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An interdisciplinary approach to the study of consciousness

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ABSTRACT. – Within the clinical framework of a case of schizophrenic psychosis confronted with the lockdown, some destabilizing discoveries of quantum mechanics and its implications in neuroscience and psychoanalysis are introduced. Through fractal logic, the Author attempts attempt to understand on the one hand the relationship between microscopic phenomena and macroscopic processes of the psyche and on the other how the idea of reality changes through the counterintuitive laws of modern physics. This leads to the unconscious being described as a wave function capable of processing in parallel and simultaneously, countless overlapping variables, of which only the one considered most adaptive in the relationship with the environment is consciously elected. The complexity of the phenomenon of consciousness is studied here both in the interdependence between immaterial processes (energy fields) and material ones (cellular biochemistry), and in its indeterminacy and non-linearity when the reference context changes drastically.

Key words: Mind; quantum; consciousness; complexity; psychoanalysis.

The extraordinary accuracy of the analogy
between thought processes and quantum ones
would suggest that a hypothesis linking them could even
be profitable. If verified,
this would naturally explain
so many characteristics of our thinking.
(Bohm, 1951)

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 […] *More satisfying than anything*
would be if physics and psychology (that is, matter
and the mind) could be seen as complementary aspects
of the same reality
(Letter from Pauli to Jung, 1952)

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The study of psychic phenomena considered at first to be shocking or inexplicable has always been a sensitive and controversial topic for the ambitiously scientific status of psychoanalysis. Already with Freud, there was much concern that the scientific community might devalue psychoanalysis and reduce it to the rank of occultism. The reason was very simple: studies that could not be directly placed within logical-rational explanations automatically became 'a research scandal' (De Martino, 1948).

Yet, in the analysis room, stunning mental phenomena were observed (Freud & Ferenczi 1908-1914; Freud, 1921a; 1921b; Jung, 1951) considered inexplicable by the notions of science at the time. 'Scientifically inexplicable' does not mean, however, that such phenomena cannot be defined or do not exist at all (Meloni, 2020), but simply that the scientific model we use is unable to understand them and, therefore, that we need a new scientific approach. A method of investigation that can explain the functioning of the psyche (pathological and non-pathological), even in its unusual and surprising forms that still have to do with human beings and their survival strategies.

Starting from this assumption and following on from my previous work on *Altered states of consciousness* (Fulco, 2022), I will try to describe my encounter with a fascinating but apparently inexplicable aspect of the psyche observed in analysis during lockdown. By focusing on some of the salient points of the clinical case of a patient of mine presented under the pseudonym Stanislaus, I will try to facilitate an interdisciplinary dialog with quantum mechanics to advance some cautious considerations on the complexity of the psyche seen in light of the overwhelming discoveries of quantum physics.

Psyche and nature

It had only been two days since Italy's general lockdown was imposed due to the COVID-19 pandemic and like many of my colleagues, I had started to follow my patients remotely. I was particularly concerned about the most serious patients in the fear that they would be further unbalanced due to the ongoing emergency. Stanislaus, who suffers from schizophrenic psychosis, was one of them. From the very beginning of the session, however, it was clear that there was something different from our usual sessions. While the patient was very frightened by lockdown, throughout the session he expressed himself in a state of consciousness that in six years of psychoanalysis had emerged only in an embryonic and ephemeral form: no dissociation, no persecutory delirium, no encrypted language, no splitting between thoughts and emotions. From the beginning to the end of that session, his psychotic withdrawal seemed to have disappeared. In its place the

patient spontaneously presented emotions, dream activity and traumatic memories never reported before, lucid reflections, etc. I felt both moved and impressed, especially when at the end of the session, in response to my request if he had understood the scope of what he was telling me and of 'how' he was expressing it, the patient said to me with a confused look: '*What's different?*'.

In consulting the clinical literature, it could be hypothesized that the integration of memories, emotions, and thoughts related to the dominant state of consciousness at the time in Stanislaus created a kind of *psychic interference* with the 'conscious version of himself' (Dennett, 1991) to which he automatically referred to in his delirious organization. The resulting confusion may, however, highlight the conflict between a first-person perspective over an alternative identity state (Dell; Nijenhuis and van der Hart in Frewen and Lanius, 2017).

Continuing this examination, we could go as far back as Freud (in Boaretto, 2011), who already showed in 1932 that, in specific and optimal clinical conditions, his patients evolved from critical conditions through the reactivation of archaic abilities of the mind that had become latent during growth. In this way, however, there is a risk of a dangerous escape into clinical practice, which, by producing psychological theories that confirm other psychological theories in an infinite cycle, risks leading psychoanalysis to solipsistic self-validation that is very sterile and counterproductive for the aspired scientific status (De Robertis, 1993).

Minolli (1997) observed that 'It is no longer possible to theorize starting from clinical observations and continue to overlook the data of empirical research', a warning to which even Mindell (2000, p.111) relates to: 'psychology needs a home,' that is, it needs to support its theories with solid, concrete foundations derived from experimental research. Conversely, Rovelli stated (in Mezzanotte, 2017) that psychology ends up getting lost in vague concepts of energies and resonances, forgetting that the entire knowledge accumulated in recent centuries converges, without exception, to tell us that there are no different realms. Humans are an integral part of nature and are not something separate from it, as they are equally made of atoms, electric fields, and elementary particles interacting: 'There is no 'Ego' and 'neurons in my brain'. They are the same thing. An individual is a complex, but closely integrated process […] The study of our psychology is refined by understanding the biochemistry of our brain' (Rovelli 2014, pp.79-80). The psyche responds to the physical laws of the universe that contain it by assuming from them the same functioning structures, just as in a fractal logic in which a smaller set is contained by the larger set, so that a change within the macrosystem is transferred vertically to its elementary parts and vice versa (Facchini, 2005).

Therefore, by modifying our study objectives now, we will try to under-

stand the psychic interference observed in the patient, putting it momentarily to one side, and coming back to it later on, after having described quantum mechanics, which is the basis of our nature (including that of our brain). We will therefore, in this way, consider a model of consciousness that, by integrating processes which are distant in terms of both spatial dimension and temporal reaction compared to the classic biochemical functioning of the cell, can maybe better explain psychic phenomena that classical science is not able to describe.

Studying the elementary level of our brain has revealed, in fact, that it is only partly regulated by Newtonian mechanics (which is valid for example for the microcellular level of the neural network). With regard to the rest, the more basic part, made up of subatomic dimensions and infinitely short reaction times, the laws of quantum mechanics come into play instead (Marcolongo, 1999). To understand the abyssal distance that there is in terms of magnitude and speed between the various interconnected levels, consider exploring a matryoshka doll where each dimension corresponds to a speed of information transfer. In this sense, by moving from the macroscopic level of the brain to the microscopic level of the neural network, to the level of the tubulins in the neuronal microtubules, the actual speed of each level of functioning will also increase in parallel. Therefore, from the brain areas measured in centimetres, one passes to the microns of cell measurements, to the femtometers of their microscopic level, so too the rate of response measured in seconds on the macroscopic level, passes gradually to nanoseconds, up to femtoseconds.

Nature and psyche

If we were to compress all matter into one place, what we would get would be only a billionth part of reality, says the quantum physicist and Nobel Prize winner Rubbia (Fantetti, 2021). This means that when we look at something/someone in material terms, there is at stake a billion other energy-related information that we do not perceive at the same time. It follows that the laptop in front of me, the chair I'm sitting on, my body, *etc*. are made up of atoms that are actually 99.9999999% 'empty space' (full of electromagnetic energy, electrons, photons, wave functions, invisible quantum fields, *etc*.). Thus, it is empty space only in appearance, that if we could eliminate it would mean that 'the whole of mankind would fit into a sugar cube' (Sundermier, 2016).

All of this can be incredible, disturbing, giving us a deeply different picture of reality than we imagined, but quantum mechanics has never been wrong in describing nature, and that is why it represents the most effective and powerful scientific theory that humanity has ever produced (Rovelli,

2020). Its basic assumptions can be summarized as follows: i) wave-particle dualism: *A quantum* (the smallest observable unit) has both corpuscular and undulatory functions that allow it to take contradictory and overlapping directions; ii) non-linearity: an electron that makes a transition from one orbital to another, does not travel all the points that separate the orbitals, but performs an instantaneous 'quantum leap' between the two levels (by absorbing or yielding a photon of energy) without assuming intermediate energy values; iii) indeterminacy: the microworld is characterized by probability events. The conditions of a quantum system, following an interference with a measurement system, cannot be accurately predicted; iv) quantum vacuum: for a very short time, matter and energy emerge and then disappear where they did not exist before; v) observer effect: with the measurement act itself, the result of the observed object is conditioned and this wrecks Einstein's concept of 'local realism', which foresaw that all objects must objectively possess pre-existing values at the time of measurement; vi) non-locality: according to the Dirac equation, two systems that interact with each other for a certain period of time and then are separated can no longer be described as two separate systems but become a single entangled system. Although Einstein rejected this concept and hypothesized hidden variables to explain it, from the 1970s onwards entanglement was documented and experimentally confirmed by scientists such as Clauser, Aspect and Zeilinger (Nobel Prize in Physics in 2022). In the 1970s Clauser structured a system that allowed calcium atoms to emit entangled photons, while ten years later, Aspect showed that by projecting two previously linked photons in independent directions, if the direction of a single photon was altered, the other photon also modified its trajectory 'instantaneously' (reaction without linear relation at higher speed of light). This is true even if it is more than two entangled particles and even if you work in multiple laboratories located at considerable distances (as much as 147 km away) as Zeilinger demonstrated in the 2012 test (Margoni, 2022).

You can already see from these points why quantum mechanics is so mind-boggling and counterintuitive compared to how we've been used to getting to know the world from classical physics. It was not by chance that Bohr said: 'Those who are not shocked by quantum physics do not understand it' (in Pais 1991, p.565). How can we blame him, for example, if we think of the 'double slit' experiment, which perhaps has highlighted its charm best of all and to which reference is often made in this article.

In summary, this test tells us that a particle of matter, such as a photon, can take on both a wave-like state (such as that of electromagnetic waves or water) and a corpuscular one. It has been shown repeatedly that a photon fired by a laser passes through a slit without changing its corpuscular state, but if there are 2 slits (A and B) it manifests its wave-like state, passing 'simultaneously' through both slits and returning to the initial state of particle when it

arrives on the control screen placed behind the slits. In this way its 'wave function' (Ψ) collapses into a visible matter state. Moreover, another extremely surprising fact, is that this experiment shows that observation automatically alters the observed object. In fact, if we decide to measure the passage of the photon through the two slits, we will not see it cross both (as you would expect after what has been stated above), but only one or the other depending on where we choose to position our optical detector.

According to the Nobel laureates Bohr and Heisenberg's interpretation of this experiment, it emerges that the universe exists as an infinite number of overlapping possibilities all possible at the same time. The choice of a person to observe those potentials determines the activation (collapse) of the potential that he/she has chosen to observe. In this regard, Bohr wrote (in Cantalupi and Santarcangelo, 2014 p. 184): 'The same reality may be the subject of two complete, contradictory representations. These two representations are called *complementary*. When the photon passes through the slit A this determines a certain possible world (which we will call world A); when it passes through slit B we will have world B. In our case, it means that both of these worlds coexist in some way, one superimposed on the other.'

It may seem difficult or even crazy to assume that a single object can have the ability to 'probe' two different places at the same time, but 'this is what happens, this is what the experiments prove' (Cantalupi and Santarcangelo, op. cit. p. 185). Thus, there is no single reality, because 'all superimposed quantum worlds are equally real' (Davies, in Facchini, op. cit. p. 143), which means that there is an infinite number of real pasts leading to the present state, and also an infinite number of authentic futures evolving from it.

At this point, one could argue that, although it is astounding, the microscopic world cannot be used to understand the functioning of the human mind. In the first case, in fact, we are talking about a laboratory in which we handle lasers that shoot photons that turn into waves through slits etc. in the second case, instead we are talking about the laboratory of our mind. And yet this is where quantum mechanics is even more of a determining factor, in order to understand psychic functioning. This objection is rejected both by experimental physics, which has shown how photons can be used to create 'artificial quantum neurons' (Spagnolo *et al.*, 2022), but especially by neuroscience that has shown the presence of photon activity by studying neuron microtubules.

That living matter reacted to light was well-known, but that it emitted it was a novelty (Dal Cengio, 2019), until in 1926 Gurwitsh described for the first time the relationship between biochemical systems and photon emission. His research was ignored for decades due to an incomplete empirical investigation (due to inadequate technical tools at the time) and therefore banished as a 'pseudo discovery' (Cortini, 1995). However, with the devel-

opment of photomultipliers (very powerful light detectors), numerous research studies were conducted at the end of the last century to support this thesis of biophotons (thus defined as they are present in living beings).

The first of these studies was that of Kaznacheyev who in 1974 detected communication between cells via biophotons. Subsequently, Rattemeyer (1981) and Popp (1983; 1992) observed that the bioelectric function of photons gradually increased with the growth of the individual. In particular, Popp's studies, even before Nobel laureate Montagnier (2011) described the relationship between electromagnetic waves and DNA, showed that DNA behaved as a sort of fractal antenna with the ability of receiving, processing and then transducing the electromagnetic cell-to-cell charge to ensure homeostasis of the system. This hypothesis was corroborated towards the end of the last century by 'the DNA Phantom Effect' research carried out by quantum biologists Garjajev and Poponin (1995) who demonstrated how an in vitro DNA sample has the ability to attract and use laser light by inducing it to spiral around the DNA helix. After removal of the DNA sample, the photons continue to spiral for almost a month as if the DNA were still there.

About a century after Gurwitsh's discovery, thanks to the complicity of applying nonlinear dynamic theories to neuroscience, we see a shift in the focus of contemporary research from the neurochemical domain to the electromagnetic domain (Di Muro, 2021). Thus, considering experimental evidence on the importance of electromagnetic energy in cell-to-cell communication (Van Wijk, 2001), cell repair, growth, and division processes (Fels, 2009), and intelligence processes (Wang, 2016), the idea is increasingly reinforced that: 'the role of biophotons at the level of the brain deserves special attention' (Rahnama, 2012).

A wave of possibility

The double material/immaterial reality of photons has inevitably generated profound resonance even in the psychological field. For example, we find traces of this in *Theoretical reflections on the essence of the psyche* by Jung (1947-1954 pp. 245–246) when he wrote:

> 'it is naturally of the greatest importance to find out whether, and if so how, the photons (shall we say) enable us to gain a definite knowledge of the reality underlying the meditative energy processes... Light and matter both behave like separate particles and also like waves. This... obliged us to abandon, on the plane of atomic magnitudes, a causal description of nature in the ordinary space-time system, and in its place to set up invisible fields of probability in multidimensional spaces'.

On the other hand, we find developments even in Paolelli (op. cit. p.105) who also wonders whether: 'Could we somehow, thanks to our conscious-

ness, act like photons do? To be wave and particle together?'. Instead Lurati (2012, p. 17), similarly to Bion's concept of 'selected fact' (1962), with the collapse of wave function, asks this question: 'What happens in the clinical material and in the minds of the analyst and patient when a specific psychic fact is chosen from all the material present in the session, deciding to follow the associative thread and abandoning all other possibilities? What consequences does this inevitable and necessary operation have on the possible representations that will appear later during the session and treatment?'.

To these important questions, Facchini (op. cit.) tries to answer, who in speaking about 'quantum psychology', argues that in the mental system one generates psychic states that contemplate all possibilities. The transition between unconscious and consciousness is described by the author as *a change of state* where the properties of a system can change from undefined to defined and vice versa. In this respect, the phase preceding the collapse of the wave function is indeterminate, since from it can start one of the infinite possibilities of existence, of different states and of different realities: 'The reality that this generates is as dual and complementary as its nature is (wave-particle); its motion is indeterminate, and by the principle of uncertainty-superposition what originates from it will also be indeterminate' (p. 151). The particle wave would thus have its discretion proceeding acausal manner and the wave function would collapse into the reality data most consistent with the type of measurement/vision chosen by the observer. As mentioned, this wave-particle intermediate state has an atypical and paradoxical functioning that describes the possibility of overlapping states, in which simultaneously an event is/is not, and can be defined in one of many infinite ways. According to Facchini, therefore, the material (corpuscle) and immaterial (wave) duality *of those* would represent, the elementary link between physical reality and psychic reality, and would ensure the integration of all experiences with the higher areas of mental activity such as memory, perception, thought and consciousness itself.

Of course, there are obstacles to this interdisciplinary dialog. The first among these is the fact that the microworld is lost in the myriad of variables of the macroworld. As Rovelli observes (op. cit. p. 116), in daily life we lose touch with what happens at the base of our functioning: 'We don't realize any of this. The world seems determined to us because phenomena of quantum interference are lost in the buzz of the macroscopic world. We can only highlight them with delicate observations and by isolating objects as much as possible.'

Yet in our daily lives we are confronted, in various forms, with mental processes which refer to the concepts of quantum physics and which constantly highlight how, both inside and outside our studies, the psyche develops alternative paths simultaneously from the dominant state of consciousness (Colaianni, 2018). Dreams, *the royal road to the unconscious* (Freud,

1899), for example, seem to be characterized by: i) atemporality: one can find oneself in time frames that continuously mix the past, present and future; ii) non-locality: represent oneself at the same time in distant places; iii) non-linearity: depicting oneself as the son of one's father but also as the parent of this father (a concept that recalls the symmetric logic of the unconscious, called 'bi-logic' by Matte Blanco in 1981); iv) observer effect: the interpretation of the dream is not unique but depends on the observer; v) entanglement: already referred to by Jung as *synchronicity* (op. cit.), this phenomenon is associated with situations where, for example, we dream of a dear friend and when we wake up, we receive a phone call from him (Teodorani, op. cit.). This last aspect, in particular, arouses opposing views in the scientific community among 'macrorealist' detractors who categorically exclude it from the macroscopic world (Mantovani, 2003), and makes cautious researchers who are intent on studying it go beyond microscopic boundaries. With this in mind, psychologist Radin (2006) talks about bio-entanglement citing a 2001 study at the University of Milan in which some neurons were grown on a cell culture plate within a single container. Later, the neurons were divided into groups, placed in separate containers and isolated in separate laboratories. When the first group was stimulated by the photons of a laser, it was seen that not only was there a reaction in the affected neurons, but also in the control group. The experiment has been repeated several times with increasingly refined techniques, always reporting both the non-locality and the instantaneity of the phenomenon (Montana, 2016).

Upon closer inspection, Mandolillo (2018) notes, there are good reasons to consider that the modus operandi of the psyche is very close to the theorizations of quantum mechanics. The author believes, in this regard, that as latent information in the individual through observation becomes conscious in the form of *insight*, so the wave without locality and shape becomes recognizable and observable by collapsing into the particle state. A perspective also shared by Colaianni (op. cit.), who considers the therapist's interpretation of the patient's unconscious material to be similar to the collapse of wave function, where the observer determines, via his/her measurement, the alteration of the observed object. Following this perspective, then, the therapist's clinical interpretation would result in some kind of measurement that would affect the patient's consciousness.

On the same theoretical line there is Mindell (op. cit.), who in integrating the physical world and the psychic world, speaks of 'quantum mind', to argue that the concept of interference is intrinsic to human nature, starting from the workings of quanta. The author compares the process of quantum interference with what he calls psychological interference, in which two different internal processes take place simultaneously, generating manifest confusion (as in *the lapsus*). When one becomes aware of something, there

is a collapse of non-locality, of indecisiveness, of complementarity, with a relative definition of the object. Just as the wave function is defined in a precise state only through measurement, so too does unconscious material change from a potential and indeterminate state to a clear and defined configuration only when observation makes it emerge on the conscious plane.

According to this perspective, therefore, *the thought of the primary process* that Freud had described in semantic terms could be explained in terms of microscopic processes. A hypothesis that is also supported in other forms in Marcolongo (op. cit.), according to which the unconscious does not have its seat in neurophysiological functioning characterized by the cell dimension, but instead is localized in quantum mechanisms that occur in the microscopic processes of microtubules.

Quantum neurodynamics

Not being able to avoid the destabilizing data that quantum physics gives us, it is therefore inevitable to ask ourselves also in what way our concept of psyche changes before returning to Stanislaus' altered state of consciousness. In accordance with what has been said, the clear distinction between psychic and physical gradually disappears and makes way for concepts such as *incarnated consciousness* (Varela, Thompson, Rosch, 1991) and *extended mind* (Sheldrake, 2006) that make *Descartes' error* (Damasio, 1995) a distant memory now. In this sense, we want to rediscuss the metaphoric 'place' of residence of consciousness, as apparently it 'cannot be placed under the skull, but under the heavenly vault' (Liotti & Cortina, 2009 p.47) given the continuous particle interactions (atoms, electrons, neutrons, photons, *etc*.) between the individual and the environment, as evidenced by Sundermier's article (2015) published by the National Institute of Nuclear Physics.

The most well-known model that attempts to explain the phenomenon of consciousness from quantum mechanics is the 'quantum neurodymanics' theory, called *Orchestrated objective reduction* (Orch-OR), proposed in 1996 by Physicist and Nobel laureate Penrose and by Neurobiologist Hameroff. This model considers the phenomenon of consciousness as the concluding process of the complex link between quantum physics and classical physics (Brancaleone, 2019).

The two researchers claim that it is in the tubulins of neuronal microtubules that the activity of consciousness lies, as when these are blocked by anaesthetics, the subject falls into a state of unconsciousness. Comparable to true 'intelligence-equipped-units' (Teodorani, 2015), the microtubules organize the form and function of neurons and communicate with both the cell membrane and with nuclear DNA. Hameroff (2021) hypothesizes that the structure of microtubules, which is well 'isolated' from the surrounding

environment and similar to that of liquid crystals, represents an ideal medium to be considered a 'pure state' which would allow for quantum effects to take place that are safe from the action of quantum decoherence. The latter occurs when the interaction between quantum systems and the external environment results in the loss of wave function coherence, making the entire system a 'mixed state'. The tubulins within them would be able to take on two opposing configurations at the same time which, according to Marcolongo (op. cit.), could correspond on the conscious plane to two alternatives, two ideas, two overlapping opposites.

The phenomenon of consciousness would occur at several distinct but interrelated stages. It would start with the overlap of the quantum states of the tubulins in the microtubules, then continue through the collapse of the wave function in microtubules, and eventually merge into the classic functioning of electrical processes via the synapses of the neural network. From this perspective, then, the collapse that would trigger a moment of consciousness would not be induced from the outside (as in the double-slit test) but would be a spontaneous internal phenomenon in the brain that inevitably recalls the *autopoiesis* paradigm of Maturana-Varela (op. cit.) or rather that of a physiological extension to bioelectric components of the brain (Colozzo, 2020). This explains why the model is called 'Objective' and 'Orchestrated': the first term refers to the fact that the collapse of wave function reduced its complexity into a single, specific 'perceptible element of consciousness'; the second term derives from the fact that this is the result of the concerted action of a myriad of connected microtubules.

Since every cell in our body is characterized by microtubules, this model opens up interesting questions about the possibility of an extra-cranial extension of consciousness, although Hameroff and Penrose point out that this phenomenon can only arise in the brain. Taken individually, cells are unable to determine a moment of consciousness because the time required to achieve objective reduction is inversely proportional to the total energy of a gravito-quantum system in which its states overlap. This means that the greater the cell mass of the microtubules of the cells involved, the less time the collapse of wave function will take place within. Because the mass of a single cell is extremely small, it would take it at least one hour to have a moment of consciousness (24 moments of consciousness throughout the day); in contrast, the massive presence of microtubules in the neural network makes them sufficiently numerous to achieve the state of coherence through a process similar to that known in physics as the 'Bose-Einstein condensate' (in which a large number of quantum particles aggregate and function as a single quantum object on a macroscopic scale). Such a mechanism would ensure that the tubulins of the microtubules of the brain are 'instantaneously orchestrated' in terms of time, by the entanglement to avoid nullification by the phenomenon of quantum decoherence

(Brancaleone, op. cit.). In the neural network, therefore, the wave function would collapse in a very short time, since the energy corresponding to the mass of the involved microtubules is in the order of billions of neurons. Thus, about 40 times a second, there would be a 'quanto-gravitational collapse' in the conscious reality of the contents orbiting unnoticed in the unconscious: this, therefore, would be the way by which the body would become a quantitatively coherent 'whole' resulting in a feeling of conscious unity in the individual (Palolelli, 2014).

Criticisms and praise have come and gone over the years in relation to this theory. According to Galzigna (2013), for example, anaesthetic action would not involve the aqueous phase of neurons in which quantum phenomena would occur, and this weakens Penrose and Hameroff's thesis. Calculation errors have been pointed out by Prati (2017), who considers the lifetime of certain quantum states in microtubules to be too short so as to result in the effects of which the two scientists speak. On the other hand, it is Teodorani's positive comment (op. cit.) that defines this model as a theory that 'leaves nothing to chance but is the fruit of logical-mathematical and experimental thinking', while according to Palolelli (op. cit. p.64) Orch-OR would demonstrate that: 'Biology is subordinate to electromagnetic processes that manage the state of tissue organization. A coordination that is unthinkable to be achieved throughout the body through the neural network alone.'

At present, Hameroff (op. cit.) points out that this model is the most complete in the study of consciousness and has not yet been falsified. That is why in 2019 it was recognized and accredited by the largest, most expensive, international and interdisciplinary consciousness study project known as ARC (*accelerating research on consciousness*). A pioneering project in which Penrose and Hameroff's theory compares with other models in the field of neuroscience, but that reduces the phenomenon of consciousness to the nervous system and studies it through the classical bio-chemical approach, such as *the Integrated information theory of consciousness* by Edelman and Tononi (2000), Dehaene's 2014 *Theory of the Global Neuronal Workspace* and *the Theory of the Attention Schema* proposed by Graziano (2020).

ARC is supported by psychologist and Nobel Prize winner Kahneman who has structured a working approach known as 'contradictory collaboration' in which tests on the brain activity of volunteers, conducted in state-of-the-art laboratories and using sophisticated data collection technologies, were analysed in real time by two or more scientists of opposing theories (Patitucci, 2019). In the specific case of Orch-OR, Hameroff explains (op. cit.), quantum interference in tubulin and microtubules will be analysed and, if detected, exposed to anaesthetic gases. A correlation between anaesthetic damping of quantum elements in microtubules and anaesthetic clinical power would validate the theory as a sub-neural correlate of conscious-

ness. If quantum interference in tubulin and microtubules is not found, or if it is found but is not dampened by anaesthetics, this theory will be falsified.

This pioneering research project 'will hardly address the issue of consciousness but will certainly increase our knowledge of cognitive processes' says Miniussi Head of the 'Center of Mind and Brain of the University of Trento' (Patitucci, op. cit.). Regardless of the final results, encouraging collaboration between scientists with opposing theories can only stimulate a rich and complex confrontation that will certainly bring about an effective shift and 'accelerate research into consciousness.' This may also go beyond the current nervous system frontier, which Damasio (2021) says is basic, but it is not enough to understand our complicated object of study: 'Any theory trying to explain the existence of minds and consciousness while ignoring the nervous system is doomed to fail. On the other hand, any theory that rests exclusively on the nervous system is also bound to be unsuccessful.'

Change and indeterminacy

At this point, let us turn back to Stanislaus's altered consciousness by trying to reinterpret it through the interdisciplinary approach presented up to here and below with a brief summary. We are hypothesizing a mental system that extends beyond intracranial boundaries, such as a 'quantum field' (Mergenau in Facchini, op. cit.) endowed with immateriality, alocality, atemporality, and absence of spatial boundaries. A field of mass-less forces that would not respect the laws of classical physics, that would interact with both internal and external processes, and that, due to its quantum functioning, would also be a field of probability. From the microtubules present in neurons and DNA molecules (understood as electromagnetic as well as biochemical functions), the biophotonic network with a single wave function in the entanglement state, whose collapse would determine what was previously undetermined. This would give a sense of coherence and unity to the individual by making conscious and manifest on the macroscopic (conscious) level a reality among the many implicit, microscopic (unconscious) potential ones.

Assuming that uncertainty is a valid principle for both the microscopic and macroscopic worlds, then we can say that the conscious version of the Self expressed by the patient in a given situation is never unique and irreversible. The dominant psychic structure would represent only the coherence of the system in that context, but as the system changes, there is a change in the psychic structure. This is what Minolli (2009, p. 76) also pointed out, citing Maturana and Varela: 'change is a process in which the body and the environment remain in a continuous structural coupling'. A process that applies to both gradual changes over time and drastic changes as Licata states (2019, pp. 92-93): 'When system-environment relationships

and the constraints on the 'border' change, collective behaviours are produced that require new descriptions, not unequivocally deductible from the model before the emergency […] In the most extreme areas of complexity, those of radical emergency, unpredictability and uncertainty dominate.'

A clear example of this is what happened in the case of the COVID-19 pandemic. In fact, the WHO (2022) data suggests that the powerful 'shock image' (Perry in Campbell, 1996) of the pandemic increased the world population's anxiety and depression by 25%. In Italy alone, there has been a threefold increase in aid applications to deal with suicidal risk compared with the pre-COVID period, with a worsening trend due to the continuing emergency (ANSA, 2021).

A worsening of mental health due to the impact of the lockdown, that I was also afraid of for Stanislaus, due to the seriousness of his psychic condition. However, my prediction did not consider the above-mentioned uncertainty principle, according to which a given system can never be precisely defined (since you can never know all the details and properties that define it). A principle that Satinover (2021) considers highly adaptive for the evolution and preservation of the species, as it allows the subject to respond to the context in a much more structured and functional way than a more linear and less complex logic. In this regard Seligman (2007, p. 320) states that this principle does not only protect quantum physics (as Nobel laureate Feynman said), but also protects psychoanalysis because it is the basis of our work: 'Psychoanalytic practice […] requires tolerance of uncertainty; if we can't handle it, or if our language discourages this possibility, we end up giving ourselves a narrow, restrictive focus that could limit the expansionary potential of the analytical framework.'

Obvious potentials in Stanislaus's alternate state of consciousness. In fact, the patient demonstrated an unexpected trajectory, a drastic adjustment in relation to the drastic change in the environment. This seems to have favoured the possibility of observing itself from another slit of meanings, that are latent and alternative to the dominant slit of his delusional state. Such a process of adaptation to the environment would be made possible, according to Kulka (1991), precisely by the role of the double wave-corpuscular nature that human beings make of themselves and that allows them to move from a condition of infinite potential to a defined condition. A function that, according to Mindell (op. cit.), allows the mental system to proceed from a rigid and automatic closure to an opening to other dimension-slits, which improves the psycho-physical structure of the subject and reduces energy loss (entropy). As a result, there would be psychic interference (experienced as a state of confusion) that would indicate the conflict between alternative versions of the self.

According to this, as Fissi (2009, p. 93) points out, consciousness would seem more like a 'macroquantum effect' than occurs in the undetermined

dimension of the unconscious: 'What naive thought gives as its primary, consciousness, is secondary, because it is only an epiphenomenum, a contingent and by no means a foregone property of those primary psychic processes that perennially harbour in the unconscious.' This appears to function as the water ripples of a pond that expand in all possible directions after an object is thrown into it, processing (in parallel and simultaneously) all available directions before electing the most functional organization on the conscious plane (in serial mode). A process that suggests that deep consciousness is based in *the implicit unconscious* as postulated by De Robertis (2009) or to put it in the words of physicist Bohm (1996) in *the implicit order*, consisting of many potential but latent realities until the collapse of the wave function determined by the observer makes it an 'explicit' on a conscious level. In this sense, unconsciously elected sets would never cease to exist, but would always remain available on an unconscious level just as quantum particles maintain a 'tendency to exist' in implicit, potential states (Kulka, op. cit.). An assumption that recalls what James expressed in other words over a century ago (1902, p. 334) about the complex structure of the mind:

> 'Our normal awake consciousness, rational consciousness, as we call it, is nothing more than a special kind of consciousness, while all around it, separated by the most transparent of screens, there are entirely different potential forms of consciousness. We can go through life without suspecting its existence, but with the right stimulus, various types of structures (…) appear in their entirety at the slightest pressure and probably have their field of application and adaptation somewhere. No view of the universe as a whole can be definitive when it leaves these other forms of consciousness out'.

Fields of energy, states of consciousness and emotions

When they asked Varela: 'Why did discontinuity emerge in evolution? Why has life, in its infinite crucial bifurcations, each time transcended itself into new, unpredictable and often highly unlikely configurations?', the Chilean neuroscientist replied: 'Because there was, among all these possibilities, the possibility of emerging. It's a situation effect. It might have happened, as it might not have happened […] life attempts the possible, life is bricolage.' (Napolitani, 2007).

According to this explanation, we might assume that in a situation like lockdown, the 'bricolage' with which Stanislaus jumped forward (rather than the step back that I feared) might have been partially facilitated by the clinical process. In fact, as argued by Frewen and Lanius (op. cit. p. 288): 'Dissociation may slowly become less necessary within a relational context that is perceived by the patient over time as increasingly less threatening.' However, 'facilitated' does not mean 'determined' by the clinical container, since as Minolli states (op. cit. p. 156): 'who 'decides' the change can only be the patient based on the

'ability and possibility' that he/she finds himself/herself at a given moment in his/her life.'

In addition, in the clinical case in question, we are talking about a drastic, discontinuous and not gradual change. A change that was considered inconceivable both by Darwin, who saw divine intervention as the only possible explanation for the rapidity of change, and by Leibniz, who, denying the existence of atoms, proclaimed *nature non-facit saltus ['nature does not make jumps']*. Modern physics tells us, however, that the otherworldly has nothing to do with such natural processes, and that there are both atoms and the subatomic world. And it is right there, in the microscopic world that we can observe sudden shifts of a system from one quantum state to another, without a continuum of intermediate states and thus called *quantum leaps*.

According to the concept of 'quantum thinking' by Bohm and Krishnamurti (1986)*, a quantum leap* is equivalent to the concept of *insight* at the psychological level. In such a case, the neurons would undergo a rapid functional change due to the electrical energy jump at the microscopic level, which would lead to a sudden change of thought from one object awareness to another, of a different type (Biasioni, 2020; Fiscaletti, 2022). This energy would be similar to the illumination of a flash that is not controlled by the brain and would facilitate a change in the subject's state of consciousness, with the feeling of greater internal order (Fiacchini, op. cit.).

A study by Chi and Snyder (2011) would seem to open up experimental research in this direction. The two scientists demonstrated in their paper *facilitating insight by noninvasive brain stimulation*, that the application of an electric field through transcranial stimulation to the anterior temporal lobes can help the person see problems in a new 'light'. In the experiment, subjects in these fields were able to reach the right perspective to solve a complex problem three times more often than control subjects.

So, it seems, while endogenous electric fields were once thought to be able to influence or control neuron activity only under particular pathological conditions that generate very intense fields (such as seizures), neuroscience is currently in the progress a major change of course that aims to study the impact of non-epileptic fields that are much weaker but much more common. These studies include that of the Anastossiou team (2011), which considers electrical function to be a primary mechanism of brain activity and that these energy fields represent an additional form of brain communication (independent of synapses), the absence of which indicates a deep coma, if not death, of the brain.

Long considered brain epiphenomena by classical science, the role of electric fields is further credited in McFadden's *Conscious electromagnetic information field theory* (2020). Such neural network energy is the basis of the phenomenon of consciousness, according to the director of quantum biology at the University of Surrey, because when neurons in the brain become active, they not only send an electrical signal along the nerve fibers, but also highly unified

energy impulses through electromagnetic fields (detectable by electroencephalogram or magnetoencephalography) that would be responsible for the state of consciousness.

Even the microbiologist Brown (2017), who conducts targeted research on natural phenomena considered as 'abnormal', moves in a similar direction when talking about *biomolecular quantum communication* to describe the expansion/compression of consciousness in relation to electromagnetic fields. According to the author, the modulation of photonic energy made by the electromagnetic antenna hypothesized in DNA functions would spread through microtubules from neurons to nuclear DNA molecules, would then travel through the whole body of a cell to superior processes such as consciousness, expanding/reducing it accordingly.

It is likely that in the future it will be possible to clarify whether there is a link between the increased lucidity in psychic insight and the endogenous fields of electricity, the same that on a microscopic scale when it strikes an electron causes it to suddenly change its energy state by blowing it into a different orbit of the atom by absorbing or yielding a photon (Rita, 2018). Certainly, assuming a link between endogenous energy fields and states of consciousness would mean dealing with emotional states as well. Emotions, in fact, in addition to having their own 'energetic essence' for their duality of being both a psychic fact and a bodily fact (Poli, 2019), are always linked to altered states of consciousness that can be caused by traumatic experiences (Frewen and Lanius, op. cit.). This is because emotional states, Damasio notes, are a phenomenon closely related to consciousness so that one cannot study one without dealing with the other (Palamara, 2002). An interdependence that LeDoux and Brown (2017) and their *Higher-order theory of emotions* (also being examined by the ARC), is due to the fact that in states of consciousness emotions and knowledge originate from a single brain neuron system.

By developing such a link between electromagnetic energy fields, states of consciousness, and emotional shock, Mindell argues that the individual would experience a kind of 'psycho-curvature' when the relationship with his/her environment changes dramatically. The author thus hypothesizes that altered states of consciousness due to the impact of emotionally deep experiences would be explicable by the same physical laws that allow us to understand the 'curvature' that light's electromagnetic energy (i.e., photons) undergoes when, interacting with a massive gravitational force, it loses linearity and diverts its trajectory.

Complexity

In conclusion, we can say that the boundary between the known and the unknown is pure convention, an illusory frontier that in the ages has always

moved as the human being has acquired new knowledge (Meloni, op. cit.). The wider our awareness, the more the hypotheses linked to the theoretical reference model at any given moment are destined to be overcome (De Masi, 2022). When this is not the case because one is too fond of the idea that science establishes the truth once and for all, one packages laws with claims of universality (De Robertis, op. cit.) and establishes a dogmatic, blind faith that is alien to the authentic scientist (Popper, 1945). Science is not made up of acquired certainties, but it is a thought that is constantly moving. Its strength, indeed, is precisely given by the ability to be intrigued even by what seems unusual, to always question everything and renew itself without the fear of subverting a world order to seek a more effective one (Rovelli, op. cit.).

This 'mourning of the unique truth and a definitive explanation', notes Mattana (2020), thus leads to a more relational and complex view of knowledge that inevitably drives even more and more clinical and psychic research to make inferences and connections with what has been demonstrated by quantum mechanics. The author states that: 'One might even assume that the relational evolution of psychoanalysis consisted of abandoning the implicit isomorphism with the world of classical physics populated by isolated objects […] to arrive at a more fluid, multiple, and interactive view of subjectivity, always linked to a complex and changing network of external and internal relations.'

Quantum physics can give you vertigo, Radin says, because it tells us that what we perceive as separate at a macroscopic level is not at all so in its constituent elements that, instead, are connected to each other in a concrete and not just symbolic sense (Montana, op. cit.). Human interaction, defined not by its components - the self and the other - but by intrinsic interactivity, requires a departure from the Newtonian vision on which psychoanalytic metapsychology is based (Kulka, op. cit.). Moving away from a deterministic view that sees the world as being built from separate elements, we can recognize a completely different universe, consisting of an indivisible and infinite unity of relationships because *the basis of nature is relational in its deepest core*. A quantum is not a thing but an intermediate state, a set of relationships that cannot be represented by the language of classical physics (born to explain non-quantum phenomena). 'Each elementary particle is that which is in relation to an observer, whatever this may be, a photon, an instrumental apparatus, the consciousness of man' (Volpe, 2019).

As maintained by Penrose (1992), it is the transition from classical physics to modern physics that is the correct way through which we should study consciousness in all its organisations, including the 'altered' ones. Contrastingly, one could say that the study of what appears abnormal and deviates from the 'norm' (assuming there is one) can help us to better understand the complexity of the mind. The clinical case of Stanislaus offers us this opportunity to see with 'other lenses' (Kant, 1787) a psychic process that in past times would have been seen as an occult or miraculous phenomenon.

The dialog between the various quantum theories and the psychoanalytic research described here can come as a blow to our knowledge and make us feel lost in the way we have conceived the reality to date. Perhaps a feeling similar to what our ancestors had to deal with when at some point they understood that the earth was not at the centre of the universe, man was not made in God's image and likeness, and the Ego was not master in its home. Quantum mechanics has implemented an epochal change compared to Newtonian physics (Minolli, op. cit.). This revolution in the way we perceive reality is unstoppable and does not leave any field of knowledge unchanged, starting with the educational system where we begin to teach its foundations (Rovelli, op. cit.) up to psychoanalysis, whose status of scientificity that Freud sought in classical physics and never found for 'presumed absence of evidence' (Marcolongo, op. cit.), could instead be obtained from modern physics as 'science on a quantum basis' (Facchini, op. cit.). From this other perspective, it would seem to be possible to say that psychoanalysis always had scientific evidence, but it was the glasses of classical science from which it was observed that were unsuitable.

There is no doubt that we are only at the beginning of this interdisciplinary approach on the study of consciousness, which keeps telling us that the answers we seek will not necessarily be found by remaining bound to the discipline from which we are starting. The complexity paradigm shows that it is in the network of theories that we find the best way to see and act in the world (Marcolongo, op. cit.): in other words, we must run the risk of having different theories and areas of knowledge in dialog to try to extrapolate 'other' concepts, following a pluralist approach from the methodological and epistemological point of view. Studying psychic phenomena using empirical research in an interdisciplinary approach means having to deepen and specify the data being processed, even if such a way of doing research in psychoanalysis is more insidious to handle and difficult to acquire (as is evident in this article). This may confuse us, mislead us, but it is a necessary risk to broaden our knowledge by crossing thresholds that allow us to understand the mind no longer as a single concept, but at multiple dimensions and functions organized in a growing complexity (Dalla Barba, in De Robertis, op. cit.).

Continuing via this perspective, it is possible to imagine that the future discoveries of physics will follow the changes of research in psychology (Facchini, op. cit.) and, at the same time, that psychology and psychotherapy will be radically renewed in their vocabulary by quantum discoveries (Mindell, op. cit.). As Davis affirms (2019), in fact, one has to come to terms with the fact that one cannot do deep psychotherapy without an updated energy model that is in line with the discoveries of quantum physics. Only in this way will it be possible to observe psychoanalytic research from another slit of meaning, which in its dialog with quantum physics finds the challenge of its time (Kulka, op. cit.). A delicate frontier in which to move with 'incorrect methodologies' (SIPRe Research Group, 2009) that enable us to move above

and beyond the current cultural and scientific context, method and methodologies in order to plant new seeds in psychoanalytic research, but they will have to be further cultivated. The fertilizer for this virgin land is still the same that our founding fathers courageously carried on their pioneering journey to a 'new world': the Plague.

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