Metaphilosophy of the Life-world
Sellars, Husserl, and the quantum image of nature

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Abstract: The aim of this article is to assess whether the notion of "life-world" could be helpful for a philosophical theory that assigns a primacy to the scientific view of the world when it comes to establish what exists. I set out to integrate the concept of "life-world" as understood in Husserl's late phenomenology with the point of view defended by Sellars in *Philosophy and the Scientific Image of Man in the World*. In what follows, I will consider the image of nature proposed by the standard "Copenhagen" version of quantum physics. This will allow me to challenge Sellars's assumptions that reality cannot be conceived as stratified, and that the term "phenomenon" has to be meant as "illusory appearance" in a supposedly Kantian sense. At the same time, I will discuss Husserl's conviction that the 'technization' of science entails a philosophical loss of meaning of the scientific image of the world.

Keywords: life-world, quantum physics, scientific realism.

The aim of this article is to assess whether the notion of "life-world" could be helpful for a philosophical theory that assigns a primacy to the scientific view of the world when it comes to establish what exists, and, accordingly, what "reality" means. In establishing this parallel, I am referring, on the one hand, to one of the most important concepts of Edmund Husserl's late phenomenology (the concept of "life-world"); on the other, I am trying to endorse the point of view defended by Wilfrid Sellars in his famous study *Philosophy and the Scientific Image of Man in the World*.

My attempt is to integrate two views that scholars have routinely described as conflicting.[2] This does not mean that the perspectives of the two thinkers

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[1] I am very thankful to Daniele De Santis, Agnese Di Riccio, Roberto Gronda, and Michele Mancarella for their precious comments on a previous version of this article; my special thanks to Giacomo Turbanti, for his comments and for the intellectual exchange that gave rise to this volume and which, I hope, will give rise to new projects.

[2] This assumption is shared by Christias (2020; 2018), who argues that the categorial framework of the life-world entails a scientific instrumentalism which takes the unobservable objects and properties of science as mere "calculational devices," and Sachs (2020; 2014), who holds that Husserl falls

philinq X, 1-2022, pp. 169-192 Submitted: March 2021
ISSN (print) 2281-8618, ETS doi: 10.4454/philinq.v10i1.387 Accepted: October 2021

I have just mentioned will be accepted in full in this article. However, I think that the integration I am going to argue for is, if not the only possibility, at least one of the most effective ways to explain how a philosophical perspective that advocates for a peculiar version of scientific realism can take into account the conceptual framework of persons.

I will articulate my argumentation into three parts. In the first, I will show that a theory of the life-world does not necessarily entails the endorsement of the primacy of the manifest over the scientific image of the human beings in the world. In the second, I will consider the image of the world that derives from the quantum revolution in physics in order to challenge two significant assumptions made by Sellars: the first is that reality cannot be conceived as stratified, the second is that the term "phenomenon" has to be understood exclusively in the supposedly Kantian sense of "illusory appearance". In the third section, I will start by challenging Husserl's conviction that the 'technization' of science entails a philosophical regression of the scientific image of the world; this will allow me to take into account the metaphilosophical implications of a perspective that assigns a role to a theory of the life-world for the justification of a form of scientific realism. Indeed, this study adopts a metaphilosophical approach for at least two reasons: firstly, it is an investigation that reflects on the meaning and conditions of a specific philosophical perspective, such as the theory of the life-world; secondly, this reflection aims to express itself on the task of philosophy in general.

1. *The conflicts of images*

As is widely known, in *Philosophy and the Scientific Image of Man* Sellars maintains that, in search for a unity of knowledge, philosophers are necessarily confronted "not by one complex many-dimensional picture," but "by two pictures of essentially the same order of complexity, each of which purports to be a complete picture of man-in-the-world" (Sellars 1962: 4). Initially, Sellars designates these two conflicting views as the manifest image and the scientific image. He identifies the former with a refinement, or a sophistication, of the original way in which humanity refers to objects in the ordinary life, whereas the latter view is that which has been developed from the modern scientific revolution.

At a second stage, Sellars acknowledges that the manifest image is scientific in a peculiar sense: it proceeds indeed from the standard ways in which

under the Myth of the Given. De Santis (2020) and, earlier, Soffer (2003) exclude this risk. Finally, let me also refer to my article (Manca 2021), where I argue that the point of divergence between Sellars and Husserl does not lie in the conception of the Given but in their different way of understanding the spontaneity of thinking.

objects appears in the perceivable world, and, by induction, infers the universal forms of the phenomenal realm. By contrast, the framework that he had initially defined as "scientific" might more accurately be called "the postulational or theoretical" (Sellars 1962: 7). It is determined by the only procedure that the inductive approach of the manifest image cannot take into account: it postulates "imperceptible objects and events for the purpose of explaining correlations among perceptibles" (Sellars 1962: 19).

Both conceptual frameworks pretend to deal with the only effectively real world. This is the core of their clash. In order to describe their differences and take a position, Sellars distinguishes three possible lines of argument:

> (1) Manifest objects are identical with systems of imperceptible particles in that simple sense in which a forest is identical with a number of trees.
> (2) Manifest objects are what really exist; systems of imperceptible particles being 'abstract' or 'symbolic' ways of representing them.
> (3) Manifest objects are 'appearances' to human minds of a reality which is constituted by systems of imperceptible particles. (Sellars 1962: 26)

Those who advocate the primacy of the manifest over the postulational image of the world could opt for the first two lines of argument.

As regards thesis (1), Sellars argues that there is nothing immediately paradoxical in thinking that "an object could be both a perceptible object with perceptible qualities *and* a system of imperceptible objects, none of which has perceptible qualities" (Sellars 1962: 26). This is why systems can effectively display properties that their parts do not have. A condition for defending this position is to recognize that the so-called emergent properties of a system depend on the properties of, and relations between, its constituents. Once we accept this, we are directly brought to endorse thesis (Sellars 1962: 3). Indeed, "if a physical object is *in strict sense* a system of imperceptible particles, then it cannot as a whole have the perceptible qualities characteristic of physical objects in the manifest image" (Sellars 1962: 27). Thus we must conclude that "manifest physical objects are 'appearances' to *human perceivers* of systems of imperceptible particles" (Sellars 1962: 27).

On the contrary, thesis (2) inevitably conflicts with the scientific realist's view, insofar as it identifies the objects of experimental natural sciences with instruments, or constructs, for explaining specific aspects of reality but these instruments can in no way grasp the essential features of the world as it is in its concreteness and wholeness. Scholars who, from a Sellarsian standpoint, have discussed the perspective Husserl elaborates in his latest masterpiece, *Crisis of the European Sciences*, assume that Husserl would have endorsed this second line of thought.[3] We cannot exclude that there are good reasons for doing this, but this view is more controversial than one might initially think.

In the reconstruction of Galilei's foundation of modern physics – where Galilei stands more for an entire movement rather than for a historically determined individual –, Husserl demonstrates how the difficulty of mathematizing sensible qualities (colours, tones, and so on) brought the new physics to express discovered laws through algebraic formulas. In his view, this resulted into an automatic procedure that progressively concealed the original picture of the world from which the revolution moved (nourished by the Platonic impulse to seek the ideal forms of the world): "In algebraic calculation, […] one calculates, remembering only at the end that the numbers signify magnitudes. Of course one does not calculate 'mechanically', as in ordinary numerical calculation; one thinks, one invents, one may make great discoveries – but they have acquired, unnoticed, a displaced, 'symbolic' meaning" (Husserl 1954: Eng tr. 44-45).

Here Husserl does not assert that systems of imperceptible particles are 'abstract', or 'symbolic', ways of representing manifest objects. He is rather claiming that algebraic formulas are symbolic constructs for grasping the laws of natural processes. Indeed, Husserl does not deny that what we perceive as colour is the result of stimulation of photoreceptor cells by electromagnetic radiation. He limits himself to point out that this was not taken for granted at the time of Galilei – evidently with the sole exception of those who fully advocated the alternative (see Husserl 1954: Eng. tr. 36-37).

Therefore, Husserl is not opposing the picture of the world arising out of the modern revolution. More simply, he is interested in highlighting the decisive support that algebra gave to the scientific enterprise, while claiming that in the history of classical physics the use of algebra favoured a 'technization' of the method of investigation. In other words, the revolutionary discoveries of early modern thinkers such as Galilei turned what was previously only a method (i.e. an art of measuring) into the proper object of investigation (i.e. in what has to be known).

More explicitly, Husserl does not think that imperceptible particles do not ultimately exist. If that were the case, Husserl's view would be as ingenuous as that of the philosopher who believes that manifest objects do not exist. Husserl holds that systems of imperceptible particles can legitimately claim a specific degree of reality, just as manifest objects are entitled to be recognized as an-

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[3] As is widely known, Sellars was indirectly influenced by Husserl's phenomenology via Farber. In his 1962 essay, Sellars does not explicitly mention Husserl's life-world, but he does that in a later essay, in which he argues that "the manifest world—the *Lebenswelt*—has its own intelligibility," but it also "poses questions which it does not have the resources to answer" (Sellars 1981a: 282).

other degree of reality.[4] This lead us to reconsider from Husserl's perspective the first of the lines of thought Sellars outlines.

I am quite sure that a reader of Husserl would be struck by the condition that Sellars introduces when he reduces the first to the third line of argument. Indeed, he clarifies that the condition for accepting that a system can have properties that its parts do not share would be taking as "paradigm example" for that "the fact that a system of pieces of wood can be a ladder, although none of its parts is a ladder" (Sellars 1962: 26). According to the phenomenological perspective, an organism cannot be reduced to its material constituents (contrary to an aggregate such as a ladder) without losing some of the properties that pertains to it as a whole. This would be the case of the forest, to which Sellars refers in order to formulate this first line of thought. Although this aspect marks a divergence between Husserl and Sellars, it does not seem to me to be the fundamental breaking point between them. Indeed, Sellars grants that the properties of a system do not simply consist of the properties of its constituents, but also the properties that arise out of the relations between the constituents. For instance, the ecological resilience of a forest is clearly determined by the way in which its trees interact, insofar as they live as a whole.

More radically, the original element of divergence between the two perspectives lies in the fact that Sellars considers the manifest image of the world inadequate and unacceptable as regards the "account of what there is *all things considered*," and this in spite of its adequacy "for the everyday purpose of life" (Sellars 1962: 27). To his view, "the world of everyday experience is a phenomenal world in the Kantian sense" (Sellars 1968: 173), for manifest object are just illusory appearances that conceal the real world of imperceptible entities. Differently from Husserl, Sellars not only excludes from the onset the possibility of accepting a stratified view of the real world as constituted by different degrees of reality, each governed by its essential laws; he also denies that the notion of "phenomenon" could have different meanings. Thus, Sellars's scientific realism rules out the possibility of a philosophical account of the life-world, unless one describes it as a good way to accounting for how persons see the things from within of the illusory framework in which they straightforwardly live.

However, this position comes at a price, and Sellars seems to be completely aware of this.

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[4] See Kerszberg 2012 for an overview of Husserl's conception of science in light of his theory of the life-world, and Trizio 2021 for an accurate investigation into the relations between phenomenology and natural sciences.

In the middle of his essay, exactly before delving deeper into the features of the postulational image of the world, Sellars identifies his "primary concern" with the following question: "In what sense, and to what extent, does the manifest image of man-in-the-world survive the attempt to unite this image in one field of intellectual vision with man as conceived in terms of the postulated objects of scientific theory?" (Sellars 1962: 18). He suddenly acknowledges that "to the extent that the manifest does not survive in the synoptic view, to that extent man himself would not survive" (Sellars 1962: 18). In other words, if there was no room for a theory of the life-world, the conceptual framework of persons could not be adequately investigated and understood.

At the end of the essay, the exclusion of both a stratified theory of what really exists and the absence of a multi-faceted notion of "phenomenon" leads Sellars to conclude that the conceptual framework of persons "is not something that needs not to be *reconciled with* the scientific image, but rather something to be *joined* to it" (Sellars 1962: 40).

In light of this, the issue I would like to tackle in the following two sections is whether we really have to be content with the perspective according to which the clash between the manifest and the scientific images of man in the world can be transcended only in imagination, as Sellars suggests. In order to pursue this goal, I would like to bring into play the picture of the world and of the scientific enterprise fostered by the quantum revolution.

2. *A complicated tissue of events*

As is widely known, the quantum interpretation of microscopic processes in physics was elaborated in the first half of 20th century through the collective effort of different personalities following different (and sometimes opposed) trajectories. Over the last decades, this arduous theory has known a great experimental success, but the ontological implications of its assumptions are the subject of a wide-ranging and multifaceted debate. In this section, my intention is neither to discuss this debate nor to provide a personal interpretation of the ontological meaning of quantum theory. Rather, I will try to show that, according to the image of science that the standard "Copenhagen" version of quantum revolution provides, the impression that Sellars sided with the worldview defended by physics insisting on the clash between the manifest and the postulational images, while Husserl strengthened the position of common sense through his theory of the life-world is questionable to say the least. In the first part of the section, I will go over the key, initial, stages of quantum revolution; I will then move to a discussion of some of its most significative achievements and their relevance for the integration I am proposing.[5]

Quantum physics developed in an attempt to explain the wave-particle duality, i.e. the fact that every microscopic event can be investigated now by describing the objects involved as particles, now by comparing their behaviour to that of a wave.

In 1900, Max Planck was seeking to understand why experimental results show that energy in a black body is distributed over various wavelength ranges when he boldly guessed that the energy carried by an electromagnetic wave comes in lumps. In the article that would win him the Nobel Prize in 1921, Einstein (1905) applied Planck's lumpy picture of wave energy into a new description of light, introducing the concept of a stream of tiny particles then called photons in order to explain the strange features of the photoelectric effect (i.e. the fact that when electromagnetic radiation shines on certain metals they emit electrons; surprisingly, this does not depend on an increase in light intensity; it is the colour of the impinging light that determines whether or not the electrons are ejected, and if they are, the amount of energy they have). Planck's and Einstein's insights marked a great progress in the history of physics but they also sparked a heated debate. Indeed, their results suggested that light has particle properties – a view supported by Millikan's experiment and the discovery of Compton scattering –, while other experiments demonstrated that photons somehow embody wave-like features of light (this is the case of Young's experiment, now known in a particular variant as the double-slit experiment).

Niels Bohr appropriated Planck's insight in order to elaborate a model for an atom. He imagined that each electron does not orbit the nucleus freely but as held in place; it vibrates back and forth by carrying energy only in multiples of some basic "quantum," that is, by taking on only a limited set of values. Arnold Sommerfeld, from the University of Münich, further enhanced this depiction by demonstrating that the ellipticity of electron orbits was quantized as well.

On the one hand, the Bohr-Sommerfeld model for an atom excited many young scholars, like Pauli and Heisenberg, who decided to explore the issue further. On the other, it raised a certain concern, voiced by figures such as Einstein and Ernest Rutherford, who in 1911 had found out the nucleus of the

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[5] For my reconstruction, I followed Greene 1999, Healey 2017, Lewis 2016, and Lindley 2007. See also Maudlin 1999 and van Fraassen 1980 for an interpretation of quantum mechanics in comparison with Sellars's distinction between two images of the world. Finally, the encounter between phenomenology and quantum physics has a long history; for an up-to-date, multifaceted reflection on the points of contact between the two ways of depicting the world see Bitbol 2020, de La Tremblaye 2020, French 2002 and 2020.

atom by working on radioactive alpha emanations. Rutherford asked in a letter to Bohr (dated March 20, 1913) how an electron decides with what frequency it is going to vibrate and when it passes from one stationary state to another (see Bohr 1981: 583). Einstein complained that Bohr's theory of a quantum jump that brings an electron to an abrupt transition from one energy level (or orbit) to another strongly questioned the importance of causality in physics. This jump happens indeed without any identifiable cause, but with a spontaneity that resembles that of the radioactive decay of a nucleus. This is why, in a letter (dated April 29, 1924) to Max Born from the University of Göttingen and his wife, Einstein wrote that he might as well have been "a cobbler, or even an employee in a gaming-house" rather than a physicist (see Einstein, Born M. and H. 1971: 82).

And yet, the young French scholar Louis de Broglie applied Einstein's depiction of light as a stream of particles to the Bohr-Sommerfeld atom. He calculated that a wavelength is exactly equal to the orbit's circumference. This allowed him to put forward the hypothesis that wave-particle duality – the feature that Einstein ascribed to light – is a characteristic of matter as well (see de Broglie 1925). Around the same time, Werner Heisenberg (who had studied with Sommerfeld in Münich, Born in Göttingen, and finally Bohr and his collaborator Kramers in Copenhagen) was working on how electrons in atoms behave. To explain the discontinuity of the inner activity of the atom, Heisenberg connected Kramer's hypothesis and Born's proposition. Kramer maintained that the structure of the atom was closer to a set of tuned oscillators rather than the solar system (in which electrons follow well-defined orbits, governed by classical mechanics). Born, on the other hand, suggested to substitute classic differential calculus (elaborated independently by Newton and Leibniz to deal with continuous variation and incremental changes) with a mathematical system that had the difference between the stages at its basic elements, rather than the states themselves.

With Pascual Jordan and Born, Heisenberg formulated the fundamental equations of the new mechanics by employing the so-called matrix method, based on multiplying two list of numbers together (see Heisenberg 1925; Born, Jordan 1925; Born, Heisenberg, Jordan 1925). In the meantime, inspired by De Broglie's calculus, Erwin Schrödinger (1926a) achieved similar results by working on an equation for describing how a matter wave should evolve. The particle-wave duality seemed to be transposed at the level of mathematical calculation. However, Schrödinger himself demonstrated the equivalence of the two calculation systems (see Schrödinger 1926b), while Born (1926) proposed to interpret an electron wave in probabilistic terms with the intention of avoiding a mathematical duality: the wave is largest where the electron is most likely to be found, and progressively smaller in locations where it is less likely to be found. Paul Dirac (1928) definitively incorporated matrix mechanics and the Schrödinger equation into a single formulation.

The height of quantum revolution was reached with Heisenberg's formulation of the so-called uncertainty principle in a 1927 article, entitled *Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik*. Here Heisenberg aims to define some terms of classical physics which remain valid in quantum mechanics and, by so doing, showing that the relative quantities "can be determined simultaneously only with a characteristic indeterminacy" (Heisenberg 1927: Eng. tr. 62). He came to this conclusion by introducing a criterion of observability. In his previous article *Über quantentheoretische Umdeutung kinematischer und mechanischer Beziehungen*, he had already postulated that a basis for theoretical quantum kinematics and mechanics could be founded "exclusively upon relationship between quantities which in principle are observable" (Heisenberg 1925: Eng. tr. 261). In his 1927 article, Heisenberg reverses the perspective of classical physics—the foundational role that a particle's position and velocity played for mechanics—, moving from the observation by measurement of the frequencies and intensities of the fluctuations of the atom, and inferring the position and velocity of electrons only on the basis of those. The point is that the experiments that can help us to measure, for instance, the position of the electron inevitably interfere with the event they are determining, making it impossible to measure the velocity with a similar accuracy.

For example, when we illuminate the electron under a microscope, every observation of scattered light coming from the electron presupposes the Compton effect:

> At the instant when position is determined – therefore, at the moment when the photon is scattered by the electron – the electron undergoes a discontinuous change in momentum. This position is greater the smaller the wavelength of the light employed – that is, the more exact the determination of the position. At the instant at which the position of the electron is known, its momentum therefore can be known up to magnitudes which correspond to that discontinuous change. Thus, the more precisely the position is determined, the less precisely the momentum is known, and conversely. (Heisenberg 1927: Eng. tr. 64)

This should be enough to understand the revolutionary achievement represented by the quantum interpretation of microscopic physical events. Every experiment for the determination of a feature of the electron inevitably perturbs or alters the atom itself. Indeed, we can predict with accuracy the probability that an electron occupies a particular position, but at the cost of admitting that it is impossible to determine velocity with the same accuracy (and vice versa), or to determine where the electron is, or even how the elements of the atom behave before getting to measurement.

I think we can end our reconstruction at this point and turn to the theoretical consequences that are relevant to our goals. I see four, strictly interconnected, aspects which needs to be assessed. Let me summarize them as follows:

1) A weakening of strong realism in science, in light of the argument that measurement interferes with the event it aims to determine;
2) A rejection of the materialist ontology that characterizes modern classical physics;
3) A decisive enhancement of the constructive capacity of mathematics;
4) An extension of the concept of intuition.

The first two aspects affect Sellars's description of the scientific image, while the last two question some of Husserl's assumptions. In the last part of this section I will focus on the first two; in the next section, I will try to clarify how the last two points leave space for a theory of the life-world within a view that ascribes to science a decisive role in the definition of what exists.

In light of the quantum scientific image of the universe, it is difficult to follow Sellars's focus on what exists. More accurately, we should speak of what happens when we endeavour to observe it. Heisenberg reminds that "in the drama of existence we are ourselves both players and spectators" (Heisenberg 2000: 25). We cannot escape from this ambiguous condition. Thus what we observe in physics – thanks to the measuring device that we constructed – is not "nature in itself but nature exposed to our method of questioning" (Heisenberg 2000: 25).

This formulation seems to suggest a form of anti-realism in science, but we should more appropriately speak of a pragmatic realism:[6] indeed, it would be misleading to think that there is no quantum world; the physics does describe the nature of the microscopic universe. The point is rather that we can only grasp it through an abstract description. While the references are real, the correlated event of our description happens at the microscopic level in a way that is at odd with our ordinary way of seeing the world. Conversely, the tools we use for elaborating our description are inevitably mediated by our mental constructs, by our capacity of devising signs that can designate the event as accurately as possible, or by figuring out appropriate experiments and constructing effective devices to verify our hypotheses.

This leads us to the second point. Heisenberg maintains that "in classical physics science started from the belief – or should one say from the illusion? – that we could describe the world or at least part of the world without any

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[6] On Heisenberg's pragmatic realism see the interesting reflections of Cappelletti 2001.

reference to ourselves," but this belief only results from "a refinement of the concepts of daily life" (Heisenberg 2000: 23). We can easily separate the object from the subject only by confining ourselves to the macroscopic sphere, in which we straightforwardly live. In the microscopic one, however, the interaction between the system and the observer is inescapable. In 1996, Carlo Rovelli proposed a refinement of the standard "Copenhagen" depiction of the state of affairs. In the traditional view of quantum physics, the observer who makes a measurement on a quantum system is macroscopic. On the contrary, in the relational interpretation of quantum mechanics, by using the word "observer" we should not refer to a "conscious, animate, or computing […] system;" rather, in a more Galilean fashion, Rovelli identifies the observer with "any physical object having a definite state of motion" (Rovelli 1996: 1641). As one can easily get, in this way the notion of "observation" merges into that of interaction: "any system, irrespectively of its size, complexity or else, can play the role of the quantum mechanical observer" (Laudisa, Rovelli 2019). The point is no longer what can I grasp with the help of technology and following my theoretical hypothesis, but the extent to which a system is able to affect the other.[7]

Quite surprisingly, when seen from the quantum perspective, Sellars's scientific image turns out to be a refinement of the manifest image, which is still more sophisticated than Husserl's ontology of the life-world. Sellars thinks in terms of a world that exist below and behind the manifest world. Even though we can grant him that his depiction of the real world as a system of particles is only an approximative way of describing a more complex universe – characterized by fields, forces, a matter that behaves like a wave – Sellars's assumption that the representation of a world in terms of a system of imperceptible objects is completely independent of the subject that investigates it is absolutely questionable.

Starting from a position that is the opposite of Husserl's, quantum theory paradoxically encroaches the same two objections that we raised against Sellars by following Husserl's perspective at the end of the previous section. More

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[7] In order to fully address the question of whether realism plays a conceptual role in quantum physics, and so understanding how the theory changes on the basis of different interpretations of the notion of "observer" itself, one would need to extend the investigation to what has been referred to as the "second quantum revolution" (see Maudlin 2019 for a depiction of the latest outcomes of quantum revolution, and Maudlin 1999 for an interpretation of the second quantum revolution in light of Sellars's distinction of two images). This move was made necessary by Einstein, Podolsky and Rosen's attempt to demonstrate the incompleteness of standard quantum theory (see Einstein, Podolsky, Rosen 1935), and by Bohm's introduction of the topic of hidden variables (see Bohm 1952). It was in fact Bell's demonstration to suggest that quantum theory can be considered complete if it accepts the non-locality of quantum systems, i.e. the possibility of systems interacting at a distance (see Bell 2004, and Maudlin 1994).

explicitly, the two points that Sellars misses are (1) that a scientific image of the world must elaborate a stratified conception of what is real, and (2) that "phenomenon" does not only coincide with "illusory appearance".

In a supplementary text to *Crisis* Husserl briefly dwells on the meaning of quantum physics for the history of scientific knowledge. Here he appreciates the probabilistic and relativistic approach it adopts, and insists on the fact that the totality of the world is divided into fields with different typical structures (see Husserl 1954: 389-390).[8]

In other words, in physics we have to think in terms of scales. When Planck supposed that an electromagnetic wave comes in lumps, he found out that the minimal unit of energy a wave can carry is proportional to its frequency. This led him to introduce a new constant in physics for expressing this quantum phenomenon. It is now known as Planck's constant, denoted "h" and, in the Dirac's reduced formulation, "ħ" (pronounced "h-bar"). It is extremely small – it is about a billionth of a billionth of a billionth in everyday unit (more specifically it is 1.05 x 10-27 grams-centimeters2/second). This entails that in those layers of reality in which Planck's constant is irrelevant, quantum effects are not significative. This is the case of the manifest world.

Richard Feynman, the famous American physicist who worked on a theory of quantum electrodynamics and invented the mathematical path integral formulation of quantum mechanics, reinterpreted the double-slit experiment by arguing that the probability for an electron to arrive at a point on the screen is built up from the combined effect of every possible way of getting there. Accordingly, he suggested that particles must be viewed as travelling from a location to another along a set of infinite trajectories. However, he also showed that if we examined the motion of macroscopic objects with his new method of calculus, all paths but one cancel each other out when they are combined. The trajectory that remains valid is approximately the one emerging from Newton's law of motion. This explains why in the everyday experience a manifest object follows a unique, predictable trajectory when travelling from a location to another.[9]

This is further evidence for questioning Sellars's view of a world behind the other, and the following identification of the manifest world with the phe-

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[8] As Argentieri (2009) has argued in his illuminating essay, Husserl's conception of a stratified reality is very close to the ontological perspective Heisenberg defends in an essay published posthumously, in which reality, understood as the totality of connections of life, is ordered "in diverse areas" (Heisenberg 1989).

[9] See Feynman 2010, ch. 19: 4: "As we apply quantum mechanics to larger and larger things, the laws about the behavior of many atoms together do *not* reproduce themselves, but *new laws*, which are Newton's laws, which then continue to reproduce themselves from, say, micro-microgram size, which still is billions and billions of atoms, on up to the size of the earth, and above". Cf. also Feynman 2006 and 1983.

nomenal realm in a Kantian sense. Moreover, if the world of imperceptible microscopic objects were the only real one, could be said about the nature of astronomical phenomena? Does Einstein's revolutionary depiction of four-dimensional spacetime refer to something that can be taken to be real? In this case as well, since the manifest objects in our perceivable world are very far from moving near light speed, the relativistic effects described by Einstein are so irrelevant to be undetected.[10]

To conclude, in contrast with Sellars's (approximative, in light of our argument) identification of reality with a system of imperceptible entities, we might quote Heisenberg's appropriate definition. By noticing that the world cannot be divided into "different group of objects but into different group of connections," Heisenberg suggested that "the world thus appears as a complicated tissue of events, in which connections of different kinds alternate or overlap or combine and thereby determine the texture of the whole" (Heisenberg 2000: 64).[11]

3. *The space of persons*

Husserl's belief that the algebraization of science entails a gradual loss of meaning generated among some interpreters the erroneous conviction that in Husserl's view the perceivable world is the only source of meaning. On the contrary, since the *Logical Investigations*, following Bolzano and Lotze, Husserl insists on the objectivity of meaning, i.e. on the fact that it is valid independently of its occurring in a psychic lived experience or being verified in a sensible experience.

It is true that Husserl sometimes exposed his notion of a "life-world" to the risk of being identified with a closed set of objects and behaviours closely linked to perceptual experience. Yet I think that this identification of the life-world with the perceptual realm is merely a remnant of the original definition of the notion Husserl offered at the end of the 1910s, but which no longer holds for the context of *Crisis* we are here considering.

At first, Husserl used the term "life-world" to designate the sphere of pre-predicative experience as opposed to that of judgement. However, his focus shifted over the years. As Iso Kern has clearly pointed out, "if it was initially formulated as a problem concerning foundational relationship between the scientific concept and the preconceptual intuition, in the course of his reflec-

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[10] Reasoning in terms of scale in physics is crucial to avoid the conflict that would otherwise arise between quantum mechanics and theory of relativity (see Greene 1999, ch. 5).

[11] After all, Sellars seems to be drawn in this direction in his famous Carus lectures (Sellars 1981b), in which he argues that a positive ontology is only possible if we speak in terms of pure processes.

tion it was transformed into the problem concerning the fundamental relation between the abstract world of objective theory and the concrete, historical world of subjective life in which 'theoretical praxis' belongs as one mode of human praxis *among others*" (Bernet, Marbarch, Kern 1989: Eng. tr. 222).[12]

When examining the process of mathematization of nature that started new physics (now labelled as classical physics), Husserl recognizes that "the process whereby material mathematics is put into formal-logical form […] is perfectly *legitimate*, indeed necessary," but he also adds that "this can and must be a method which is understood and practiced in a fully conscious way" (Husserl 1954: Eng. tr. 47). In other words, in Husserl's view the tendency to employ *formulae* is perfectly justified by the fact that they facilitate our capacity for predicting what is to be expected in experience or in the experimental verification. However, as we have already emphasized, Husserl sees the process of algebraization of science as an authomatization of thinking that leads to a systematic displacement of the symbolic method of calculation, which progressively becomes the very object of investigation instead of maintaining its necessary but only supportive role for knowledge.

This shows that what is at stake for Husserl here is a historical process. The loss of meaning technization would imply does not merely concern the way in which the 'world of formulae' is rooted in the perceivable world. It rather concern the capacity of the mind to lead the symbolic transformation of scientific thinking back to a historical change of paradigm, thus back to a cultural event determined by an epoch's worldview, and located in what Sellars would call the space of reasons—the conceptual framework of persons where we demands for and articulate our reasons.

In *Crisis* and in the famous, posthumously published, essay on the origin of geometry, Husserl stresses that the life-world is historical, thus it has to do not only with perceptible objects but also with the culture we inherit, with the values we embrace or reject, with the language of communities and individual intentions (to state this in Sellarsian terms again). The natural attitude we straightforwardly adopt within the horizon of the life-world coincides with the personalistic attitude that characterizes us as citizens who hold a certain worldview and are guided by cultural motivations. This explains why some of the discoveries of the modern scientific revolution have become so familiar to us: even if we do not study them in depth, we would never dream of questioning their soundness. For instance, even though the earth appears to us perceptually as the stable ground of our everyday experience, we have

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[12] For a thorough reflection on the development of Husserl's conception of the life-world let me refer to Manca 2016, section 1, ch. 3.

become familiar with the awareness that it revolves around the sun.[13] This implies that objects of a life-worldly view of things can be not only what one grasps or verify by perceptual experience, but also knowledge that we acquire, theories that we postulate, discoveries that become the common background of an epoch.

In this sense, when Husserl identifies the loss of meaning brought about by the technization of science with the concealment of the life-world understood as the ground of each cultural event (like the introduction of a new method into natural science), he is pointing out to the difficulty for the community to recognize a decisive advancement in knowledge it nonetheless accomplished.

When Sellars describes the manifest image as a refinement of the original one, he emphasized that in such a scientific elaboration of the ordinary depiction of the world the categorial conditions do not effectively change, but all object are assimilated to persons, albeit some of them as "truncated". Husserl's scepticism about the process of technization in the scientific realm turns the attention to the acts more than on the objects. According to this noetic perspective, the change of paradigm was effectively generated by a truncation of the social, cultural, and more generally shared experiences, rooted in the space of persons.

The problem seems to coincide with the fact that natural scientists focused on the elaboration of calculus as a method rather than delving deeper into the philosophical reasons behind it. For sure, this has to do with the fact that philosophy has progressively lost the primacy in the elaboration of an image of the world that it held for centuries, a primacy that was assigned to natural sciences.

It is misleading to think that the specialisation of knowledge leaves little room to the reflection on the philosophical implications of scientific discoveries. Indeed, in the 20th century thinkers such as Einstein, Bohr, and Heisenberg not only gave conspicuous space to the need of elaborating a conceptual framework of the world, but in some cases they started from a philosophical

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[13] It is not by chance that I cite this example. There is a manuscript by Husserl, further valued by Merleau-Ponty, in which Husserl argues that even if, after Copernicus, the earth must be considered one body among others, it remains for us the firm ground of our experience (see Husserl 1968). With this, Husserl does not want to return to the Ptolemaic geocentric theory. Rather, he wants to argue that the "paradigm shift" in the context of the scientific image does not affect the manifest image. The "Earth" as the object of a theoretical-objective intention is completely different from the earth as the reference context of ordinary sensory experience. This explains why we are able to become familiar with the cognition that the earth revolves around the sun and that the apparent movement of the sun is only an illusion determined by the movement of the earth around its own axis, while perceiving the earth as the stable ground of our experience. Let me refer to my essay (Manca 2014) for an account of Merleau-Ponty's reading of this manuscript, and his picture of science in comparison with Sellars's.

reflection on the existing paradigm to formulate their hypotheses – that is, to postulate an image of the universe whose verification depended on experiments frequently not conducted by them.

Yet, I think we should look at another, more decisive point: these thinkers carried out their theoretical activity in and through a complex mathematical language. Even though later in their research activity they devoted themselves to disseminating their discoveries in ordinary language – obviously leaving behind some of the rigour of the proper formulation–, mathematics remains the language they developed not simply to communicate the conceptual contents of their theoretical activity, but also to conceive them.

For Einstein (1931: 69), Newton's choice of enunciating the laws of motion in the form of total differential equations was "perhaps the greatest intellectual stride that it has ever been granted to any man to make". Newton makes only a marginal, not systematic use, of symbolic, mathematical language, but this paradoxically allowed his successors to elaborate a scientific paradigm in opposition to that which Newton himself consolidated.

Thus, mathematical language leads human thinking to refine its art of measuring, independently of the capacity of speaking of what is real. For instance, some of the most influential representatives and interpreters of quantum mechanics look at wave function – which describes the quantum state of an isolated system – exclusively as a calculational tool that refers to an abstract mathematical space, but cannot be said to have an objective, physical existence.

Husserl's suspicions aside, these two examples proves that he is right in identifying mathematics with a human construct for grasping the essential features of the physical world. In other words, from this perspective, it is not possible to maintain that nature is written in hidden mathematical characters, which human mind would then need to decipher (as Galilei had it), because the category of subject cannot be separated from that of object. We have seen that this thesis is common to quantum theory and Husserl's phenomenology. Mathematics, on the other hand, is human mind's most effective tool for forcing nature to speak; it is the linguistic practice that allows human mind to delve deeper into its interaction with nature, with which it actually shares an inborn unity. This seems to me the only way to hold together Husserl's conviction that mathematics alone can depict the "true being-in-itself" of nature and his critique of the unreflective use of algebraic formulas, which natural scientists pursue in even more systematic ways.

Moreover, this conception of mathematics reveals the point of contact (and, in fact, also the point of divergence) of Husserl's idealism and Sellars's nominalist psychologism. As is widely known, one of the most famous theses that Sellars (1956: 162) defended in his *Empiricism and the Philosophy of Mind* is “the denial that there is any awareness of logical space prior to, or independent of, the acquisition of a language”. Even though Husserl insists that rational rules are already in play at the level of passive, unconscious experiences of the world, and that sense displays a pre-expressive dimension, he would agree with Sellars’s belief that language is the natural form of sense. Thus, for both thinkers, the awareness of concepts drawn on in our life is strictly dependent on the use of a language.[14] In the case we are examining, the mind could not acquire awareness of the quantum image of world without the use of the mathematical language. Neither the relativity of time and space, nor the equivalence between matter and energy, nor the fluctuations of the atom, nor the ambiguous behaviour of matter in general, would be accessible to us without relying on an advanced mathematics.

As Husserl explains in *Crisis*, at the basis of modern scientific revolution there is the conviction that mathematics is no longer a formal transposition of concrete relations, but a new way of thinking. Algebraic formulas are not simply abbreviations; rather, they stand for an ideal construction of the world. The technization of science shows that the conception of mathematics as an ideal garment of reality, as something that is built on the life-world, cannot work. The step further that the quantum worldview takes is to understand mathematics as a linguistic practice, which allows not simply to describe but to organize a scientific experience and to construct (via technological mediation) a connection – beyond the ordinary one – between that event which is called “mind” and that event which is the phenomenon “world”.

We can thus move to the second aspect I wanted to highlight. Heisenberg titles his 1927 article on uncertainty in quantum physics *Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik*. Whereas the adjective “anschaulich” has been translated as “physical,” and more seldomly as “actual,” it literally means “intuitive”. Heisenberg is here clearly referring to what can be measured and not to what can be perceived by the naked eye. The terms “physical” or “actual” are misleading because they could suggest a reference to a content that has to be taken as real independently on the observer who grasps it (‘observer’ should be understood according to the extensive meaning we have already expanded upon by following Rovelli). By contrast, as is already pointed out, quantum theory takes the product of the interaction between physical systems as always known. Thus, if one looks for a more explanatory translation, closer to Heisenberg’s own intention, the adjective “anschaulich” could be rendered as “graspable”. Indeed, Heisenberg would prefer

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[14] Instead, the difference between the two thinkers is that, for Sellars, a concept is a social, intersubjective construct of ordinary language, while, for Husserl, a concept always refers to an ideal sense.

to emphasize the need to start from what can be observed in an experiment in order to determine what the theory can grasp or not (and to what extent), rather than making use of traditional concepts without discussing them.

Still most significantly, the use of the term "anschaulich" extends the notion of intuition that is not that far to the one that Galilei carries on with his revolution in physics. Like Heisenberg did with respect to the tradition of the classical physics that stems from Galilei – and in contrast with the Aristotelian conceptual apparatus that he inherited from the Scholasticism of his time – Galilei himself discloses the intuitive power that a theoretical attitude offers in relation to reality. Imagining a mental experiment, formulating hypotheses, constructing an experimental verification of them, grasping the ideal forms of a concrete phenomenon, and using mathematics for this, are closely interconnected activities.

All this shows us that the concept of "intuition," as it is the case for that of "meaning," to speak more generally, develops in history. This does not entail that the meaning of a concept is contingent and can be modified at will. Rather, this suggests that one's life-world can always be extended to new categories, to new way of grasping a reference for what we mean.

Apart from the cases in which Husserl risks to completely identify the life-world with the perceivable dimension of reality, he frequently describes the life-world as the open horizon within which we can familiarize with new objects, while others may be reconsidered to the point of losing their original grip; as the context in which new attitudes may be undertaken, old practices forgotten, or, in Husserl's words, allowed to be sedimented.

This brings us to the conclusive remarks of this essay. A philosophical consideration of the life-world seems to be necessary even for a perspective that ascribes a primacy to science in outlining what is real. Indeed, Husserl's life-world coincides with the sphere of persons, in which we articulate and are able to justify our reasons, i.e. to prefer an image of the world to another. The involvement of quantum theory led us to a further reflection on this issue. When we state that we should replace the belief that reality is a system of imperceptible objects with one that depicts it as a complex tissue of events and interactions between systems (on the basis of a scientific perspective that has enjoyed enormous experimental success), we are not modifying the belief that the best way to understand what is real is to postulate what can be observed by measurement. In putting forth this option, however, we are removing an obstacle in understanding the conflict between the two images. We are, in fact, understanding that the conflict is rooted in a historical paradigm that develops a certain representation of the terms at stake. In other words, this position emphasizes that the point of contact between the two images does not lie in making perceivable what is indeed not perceivable, but in the ability of getting acquainted with a vision of the world that could only be partially expressed in ordinary language. An alternative is possible that avoids the conflict ending in an aporia.

The option we are offering does not only allow to provide a naturalistic, scientific, description of the form of life we identify in the manifest image with the term ‘person’ so that a conjunction of the two perspectives is made possible through an analogy that links one category of the scientific image to another in the manifest; it also allows one to assert that the scientific view of the world recognises the need to recur to the sphere of persons – i.e. to the way they ordinarily conceive of themselves – in order to understand its genesis and justify its primacy.[15]

Without a genetic analysis of the scientific attitude in the historical human life-world, there is no possibility of understanding mathematics as a linguistic practice that constructs a world rather than merely describing it in a formalistic way. The opportunity a theory of the life-world offers is barred to an understanding that continues to think that the world is completely independent of the mind that thinks it. This last is, on the contrary, part of the physical system whose it can become a macroscopic observer. As we stressed, the product of our knowledge, i.e. what a scientist is entitled to call “reality,” is always the result of an interaction between physical systems – in the case of the human mind enhanced by the mediation of technology and the elaboration of increasingly sophisticated languages. If we maintained that the phenomenon is what appears of something that remains hidden, we would not be thinking about the issue adequately. What we should claim is rather that reality is always only what appears on the basis of the way in which we interrogate it.

In the light of this, we can detect a metaphilosophical commitment within a theory of the life-world in a twofold sense.

Firstly, to question the need to resort to the sphere of persons even from a perspective that embraces scientific realism from the outset is to lay the foundations for a full justification of the latter. From this perspective, a theory of the life-world helps to clarify the sense of the primacy of the scientific image of the world.

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[15] Let me notice that in science it is often inevitable to introduce descriptive terms that derive from the routine of the conceptual framework of persons in the manifest world: one speaks, indeed, of “corpuscles,” “wave,” “quantum foam,” “scales,” “black body,” etc. As Sellars himself has pointed out, although it is necessary to make an effort to replace the observation language with theoretical language (and to understand that this does not imply that anything is left out), “only the most pythagoreanizing philosopher of science would attempt to dispense with descriptive (that is, nonlogical) predicates in his formulation of the scientific picture of the world” (1961: 126).

Secondly, more broadly but also more essentially, a philosophical enquiry into the life-world activates a philosophical reflection on what philosophy can do in its perennial attempt "to understand how things in the broadest possible sense of the term hang together in the broadest sense of the terms" (Sellars 1962: 1).

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