Journal of Scientific Exploration, Vol. 3, No. 1, pp. 15–26, 1989
Pergamon Press plc. Printed in the USA.
0892-3310/89 $3.00+.00

INVITED ESSAY

Anomalies: Analysis and Aesthetics

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Abstract—In properly allying itself with traditional scientific tenets and procedures, anomalies research also risks encumbrance by scientific stodginess, scientific segregation, and scientific secularity. In particular, the contemporary rejection by established science of its own metaphysical heritage and essence precludes its further evolution into physical and biological domains where consciousness plays demonstrably active roles. Some orderly rapprochement of subjective and objective experience and representation within the scientific paradigm will be required to make it effective in such arenas.

Three epistemological premises prompted the conception and birth of our Society for Scientific Exploration, and have guided its early life:

1. Empirical anomalies in any scientific sector can be precious indicators of the limits of established wisdom and can open trails to better understanding.
2. Study of such anomalies must be pursued with uncompromising rigor and critical conservatism.
3. Contemporary anomalies research needs an objective interdisciplinary forum for comfortable professional discussion of the phenomena and their implications.

By our membership policies, the structure and conduct of our meetings, and the design of our publications, we have attempted to implement these ideals to insure that SSE shall indeed propagate its research with at least as high a level of technical rigor and critical judgment as prevail in most mainstream scientific organizations. Yet, in this lofty commitment there lurk possibilities for severe pragmatic tensions, if the premises are not profoundly interpreted and carefully balanced.

The problem, of course, is not with the principles, per se, but with their abuse. As Dorothy Sayers reminds us, the familiar adage "the road to hell is paved with good intentions" may not so much refer to noble aspirations left unfulfilled by neglect, distraction, or incompetence, as to those pursued so slavishly that they become ends in themselves, to the point of negating, or even inverting, their original virtues. The sacred tenets of science are by no means invulnerable to such distortion by excess. As a present and pertinent example, we might point to the prevailing plethora of criticism concerning the conduct and interpretation of the various forms of anomalies research in which we are engaged. To the extent that such commentary is informed, fair, and constructive, it provides important restraints along the paths of understanding, and nothing that follows here should be construed to contradict the essential role of such critical analysis in the scholarly progress of our Society. But in its uninformed, unfair, or self-serving misapplication, such criticism becomes distracting, divisive, and counterproductive, and must be courageously resisted.

So also with excessive deference to other canons of the scientific process. In allying ourselves too assiduously with the prevailing content, methodology, and standards of science, we can become bound by its dogma and limited by its self-imposed horizons; in over-valuing scientific caution, we can become mired in scientific inertia. Three categories of such encumbrance that bear quite directly on the SSE situation might be termed "scientific stodginess," "scientific segregation," and "scientific secularity." Let us consider the first two very briefly, and the third in more detail.

Scientific Stodginess

Many of us have witnessed, and possibly even contributed to, legitimate professional disagreements that have escalated to matters of principle, then into ad hominem personal conflicts, and thence to outright bigotry and inanity. Many of the greatest minds of science have similarly blundered into such foibles. History records a dreary sequence of cases where scholars of immense stature, themselves having broken through entrenched pedantry to open new horizons, later obstructed scientific progress with their own brands of bombast. We think of Ernest Rutherford, who first showed the world the nuclear atom, subsequently fulminating:

> It is a very poor and inefficient way of producing energy, and anyone who looks for a source of power in the transformation of atoms is talking moonshine. (Rowland, 1957, p. 129)

With equally misplaced authority, the Astronomer Royal, Richard Wooley, proclaimed one year before Sputnick, that "space travel is utter bilge." Lord Kelvin assured us that x-rays would prove a hoax and that heavier-than-air travel was impossible. Ernst Mach decried both atoms and relativity. D'Alembert distrusted probability theory, and Lavoisier and Ostwald disputed atomic chemistry. The list of such derailments of scholarly judgment is long and humbling.

More modern examples of similar abuse of scientific conservatism also abound. In the particular fields of our interest, we find them displayed not only by individual critics, but by a number of fully-blown professional organizations. And the tragedy lies not only in the direct encumbrance of the research they decry, but even more seriously in the adulteration of legitimate criticism that could constructively separate valid evidence from fantasy.

One obviously should not claim that short-sighted authoritarian opposition of this sort automatically guarantees the validity of the concept criticized. Nonetheless, there may well be some subtle correlation between the emotionality of a critical reaction and the viability of its target, especially when the latter seriously threatens some deeply entrenched professional or personal position. In this respect, "the lady protesteth too much" criterion may occasionally apply to Madame Science, as well.

Scientific Segregation

Modern science has proven supremely effective in systematically subdividing complex problems into more manageable portions, discriminating among potential mechanisms and competing concepts, analyzing elemental processes, and cataloging the results. In general, however, it has proven considerably less effective in putting the pieces back together—in synthesizing new systems and unfamiliar interactions, especially when these have involved multidisciplinary aspects. To confirm this imbalance of competence, one need look no further than the number of extant specialist and sub-specialist professional societies and journals compared to those addressing interdisciplinary topics or strategies, or examine the relatively primitive states of such fields as human factors engineering, operations research, complex systems analysis, etc., or note the essential absence of any basic discipline that might qualify as "systems science."

Along with this severe conceptual subdivision come equally esoteric languages that further inhibit transdisciplinary dialogues, engender professional chauvinisms, and even raise suspicions fostered by unfamiliarity and exclusion. This "Babel" of hyperspecialization is becoming a progressively greater obstruction to the comprehension and application of much conventional modern science; in the fields of research that our society encompasses, it could be quite fatal to the entire enterprise. The cartoon of Figure 1 (courtesy of Henry H. Bauer) is a reasonably apt caricature of some comments overheard in the corridors of SSE annual meetings and, if we are totally honest, of our own private hierarchies of credibility. How often do we feel that the courageous experimentation and blazing insight featured in our own research deserves the most broad-minded respect and admiration from our colleagues, while the work some of them pursue is just too controversial and too extreme to be fully credible? Yet it is quite possible that each of our topics remains anomalous precisely because we lack the breadth of perspective to put it in that larger context of understanding wherein the phenomena can be accommodated naturally, and wherein more comprehensive theoretical models could pertain. Are we not more likely to unfold that broader

Fig. 1.*

comprehension collectively, rather than individually? And do we not need to learn how to converse collectively before we can reason collectively?

Scientific Secularity

The third, and possibly most severe, class of impediment imposed by the excessively rigid stance of modern science, and the one on which we shall dwell a bit, devolves from its categorical and contradictory denial of its own metaphysical essence and heritage. The very word "metaphysical" has come to carry distasteful or suspicious connotations for most scientific purists, and is usually applied pejoratively in any research context. As we use the term here, however, it is simply meant to encompass all subjective, intuitive, impressionistic, or aesthetic aspects of a scientific situation which, while not submitting comfortably to prevailing catalogues and formalisms, nonetheless are found empirically, or hypothesized heuristically, to be relevant to the given event or process. The historical precedents for inclusion of such factors in scientific study and applications are floribundant beyond question. Ancient science, from prehistoric civilizations through the Egyptians, Babylonians, Orientals, and classical Greeks, was an inextricable admixture of mystical, magical, and analytical manipulation that served for millennia to undergird the technological needs of those societies. Medieval alchemy likewise propagated as a sacred marriage of the Hermetic philosophical tradition with the early methods of analytical chemistry. Even the first

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echelon of the analytical astronomers—Copernicus, Tycho Brahe, Kepler, Galileo—now popularly represented as breaking through the suffocating fog of theological dogma with sound scientific methodology, actually carried forth much of the same metaphysical tradition. Note how Copernicus justified his heliocentric universe:

> In the middle of all sits the Sun enthroned. In this most beautiful temple, could we place this luminary in any better position from which he can illuminate the whole at once? He is rightly called the Lamp, the Mind, the Ruler of the Universe: Hermes Trismegistus names him the Visible God, Sophocles' Electra calls him the All-Seeing. So the Sun sits as upon a royal throne, ruling his children, the planets which circle around him. (Bronowski, 1973, pp. 196–197)

Kepler similarly rationalized his orbital geometry:

> . . . when intersected by a plane, the sphere displays in this section the circle, the genuine image of the created mind, placed in command of the body which it is appointed to rule; and this circle is to the sphere as the human mind is to the Mind Divine . . . (Pauli, 1955, p. 161)

Even the mighty Isaac Newton, on whose classical mechanics and optics modern science is irrevocably based, has been accurately described by one biographer as:

> . . . not the first of the age of reason. He was the last of the magicians, the last of the Babylonians and Sumerians, the last great mind which looked out on the visible and intellectual world with the same eyes as those who began to build our intellectual inheritance rather less than 10,000 years ago. (Keynes, 1963, p. 311)

and by another as that premier scientist who regarded the ultimate mechanism of change in the universe to reside in the "mystery by which mind could control matter" (Kubrin, 1981, p. 113).

Ah, we say, but did not Sir Francis Bacon, the Age of Enlightenment, the Scientific Revolution, and the formation of the Royal Society clean all of this naïve metaphysical junk off of the work tables of modern science? Not quite. It is true that Bacon, the acknowledged father of the modern scientific method, insisted on a critical dialogue between hard empirical evidence and sound analytical logic, but he then proceeded to apply such methods to the study of telepathic dreams, psychic healing, and "experiments touching transmission of spirits and the force of the imagination" (Walker, 1972, p. 127). In his Charter for the Royal Society, Robert Hooke indeed rejected "meddling with Divinity, Metaphysics, Moralls, Politicks, Grammar, Rhetoric, or Logick" (Lyons, 1944, p. 41), but then went on himself to study, write, and lecture on keenly metaphysical topics. His colleague Robert Boyle, author of "The Skeptical Chymist," retained an intense commitment to the Hermetic heritage (More, 1962), and the Royal Society as a whole promoted scientific study of astrology, alchemy, prophecy, magic, and witchcraft.

To be sure, toward the close of the 19th century, the profound triumphs of electromagnetic wave theory prompted the prevailing physics establishment to wax rather smug about the omnipotence of deterministic, causal science, apparently overlooking the intuitive conviction of natural symmetry that had led Maxwell to propose his subtle, but all-important, displacement current. But the complacency was short-lived, for over the following decades there erupted a host of new physical anomalies—black-body radiation, atomic and molecular line spectra, photoelectric and Compton effects, specific heats of solids, and numerous others, that simply could not be swept under the classical scientific rug, and the enigmatic era of modern physics was at hand.

An enigmatic era indeed, featuring quanta and photons, wave/particle dualities, uncertainty and exclusion principles, probability-of-observation wave mechanics, and countless other counter-intuitive concepts that reimbued physical science with a distinctly metaphysical aroma. And none recognized the philosophical inescapability and pragmatic impact of this dimension more profoundly than the patriarchs of modern physics themselves. The father of their clan, Max Planck, courageously broached the fundamental issue:

> Once we have decided that the law of causality is by no means a necessary element in the process of human thought, we have made a mental clearance for the approach to the question of its validity in the world of reality. (Planck, 1932, p. 117)

Neils Bohr responded with his own radical conviction:

> . . . causality may be considered as a mode of perception by which we reduce our sense impressions to order. (Bohr, 1961, p. 116)

Erwin Schrödinger took a yet more vigorous metaphysical position:

> The world is given to me only once, not one existing and one perceived. Subject and object are only one. The barrier between them cannot be said to have broken down as a result of recent experience in the physical sciences, for this barrier does not exist. . . . Mind has erected the objective outside world of the natural philosopher out of its own stuff. (Schrödinger, 1967, p. 137 and p. 131)

And Louis de Broglie, the Prince of particulate probability, closely presaged our own present convictions about the role of consciousness in the establishment of reality:

> Science is therefore a strange sort of penetration into a world which through human consciousness and reason has learned to become aware of itself. (de Broglie, 1962, p. 220)

Even in the most exact of all the natural sciences, in Physics, the need for margins of indeterminateness has repeatedly become apparent—a fact which, it seems to us, is worthy of the attention of philosophers, since it may throw a new and illuminating light on the way in which the idealizations formed by our reason become adaptable to Reality. (de Broglie, 1939, pp. 281–282)

There is no substitute for thorough reading of the extensive personal writings of these and the other pioneers of modern physics to acquire full appreciation of the implicit and explicit mystical dimensions of this era of science. And it is an era that is far from closed. Even now, we continue to be confronted by latter-day EPR paradoxes and action-at-a-distance experiments that severely contradict the premises of local causality. In our conceptualization and linguistic representation of sub-nuclear phenomena on one extreme—quarks, gluons, strangeness, charm, and so on—and of astrophysical and cosmological processes on the other—quasars, black holes, cosmic strings, pulsating bubble universes, etc.—there smolder some of the same metaphysical propensities that were more explicitly enflamed in Hermes's precepts or the alchemist's forge.

And we certainly must include in this list the research encompassed by this Society, which in many of its projects addresses frankly metaphysical effects. For example, data on man/machine anomalies like those shown in Figure 2 have been presented in this forum on several occasions (Jahn, Dunne, & Nelson, 1987). The particular case shown pertains to the interaction of one human operator with a microelectronic random event generator (REG) in a very carefully controlled sequence of experiments extending over nine years. Plotted are the accumulated deviations of the output of the machine from chance expectation, obtained under a tripolar protocol wherein the operator alternately attempted to achieve a high number of

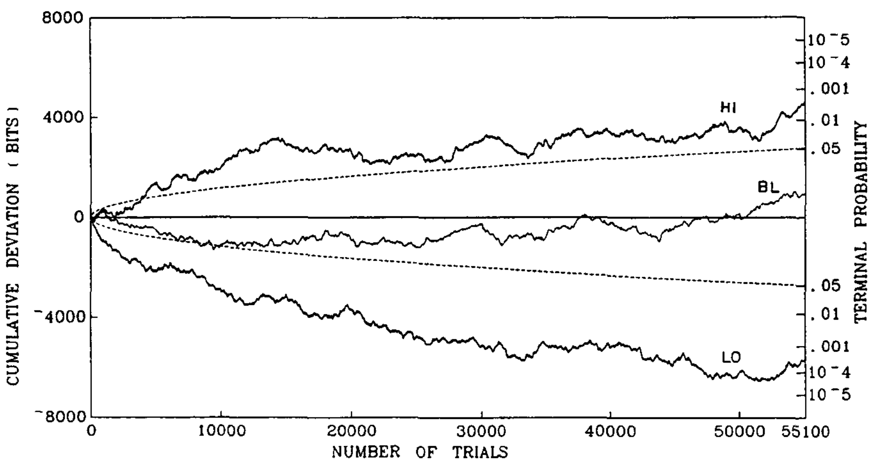

Fig. 2. REG cumulative deviations from chance, one operator.

counts (HI), a low number of counts (LO), or the chance number of counts (BL), interspersed in a random sequence of efforts, with all other technical and procedural aspects of the experiment held identical. As can be seen from the figure, the null-intention or baseline effort yields a string of data oscillating stochastically about the theoretical chance mean. The high-intention efforts produce results displaying the same sort of stochastic oscillations, but now superimposed on a systematic trend toward ever increasing excess above chance. The low-intention efforts show a similar, but even more substantial trend in the opposite direction. On this figure, the dashed parabolas represent the loci of .05 likelihood of achieving the given excursions by chance, and the scale on the right ordinate shows the full range of terminal probabilities against chance for this huge sequence of data. Specifically, for the more than 30,000,000 bits processed in the more than 50,000 tripolar trials of this operator's program, the likelihood of obtaining the displayed split of the HI and LO data by chance is less than a few parts per million.

More than 30 other operators have performed this same experiment. Some achieve much like the example shown in Figure 2; some are successful in only one direction of effort, or in the other; some display only chance results; a few achieve extra-chance results in directions opposite to their intentions. But despite these major differences in detail, in most cases each operator's pattern is serially consistent with itself, i.e., internally replicable in the statistical sense, so much so that we refer to the individual cumulative deviation graphs as operator "signatures."

In some cases, these signatures are sensitive to secondary technical parameters of the experiment, such as whether the operator is allowed to choose the direction of effort or is instructed by some randomization criterion, or whether the operator is allowed to initiate each trial at his comfort or is presented with a regularly spaced sequence of automatic trials, or whether on-line feedback is provided and in what form. In other cases, however, the signatures appear insensitive to such options. Nonetheless, if the results of all operators, obtained under all permutations of these secondary parameters, are combined in a grand concatenation, the cumulative deviations still compound to highly significant statistical departures from chance behavior (Figure 3).

Although these REG data are clearly operator-specific, intention-specific, and in some cases parameter-specific, curiously they seem to be much less device-specific. Several other similarly extensive experiments have been performed using different microelectronic noise sources, pseudo-random sources constructed from arrays of microelectronic shift registers, programmed computer algorithms, and even macroscopic mechanical analogue devices. In a number of cases, an operator's signature of performance is found to transfer with remarkable similarity from one class of device to another. For example, Figure 4 shows a comparison of the cumulative deviation signature of one operator on a microelectronic REG, a shift-register pseudo REG, and a macroscopic Random Mechanical Cascade (RMC)

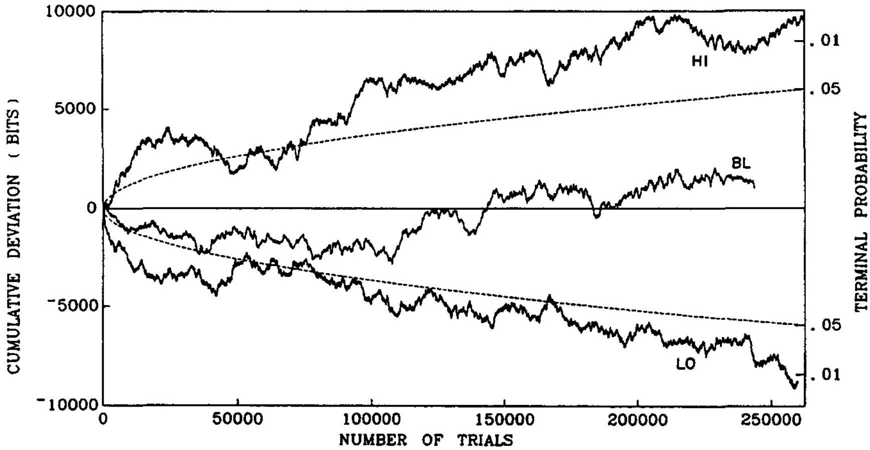

Fig. 3. REG cumulative deviations from chance, all operators.

respectively. Note the perseverance of the substantial low-intention efforts, the less substantial but characteristic high-intention trace with its initial strength and subsequent decline, and the well-behaved null-intention results.

A great deal more data from experiments of this sort could be shown, where the only independent variables of consequence are the individual operators and their directions of effort (Dunne, Nelson, & Jahn, 1988). Although these illustrations have been drawn from our own research base, many other studies (referenced in Jahn, Dunne, & Nelson, 1987), including some presented to this Society over the past several years, would seem to lead toward similar conclusions. Obviously, many more experiments of this class, including independent replications of those already reported, are now required, for unless such results can be directly discredited, the need for some metaphysical component in any model attempting to explicate, or even to correlate, the data seems unavoidable.

Summary

What is the point of this potpourri of historical, philosophical, and scientific musing? It is not, of course, a plea for return to blind superstition or superficial mysticism, nor for compromise with soft-shell science of any form. Rather, it is a suggestion that research such as our society fosters would be better served by a more complementary balance between our objective and subjective perspectives, of much the same sort that Bohr proposed:

> . . . we must, indeed, remember that the nature of our consciousness brings about a complementary relationship, in all domains of knowledge, between the analysis of a

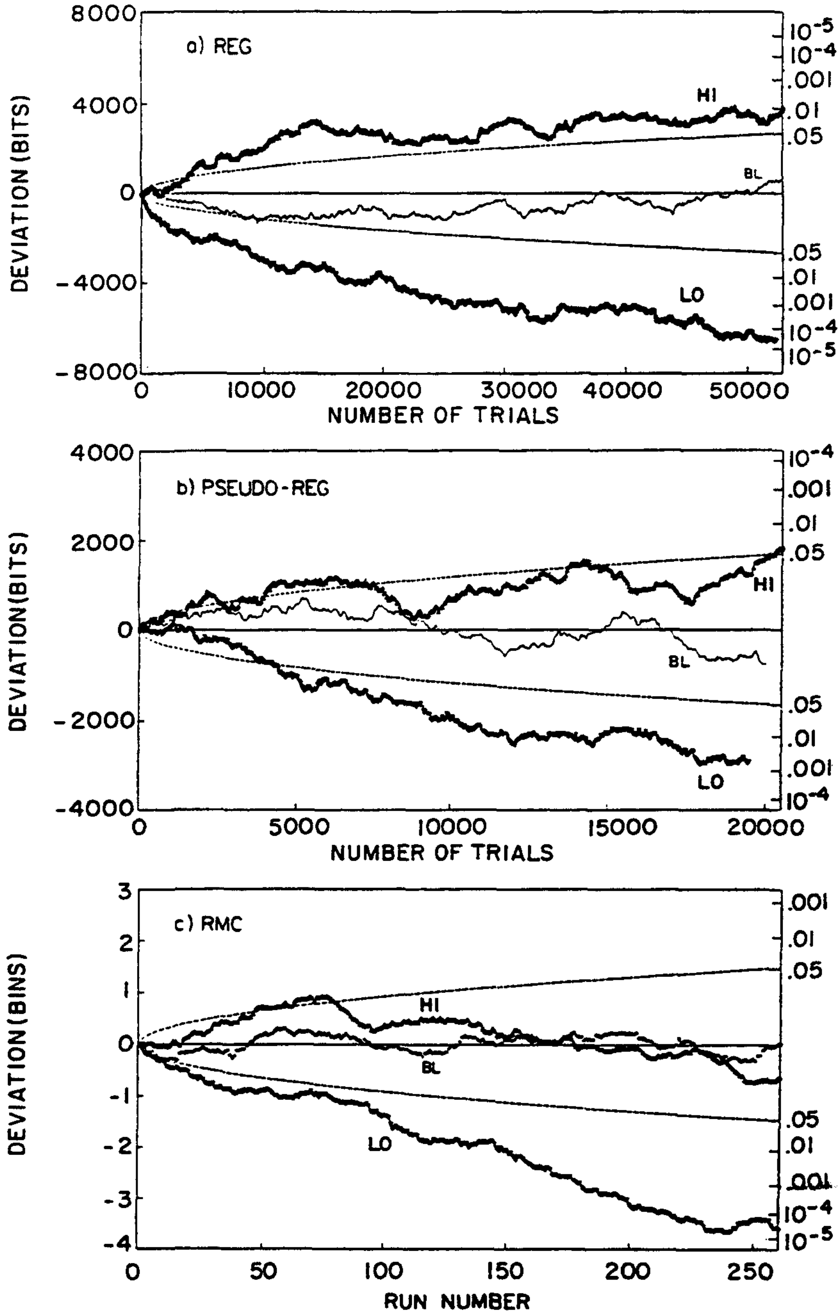

Fig. 4. Cumulative deviations, one operator on three experiments.

concept and its immediate application. . . . in associating the psychical and physical aspects of existence, we are concerned with a special relationship of complementarity which it is not possible thoroughly to understand by one-sided application either of physical or psychological laws. . . . only a renunciation in this respect will enable us to comprehend . . . that harmony which is experienced as free will and analyzed in terms of causality. (Bohr, 1961, pp. 20–24)

Heisenberg also offered a similar generalization of the complementarity principle:

We realize that the situation of complementarity is not confined to the atomic world alone; we meet it when we reflect about a decision and the motives for our decision or when we have the choice between enjoying music and analyzing its structure. (Heisenberg, 1958, p. 179)

and Pauli specifically addressed it to our context:

On the one hand, the idea of complementarity in modern physics has demonstrated to us, in a new kind of synthesis, that the contradiction in the applications of old contrasting conceptions (such as particle and wave) is only apparent; on the other hand the employability of old alchemical ideas in the psychology of Jung points to a deeper unity of psychical and physical occurrences. To us . . . the only acceptable point of view appears to be the one that recognizes *both* sides of reality—the quantitative and the qualitative, the physical and the psychical—as compatible with each other, and can embrace them simultaneously. . . . It would be most satisfactory of all if physics and psyche could be seen as complementary aspects of the same reality. (Pauli, 1955, pp. 208–210)

In short, our plea is for more formal acknowledgement of the pervasive metaphysical stream that continues to permeate and nourish much of our contemporary science and technology. This acknowledgement is not likely to be initiated by any of the well-established sectors of modern analytical research. These are too structured and hierarchical, too busy and comfortable, and admittedly too effective, to confront this dimension without considerably greater demonstration of its local relevance and provincial benefits. But within the traffic pattern of SSE, we not only have the opportunity and the disposition, but very possibly the necessity, of reengaging the analytical and the aesthetic aspects of scholarly science. Man/machine anomalies like those displayed in Figures 2–4, for example, are not likely to be rendered theoretically comprehensible without some disciplined inclusion of the role of consciousness as an active ingredient in the establishment of reality. One modest attempt at such a model, presented earlier to SSE, allows consciousness the same wave/particle duality it has ascribed to various physical systems, and then invokes the formalisms of quantum wave mechanics to represent interactions of consciousness with its environment (Jahn & Dunne, 1986, 1987).

Clearly, any attempt to generalize the analytical mechanics of science to encompass the metaphysical mechanics of consciousness is a monumental task, fraught with all manner of seductive and dangerous sinkholes of naïveté. But it is a task that is ultimately unavoidable. As Carl Friedrich von Weizsäcker put it nearly 50 years ago:

Two fundamental functions of consciousness underlie every statement of physics: cognition and volition. (von Weizsäcker, 1941, p. 489)

We can and, wherever possible, we should keep trying to accommodate our growing assortment of empirical anomalies within the concepts and formalisms of established science. But when this fails, and when all legitimate attempts to disqualify the anomalous data subside, there is no alternative but to expand the conceptual base. Like Sherlock Holmes, when confronted by an array of valid but irreconcilable evidence, we must boldly and cleverly redefine the question. In so doing, however primitively and incompletely, we shall not only enlighten some of our own enigmas and advance our parochial understanding, but we may well offer all of science a precious key to a more powerful future paradigm for many other areas of its endeavor.

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