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A BURNING QUESTION: EINSTEIN'S PARADOX OF CORRELATIONS

In 1927 at the fifth Solvay Council, that reunited all the aristocracy of theoretical physics, Einstein, regarding with solicitude the new-born "quantum mechanics" of Louis de Broglie, Schrödinger, Heisenberg and Dirac, discerned with his usual sagacity an indelible mark that was destined to become, with time, a subject of passionate discussion among those whose vocation is to adulate this enigmatic and capricious personality.

In 1926 Born had given the prophetic stroke to the portrait. Turning to probability as to the official factotum of the reconciliation of the continuous and the discontinuous—here, the associated wave and particle—he transmuted the waves of de Broglie and Schrödinger into an *undulatory calculus of probabilities*, deducing, from a surprising principle, consequences that were even more surprising but always verified through experiment. Parting from the idea that the intensity of the wave is the probability of the detection of the particle at a given point

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and time, Born replaced the classic principle of addition of partial probabilities with his "principle of the addition of partial amplitudes" that are, as in classical optics, represented by "complex" dimensions, with one real part and one imaginary part. In general, the square of the module of the sum of amplitudes will be the probability. This expression contains, of course, the terms "square" and "rectangular." The first, if they were alone, would give the former law; as for the second, they express the existence of phenomena of interference that are at the origin of the thousand and one well verified paradoxes of the "new mechanics"—the one thousand and first being the one under consideration here.

Speaking at the 1927 Council, Einstein especially drew attention to what seemed to him to be an incompatibility between a certain consequence of Born's principle and a principle from his own theory of relativity of 1905. The example discussed was as follows: a wave falling straight onto a flat surface pierced by a small opening (C) and defracted by it; a photographic plate hemispheric to the center C will receive from C, at L, the associated particle (here assumed to be alone, to simplify). How, asked Einstein, is N instantaneously informed that it is not

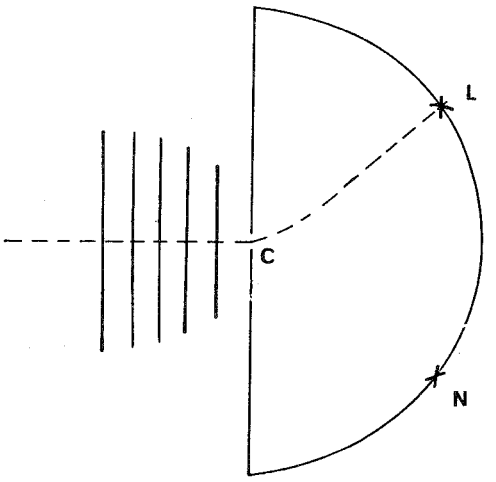

Fig. 1. Einstein's 1927 experiment.

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to receive the particle? There would be no paradox, of course, if we could postulate that "the die is cast," so to speak, at C when the screen is traversed. There it is, however: from the principles of "undulatory calculation of probabilities" themselves, it results that it is not at C but "at L and/or N" (as the Anglo-Saxons put it) that the die is cast.

If I may, I would like to insert a personal memory here. Around 1947 this question (along with others, of course) was hotly discussed in a group activated by Louis de Broglie, to whom I made this remark one day (a remark that I had been ruminating for some time): there *is* a pathway of information between L and N, and it is the "zigzagging" line LCN that connects the two (positive and negative) through their common past, C. In addition, we know that the principle of *past future-intrinsic symmetry* (that is, of the invariability of formulas through a reversal of the order of succession of phenomena) is general in physics. Loschmidt in 1876 and Zermelo in 1896 "exaggerated" it in statistical mechanics, in the "paradoxes" that bear their names. This principle, present in the classical mechanics and theory of waves is *also* present in the calculation of probabilities, where it is not mathematically evident that prediction must not be symmetrical with retrodiction: this is what is classically called the "problem of the probability of causes." Now, I continued, the phenomenon discussed here—the chance happening or "collapse of ψ" in the jargon—is an "elementary" phenomenon and as such *must* be endowed with the past-future symmetry, the "T-symmetry." However, this implies that at the final stage of the elementary phenomenon, the causality is exerted in the T-symmetrical way—while at the macroscopic level of classical physics it appears T-asymmetrical, operating from the past to the future, for statistical reasons that have now been clarified and come from jurisprudence more than from law in the strict sense.

As I was leaving, Madame Tonnelat (who had also been present) told me that "the master" had looked at me "oddly," as though he had doubts about my sanity. The fact remains, however, that I was able to express this idea in the *Comptes rendus de l'Académie des sciences* in 1953 and, later, often in the most respectable publications in a more and more detailed

fashion. Today, when the discussion is all the rage, *all* solutions given for the enigma are "mad" in one way or another. *All* theorists involved agree that an important "change of paradigm" (to use the words of Thomas Kuhn[1]) has become inevitable, but there are not two theorists who agree on the same paradigm. This is certain proof that a "scientific revolution" is taking place.

In 1935 Einstein, Podolsky and Rosen again stated the paradox, this time by formulating it mathematically but leaving aside the question (an essential one) of its agreement or disagreement with relativity. Afterward, never forgotten but not yet given in terms for experimentation, the problem fed an academic discussion that continued indefinitely and, like a long daydream, was the generator of virtually formidable fantasies. In 1935 Schrödinger saw "magic" in it; in 1949, in the introduction and, especially, in the conclusion to the volume bringing together the essays composed in his honor,[2] Einstein called this paradoxical "long distance correlation" "telepathy." In 1957 Louis de Broglie raised an objection to its incompatibility with "our classic ideas on space and time."

In 1965 Bell published the famous theorem that would set off the powder keg. This theorem threw a harsh light on a specific consequence of the difference between the old and the new calculation (undulatory) of probabilities and on a difference that was testable.[3] If quantum mechanics was, once again, correct, then the formula itself of the long distance correlation between two measurements having a bearing on systems with a common origin prevented these two arbitrarily distant and classically separated subsystems from having been conceived as *objects* individually *endowed* with *properties*. This is what, in Einstein's terms as used again by d'Espagnat, is called the *non-separability of two measurements issuing from a common preparation*. The

[1] T.S. Kuhn, *The Structure of Scientific Revolutions,* Chicago, University of Chicago Press, 1962. P. Duhem, *La Théorie physique, son objet, sa structure*, Rivière, 1906 and 1913, Part II, Ch. IV and VI. Duhem was a precursor of the theory of Kuhn's paradigms.

[2] *Einstein: Philosopher, Scientist*, P.A. Schilpp, ed.; Evanston, Illinois, The Library of Living Philosophers, pp. 83 and 683.

[3] The word "test" re-entered French through English, from Old French, where it had exactly the same meaning.

temporally symmetrical phenomenon of a *non-separability of two preparations converging toward a common measurement* must then also exist (as I had noted).

These two types of experiments have now been made, the first in 1972 and 1976, the second (although it was not at first interpreted in this way) in 1967-68. Their results completely justify the "new mechanics."[4] There is no doubt that if these very delicate experiments had been made before 1921, at the time of the "old quantum mechanics" of Planck (1900), Einstein (1905) and Bohr (1913) *they would have evoked the same stupefaction as Michelson's experiment that led to relativity.*[5]

Faced with the situation thus created and the theoric context in which the problem is formulated, what are the options for the physicists concerned? In a recent article,[6] Eberhard gives his conclusion in the following form, which seems to me excellent. Four, and only four, issues exist, namely:

1) We calculate according to the rules (they are never at fault), but we abstain from reflecting on their implications, in order to avoid a migraine. This is the option taken by the majority of practicing physicists, whose competence in difficult calculations does not need proof. However, it is also the policy of the ostrich.

2) Perhaps, in sufficiently "sophisticated" conditions, quantum mechanics will be found faulty in this problem, and good old realism, admitting the concept of separable objects, may, in spite of everything, be restored. In 1935 Schrödinger and Furry had independently suggested (without great convinction) that perhaps Einstein's correlation would be redeemed with time; in

[4] The most precise verifications of "direct" correlation between "future measurements" due to Friedman and Clauser (1972); Clauser (1976); and Fry and Thompson (1976) concern the linear polarizations of two photons issued from a "cascade." A striking verification of "inverse" correlation between "past preparations" due to Pflegor and Mandel (1967-1968) concerns the impossibility of "retrodicting" from which of the two lasers each photon detected in the zone of interference came.

[5] A controversial point of history is to know whether or not in 1905 Einstein was acquainted with Michelson's experiment. The argumentation mentions in a general way the experiments in optical kinematics, the earliest of which was the one of Arago (1818) that inspired Fresnel with his formula of the "dragging along of the ether". In 1930 Hadamard demonstrated how to deduce the formulas of Lorentz-Poincaré from Fresnel's formula and from a postulate of the theory of groups.

[6] P. Eberhard, *Nuovo Cimento*, 46B, 1978, p. 392.

1978 Selleri and his group launched a "trial balloon" of an analogous nature. However, on one hand, the results of experiments (which were accumulating) did not at all tend to confirm this kind of supposition and on the other, strong *a priori* objections could be made, connected to what is well established.

3) Perhaps, then, it is relativity that is mistaken—an idea that in 1927 Einstein did not consider very attractive. D'Espagnat, quite explicitly, and Piron, more elliptically, have recently become champions of this possibility. But as concerns its schemes in general, relativity, like quantum mechanics, has never been found in default. More specifically, it can be demonstrated (and I have done so) that the scheme of "relativist quantum mechanics" perfectly describes all the phenomenology of Einstein's correlations, direct as well as inverse.

4) If we decide to keep our eyes open and if, for the most solid reasons, we do not lose confidence in either quantum mechanics or relativity, the *only remaining issue is to change the concept of causality that macroscopic experience has suggested to us, but that lacks precision at the microscopic level.* The idea that seemed insane in 1947 became respectable in 1978.

Here, the discussion of a specific point is imperative. Several of the theoricians involved in the matter have, like Einstein in 1927, expressed the opinion that the now-confirmed existence of these paradoxical correlations is incompatible with a fundamental principle of relativity, the existence of a speed limit for signals, while obviously neither Eberhard nor I think so. It is important to discover from where this lack of agreement stems.

The heart of relativity is made up of the Lorentz-Poincaré formulas of change of space-time reference,[7] having a *group* structure. We must thus distinguish between the restricted or "orthochronic" group in which reversible time is excluded, and the "complete" group, called *T-symmetries*,[8] where it is accepted for the same reason as the reversal of the three space axes, called *P-symmetries.* The complete Lorentz group is *PT-invariant* in the sense that not only the continuous changes in reference but the

[7] These formulas were already known to Larmor in 1898 and also, almost exactly, to Voigt in 1887.

[8] Specialists distinguish the *T-reversal* of Wigner from the *T-symmetry* of Rachah. We will not go into these fine points.

PT-symmetries have an *intrinsic* sense in four-dimensional geometry (which is the cadre of relativity).

The foregoing being the prologue, here is the play. The limited relativity defined by Einstein in 1905 was invariant under the orthochronic Lorentz group. Moreover, it obeyed the rule of Einstein that prohibited "telegraphing into the past," that is, the familiar principle of "delayed" causality, acting from the past toward the future. Let us agree to call it *macrorelativity.*

On the other hand, these equations of quantum mechanics are generally (the reason for this restriction will soon be apparent) T-invariant, like the other equations of basic physics. It follows, as we have just said, that the equations of relativist quantum mechanics must be PT-invariant, which they are in the majority of cases. However, here nature reserved a great surprise. In 1956 Lee and Yang cut a Gordian knot in the physics of weak interactions by demonstrating that they are neither P- nor C- invariant, the C-symmetry being defined as the exchange of particles with antiparticles (for example, electrons with positrons). In 1955-57 Pauli and Lüders showed that, under plausible and very general hypotheses, relativist quantum mechanics is essentially CPT-invariant, a conclusion that nothing for the moment contradicts. Thus, *at the level of relativist and quantum microphysics the principle that generalizes the classic T-symmetry is the CPT-invariance.* Let us call all Lorentz and CPT-invariant theories *microrelativist.*

I hope the reader will excuse this somewhat technical, but necessary, digression.

It is easily seen that *if the existence of Einstein's correlations is in fact incompatible with macrorelativity, it is, on the contrary, completely compatible with microrelativity.* How could it be otherwise since it is a question of a phenomenon arising from relativist quantum mechanics? However, the question I pose is a different one: how can eminent physicists of elementary particles, who invoke CPT-invariance in their calculations, challenge it at the level of philosophical interpretation? How is it that they do not see that *phenomenology imposes the CPT-invariance at the level of conceptualization* (of the "collapse of ψ," causality, *et cetera*)? The discomfiture is terrible, I agree; it is *true* that Einstein's correlations are earth-shaking and that

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they open an abyss under the feet of good sense. However, if there is an abyss, I prefer the assistance of a helicopter to that of some ladders and ropes.

I think, therefore, that what is to be done here is to *read formalism literally*, without subtracting or adding one iota, and it is *this* that "will reveal the meaning of the Scriptures."

In this, we will only be imitating illustrious examples. Copernicus noted that by claiming the Sun to be "fixed" instead of the Earth, celestial kinematics were so simplified that it must be much more "true" that way. In 1905 Einstein noted that by claiming the place and time designated as "x" and "t" in the formulas of Lorentz-Poincaré as true, but relative, we simplify the interpretation of the facts (although dissociated from previous assumptions) that the "view of the world" so defined must be more "true" than the previous one. My present position is analogous: by cutting the cloth of interpretation to fit "very close to the body" of mathematical formalism (operational) we will equip the explorer of physics with a costume suitable for his voyage.

Therefore this sphinx—the paradox of Einstein or of Einstein-Podolsky-Rosen, as I see it—was born of the union of two previous paradoxes: the principle of past-future symmetry, or T-symmetry, of the basic equations of physics, becomes the principle PT-, then CPT-symmetry and the principle of the addition of amplitudes rather than the partial probabilities of Born. Now, each of these progenitors having a well-established paradoxical reputation, *quid* for their progeniture!

CPT-symmetry and addition of partial amplitudes appear on using Feynman's rules of calculation, the main theme of which is the *zigzag* pattern of space-time that has enchanted writers of "popular" science, antiparticles being interpreted as particles "going back in time" (as they express it, abusively simplifying the subject). Still, these facts, once and for all established in a few pages, provide evidence of the mathematical relationship of transitions that are mistrusted as strangers and furnish the formula for it at one blow, where previously pages and pages of calculation were necessary. It is truly a marvellous algorism.

How does this union of water and fire come about, the relativist "all is written" water (the future can only be what it

will be) and the fire of the calculation of probabilities (in which "transitions" take place)? In order to believe, you must have seen: pen in hand, you must play by the rules of the game of these calculations of statistical prediction—or retrodiction. It is not my purpose here to give details of the "how" of this success. It may be analyzed in terms of the frequential interpretation of probability, based on the idea of identical repetitions of a given preparation or measurement in these distinct areas of space-time; or in terms of informational Bayesian interpretation in which intrinsic past-future symmetry is found as a symmetry between information-knowledge and information-organization (that "received" at the time of a measurement and that "given" at the time of a preparation, connected to each other by this "message" that is the evolution of the quantum phenomenon).

CPT-symmetrics, Feynman's amplitude of transition, is thus intrinsically as "neutral" between prediction and retrodiction as it is between particles and anti-particles. Also, just as the predominance of particles over anti-particles (those twin sisters) comes from jurisprudence rather than from law, so the predominance of prediction over "blind statistic" retrodiction (a deck of cards being dealt "in order," a series of shuffles will put it "in disorder," but no one will believe that it had been put in order at a given point by a series of shuffles, at least, not in macrophysics). However, the right to existence of antiparticles having been recognized by theory (Dirac's quantum and relativist theory of the electron in 1927), we have looked for, and found, antiparticles. Similarly, the right to existence of the phenomena of "blind statistical retrodiction" (that is, the phenomena of decreasing probability discussed by Loschmidt and by Zermelo, or phenomena of waves converging toward "wells" rather than diverging from "sources," phenomena equivalent to the former in the "undulatory calculation of probabilities") is confirmed by mathematics; and this promotes research as to whether they could not be observed within certain contexts. What such contexts would be was discreetly but very clearly suggested by E.P. Wigner in his book, *Symmetries and Reflections*.[9] Posing

[9] E.P. Wigner, *Symmetries and Reflections*, M.I.T. Press, 1967, pp. 171-184.

as a principle that all action implies or involves a reaction, Wignes thought that to the action of matter on psychicism (the acquisition of information-knowledge) must logically correspond an action of psychicism on matter (manifested as information-organization). This observation is particularly significant in quantum mechanics in which studies vie with each other in repeating the affirmation of Heisenberg and Bohr that "every act of measuring implies a reaction of the measuring equipment on which it is made." Since (and von Neumann dwelt upon this) the boundary between measuring apparatus and observer is arbitrary, the inevitable implication (but one never mentioned to my knowledge except by Wigner) is that *there is a reaction of the observer to what is measured.* And there the secret is out. It is what is called "psychokinesis" in "parapsychology."

Wigner (very straight-faced in this passage) adds: "Every phenomenon is unexpected and extremely unlikely before its discovery, and some phenomena remain so for a long time after their discovery." He adds that to his knowledge no philosopher before him had made this remark. However, there is one: Descartes.[10]

At this point in the discussion, we must tie up the loose ends. Therefore: Feynman's zigzags connect, over great spatial and temporal distances, "preparations" and "measurements;" this occurs in a strictly symmetrical manner in past and future (CPT-symmetry) as shown by the famous space-time zigzags verified by the paradoxical correlations of Einstein (on which spatial or temporal distance has no effect.)

The CPT-symmetry causality beyond infinity, indifferent to the past-future exchange, is thus *finality as well as causality,* and once more it mocks distance.

The acts of preparation and measurement are only different from one another in appearance, as we may easily see if we look carefully at formalism. They are *preparation-and-measurement* or *measurement-and-preparation*, and involve *information-causality-and-organization.* It is *there* that formalism situates the interaction between psychicism and matter, this interaction postulated when probability is regarded as essential rather than

[10] R. Descartes, *Lettres*, Adam-Tannery, ed., Vol. I, Letter 525, p. 222; and Vol. III, Letter 302, p. 663.

facultative, as is the case in quantum mechanics. Such probability could not be *either subjective or objective*, because it is necessarily *both at the same time.*

Finally, the "collapse of Ψ," generally conceived as a filtering of divergent waves (such as the one realized at the macroscopic level by a network) must be defined and perceived in a CPT-invariant way: it is a "collapse-and-post-collapse." Technically, it is the selection of *one* canal $< \Phi_i | \Psi_j >$ from the nework of canals $< \Phi | \Psi >$ defined by the amplitude of Feynman, for the transition between a preparation $|\Phi >$ and a measurement $|\Psi >$.

Very well, we say. And psychokinesis? How is it that we never see it in the laboratory when we observe the quantum transitions such as are described so well by the calculation of probabilities applied "blindly" in prediction? In my opinion, it is because of the attitude itself of impartial observation that says, by definition and decision, in "macrophysics" we are obedient to the principle of growing probability. To establish a context of "antiphysics," we must be able to enter into a state of arbitrary expectation, which seems possible, as the successful experiments of Helmut Schmidt[11] in psychokinesis have shown. Such experiments show flaws in the classic "principle of the the probability of causes," and furnish examples in which the formula of conditional probabilities of Bayes must be applied *in prediction.* It is erroneous to say that such experiments are not "repeatable;" but it is not erroneous to say that they are "neutralized" or "contaminated" by a majority of observers imposing the glacial attitude of "impartial observation." Mathematical formalism provides evidence: if, according to the "official" interpretation of quantum mechanics, it is really the act of observation that "collapses ψ," then two or more observers of the same transition are in collaboration to *observe-and-produce* the result.

As for the paradox of the non-separability of two measurements or two preparations distant in space and without a "present" connection, the "zigzagging" scheme of Feynman formalized it, respectively, as a connection relayed either in a

[11] H. Schmidt, the physicist, is not to be confused with the West German Chancellor. See *Found. Phys.* 8, p. 464; *Bull. Amer. Phys, Soc.* 24, p. 38 (1978); *Proc. Intern. Conf.*, "Cybernetics and Society," I.E.E.E., 1977, p. 535.

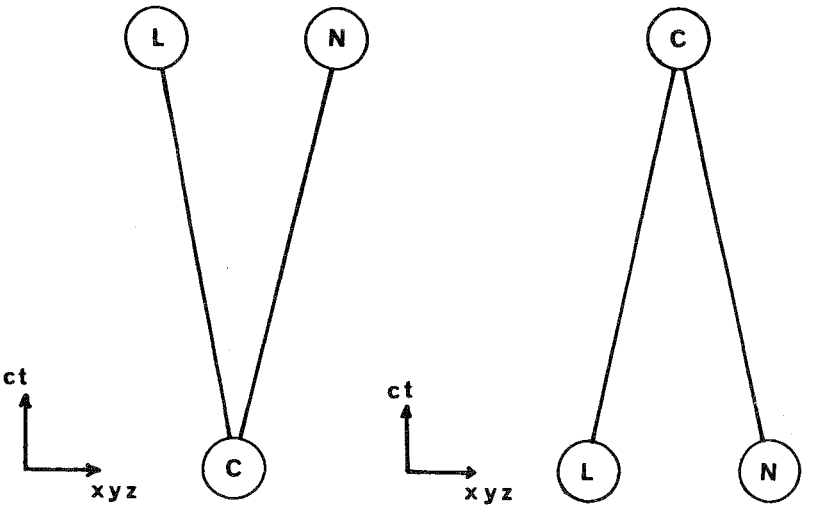

Fig. 2a and Fig. 2b. Spatial-temporal image of Einstein's correlation: direct (2a) and inverse (2b). LCN is Feynman's zigzag.

common past (Fig. 2a) or in a common future (Fig. 2b), however great the spatial and temporal distance, with no weakening.

This CPT-invariant non-separability fits perfectly with "relativist non-separability" coming from what spatial-temporal geometry substitutes for the former past-future dichotomy, the trichotomy *past, future* and *elsewhere* through the "cone of light" (also quite popularized). To use the terms of Bergson,[12] in which the mechanics of Newton authorized a view of the world according to which "the universe dies and is reborn every instant"—at each *t* moment of "universal time"—the spatial-temporal geometry of Poincaré and Minkowski imposes a view of the world in which the past and the future "exist." The past does not "still" exist (which would be self-contradictory) but lies below, like the valley for the mountain climber; the future does not "already" exist but lies above like the summit for the mountain climber. This concept is no longer to be associated with the "orthochronic" macrorelativity of 1905 but with the "CPT-invariant" microrelativity of 1955-1957.

[12] H. Bergson, *L'Evolution créatrice*, Ch. I.

It goes without saying that this leads directly back to the pleasantries of Einstein, Schrödinger, and Louis de Broglie: "telepathy," "magic," "impossible to understand with our classic ideas on space and time, and even with the relativist ideas on space-time," (*macro*-relativist, of course.)

To conclude, I think that the "paradoxical" properties of space-time telegraph, as stated by relativist quantum mechanics—especially by Feynman's scheme of zigzags—amply justify all psychological or neuropsychical research on phenomena such as telepathy, pre-cognition or post-cognition.[13]

It thus seems clear to me that the metaphysics to be associated with relativist quantum mechanics is essentially different from the one that can be associated with non-quantum and non-relativist mechanics. It seems to me that it was anticipated by Bergson, or in the Vedanta.

For Bergson, *Homo sapiens* deludes himself about his condition because he is *Homo faber*, who "mutilates" the totality of the real by *arbitrarily* "cutting out" of it essentially non-separable parts: if man could rise to Intuition he would have a better view and, in addition, the key to Creative Evolution.

In the Vedanta we read that *separability* is an *illusion* that is relative to a *pragmatic* approach. Certain psychological techniques would lead to a "cosmic consciousness" and to "paranormal powers."

The *rapprochement* between relativity and quanta, on one hand, and oriental metaphysics, on the other, is the object of a book by Capra,[14] who proposes the following idea: "Elementary particles" having such strange qualities that they are not always "separable objects" should instead be understood as *informational channels* connecting preparations and measurements. That is very similar to my space-time telegraph...

To be as daring, we must go one step further and ask ourselves if we can "dialogue" with the "particles" as we do with a

[13] *Honni soit qui mal y pense!* Out with the charlatans and muddled heads who only reason by "woolly" approximation! As for myself, it was by meditating on the implications of the *internal symmetries* of relativity, calculation of probabilities and quantum mechanics that I became convinced that there is some truth in what is called "parapsychology." It was only *afterward* that I investigated and was persuaded of the seriousness of some research...

[14] E. Capra, *The Tao of Physics*, Shambala, Berkeley, 1957.

telephone operator. Certain physicists have had this audacity and have published it in respectable journals.[15] This initiative belongs to them, and I will merely make some remarks in its favor.

The first observation may seem a "canard," but I am not so sure. A foundation stone in the construction of quantum formalism is the theory of projection operators and *categorical questions* to be answered only with "yes" (considered as "1") and "no" (considered as "O"). The elementary measurement or preparation is thus considered as a *posed question* to which the particle *answers*. Do we dialogue with the particles? The question is perhaps not as absurd as it seems. If that were the case, *psychokinesis* would be related to a *suggestion*...

What is certain is that the boundary between the living and the non-living is difficult to establish. For example, is it above or below the crystallizable virus? Materialist reductionism pushes the boundary back to one extreme but the believers in "everything is sentient," the "animists," according to d'Espagnat,[16] push it to the other extreme. To each his own.

Finally, we must conclude, which I will do in two parts: impersonally stating a thesis, then defending it.

The word paradox that figures in the title and on every page of this study has not been defined. What, then, is a paradox?

In almost every dictionary, the first definition for the word "paradox" is "a surprising statement that may however be true." This is the etymological meaning. For example, the heliocentrism of Copernicus was such a paradox.

As for the word paradigm, Kuhn, and with him Wittgenstein, gives it the meaning of *Weltanschauung*, that is, "world view."

The elucidation of a strong irreducible paradox is the promulgation of a new, fitting paradigm. For example, we have the relativity of Einstein and Minkowski, as interpretation of the formulas of Lorentz-Poincaré. Both Copernicus and Einstein

[15] E.E. Witmer, *Amer. Journ. Phys*, 35, 40, 1967; A. Cochran, *Found. Phys.*, I, p. 235, 1971.

[16] B. d'Espagnat, *À la recherche du réel*, Gauthier Villars, 1979. See pp. 114-120.

transformed a *mathematical recipe* into an *explicative conceptualization.*

Lord Kelvin[17] in a conference held in 1900 said he saw two clouds in the otherwise clear sky of theoretical physics: the anomalies of specific heat and the unexplained experiment of Michelson. He thus very precisely characterized the sources of two gathering storms: that of Planck's quantum theory in 1900 and that of Einstein's relativity in 1905. I believe that in spite of all the thunder the real storm of relativist quantum mechanics is massing over our heads *now*, and it is that of Einstein's correlations.

On this point, I agree with the other physicists involved, as the notes to this paper will prove.

But the solution that I propose—and that is quite simply to read the relativist quantum mechanics formulas, with their CPT-invariance—causes alarm in that it contradicts existing ways of thinking.

Here I have attempted to present the problem by rising above it so that I could see it in its entirety, but the *exposé* I have made is still that of the problem as I see it. It could hardly be otherwise, the counter-proof being found in the writings of the other physicists involved...

[17] Lord Kelvin, *Phil. Mag.*, 2, 1, 1901.