subsist in the mind of some Eternal Spirit.

- Bishop Berkeley

Science and Ego

As scientific instruments have probed farther into the reaches of space and time, and deeper into sensory realms beyond the puny range of human experience, humanity has gradually receded from their view. Where our unaided eyes perceive humans as the center of existence, telescopes and microscopes reveal no special role for their inventors in the grand scheme of things. So vast is the universe we see with our instruments, and so small is humankind, we are forced to conclude that the earth could explode tomorrow and the rest of the universe would hardly take note.

The insignificance of humanity is almost impossible for most humans to accept. It was bad enough when, in the sixteenth century, Copernicus suggested that the earth may not be the center of the universe. It became worse when, in the nineteenth century, Darwin proposed that we are an accidental mammalian species and not some unique creation of God. And this painful message was only reinforced when, in the twentieth century, astronomers declared that the sun is but one of ten billion trillion stars in a universe at least a hundred billion trillion kilometers in extent, and geologists showed that recorded history is but a blink of time: a microsecond in the second of earth's existence.

The most economical conclusion to be drawn from the complete library of scientific data is that we are material beings composed of atoms and molecules, ordered by the largely-chance processes of self-organization and evolution to become capable of

the complex behavior associated with the notions of life and mind. The data provide us with no reason to postulate undetectable vital or spiritual, transcendent forces. Matter is sufficient to explain everything discovered thus far by the most powerful scientific instruments.

But what about you and me? Simple, everyday observation tells us that we are individually mortal and that our bodies must someday lose their abilities to move, act, and think as we dissolve back into the earth from which we arose. Still, we find it very difficult to accept inside, what the data outside say about our individual selfhood. The message of our senses and instruments conflicts too profoundly with what our inner voices insist.

Humans, for evolutionary reasons, or no reason at all, possess egos that listen largely to their own counsel, most often ignoring other conflicting messages. These egos are so massive that they are the foci toward which all other bodies gravitate. The ego can hardly conceive of a universe in which it is not an active participant. Ask yourself: Can you imagine a universe without you? As much as I try to be objective, to accept the judgment of reason, I still find it very difficult to develop that image.

From the time of its first murmurs, science's message of humanity's insignificance has been resisted by powerful forces within Church and State. Religion is always ready to affirm the inner message and provide comforting promises of sub-godhood and immortality. And the State has always found religion useful in keeping the populace in line, to provide divine justification for its actions.

And so, while science may have triumphed in some intellectual circles, and while few deny science's remarkable power and utility, most modern humans simply ignore the unwelcome implications of scientific discovery. The alternative, soothing message of the feel-good religions of today, from modern evangelical Christianity to the cults of the New Age, is far more appealing: *You are the image of God, if not God himself. You are one with the entirety of existence. Your physical death means nothing! You will live on beyond death, as an inseparable component of the essence of existence.*

Still, some other sense, a spark of reason, hints that this may be a hopeless delusion. It seems that the objective outer message of our senses cannot but conflict with the subjective inner message of ego. They cannot both be correct. How can we

decide between the two? Can the two views be made compatible?

Ego has shown no signs of changing for thousands of years, while science is characterized by progress, flexibility, and the continual discarding of old ideas to make room for new discoveries. Scientists readily admit that their conclusions are tentative. Wouldn't it be wonderful if science could only finally confirm what our inner voices have been telling us all along - that we really are immortal personalities with a meaningful, if not leading role in the cosmos?

A host of recent authors have proclaimed that this revolution in scientific thought has in fact occurred, that the new physics of the twentieth century has discovered that human consciousness, not matter, is the fundamental substance of the universe. This notion has struck a responsive chord. But is that chord being played on the fine strings of a heavenly harp, or is it simply the stroking of the last bits of straw grasped at by an ego incapable of accepting reality?

Convergence?

For more than a decade now, gurus of the New Age and preachers of the New Christianity have been telling us that developments in twentieth century physics and astronomy - quantum mechanics, big bang cosmology, the so-called "anthropic" coincidences, and the new sciences of chaos and complexity - are leading toward a convergence of the differing views of the universe provided by the outer voices of science and the inner voices of ego. They proclaim that the discoveries of modern physics imply a central role for human consciousness, and for a universe created with them in mind. In their view, human beings are not tiny, negligible points in space and time but an integrated part of a greater, cosmic whole - elements of an infinite field that spreads throughout all of space and time.

In some New Age writings, our bodies are said to exist in symbiotic relation to Gaia, goddess earth, and through Gaia to the rest of the universe. And, our minds are said to be tuned into a greater *cosmic mind* that reaches inside to the smallest particle, outside to the farthest galaxy, back to an infinite past, and ahead to an eternal future.

In New Christian thought, our spirits tune into the cosmic mind of Jesus. The phrase "mind of God" has become fashionable in books and magazine articles that

attempt to link modern science to religion, as science is interpreted as the process of discovering the laws that God laid down in creating the universe. A huge literature has been generated, as modern Christian writers and the secular media attempt to reconcile science and religion.

In reality, most of the arguments being heard are not new. They encompass elements that are as old as history, and probably pre-history. They hark back to the idealistic philosophy of ancient India, to Plato and Pythagoras, and to the deism of the Enlightenment. But today's cosmic mind has been re-packaged by an appeal to twentieth century science for its authority.

The new wrinkle on venerable Eastern and Platonic/Christian mysticism exploits certain interpretations of quantum mechanics, the revolutionary theory of physics that was developed early in this century. Traditional religious myths, East and West, call on scripture or the utterances of charismatic leaders as their authorities. By contrast, the new mythology is supposedly grounded on up-to-date scientific knowledge. Since the seventeenth century, a materialistic, reductionist view of the universe had formed the foundation of the scientific revolution. Now this is to be cast aside by a new spiritual, holistic science.

The Development of Quantum Mechanics

Quantum mechanics was developed early in the twentieth century to explain certain anomalous phenomena associated with light and atoms. By the 1930s, its mathematical structure had evolved almost to the point where it exists today as the major theoretical tool of physics and chemistry. Calculations using the mathematical formalism of quantum mechanics have been tested against countless laboratory measurements for almost a century, without a single failure.

Quantum mechanics is often associated with "uncertainty." Nevertheless, it is capable of calculations to a high degree of precision. For example, the magnetic moment of an electron, which measures the strength of the electron's magnetic field, is calculated in quantum electrodynamics, an extension of quantum mechanics, to be 1.00115965246. Its measured value at this writing is $1.001159652193 \pm 0.0000000010$. Thus, the calculation is correct to at least one part in ten billion. We have neither

measured nor calculated the earth's magnetic field with anything approaching this accuracy.

Among its many applications, quantum mechanical calculations have made possible lasers, transistors, computer chips, superconductors, plastics, thousands of new chemicals, and nuclear power. Today's high speed computers are products of quantum mechanics. Quantum mechanics lies at the heart of physics, chemistry, biology, and life itself. It may provide the key to understanding the origin of the universe, showing how everything can have come from nothing.

While the methods of quantum mechanics have proven their utility, no consensus exists even to this day on what quantum mechanics "really means." Some argue that the question itself is meaningless, that the mathematics speaks for itself.

Descriptions of quantum mechanics are conventionally cast in terms of the *Copenhagen interpretation*. This interpretation was primarily the offspring of Niels Bohr and Werner Heisenberg who, along with Erwin Schrödinger (who did not support Copenhagen), were the revered primary inventors of quantum mechanics. Today an evolved Copenhagen remains the consensus view among most physicists, who see no reason to change a theory that has worked well over a great period of time and has never been demonstrated to be incorrect - by either experimental facts or mathematical proof.

As we will see, however, the Copenhagen interpretation contains more than the minimum number of assumptions that is needed to provide a foundation for quantum mechanics as it is actually practiced by scientists. Copenhagen includes the added assertion that quantum mechanics is *complete;* Bohr and his colleagues of the Copenhagen school claimed that no theoretical structure can be found that is capable of making predictions about observable phenomena that does not fit within the framework of quantum mechanics. This was not meant to imply that quantum mechanics can now explain everything; just that any new theories must not contain elements that violate the basic precepts of quantum mechanics.

This assertion is disputed by the proponents of so-called *hidden variables* theories. They seek a deeper theory that lies beyond conventional quantum mechanics. We will be investigating these issues in great detail in this book.

On the Fringes

While the mathematical formulation and methods for the practical application of quantum mechanics have remained largely unchanged and unchallenged for six decades, the deeper philosophical significance of quantum mechanics has continued to be debated. On the fringes of this debate we find numerous popular articles and books that promote a stupendous notion: Our egos could be right after all. Humans and human consciousness may indeed constitute the fundamental essence of reality. If you were to judge by the space occupied by this genre on the shelves of popular book stores, you would conclude that it has become mainstream science.

On the contrary, the pragmatic, mainstream physicist's attitude toward the new quantum metaphysics has generally been to ignore it, figuring it will simply die away like any other popular fad. Most physicists prefer to leave deliberations on the "deeper significance" of quantum mechanics to the philosophers who make their livings discoursing on the meanings of words, and never seem to settle anything anyway. Physicists like to think of themselves as people of action, not words.

Unfortunately, arguments over words have a much greater impact on human life than most physicists prefer were the case. Words are not benign. Words generate action. Words sell products, inspire devotion, incite riots, and start wars.

Words also help physicists get the large sums of money needed to build their action-toys. As a practicing researcher in high energy particle physics and astrophysics for over thirty years, I spend much of my time writing proposals, progress reports, technical notes, and scientific papers. I attend several international conferences each year where I listen to speakers, present my own work, and exchange ideas in hallway and dining table conversations - all utilizing the medium of words. Often these discourses are philosophical in nature, addressing the meaning of the research being conducted and its value to science and society.

The jargon of quantum mechanics has inspired some people to extract mystical messages that were never intended to be there. In particular, deep meaning has been found in the unfortunate way physicists often describe the process of measurement. Sometimes they make it sound as though the conscious act of observation, by itself,

creates the quantity that is being measured.

You will frequently read the statement that physical objects do not possess a certain property until that property is measured: An electron in an atom has no position until that position is determined by measurement; a photon has no polarization until it passes though the polarizing sheet that is used to measure polarization.

The source of this strange assertion is the practical fact that physical notions, such as position and polarization, are *operationally* defined in terms of the apparatus that makes the measurement of the associated quantity. These measurements are performed according to a well-prescribed procedure that can then be repeated independently by someone else. This is what gives science its claim on objectivity.

Thus distance (the quantity of space) is what you (or anyone else) measure with a meter stick. Time is what you (or anyone else) measure with a clock. Polarization is what you (or anyone else) measure with a polarimeter. All these operational quantities were defined by human beings. Is there any reason to assume that any has an intrinsic reality that exists in the absence of its measurement? As we will see, there is ample reason to assume at least some aspect of reality when the results obtained are predictable and repeatable.

The idea that properties are brought into being by the act of their measurement clashes with our intuitive notion that the universe possesses an objective reality independent of the observer. Surely, as Einstein insisted, the moon is still there when no one is looking.

But many authors have construed quantum mechanics, with its strict use of operational terms, to imply a central role for the human mind in affecting the very nature of reality itself. Let me give a sampling of some of the expressions of this viewpoint.

Physician Robert Lanza has written that, according to the current quantum mechanical view of reality, “We are all the ephemeral forms of a consciousness greater than ourselves.” The mind of each human being on earth is instantaneously connected to each other - past, present and future - as “a part of every mind existing in space and time.” In Lanza’s view, quantum mechanics tells us that all human minds are united in

one mind and "the entities of the universe - electrons, photons, galaxies, and the like - are floating in a field of mind that cannot be limited within a restricted space or period . . ."[1]

Physicist Fritjof Capra has long been an influential proponent of mystical interpretations of quantum mechanics. He first expressed his ideas in 1975 in *The Tao of Physics*, which drew strained parallels between modern physics and Eastern mysticism.[2] Quantum mechanics, in Capra's view "reveals the basic oneness of the universe" in a manner that harmonizes with the Hindu notion of *Brahmin*, the "unifying thread in the cosmic web, the ultimate ground of being: 'He on whom the sky, the earth, and the atmosphere are woven (Mondaka Upanishad, 2.2.5)' "

Capra's film *Mindwalk*, which showed in major theaters in 1992 and is available in video stores, gives considerable insight into his hopes for the potential social and philosophical impact of this new perspective. So let me take some space to review it. *Mindwalk*, written by Capra and directed by his brother Bernt, was based on *The Tao of Physics* and a later book, *The Turning Point*.[3]

In the film, an American politician, played by the fine actor Sam Waterston, comes to France after losing his bid to be President. There, he and his friend, an expatriate poet played by John Heard, wander into the spectacular fortress of Mont St. Michel in the English Channel. Soon they meet a disillusioned physicist, played by Liv Ullman, and for the rest of the film the two men roam around the fortress, slack-jawed with astonishment at the profound ideas Ullman pours forth: The world is in trouble from overpopulation and pollution. Americans eat too much red meat. Wow! The presidential candidate had not heard about this before.

The problem, according to Ullman, is a crisis in perspective. Humanity still follows the mechanistic reductionism of Descartes and Newton, viewing the world as being like the old clock in the fortress tower. However, a new, holistic physics called *systems theory*, in which the universe is seen as one interconnected whole, has now overthrown evil reductionism. If humanity will only adopt this revolutionary perspective and realize that we are all one with each other, the earth, and the cosmos, then the planet will be saved from self-destruction. What a magnificent thought, the politician gushes. Why don't you come back to America with me, Professor, and join

my staff? Let's put these new ideas to work for humanity.

Finally, outside the fortress on the spit of land that joins it to the mainland, Ullman is asked to explain life. She says, "Life is self-organization." Poet Heard is so overwhelmed by this deep concept that he flops down in the sand, repeating the line over and over: "Life is self-organization, life is self-organization. . ."

Unfortunately, this is the only hint of the most far-reaching idea that appears in Capra's *The Turning Point*. There he suggested that all material systems, from humans to animals, plants, the earth, and the cosmos itself, are part of one gigantic mind. Holistic physics provided him with a model for the vague notion of cosmic consciousness: We are all one with the cosmos, speaking to each others' minds with extrasensory perception (ESP), able to break down the barriers of space and time and the laws of physics. We can achieve anything, perform miracles, if we just think we can.

Capra's ideas have taken hold within the New Age movement in America. Marilyn Ferguson in her 1980 New Age bible, *The Aquarian Conspiracy*, said that new scientific knowledge has revised "the very data base on which we have built our assumptions, institutions, our lives." Promising far more than "the old reductionist view," the new scientific perspective "reveals a rich, creative, dynamic, interconnected reality."[4]

Capra has not been alone in claiming parallels between the new physics and Eastern mysticism. In *The Dancing Wu Li Masters,* Gary Zukav says physicists "are dancing with Kali, the Divine Mother of Hindu mythology." Zukav sees the new physics as suggesting that "there really may be no such thing as 'separate parts' in our world."[5]

In a chapter called "The Dancing Moo-Shoo Masters" from his recent book *The God Particle,* Nobel prize-winning physicist Leon Lederman has spoofed the notion that physics has any connection with the philosophies of the ancient Orient. He calls Capra's and Zukav's conclusions "bizarre."[6]

The idea of a cosmic field of mind merging physics with Hindu mysticism has also been promoted by Maharishi Mahesh Yogi and his Transcendental Meditation (TM) movement. Trained at one point as a physicist, the Maharishi also claims modern physics as his authority. In newspaper ads placed around the country in the 1980s, the

Maharishi very specifically associated his version of cosmic consciousness with the *GUT* (Grand Unified Theory) field of particle physics that was in fashion at that time.

Unfortunately, reality intervened. Theoretical particle physicists, applying the simplest version of GUT, made a very firm, testable prediction that the proton was unstable with a very long but measurable lifetime. After a series of accurate, multi-million dollar experiments, proton decay was not found at the expected level.[7] As a result of this and other precision tests, Grand Unified Theories have fallen out of fashion and the Maharishi's association of the GUT field with the cosmic mind has been discarded.[8]

At this writing, GUT has been replaced as the Maharishi's cosmic field by the currently more trendy *superstrings* If superstring theory is found wanting, as I suspect it will, I am sure the Yogi will find some other physics fashion to exploit. He can always claim, like another Yogi named Berra, that he never said half the things he said.

One of the Maharishi's disciples, Dr. Deepak Chopra, is perhaps the most successful of a growing group of authors who have appropriated the quantum as the foundation for alternative, non-medical methods of healing based on the belief that mind can overcome the limitations set by the laws of physics and biology. Chopra's 1989 book was entitled *Quantum Healing: Exploring the Frontiers of Mind/Body Medicine.*[9] His latest best-seller is called, *Ageless Body, Timeless Mind: The Quantum Alternative to Growing Old.*[10] Placing the word "quantum" in the title of a book may not guarantee it for the best seller list, but it's worth a try.

In Spring, 1994, Chopra visited Honolulu to give all-day seminars on "Quantum Healing." At the time, an English department colleague of mine assured me that Chopra has "helped a lot of people" with his holistic methods.[11]

Of course, promising a halt to aging is a dangerous thing. Let's see what Chopra looks like in ten years. He already looks older in the photograph on the dust jacket of the latest book compared to the earlier one. Hopefully Chopra will not suffer the fate of Dr. Stuart M. Berger, author of *Forever Young,* who died at age 40 weighing 365 pounds after falling off his diet of steamed broccoli.[12]

In a similar vein, Johns Hopkins University psychiatrist Patricia Newton uses the quantum as basis for what she says is an Afrocentric approach to healing. In a talk

presented before a medical conference in 1993, Newton said that traditional healers "are able to tap that other realm of negative entropy - that superquantum velocity and frequency of electromagnetic energy and bring them as conduits down to our level. It's not magic. It's not mumbo jumbo. You will see the dawn of the 21st century, the new medical quantum physics really distributing these energies and what they are doing."[13] Shirley MacLaine could not have put it better.

I do not deny a certain limited value in the traditional healing methods from many cultures. Surely, over the ages, useful treatments for a host of aches and pains were discovered by trial-and-error. It appears that many of these methods trigger the well-established placebo effect and perhaps other mechanisms by which the human body heals itself. No doubt Western medicine can improve its methods for treating the "whole person." I simply wonder what it all has to with the quantum.

In *The Tao of Physics,* Fritjov Capra also made a strong association between the unbroken wholeness he saw in Eastern philosophy and a similar-sounding theory of physics that also was once quite the vogue, but has now dropped from sight. Few of today's graduate students in physics would even recognize the name of this faded concept: *bootstrap theory*.

Dating from the 1960s, when Capra worked as a theoretical physicist in Berkeley, bootstrap theory speculated that all the properties of physical systems could be derived from a set of equations whose input assumptions were little more than some general rules of mathematical smoothness ("analyticity") and self-consistency.

While this was a nice thought, and it once gave Capra a vague basis for his speculations, bootstrap theory simply did not work. It failed to describe the data while the conventionally reductionist theories of quarks and leptons, now referred to as the *Standard Model*, eventually did. For that purely pragmatic reason, not for any lack of popular or aesthetic appeal, bootstrap theory no longer appears in physics textbooks.

Being a failure, bootstrap theory does not provide a very convincing model for Capra's holistic universe. By its vividly-contrasting success, the quark-lepton model provides every reason to continue to look to reductionist ideas to provide the framework for understanding the physical world. However, let me caution the reader against making the connection between reductionism and Newtonian determinism that

is found in so much New Age literature. A non-deterministic but still reductionistic universe is perfectly possible.

ESP and Quantum Mechanics

Many authors, including Capra and the others mentioned above, have argued that so-called psychic, or **psi** phenomena provide an empirical basis for a connection between the human mind and the cosmos. They refer to the numerous reports of experiences that people label as psychic: premonitions, out-of-body and near-death experiences, miraculous cures, stigmata, poltergeists, "mystical" experiences, past-life regression, ESP, remote viewing, and others. These are taken, in sum, as a strong indication that the mind is something beyond matter, that it has the ability to overcome the laws that rule the behavior of normal material objects.[14]

Einstein once said that he would not believe in ESP unless it was observed to fall off with distance. This view was based on the well-established physical principle of energy conservation. If a mind is radiating some form of "psychic energy" in all directions, then that energy should spread out over an area that increases with the square of the distance from the source.[15]

Since the 1930s, unsuccessful attempts have been made by parapsychologists to measure a distance effect for ESP.[16] In most sciences, the failure of an experiment to confirm a theoretical prediction is taken as a strike against the theory. However, those whose personal beliefs are unshakable by facts will always find a way to rationalize such failures.

One way to explain the absence of an ESP distance effect is to argue that the psi signal is some type of encoded message akin to a radio broadcast. Such messages can be transmitted without degradation over large distances - though they still have a finite range. This is not implausible in itself. However, Einstein's point was that the observation of a distance effect would have been a strong point in favor of ESP and perhaps converted him into a believer. This did not happen.

With the failure of distance experiments to produce an effect, some psi believers began to develop the idea that ESP was a non-physical phenomenon, unbound by limitations of space, time, or energy. Instead of interpreting the lack of a distance effect

as a failure of the ESP hypothesis, they took it as positive evidence that ESP is not a phenomenon akin to electromagnetic radiation. If ESP violates conventional principles of physics, then perhaps it goes beyond conventional physics toward a broader, all-encompassing theory of mind and the universe. Perhaps, but the absence of evidence for ESP can prove little one way or the other.

In 1974, American physicist Jack Sarfatti was working in London with the distinguished quantum theorist David Bohm. Before his death in 1992, Bohm was the central figure in quantum mysticism. His name will appear often on these pages, in both this later role and his earlier one as a major contributor to the development of quantum physics.

Bohm, Sarfatti, and the prominent author Arthur Koestler were among those present on June 21, 1974 when the famous Israeli psychic, spoon-bender Uri Geller, gave a demonstration of his powers in London. Geller succeeded in bending a metallic disc and triggering a strong burst from a Geiger counter held in his hand.[17]

The next day, the performance with the Geiger counter was repeated before Koestler and author Arthur C. Clarke, among others. According to a press release put out by Sarfatti that was widely distributed, Koestler was "visibly shaken" and reported a strong sensation simultaneous with the burst. The previously skeptical Clark was also impressed and challenged magicians to "put up or shut up" in duplicating Geller's feat. At the time, Sarfatti said that Geller had demonstrated "genuine psycho-energetic ability" under "relatively well-controlled and repeatable experimental conditions."

Both Koestler and Clarke became prominent in promoting the possibility of paranormal phenomena. Before he died, Koestler endowed a chair in parapsychology at Edinburgh University. Clarke, who has been an influential science popularizer and science fiction writer for decades, has been surprisingly un-skeptical of psychic phenomena in a series of British TV programs that are occasionally replayed on U. S. cable TV.

As for Geller's London demonstrations, plausible explanations can be found that do not rely on the invocation of supernatural forces. Martin Gardner has pointed out that Geller could have simply hidden a small amount of harmless radioactive substance, such as a radium watch dial, on his body to cause the Geiger counter to read a higher

level of radiation.[18] Geller's performances are accompanied by much writhing and twisting that offers him ample opportunity to put a magician skills to use.

Sarfatti tells me he no longer believes that Geller has the power to affect physical objects with his mind. Apparently this happened after magician James Randi duplicated Geller's tricks for Sarfatti.[19]

For thousands of years people have told stories and related personal anecdotes that have convinced them that the mind has special powers that reach beyond the world of matter. Despite this, science has yet to accept the reality of psi as a fact. Beyond anecdotal tales and magician's tricks, which have little scientific value except as data for studies of anecdotal tales and magician's tricks, psychic phenomena have a history of scientific and semi-scientific investigations dating back to the mid-nineteenth century. I have previously written about these studies, and the claims made that they support the existence of psychic phenomena, in my book *Physics and Psychics: The Search for a World Beyond the Senses.* [20]

My conclusion agrees with that of a 1987 inquiry by the National Research Council (NRC) of the U. S. National Academy of Sciences: After a century and a half of study, "the best scientific evidence does not justify the conclusion that ESP - that is, gathering information about objects or thoughts without the intervention of known sensory mechanisms - exists."[21]

Unsurprisingly, the parapsychological community emphatically disagrees with this conclusion.[22] They continue to insist that the sum total of observations over these years is a strong indication that "something must be there" beyond the reach of conventional, materialist science. The subject refuses to die, as each discredited claim is replaced by new ones from a different variation of psi experiment.

In one way, parapsychology does mimic conventional science: Most attention is focussed on the latest fashions. One current parapsychological fashion in the **ganzfeld experiment** in which a subject in a sensory-deprived state attempts to read the mind of another. Recently, strong positive, replicable results have been claimed.[23] However, leading experts still find these experiments flawed and no single experiment is by itself convincing.[24] Work is continuing, especially in Edinburgh where a major effort is underway to see if previous results can be replicated. It remains to be seen whether

these and other ganzfeld experiments will yield results any more reliable than those of their predecessors in psi science, or simply follow precedent and fade away as the next psi fashion moves into their place.

Significant results in recent years have also been claimed in experiments that study whether humans (and in some cases, animals and even cockroaches) can affect the output of random event generators (**REG** experiments, or sometimes **RNG**, for random number generator). These touch especially on the subject of this book because quantum fluctuations are sometimes used to produce the random events that form the data base. Thus any significant deviation from expectations would be direct evidence for a quantum-mind connection, provided all experimental artifacts could be ruled out.

Although hundreds of REG experiments have been reported,[25] the largest data samples have been collected by Helmut Schmidt[26] and by the group headed by Robert Jahn at the Princeton Engineering Anomalies Research Center (PEAR).[27] Both projects claim significant deviations from expectation at a level than cannot be explained by statistical fluctuations or experimental artifacts.

Still, the two sets of experiments do not agree quantitatively, and so cannot claim to independently replicate each other. In fact, you could even argue that since they quantitatively disagree, they thereby disconfirm each other. Schmidt reports that 0.5 percent of his hits are above expectations, while the PEAR result is 0.02 percent high. In either case, the effect claimed is small and becomes noticeable only after a huge number of trials. Also, it is not clear whether PEAR even replicates itself, because the size of the effect from their early trials disagrees with that of later trials.

I discussed the status of the REG experiments through 1990 in *Physics and Psychics*.[28] At that time, critics had found a number of deficiencies in the experimental protocols and noted that most of the PEAR effect was essentially due to a single operator, who just happened to be the first subject as well as a primary member of the research team.[29]

The PEAR group remains very active and claims to have answered its critics. However, its members continue to report results in a cumulative fashion and it is not clear from their papers that these are not affected by biases that may have been introduced in the early, developmental phases of the experiment.

History is full of reports of exciting new results obtained in the preliminary stages of scientific experiments, only to see the effects go away as the experiments are improved. Two examples that come immediately to mind are the ESP work by Joseph Banks Rhine at Duke University in the 1930s and the recent reports on Cold Fusion.

One severe criticism of the PEAR protocols is that experimenters also act as operators and their results are included anonymously in the cumulative data sample. While the experimenter-operators are subjected to the same controls as the others, this still strikes most observers as an unwise procedure that leaves them open to the suspicion, however unfair, that they have somehow "cooked up" the effect. Indeed, as mentioned, the results are less significant when the experimenter data are removed, though they are still claimed to be significant.

This is not to say that any cheating has occurred, but given the history of ESP research, this must remain an economical explanation until it ruled out to the highest degree. Normal scientific protocols in which the experimenters are kept from having any influence on the specific outcome of an experiment are strongly called for in this case. The researchers can still serve as subjects to test out the equipment and experimental procedures, but their data runs should be excluded from the samples used to test for an effect.

Even if the PEAR experimental protocols are assumed to be adequate, the significance of the result remains arguable. Using standard ("classical") statistical tests, probabilities of the order of 10^{-4} for the result being simply due to statistical error have been reported.[30] As well as I can tell from reading the papers, this is intended to mean that only one experiment in ten thousand similar ones would have given the same deviation, or a greater one, as the result of normal statistical fluctuations.

This type of measure of significance, called the **significance level**, is widely used, including within my own field of particle physics. However, statistics experts argue that it is not always appropriate, depending as it does on hypothetical, non-existent experiments. Some recommend that other techniques, including but not limited to those referred to as **Bayesian**, should be used to determine the level of significance of an experimental result.[31] In a Bayesian analysis, different *a priori* hypotheses are tested against the data.

A Bayesian analysis of the PEAR data has been done by PEAR researcher York Dobyns. The result was a range of significance, depending on assumptions, that included "no-effect" as a strong possibility.[32] Dobyns used this result to argue that the classical (significance-level) method should be taken as more reliable in this situation than the Bayesian method, because it is insensitive to assumptions.

However, astronomer William Jefferys has responded that the classical method involves hidden and less well-formulated assumptions, and that Bayesian methods at least put their's up-front.[33] The Bayesian analysis of PEAR data suggest that the classical result is too optimistic by a factor of at least ten and perhaps hundreds. A significance level of 10^{-4} merits attention, although any effect must certainly be independently confirmed when one is claiming an important new result. Any lower significance level, say 10^{-3}, should not create a stir. In the hundreds of experiments done yearly, statistical fluctuations will produce many artifactual effects at the 0.1 percent significance level.

I conclude that, as with the ganzfeld experiments, we are forced by scientific method to adopt a skeptical, wait-and-see attitude toward the random event generator experiments. Under normal standards, no one has a right to claim evidence for a quantum-mind connection based on these results, though this has been done[34]. Even weak claims will be blown out of proportion in the public media. Experiments of such momentous implication must be independently replicated at the same quantitative level, with believable statistics and far tighter experimental procedures, before they can be used to support the mystical belief in a cosmic mind.

Most parapsychologists believe the evidence for psi is strong enough to conclude that the phenomena are real. I think they are dead wrong. In my mind, all these years of searching with no convincing evidence should be taken as a clear indication that psi does not exist. So parapsychologists and I disagree on this. Nevertheless, no conscientious parapsychologist can deny that a broad scientific consensus has yet to be assembled in support of their position.

Still, the average person is likely to wonder how so many observations of mysterious phenomena reported in thousands of books, articles, and newspaper stories over many years could be wrong. Movies and TV continue to exploit the public's thirst

for such tales, with programmers paying token lip-service, at best, to the very real doubts that exist in every case where evidence for psychic forces is claimed.

Many of the stories used have already been proven to be hoaxes or downright fabrications. But they are rarely reported as such in the popular media, in what can only be described as scandalous behavior on the part of the authors and producers of these fables.

Undoubtedly, some narratives are honest reports of unusual happenings and simply misinterpreted as requiring the intervention of magical forces beyond the familiar world of matter. People tend to look for mysterious explanations when the improbable occurs; they are more interesting; more comforting than the mundane. But with billions of people in the world, improbable events occur somewhere on a daily basis. When the critical, skeptical methods of conventional science are applied to the observations labelled as psychic, and when those data are sufficiently clear to form a judgment, more economical explanations not involving extraordinary new hypotheses have so far always been found.

The average person is not scientifically trained and generally unaware of a primary rule of scientific discovery: *Extraordinary claims require extraordinary evidence.* To demonstrate an extraordinary claim, like the miracle of ESP, extraordinary evidence must be obtained. Only after every alternate, mundane explanation has been ruled out with the highest degree of certainty can one begin to entertain hypotheses that introduce new elements that go beyond current science. So far, the evidence for psi phenomena has been ordinary at best.

Still people continue trying to make something of nothing. In recent years, some proponents of psi phenomena have interpreted quantum mechanics as providing a basis for instantaneous ("nonlocal") psychic communication across the universe. As physicist Amit Goswami has put it:

> "The farther away the point, the less intense is the signal reaching it. In contrast, nonlocal communication exhibits no such attenuation. Since the evidence indicates that there is no distance attenuation of distant viewing , distant viewing must be nonlocal.[35] Thus it is logical to conclude that psychic phenomena, such as distant viewing and out-of-body experiences, are examples of the nonlocal

operation of consciousness.

> "Any attempt to dismiss a phenomenon that is not understood merely by explaining it as hallucination becomes irrelevant when a coherent scientific theory can be applied. Quantum mechanics undergirds such a theory by providing crucial support for the case of nonlocality of consciousness; it provides an empirical challenge to the dogma of locality as a universal limiting principle."[36]

In this book, I take up Goswami's challenge.

As we see from this quotation, quantum mechanics offers believers in ESP a hypothetical basis for their continued insistence that something must exist beyond the world of conventional physics. That something is usually associated with human consciousness, which is assumed to possess qualities than cannot be explained from purely material, physical considerations.

Arthur Koestler once remarked that "the apparent absurdities of quantum physics . . . make the apparent absurdities of parapsychology a little less preposterous and more digestible."[37] Again, quantum mechanics provides the metaphor. A "quantum mechanics of consciousness" has been proposed in which consciousness is represented by the quantum mechanical wave function.[38]

Recently, quantum physicist Henry Stapp has written a paper, published in the prestigious journal *Physical Review,* suggesting that a new version of quantum mechanics can account for the REG results through an interaction between consciousness and the quantum wave function.[39] I will come back to this, and many other claims, later in this book.

The quantum-consciousness connection, and its association with mystical notions of wholeness, provide a metaphor that believers in the existence of psychic powers use to lay a veneer of scientific respectability over ideas that require a drastic revision in our existing models of reality.[40] However, as we will see, that veneer is so thin as to be invisible. Quantum physics is supported by solid experimental evidence, but psi phenomena are not and the admitted absurdities of parapsychology remain absurd.

Aether and Spirit

The cosmic mind, viewed from the paranormal perspective, is some sort of invisible field that pervades the universe. Human minds are supposedly linked to this field, able to excite it and receive excitations from it. This is far from a new idea. In fact, a very similar notion developed in the nineteenth century, for much the same purpose.

As science gradually became established, people sought ways that it might be reconciled with their traditional beliefs, or even used to buttress those beliefs. In the nineteenth century, some scientists associated spiritual or psychic forces with the **aether** that was thought to fill all space and provide the medium for the transmission of light from distant stars. Going beyond physics, these scientists suggested that the aether provided the mechanism by which humans connected to a imagined world beyond matter - the world of the spirit.

The belief in a universal, cosmic fluid pervading space has even older roots. To the ancient Greeks, aether was the rarified air breathed by the gods on Olympus. Aristotle used this term for the celestial element, the stuff of the heavens, and said it was subject to different tendencies than the stuff of earth. That is, aether was not bound by the same laws as ordinary matter.

When Newton was prompted to explain the nature of gravity, he replied that gravity might be transmitted by the invisible aether.[41] He further suggested that the aether also may be responsible for electricity, magnetism, light, radiant heat, and the motion of living things that he, like his contemporaries, thought was the consequence of some source beyond inanimate matter.

Today, with knowledge not available to Newton, we can account for life as a purely material phenomenon with no need to invoke any special life-force. Despite this, and the complete absence of scientific support for the existence of immaterial, vital forces, we still hear of ch'i, ki, prana, and psychic energy - usually in association with alternative healing. Again the ego is doing the thinking, assuming that something special must account for the wonder of its own existence.

Newton had envisioned matter and light as particulate in nature, though they appear continuous to the human eye. Gravity, however, seemed to be something else, acting invisibly - holistically - over the entire universe. (It should be noted, though, that

the gravitational force falls off inversely with the square of distance, unlike the imagined psychic fields.)

In the mid-nineteenth century, the mathematical concept of the field was developed to describe the apparent continuity of matter, light, and gravity. A field has a value at each point in space, in contrast to the properties of a particle which are localized to an infinitesimal region of space.

Pressure and density in a fluid are two examples of how the field concept is successfully applied in practice. Although matter is discontinuous at the atomic and molecular level, these "matter fields" provide for an accurate description of the behavior of solids, liquids, and gases because, on the everyday scale, matter appears continuous to a very good approximation.

As the phenomena of electricity and magnetism became better understood, they also were described in terms of fields. Then, in 1867, James Clerk Maxwell had one of those rare insights that punctuate the history of science. He discovered that the equations uniting electricity with magnetism called for the propagation of electromagnetic waves in a vacuum, Furthermore, these waves moved at the speed of light.

Waves were already very familiar phenomena in physics. In (apparently) continuous media such as air, pressure and density propagate as sound waves when the media are excited. For Maxwell's electromagnetic waves, the question arose: What's doing the waving? The analogy was drawn that all of space out to the most distant stars was filled with an elastic medium - the aether - whose excitation produced the phenomenon of light.

Electromagnetic waves beyond the narrow spectrum of visible light were predicted, soon observed, and put to use in "wireless telegraphy." One of the early workers was the English physicist Oliver Lodge. While making major contributions to physics and engineering, Lodge joined William Crookes, Alfred Russel Wallace (co-discoverer of evolution) and other notable nineteenth century scientists in extending their horizons to search for phenomena that transcended the world of matter.

If wireless telegraphy was possible, why not wireless telepathy? If electrical circuits could generate and detect ethereal waves, why not the human brain?

Coincidentally, certain people who claimed to possess the ability to communicate with other minds, living and dead, had just appeared on the scene. They were called spiritualist mediums a century ago; today their spiritualist descendants are known as psychics or channellers.

Unfortunately, most scientists lack the specific skills needed to distinguish fact from illusion in the world of magic. The universe does not lie; people lie. And so Lodge and other nineteenth century psychical researchers unwittingly allowed themselves to be fooled by the tricks of professional fortune-tellers and sleight-of-hand artists posing as spiritualists. They permitted their wishes and dreams to govern their senses and reason. Lodge, desperately wanting to believe in life after death, had written passionately about imagined communications with his son Raymond, killed in Flanders in 1915. Sadly, he accepted the wildest claims of mediums and skilled stage magicians.[42]

Spiritualism offered scientists like Lodge a way to reconcile science with a belief in immortality. The resurrection of the complete body had always been the primary tenet of Christianity. If only Jesus's soul had gone to heaven, why would his body have been missing from the tomb? The Catholic Church has insisted that the Virgin Mary's body also ascended, atom by atom, to heaven. As for the rest of humanity, our bodies had to await the Day of Judgment for our complete resurrection.

By the nineteenth century, however, it had become clear that it was absurd to think of all the atoms of a human body reassembling on Judgment Day. Our atoms are being replaced moment-by-moment anyway. So the idea of a "spiritual body," separate and distinct from matter, was developed.[43] Lodge proposed that the aether was the substance of spirit. As he put it:

> "The body of matter which we see and handle is in no case the whole body; it must have an etheric counterpart to hold it together, and it is this etheric counterpart which in the case of living bodies is, I suspect, truly animated. In my view, life and mind are never directly associated with matter; and they are only indirectly enabled to act upon it through their more direct connection with an etheric vehicle which constitutes their real instrument, an ether body which does not interact with them and does not operate on matter. . . .An etheric body we

> possess now, independent of accidents that may happen to its sensory aggregate of associated matter, and that etheric body we shall continue to possess, long after the material portion is discarded. The only difficulty of realizing this is because nothing etheric affects our present senses."[44]

Few of the faithful today realize that the notion of a separate "spirit" and "body" was a fairly recent development in Christian thinking, though it goes back ages in India and Greece. That is not to say that the idea of a spirit or soul is new to Christianity, but simply that the sharp distinction between body and spirit, or body and mind, now commonplace in Christian thinking was a modern innovation that cannot be found in the scriptures or early teachings of the Church.

Relativity and Quantum Mechanics

Near the turn of the century, Michelson and Morley sought to find experimental evidence for the electromagnetic, or "luminiferous," aether and succeeded in showing instead that it did not appear to exist. Shortly thereafter, in 1905, Einstein developed his theory of relativity which demonstrated that the concept of an aether was mathematically and logically inconsistent with Maxwell's equations of electromagnetism. Einstein concluded that electromagnetic waves, including light, could not be the vibrations of an aether. Still, Oliver Lodge remained firm in his belief that a universal cosmic fluid existed that could be excited by the human mind. To Lodge, the aether was a necessity, the cosmic glue without which "there can hardly be a material universe at all."[45]

Lodge was similarly unhappy with what he was hearing quantum physicists, like Planck and Bohr, say about the fundamentally discrete, quantized, nature of all phenomena. He deplored "the modern tendency . . . to emphasize the discontinuous or atomic character of everything."[46] But progress passed him by, as evidence accumulated that matter is composed of discrete atoms, that electricity is the flow of electrons, and that light is a current of particles called photons.

By the time Oliver Lodge died in 1940, both the luminiferous aether and material continuity were already long in their graves. Today the electromagnetic aether is no longer a candidate for the stuff of spirit. The aether simply does not exist. In its place,

even more ephemeral aether fields have been imagined as sources for spiritual quintessence - the field of the quantum wave function, the "quantum potential," or perhaps, as Danah Zohar suggests, the vacuum itself.[47]

Like Lodge, Ernst Mach, and many other capable physicists of the early century, Einstein was uncomfortable with quantum mechanics, calling it "spooky." In 1935, he and two collaborators, Boris Podolsky and Nathan Rosen, wrote a paper arguing that quantum mechanics was incomplete because it does not provide for a description of what they called "physical reality."[48]

Einstein and his collaborators pointed out that, following conventional quantum mechanics, an experiment performed at one point in space seems to immediately determine the outcome of another experiment performed at a different point, even when the separation between these points is such as to require a signal moving faster than light to carry information from one to the other in the elapsed time interval. In fact, a signal must move at infinite speed to connect two simultaneous events separated any distance, even one as small as an atomic diameter. This distance could also be billions of light years, if all events past and future are to be connected.

Yet quantum mechanics seems to allow for just such an instantaneous correlation between separated events. This has provided a scientific basis, at least in some minds, for the notion that the universe is one simultaneously-connected whole. Einstein referred to this quantum connectivity as a "spooky action at a distance," noting that it was incompatible with his claim that no signals can move faster than light.

Like so many of the strange effects of quantum mechanics, this apparent paradox, which we will be examining in great detail, is a consequence of the wave-particle duality in which physical systems seem to behave either like waves or particles, depending on which type of property you are trying to measure. Again the distinction is between the discrete, localized properties of a particle and the continuous, distributed properties of a wave field.

Now it is not commonly appreciated that instantaneous correlations between separated events were already present in pre-relativistic, pre-quantum physics. Prior to Einstein, no limit existed on the speeds of bodies. Furthermore, classical waves, even those moving at finite speed that you stimulate by tossing a pebble in a lake, can

produce correlations between separated phenomena. You can imagine such a wave carrying information in the modulation of its amplitude or frequency, just as with sound and radio waves.

As a radio wave propagates outward, all the information carried by the waveform spreads through space. At any given time, two separated receivers on the wave front obtain that identical information; they simultaneously hear the same program. The two receivers can be said to be correlated, but that relationship is not a causal one in which an action at the place of one receiver generates a result at the place of the other receiver. Observers at the receiver positions cannot instantaneously signal each other unless that signal can move at infinite speed.

So, independent of quantum mechanics, observations at separated points in space can still be correlated. This correlation, however, does not imply superluminal signalling nor any other miracle; no physical law is violated. Two points in space can receive the same information when that information originates from the same point.

Quantum mechanics, on the other hand, has suggested to some that measurements made at one point in space can instantaneously affect the outcome of measurements at another point. This notion, which was expressed in the Goswami quotation above, is termed **nonlocality**. It implies some sort of superluminal signalling, in violation of Einstein's assertion that nothng can go faster than light. As we will see in the following chapters, the consequences of nonlocal communication are so profound as to turn most of our concepts of space and time on their heads. Indeed, the realization by Einstein that motions at infinite speed made it impossible to assign points in space and time a unique reality led him to assert that a maximum speed, the speed of light, exists.

In 1964 John S. Bell, stimulated by the ideas of David Bohm, showed how it was possible to experimentally test the spooky way quantum mechanics seemed to allow for superluminal action at a distance.[49] Bohm, following a largely forgotten suggestion of de Broglie a quarter century earlier, had proposed an alternative interpretation of quantum mechanics in which yet-undetected entities were responsible for the wave-like behavior of particles.[50] Following convention, I will call these entities **hidden variables**, though the term is not particularly enlightening.

Bell showed the way to experimentally decide between the most important class of hidden variables, those that are both "local" and "real" as are the variables of classical physics, and the conventional interpretation of quantum mechanics. **Local** variables do not violate Einstein's relativity and involve no superluminal signalling. **Real** variables, in this context, are like the familiar variables of classical physics, being simultaneously measurable and behaving in predictable ways.

Now, after a series of precise experiments, the issue has been decided: Hidden variables that are both local and real are ruled out.[51] Real, nonlocal hidden variables, such as those introduced by de Broglie and Bohm, remain possible alternatives to the conventional interpretation of quantum mechanics.

But nonlocality implies superluminal connections at some level, and at least an apparent violation of relativity. Since experiment has yet shown any such violation, a more economical interpretation of the results on experimental tests of Bell's theorem is simply that no hidden variables exist. Popular literature, however, would lead you to think that nonlocality is a demonstrated fact of nature. As I will explain in great detail in these pages, nonlocality exists only in theory. No superluminal motion or communication has ever been observed.

Experiment, not theory, will decide whether nonlocality is indeed a fact of nature. So far, it is not known to be a fact. Those quantum interpretations that incorporate nonlocality claim, with a certain illogic, that the superluminal transfer of information is still impossible. However, I fail to see how nonlocality can imply anything meaningful other than communication, or other motion, faster than the speed of light.

The New Holism

With experiment ruling out local hidden variables, a new holism has begun to develop. For example, Bohm's nonlocal *quantum potential*, which we will describe later, seems to imply an interconnectedness between separated phenomena that does not exist in reductionist physics. In the new holism, a revised quantum mechanics provides the mechanism by which signals can move faster than light, making possible the instantaneous connections across the universe.[52]

However, the nonlocality of hidden variables, or other variations on nonlocal, causal mechanisms underlying quantum mechanics, is a nonlocality within that specific interpretation and not necessarily within quantum mechanics itself as a theory that describes the results of observations.

If the apparent empirical violation of Bell's theorem is to be construed as evidence for nonlocality in nature, which is by no means demonstrated, then that nonlocality is contained in hidden variables or other structures that play no role in quantum mechanics as it is currently practiced. Any theory of hidden variables is thus a new theory, a *sub-quantum* theory that must lie deeper than quantum theory.

This has not discouraged many authors from finding other mystical messages within the conventional Copenhagen interpretation of quantum mechanics. They conclude that we can never adequately describe, in scientific terms, the "irreducible whole." This obscure concept has been related to the "being-in-itself" of that master of obscurity, philosopher Martin Heidigger.

For example, in their book *The Conscious Universe*, astrophysicist Menas Kafatos and philosopher Robert Nadeau associate being-in-itself with the quantum wave function:

> "If the universe were, for example, completely described by the wave function . . . . One could then conclude that Being, in its physical analogue at least, had been 'revealed' in the wave function. We could then assume that any sense we have of profound unity with the cosmos or any sense of mystical oneness with the cosmos, has a direct analogue in physical reality. In other words, this experience of unity with the cosmos could be presumed to correlate with the action of the deterministic wave function which determines not only the locations of quanta on our brain but also the direction in which they are moving." [53]

However, let me add a cautionary note. The vision of the new holists is not so appealing as it may first appear. The field of cosmic mind, whether aether, wave function, or quantum potential, is completely deterministic. In whatever manifestation, holistic physics possesses the very Newtonian, mechanistic character that is so decried by New Age authors.

In the view of quantum holism, though we humans are proscribed by the

uncertainty principle from ever being able to predict the exact outcome of events, those events are predetermined nevertheless. In a holistic universe, everything is intimately and instantaneously connected to every event past and future, here on earth and far out in space, with no room for chance or choice.

I ask myself: Do I really want to be one with the universe, so intimately intertwined with all of existence that my individual existence is meaningless? I find I much prefer the notion that I am a temporary bit of organized matter. At least I am my own bit of matter. Every thought and action that results from the remarkable interactions of my personal bag of atoms belongs to me alone. And so these thoughts and actions carry far greater value than if they belonged to some cosmic mind that I cannot even dimly perceive.

The mystical holist trades the real, pulsating life of the outer world for what he perceives as an inner world of peace. But that peace is the peace of a prison. Science has always provided the means for breaking us free from the prisons of ignorance and superstition. I hope to convince you that science has not suddenly reversed its course and become yet another set of shackles for humanity to carry. On the contrary, science continues to provide the key that unlocks all of our chains so that our bodies and minds are free to roam the universe.

Notes

1. Lanza1992, pp. 24-26. For my response, see Stenger 1993.

2. Capra 1975.

3. Capra 1982.

4. Ferguson 1980, p. 145.

5. Zukav 1979, p. 314.

6. Lederman 1993.

7. GUT predicted that the average proton lifetime was of the order of 10^{32} years. The current experimental limit is greater than 10^{33} years.

8. Technically, only one particular GUT was falsified so all possible GUTs are not ruled out. But when the simplest model failed, theorists started looking elsewhere.

9. Chopra 1989.

10. Chopra 1993.

11. For a critical review of Chopra's ideas, see Butler 1992, pp. 110-118.

12. *Newsweek,* March 23, 1994, p. 81.

13. Patricia Newton, talk before the 98th Annual Meeting of the National Medical Association, San Antonio, Texas, 1993. Quotation provided by Bernard Ortiz de Montellano (private communication).

14. Palmer 1986.

15. A focussed beam will fall off less rapidly, but still will be expected to decrease in intensity as one moves away from the source. The more focussed, the lower the decrease, but also the less likely that the beam will intercept a receiver. For a discussion of Einstein's view on ESP, see Gardner 1981, pp. 151-157.

16. Rhine 1954. For a more recent attempt, see Dunne 1992.

17. See *Science News* 106, July 20, 1974, p. 8. See also Gardner 1981, p. 94, for his

recounting of the events. In a private communication with me, Sarfatti has confirmed the accuracy of these reports.

18. Gardner 1981, p. 94.

19. See Randi 1973, 1985 and Gardner 1981, note 7, p. 104.

20. Stenger 1990. Uri Geller filed three lawsuits against me in 1992 over this book. All were settled in my favor.

21. Druckman 1987.

22. See, for example, Palmer 1989, p. 10.

23. Bem 1994.

24. Blackmore1994, Hyman 1994.

25. Druckman 1987, p. 185.

26. Schmidt 1969, 1992, 1993.

27. Jahn 1986, 1987, 1991, 1992; Dunne 1992.

28. Stenger 1990, pp. 180-184. Other critiques can be found in Hansel 1989, Druckman 1987 pp. 184-190, and Alcock 1990.

29. Alcock 1990, pp. 6, 107.

30. Dunne 1992.

31. For a nice introduction to Bayesian methods of inference, and its connection to Occam's razor, see Jefferys 1992a.

32. Dobyns 1992.

33. Jefferys 1992b.

34. Jahn 1986, Stapp 1994.

35. Distant viewing, or remote viewing, is a formerly fashionable version of ESP. Like all other previous ESP fashions, it has been thoroughly debunked.

36. Goswami 1993, p. 136.

37. See, for example, Oteri 1975. The Koestler quotation can be found on p. 268. See also, Puharich, 1979.

38. Jahn 1981, 1986; Schmidt 1969, 1993.

39. Stapp 1994.

40. For a review of the early history of quantum theory and ESP, see Gardner, 1981. This article originally appeared in the New York Review of Books, May 17, 1979. The reprint also contains letters reacting to the review and Gardner's response to these. Also, see Stenger, 1990, pp. 246-250 for my review of Evan Harris Walker's quantum theory of psychokinesis given in Puharich 1979.

41. For a history of the idea of the aether, see Cushing 1989, pp. 272-311.

42. For further discussion and references, see Stenger 1990, Chapter 7.

43. Lamont 1990.

44. Lodge 1929, p. 14.

45. Lodge 1920.

46. Lodge 1914, p. 21.

47. Zohar 1990, p. 225.

48. Einstein 1935.

49. Bell 1964.

50. Bohm 1952.

51. Aspect 1982.

52. See, for example, Talbot 1991.

53. Kafatos 1990, p. 124.