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Realism, general relativity and Schrödinger's Cat

Realismo, relatividad general y el gato de Schrödinger

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Abstract

This paper examines the nature of reality, including the possibility of freedom, in the framework of modern physics. Additionally, it proposes a reform for the metaphysics of realism. For realism, the world is the way it is independent of the mind. However, general relativity supposes that the speed of objects and the temporal order of events depend on the frame of reference adopted. Which frame of reference is adopted depends on human interests. However, there are still physical facts independent of the frame of reference: the speed of light, spacetime distance, and the equivalence of matter and energy, amongst others. On the other hand, the Copenhagen Interpretation supposes that quantum states are in a superposition that is only realized at the moment of observation, leading to the implication that Schrödinger's cat is both alive and dead until observed. However, less incredible realist possibilities are analyzed. Modern physics, whether determinist or indeterminist, also threatens the possibility of freedom. The compatibility of freedom as self-government and modern physics is analyzed and developed. Although central aspects of realist metaphysics are conserved, a philosophical-scientific conception of the universe that integrates mental beings within it emerges, which supposes a reform for standard scientific realism. The existence of facts independent of what we happen to think is saved alongside ineliminable mental phenomena.

Keywords

Metaphysics, Epistemology, Relativity, Quantum Mechanics, Freedom, Science Philosophy.

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Resumen

El presente trabajo examina la naturaleza de la realidad en el marco de la física moderna, incluyendo la posibilidad de la libertad. Adicionalmente, propone una reforma a la metafísica del realismo. Para el realismo, el mundo es como es, independiente de la mente. Sin embargo, la relatividad general supone que la velocidad de los objetos y el orden temporal de los eventos dependen del marco de referencia que se adopte. Qué marco de referencia se adopta responde a intereses humanos, pero sigue habiendo hechos físicos independientes del marco de referencia: la velocidad de la luz, la distancia espaciotemporal, la equivalencia entre energía y materia, entre otros. Por otro lado, la "interpretación de Copenhague" estima que los estados cuánticos están en una superposición que solo se concreta en el momento de observación: el "gato de Schrödinger" está vivo y muerto, hasta que lo observamos. Sin embargo, se analizan posibilidades realistas menos inverosímiles. La física moderna, determinista o indeterminista, también amenaza la posibilidad de que tengamos libertad. Se analiza y desarrolla la compatibilidad de la libertad como autogobierno con la física moderna. A pesar de que aspectos centrales de la metafísica realista se conservan, se concluye con una concepción filosófica-científica del universo que integre a los seres mentales dentro del mismo, lo cual supone una reforma a la metafísica del realismo científico estándar.

Palabras clave

Metafísica, epistemología, relatividad, mecánica cuántica, libertad, filosofía de la ciencia.

Introduction

Modern physics challenges many common senses of reality. The four-dimensional block universe, three spatial and one temporal, represented in Minkowski's graphs (Hossenfelder, 2022), would give force to Parmenides and Plato's position that reality is eternal, change is illusory, and the passage of time is only an illusion of our perception. Also, the fact that space is curved by massive bodies as if it were made of rubber, as was proved by Sir Arthur Eddington in 1919 with observations of the curvature of light from distant stars behind an eclipse, is a fact that defies common sense. The displacement of Euclidean geometry (adopted by Newton and postulated by Kant as a necessity a *priori* condition of the knowable universe itself), by Riemann's geometry of curved space, postulated in Albert Einstein's universe, constituted an event worthy of being considered a true "scientific revolution" (Kuhn, 1962). Aristotle would perhaps smile with this twist as if it were a reincarnation of his aether, supplanting Newton's "eerie action at a distance" of gravity for a malleable space.

This article deals with the question of realism in the foundations of the two great theories of modern physics: general relativity and quantum mechanics. Aspects of these theories challenge one of the pillars of scientific realism: the idea that the universe is the way it is independent of what we think or observe of it. General relativity, and more specifically special relativity, involves Galileo's idea of the relativity of motion and

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extends it to the relativity of time. For general relativity, there are several frames of reference for which the velocity of objects and the temporal order of events are distinct, and there is not particularly "real" frame of reference in front of the rest. Second, for the most widespread interpretation of quantum mechanics, the Copenhagen interpretation, the probabilistic values that characterize particles are not determined until they are observed. Protagoras and George Berkeley would be pleased with this confirmation of their theories, in the face of their realistic rivals, whose theories would be refuted by the very science they claim. The objective of this paper is to provide a realistic response to the challenges posed by modern physics, within the framework of an integrative philosophical-scientific vision of the universe. The epistemological and metaphysical analysis of modern physics has been an important task since its inception, and debates about it continue to evolve human knowledge. Likewise, as this article suggests, while scientific realism is one of the most accepted positions in professional philosophy, it is also in need of refinement.

Methodologically, to answer the challenges posed by modern physics, we seek resolutions of philosophical concerns using the same resources and without leaving the same framework of knowledge that physics itself delineates. Thus, it is under the understanding of modern physics and assuming its approximate truth that answers to philosophical questions about reality are sought. In the second section, this paper argues that general relativity maintains some crucial aspects of the independence of reality from our thinking of it. In the third section, it argues that quantum mechanics does not imply an idealistic thesis, as there are more promising realistic relevant alternative interpretations. In the fourth section, it states that realism is superior to epistemological, metaphysical, ethical, and educative subjectivist idealism. In the fifth section, it mentions that the causal view of modern physics does not eliminate freedom as self-government—a conception that holds much of what we value in freedom. In the last section, it concludes with some general reflections on the vision of scientific realism, modern physics, and a reform to its standard metaphysical formulation.

Realism and general relativity

Realism implies the thesis of a world independent of the mind: the idea that the world, in general, is as independent of mental states. The physical world is supposed to be the paradigmatic case of a world independent

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of the mind. However, general relativity theory, and particularly special relativity, states that:

- The movement is relative to a frame of reference.
- Time is relative to a frame of reference (Hossenfelder, 2022; Zee, 2013; Bunge, 2016).

Thus, for general relativity, it might seem that Protagoras was right when he formulated subjectivism with the famous phrase: "the human is the measure of all things, of things that are, and of things that are not" (Plato, ca 375 BC). The same object can have different speeds according to different frames of reference, and there is not intrinsically truer, or absolutely correct, frame of reference. Thus, questions such as "how fast is the planet moving?" and "does the Earth rotate around the Sun or the Sun around the Earth?" do not have a single coherent answer. Relative to the Sun's frame of reference, the Earth moves at 107,226 km/h around the Sun. In relation to the frame of reference, the Earth does not move and it is the Sun that moves at 107 226 km/h. This is what is known as "Galilean relativity" (Hossenfelder, 2022; Zee, 2013).

Intriguingly, this means that, although the simplest trajectory is plotted in the heliocentric model, the geocentric model is accurate in the Earth's frame of reference (Hossenfelder, 2022; Zee, 2013). While it may be more useful for us to use the Sun as a frame of reference, there is no absolutely "better" or "correct" frame of reference independent of our mind-dependent uses. Thus, Galilean relativity has some tension with the common interpretation of Galileo's claim that we have learned, that the heliocentric model would be the absolutely correct one. It is correct, but relative to the frame of reference of the Sun, which turns out to be more useful and easier to calculate for our human purposes. Given other purposes, the geocentric model would also be correct (Hossenfelder, 2022; Zee, 2013). Since human purposes and computing abilities are mental, the discovery that the Earth revolves around the Sun and not vice versa does not constitute the discovery of a fact independent of the mind.

This conclusion translates to the framework of general relativity theory, which states that the speed of light is constant from all frames of reference. This implies that, relative to different frames of reference, an event occurs before, after, or simultaneously with different events. There is not a single time when a specific event occurs, as different frames of reference order the sequences of events in the universe differently. Moreover, there is no single true frame of reference (Hossenfelder, 2022; Zee, 2013).

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All frames of reference are equally valid, although some may be more useful for our purposes.

According to the theory of general relativity, and specifically special relativity, unlike other phenomena, light reaches its target at 299,792 km/s in vacuum, no matter how fast the target moves (except for the speed of light itself) towards or away from the source. Thus, a laser will reach a target at 299,792 km/s in exactly one second, whether the target was still or moving toward or away from the source at 100,000 km/s (Hossenfelder, 2022; Zee, 2013).

Suppose a spacecraft A chases another spacecraft B at this speed and both fire lasers at each other. The time it will take for the lasers to reach the other ship will be the same. From the point of view of an observer watching the chase, both ships fired at the same time, however, the light from A to B will have traveled a longer distance, since B advanced while the laser reached it. Consequently, A had to fire before B, from the perspective of spacecraft. Thus, there are at least two sequences of events as to who fired first in pursuit. But these are not the only frames of reference. If there was a third craft C between the original two, moving from A to B at a faster rate, B would have been the first to fire. This is because, from C's perspective, B would have to fire the laser first to reach spacecraft A moving away from its frame of reference. What is the "only right" order? None. All are correct for different frames of reference, and no frame of reference is the "only true frame" (Greene, 2020; Carroll, 2020; Hossenfelder, 2022; Zee, 2013).

For general relativity, the duration of events varies according to their relative velocity. If you take off on a rocket at close to the speed of light and return to Earth a year later, *ceteris paribus*, you may be landing thousands of years later in the age of Earth (Hossenfelder, 2022; Zee, 2013). What was for you a year on a rocket could be for someone on Earth thousands of years. In that sense, it is possible to travel back in time to the future faster than the normal speed we share in our ecological niche on Earth (Hossenfelder, 2022; Zee, 2013).

The question at this point is whether we can also travel back in time to the past. The answer seems to be no (Hossenfelder, 2022; Zee, 2013), as we would have to travel faster than the speed of light and that would be naturally impossible, although some physicists play with the possibility, including in the early universe (Krauss, 2017). In the literature on the possibility of time travel, the "grandmother paradox" emerges. This paradox highlights the causal cosmic chaos that would create the possibility of time travel. The grandmother paradox asks what would happen

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if a time-traveling killer murders his grandmother, thereby never being able to be born, exist, and thus never cause the death of his grandmother (Hossenfelder, 2022; Zee, 2013). But if his grandmother did not die because the killer was not born, then the killer would be born. But if the killer was born, he murdered his grandmother and was never born. It is sometimes theorized that in the early universe it traveled faster than the speed of light, however, if it traveled faster than the speed of light, it would be set back in time and would never have reached the current stage where this speed limit is not violated.

In the framework of general relativity theory, are there facts independent of the mind? Yes, one is the speed of light, which remains constant under the Lorentz transformation (Bunge, 2016). Second, spacetime distances remain constant under the Lorentz transformation (Bunge, 2016). Third, the fact that there are multiple frames of reference that produce different outcomes in terms of movements and timing of different events. Fourth, the existence of objects that move and emit light. Fifth, that the passage of time is slower for faster objects, compared to less fast objects. Sixth, the conservation of energy, and the equivalence of matter and energy of the famous equation $E = MC^2$ remain true independent of the frame of reference (Bunge, 2016). However, it seems that certain times, the order and speed of the movement of objects are frame-dependent properties and, consequently, are mind-dependent facts. As Mario Bunge himself (2016) analyzes:

> Special relativity also proved that the values of certain properties, such as distance, duration, mass, temperature, and electric field strength, depend on the frame of reference, while others, such as spatio-temporal distance, electric charge, and entropy are invariant with respect to frame of reference changes... Therefore, the relativization was partial and refers to the relationship with the objective frame of reference, not with the conscious subject... There is nothing unreal or apparent in the dependence of a frame, neither in relativistic physics nor in classical physics... Invariance assumes reality, but not the other way around (pp. 80–81).

Realism and Schrödinger's Cat

Quantum mechanics is famous for driving a number of anti-realistic implications (Penrose, 2016). The center of quantum mechanics is the "Schrödinger equation." For this equation, the state a quantum particle has depends on the probabilistic evolution of the function wave, which collapses at the moment of observation, in which the probability is fixed

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in a given state. Thus, the state of the material subject to the laws of quantum mechanics would depend on the observer. George Berkeley (1710) would come from death to recognize his metaphysical principle of the universe: *esse est percipi* ("to be is to be perceived").

On the other hand, Schrödinger refuted this interpretation of his theory, with his famous "Schrödinger cat" (Penrose, 2016). In this hypothetical experiment, it is assumed that there is a box with a radioactive material operating under the laws of quantum mechanics with a probability of decaying. This material is connected to a gun pointed to a cat. If it decays, it shoots the gun and kills him. If it does not decay, it does not shoot and the cat lives. Now, before looking on the inside, is the cat dead or alive? Copenhagen's interpretation, which became the most deeply rooted among scientists and the general consciousness, would say that there is an overlap between a state of decayed material and dead cat, and a state of undecayed material and living cat. Only when the box is opened, and it is seen what it is on the inside is the life or not of the cat determined. Before that, the cat is alive and dead (Penrose, 2016).

Copenhagen's interpretation is frequently attributed to Schrödinger as having admitted the idealistic implication, however, that does not seem to be the correct understanding of the situation (Penrose, 2016). Albert Einstein replied that the

> [Copenhagen's] interpretation is more elegantly refuted by the system of radioactive atom + Geiger counter + amplifier + powder charge + cat in a box, in which the psi function of the system contains the cat both alive and torn to pieces. Should the cat state be created only when a physicist investigates the situation at some definite time? (Maxwell, 1993).

Famously, Einstein, despite being one of the pioneers of quantum mechanics, objected in the same line of this interpretation with the Einstein-Podolski-Rosen paradox (Mermin, 1985), something that in popular consciousness has been mimicked with his claim that "God does not play dice with the universe". What the Nobel Prize in Physics, Roger Penrose (2016), points out about these cases, is that what these physics, Schrödinger and Einstein, pointed out was not an acceptance that the cat was in an overlap between dead and alive that is only defined once it is observed. What they point out is that the interpretation or the theory itself must change, because Copenhagen interpretation is blatantly absurd. The categories "live cat" and "dead cat" are mutually exclusive, and the cat could not be in both (Penrose, 2016).

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An idea proposed in this context is to say that the exit is in the consciousness of the cat (Carroll, 2019). As it is a conscious being, it will be fixed by its own observation that it is alive or dead compatible with the decay arrangement of radioactive material, so it would not be confined to the problematic live/dead overlap. However, while the case of the cat is striking, we can replace it with states of unconscious beings with the same effect. We can replace the jack with a *switch* that can start down, it stays there if the material does not decay and rises if the material decays. Prior to observation the *switch* would be in an up/down overlay that is only fixed once observed, which, again, demonstrates the implausibility of the statement (Penrose, 2016).

To highlight the implausible implication of the Copenhagen interpretation, we can point to decay dating techniques of radioactive material, the material used in the case of Schrödinger's cat. Peppe and Deino (2013) provide a catalog of methods. The most famous is carbon dating. True, it measures the dating of living objects (considered reliable up to 50,000 years of age). True, that it includes cats and other beings with consciousness from many years ago, however, it also measures the age of shells and trees, which would require additional arguments to say that they are beings with consciousness, in addition to having metabolic cycles and processing information. If a shell existed 30,000 years ago, does its existence depend on an observation made by an archeologist who was born 29,970 years later? Does current observation change events 30,000 years in the past? Other methods also used to date objects, even inorganic, are K-Ar dating using decay of isotopes K-40, uranium-lead, uranium series using U-238 and Th-230, fission tracks with U-238, among many others (Peppe and Deino, 2013). could observations using these methods now determine if a volcano erupted thousands of years ago? Clearly, no. This is the point of Schrödinger's cat.

Another alternative is Everett's interpretation of multiple worlds, which itself rejects the metaphysical primacy of the observer (Carroll, 2019). For this interpretation, the Schrödinger equation describes the deterministic evolution of the universe, which is constantly splitting into multiple universes that realize the various possibilities specified by the equation and never interact again. In some universes the cat is alive and in others it is dead, but never alive and dead in the same universe (Carroll, 2019). When making an observation, we simply observe the cat that is in the universe where the version of us is. In some our version observes a live cat version and in others observes the dead cat version (Carroll, 2019). Hossenfelder (2022) argues that the claim constitutes pseudosci-

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ence, as it is, in the Popperian spirit, not falsifiable: it does not generate predictions at risk of being empirically refuted. Penrose has criticized that this interpretation does not constitute a true explanation, in this case, of the observed phenomenon that the cat is either alive or dead, but not both. It is unexplainable from the observed fact that the cat is alive, that we are in a universe, among other possible ones, where the cat is alive.

We wanted an explanation of the observed fact of the cat's life. Now we "explain" it in an *ad hoc* way by multiplying cats, observers and universes infinitely. Everett's model is a clear violation of Occam's razor, being orders of magnitude more complex than need. Everett's interpretation sounds like a child's argument that the coin tossed will be expensive. When the seal comes out, he says he has won anyway because in another universe the coin is expensive. It is an *ad hoc* and complex proposal. Schrödinger confronted us with an absurd interpretation of his equation, in the strict sense, a *reductio ad absurdum* in formal logic: the cat is alive and not alive. Everett returns coherence with another reduction to the absurd: the cat, the observer, and the universe multiply infinitely.

Another interpretation uses paraconsistent logic. For realistic paraconsistent logic there are contradictions in the world (Priest, 2014). For example, if two inconsistent laws of the same rank are created certain acts may end up being legal and illegal, or if someone has contradictory beliefs, they may believe that P and that ~P. Paraconsistent logic has also been used to analyze certain paradoxes, such as the "liar paradox." "This phrase is false" could be true and false at the same time, because if it is false, it is as it says it is, then it is true, and if it is true, it would have to be as it says it is: false. Perhaps the superimposition of states between decayed radius and non-decayed radius is yet another example of existing inconsistencies in the universe, I would suggest this idea. This idea may be worth exploring for the most part in the fundamentals of quantum mechanics. However, the possible existence of contradictions does not imply that all contradictions exist. The fact that the cat is alive and dead at the same time does not seem to be a possible situation, which would seem to remain the paradox of Schrödinger's cat.

Another interpretation is that of Bohm, originally suggested by Einstein and De Broglie (Veritasium, 2016; Harris *et al*., 2016) and most recently defended by Mario Bunge (2016), among others. To them, it is clear that the cat is either alive or dead, and not in an overlap between the two states that is only defined by observation. In both cases, it is recognized that quantum matter operates according to quantum laws, including when it interacts with physical entities like us. Ignorance of the state

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of the dice does not imply the absence of its pre-observation state or that we interact with them and change it, since we are also physical entities. But this does not imply that our mental activity is setting a reality that does not exist without observation. (It is worth noting that this issue is distinct from the return of the "creepy action at a distance" in quantum mechanics, with quantum entanglement, among other distant events.)

It is worth noting that this interpretation in De Broglie and Bunge (2016) allows probabilistic causation with non-local effects, but they remain objective facts of the universe. In such a case, perhaps the Cat is alive or perhaps dead, with some objective probability given the circumstances, but it is never in an overlap between dead and alive. De Broglie's realistic world of quantum mechanics is stranger than a deterministic world of local causation. In such a case, God did play dice with the universe, but this is little strange compared to a world without facts, a world of impossible states prior to observation, of a living and dead cat prior to observation, which is defined between the two only with observation, or a universe that multiplies in different universes at each instant. Again, Bunge manages to formulate the realistic conception for the foundations of quantum mechanics with great clarity and depth:

> In the new realist interpretation, the dispersions, "indeterminations," or "uncertainties" are as objective as the probabilities underlying them: they are properties of the quantum themselves, whether observed or not (Bunge, 1967, 1973, 1985; Gottfried and Yan, 2003; Lévy-Leblond and Balibar, 1990; Phillips, 1949) (Bunge, 2016, p. 108).

Reasons to Prefer Realism Over Idealism

Metaphysical idealism and its epistemological counterpart, subjectivism, can recognize the existence of our mind, our preferences, our mental states, our consciousness, and the mental contribution contained in much of our knowledge and reality itself, as beings within the world. The perception of red, the blue of the sea, the value of money, the ethics of driving on the left or the right, the taste of chocolate ice cream versus passion fruit ice cream, all are examples of the mental, epistemological and metaphysical contributions (Restrepo Echavarría, 2023). However, subjectivist/idealist philosophy has serious weaknesses. It is clear that whatever you think, if you jump from the tenth floor, without any equipment, the force of gravity will operate and you will crash into planet Earth at an acceleration of 9.8 m/s^2, correcting for the resistance of the air against the body. The

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independent reality of the mind clashes and disproves the wrong ways of thinking and acting. Even scientific knowledge, which is increasingly approaching reality, refuting misconceptions, would be impossible if it is simply what we want. We were never wrong, for there would be no external reality to correct us. Subjectivist/idealist philosophy does not allow the existence of an external world that would exist even if we did not exist (Restrepo Echavarría, 2023).

It is important to mention Marx's (1852) assertion that humans create history, even if it is not always according to our taste. Perhaps an idealist could say that we create gravity, even if it is not to our liking. But then, was gravity born with humanity instead of being one of the factors that made possible the causal network that led to humanity's existence? Logical considerations and the best physics pay against this possibility (Restrepo Echavarría, 2023).

The existence of the mind is relatively recent in the history not only of the planet Earth, but of the universe (Chaisson & McMillan, 2017). For billions of years, since the Big-Bang, a universe has evolved without the human species and no other animals. The light of the explosion began to cool (cosmic microwave background radiation) and by quantum temperature fluctuations, eventually, hydrogen atoms emerge, which by agglutinations made by gravity initiate the proton-proton chain emitting nuclear energy at the center of stars compressed by their own weight. Atomic elements of life, such as carbon, are born, and in subsequent generations of solar systems, there may be life. Life, as Aristotle noted, cannot all feel and think. First it took millions of years for our planet to be covered with plants and generate an atmosphere with oxygen, bacteria, primitive animals, eventually dinosaurs, mammals, already with complex mental systems, capable of having interests, perceptions, tastes and suffering. Eventually we emerge humans with these mental abilities and our remarkable abilities of reasoning, problem solving, language, and social organization. During more than 99% of this process of universe evolution to the present, which causally explains the eventual emergence of the human mind (and not the other way around), the human mind did not participate (Chaisson & McMillan, 2017). In summary, subjectivism/idealism does not know the reality of the external world, its physical, chemical and biological causal processes, the reality of the past, and particularly of our cosmic and evolutionary history, and our place as beings part of the universe that can look fascinated, curious and open to knowledge, to the rest of the vast cosmos (Restrepo Echavarría, 2023).

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When learning, new knowledge is acquired, sometimes refuting a false belief, perceptual illusion, cognitive bias, personal or social prejudice, false propaganda, superstition, undue authority, or unfair judgment. It seems incredible to be able to educate us when accusations of witchcraft are as true as their denial, that there were weapons of mass destruction in Iraq to what was a lie by Bush and the military-industrial complex, and that we fall by gravity to what was not. What remains for the subjectivist/idealist educator is the sophists' stance: teaching young people how to be successful in the face of power, in essence, be mediocre like Eichmann in his banal evil (Arendt, 1963). A minimum of thought would reveal not only the incoherence of the position, as it would be evaluable to review whether it is true that it would provide success to the student, but the lack of meaning of life and the anti-citizen decomposition of society that it would imply. It is not possible to educate for knowledge and emancipation if all belief is true simply because of the fact of having it (Aguilar Gordón, 2019; Alonso Rodríguez, 2021).

Freedom in the framework of modern physics

Laplace's demon endangers freedom and moral responsibility. Philosophers have concerned themselves with free will intrinsically, as well as derivatively being the condition for moral responsibility, for we cannot be morally responsible for things over which we have no control. Laplace imagined a demon who, knowing the state of each particle in the universe and the physical laws that apply to them, could predict the sequence of the rest of the universe's events in the same way that if you know with certainty the physical properties of a coin toss you would know if it will fall on face or seal with 100% certainty. For Laplace, Newton, Einstein, and the Bohemian interpretation of quantum mechanics, the universe is deterministic, and the future is fixed from the start (even if the chaos of the universe system and the Heisenberg Uncertainty Principle make impossible the computational power required for Laplace's demon to actually make the prediction).

From this consideration, the argument of the consequence and position of hard incompatibilism is strengthened (Van Inwagen, 1975; Pereboom, 2013). The consequence argument recognizes that, if determinism is true, all our wills and actions are the inevitable consequence of the laws of nature and conditions of the past, even before we were born. Thus, to be free and morally responsible, we would have to change the

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laws of nature or conditions of the universe before we were born, which we obviously cannot do (Van Inwagen, 1975; Pereboom, 2013). The only option would be, as Nietzsche put it, that to be free we would have to be a cause without cause, which is hard to believe without falling into an anti-scientific, *ad hoc,* and superstitious position.

Libertarians state that quantum mechanics postulate events that have a random component (Kane, 2013). Thus, at the micro level a particle can move to one side or the other even if the history of the universe is fixed. For libertarians, probabilistic quantum events open the cosmos garden paths. Armed with these paths, libertarians postulate that we have the freedom to freely choose between them.

But, does one element of nature's fundamental chance give us freedom? Chance is not a type of control we have (Pereboom, 2013). If we conditioned our wills and actions on the outcome of a hypothetical currency subject to fundamentally random movements, there would not be free wills or actions. They would be at the antipodes of freedom, far removed from reason, deliberation and values. If we do not have freedom if we are determined and we do not have freedom subject to upward movement, there seems no reason to think that if our wills or actions are the determined result of historical conditions with a component of chance, we would be freer (Pereboom, 2013).

Libertarians respond that what makes the probabilistic causation of quantum mechanics is to open possibilities and that our wills and actions are caused in a free, non-random way. However, the frequencies of events that would be observed would be exactly those that are in accordance with the probabilistic laws of quantum mechanics. Thus, there would be a series of trillions of events for which we have a sufficient physical explanation compatible with the rest of physics and another additional explanation, based on free will, that coincides in its observable results and would not change the distribution of frequencies of events. As Pereboom points out, this is an implausible "wild coincidence."

At this point in the discussion, Manuel Vargas (2013) suggests revisionism: to reengineer our concepts of freedom and moral responsibility, so that they are compatible with the laws of physics, whether deterministic or probabilistic. Classical discussion of freedom integrates metaphysics and political philosophy. Thus, for example, we find in Plato that freedom is that capacity of reason to lead us in our life without being dominated by the passions or prides of the soul. Thus, Phineas Gage is an example of someone who lost his freedom with an accident that pierced his frontal lobe (Harlow, 1868; García Molina, 2012). After the

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accident, Phineas lost his ability to reason, deliberate and balance, he became an unbridled role in the whirlpool of his emotions, a loving moment, the second moment hating, laughing, crying, without any stable coherence (Harlow, 1868; García Molina, 2012). Likewise, Bunge places freedom neuropsychologically in the prefrontal neocortex, dedicated to reasoning, deliberation, planning, and evaluation. This approach explains a reason why, for example, an infant is less free, and therefore less morally responsible, than an adult. Freedom and responsibility must be cultivated (Vargas, 2013).

It is worth noting that, from the perspective of microphysics, the mind, including the ability to respond to reasons, values, deliberations, and other cognitive processes, are overshadowed. In this perspective, it is not only freedom and responsibility that is eliminated, but also intelligence, perception and knowledge. It is only when we take a perspective of the systems that make up microphysics that we realize the emerging properties that characterize systems, among them the mental properties of biopsychosocial beings such as humans.

Likewise, when a person is rational, but subject to a number of external conditions, his freedom may be reduced. An example of this is when someone threatens you with a gun for stealing your wallet. There is an element of violent obligation against their rights. The same happens when he is enslaved, in prison, in poverty or under the effects of false propaganda, either Stalinist style or the propaganda model in "democratic" capitalism (Herman and Chomsky, 1988). These situations indicate clear and strong reduction of freedom due to external factors.

In this context, the concept of non-domination from political philosophy becomes particularly useful for analyzing freedom. There may be factors, both internal and external, that affect freedom. In the absence of domination there is a kind of freedom in complex systems like humans that is worth distinguishing, securing, and cultivating. We find self-government in the ideal regulatory limit of a healthy educated person living in systems where domination has been eliminated. The ideal of self-government is an emancipatory ideal to which we can approach, even if the laws of physics are deterministic or probabilistic (Vargas, 2013; Shapiro, 2012).

Perhaps this way of seeing freedom, responsibility and the senses of life does not preserve all our pretheoretical intuitions. In this case, we realize that freedom does not require that there are metaphysically real alternative paths that we can take in a decision (Vargas, 2013). This is a consequence of this revisionist proposal. However, revision of our concepts is common in the sciences. In this case, this assumption would be

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replaced by the assumption that the available alternative to be taken will depend on the decision of the subject, even if this decision can be traced to far-off factors beyond their reach. Originally, atoms were conceived as indivisible particles. This was conceived by Democritus and Epicurus, and this idea was retained until the concepts developed by Dalton and Mendeleev in their pioneering works on elements of the periodic table in the 18th and 19th centuries. However, Thomson and Rutherford, in transit to the 20th century, discovered that the atom had parts, with a proton nucleus orbited by electrons (Heilbron, 2018). Rutherford speculated about the existence of a neutron also in the nucleus of atoms, but it was Chadwick who got the credit for discovering it in 1932. Eventually, it was discovered that even protons and neutrons were not indivisible but were composed of quarks. However, this did not lead us to conclude that the atom does not exist. We had to review our concepts and design new ones that allow us to follow our exploration and knowledge of the universe (Heilbron, 2018).

The same goes for freedom and moral responsibility. Modern physics comes into tension with them. But it is because we will not find freedom and responsibility at the fundamental levels of physics. We will find them in the psychosocial systems of our lives. From a more detached and historical perspective, this is not so unexpected. In fact, this proposed new modern turn is in tune with the classical approaches of Ancient Greece. As it happened with the revision of the concept of the geometry of space in the transit from Newton to Einstein, who is again in some tune with certain aspects of Aristotle's theory. Freedom and moral responsibility are too precious to lose. Science and nature give us the opportunity to preserve them. We are right to take it.

Conclusion and discussion

The scientific understanding of us and the universe, while fascinating, contains a number of challenges not only for certain common senses, but for realism, even scientific realism, and our concept of ourselves as beings with degrees of freedom and moral responsibility over our actions and our lives.

General relativity maintains the Galilean relativity of motion and extends it to the time and order of events. There are multiple frames of reference according to which objects move at certain different speeds in certain different directions, without there being any single speed and direction of movement of objects. Likewise, there are different frames

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of reference that fix different moments and order for the events of the universe, without there being any particular moment or order that is the only real one. In any case, the laws of general relativity remain the laws of the universe independent of us, they existed and applied long before the emergence of the mind and will apply long after mental beings, like us, are extinct. Objects and events, with different spatial and temporal coordinates, exist independent of reference frames.

Likewise, Copenhagen's interpretation of quantum mechanics that was popularized in planetary consciousness challenges the realistic concept that there is a reality that exists independent of observers. However, this is not the only interpretation in force. There are other options compatible with realism that do not have the great epistemological, metaphysical, ethical, and educational disadvantages of subjectivism and idealism implicit in Copenhagen's interpretation. The realistic interpretation of Einstein, De Broglie, Bohm and Bunge, for example, does not have the absurd conclusion of Schrödinger's cat where it is in an undetermined overlap between dead and alive before observation comes to define it. Nor does it have the absurd consequence that there were no erupting volcanoes, planets, stars and the evolution of the universe and life, before the emergence of beings with neurons organized in such a way that they could observe them.

Likewise, realism, in contrast to idealist-subjectivism, makes sense of the phenomena of learning, error correction, critical thinking, and resistance to unjust authority. Idealist-subjectivism strips us of our epistemological system of immunity against falsehood, lies, and injustice, and at best can simply adhere to power, as advocated by Protagoras, Thrasymachus, Gorgias, and Heidegger, who eventually put it into practice. The resulting postmodern relativism, with its disregard for truth and reality, ends up even being founded on an admitted intellectual farce. Lyotard confesses that his "Postmodern Condition," the pillar of postmodernism, is his worst book, among all his bad books, where he invented stories, cited books never read and the whole process of production and dissemination is a kind of parody (González Arocha, 2021).

It is important to make a comment on scientific realism. In its standard version, scientific realism includes the metaphysical thesis that:

- The world has a definite structure independent of the mind (Psillos, 2009).
- The world exists outside of conscious subjects (Cárdenas, 2011, p. 93).

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- Metaphysically, realism is committed to the mind-independent existence of the world researched by the sciences (Chakravartty, 2017).

This formulation, however, succumbs to severe objections derived from its eliminativism with respect to the mind (Restrepo Echavarría, 2023). Here I summarize the six objections. This thesis says that the world is as independent of the mind. I mean, the real world is not mental. First of all, however, if we are beings who think, even that we think that the mind does not exist, the real world contains us who are thinking beings. The position is as incoherent as asserting the theory that "I think I do not think." We had learned this lesson from the *Metaphysical Meditations* of René Descartes.

Second, scientific realism proposes to give special epistemological and metaphysical recognition to science. However, science is not only the scope of their research, but it is scientists, mental beings with knowledge objectives, who make observations, have ways of thinking, and who sustain and test their theories. The sciences, even the supposedly "least mental of all," physics, include scientists. In physics, unlike behavioral psychology, there are few overtones about recognizing that research is done by mental subjects trying to approach the world. Any writing by Einstein or another great physicist is proof of that. For example, in his 1923 work, Einstein talks about the "ideas of Eddington, Levi-Civita, and Weyl." In fact, every bibliography is a recognition of the ideas of other mental beings that we recognize as such precisely because of the ideas that we attribute to them, and the physicists are no exception. Bolaños Vivas (2017) highlights this reality in his conceptualization of knowledge.

Third, scientific realism is not only realistic about physics, it is realistic about the sciences in general. There are sciences that study mental beings, as beings that reason, perceive, feel, learn and have social relationships. Psychology, as noted by Balseca Bolaños and Viteri Basante (2021), as well as education, sociology, economics, and much of biology and zoology, involve an ontological commitment to the existence of mental beings. Thus, the formulation of standard scientific realism suffers from being empirically inadequate. Theories are empirically adequate when they agree with observations (Van Fraassen, 1980). Scientific theories claim to be at least empirically adequate, though realism asserts that they must also correspond to those unobservable parts of the universe. However, standard scientific realism is incompatible with the observable fact that these sciences deal with mental realities.

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Fourth, a view of the real world as independent of the mind eliminates the possibility that consciousness is part of the real world. We may doubt that the ocean itself is blue, but denying the existence of conscious experiences of blue perception is a mental act that cannot be sustained honestly. Consciousness is the reality that we know directly, as part of reality itself. Denying the existence of our phenomenal states of pain, joy, perception of colors, smells, tastes and others, is a price perhaps unpayable epistemically and metaphysically.

Fifth, ethics, according to all theories, presupposes the existence of mental phenomena such as happiness, suffering, reason, consent, good life, and virtue. If the metaphysical thesis of standard scientific realism were true, a world without any of this is equivalent to ours, which does involve these mental states with their derived criteria of justice, good and evil. This would be a huge entry price to pay for a metaphysical thesis unlikely to be true given the observations made.

Sixth, asserting that the world is as independent of mind implies the assertion that the mind would have no causal link with the physical world. At best, this would imply that the mind is an epiphenomenon with no connection to the objects that seem to cause our perceptions and no connection to the actions we attribute to our cognitive control, in such common activities as running, driving, sitting, talking, etc. The coherence between our mental states and the causal flow of our environment would be an implausible coincidence, all to sustain the unattractive position that the mind does not cause, not being part of the independent world of the mind. In the worst case, it would be noted that epiphenomenalism over the mind violates the elastic principle that only things with causal links exist, and would end up back in eliminativism. Evidently, under this assumption, freedom would be beyond any *ab initio* scope.

Wittgenstein's philosophy has fallen into a trap worth remembering. In his antimetaphysical analysis of philosophy he concluded that his own analysis would be meaningless and therefore famously deduced that "what cannot be spoken of, must be silenced." He went on to publish his book, evidently falling into a contradiction. To avoid falling into analogous traps, scientific realism and more generally our scientific view of the universe must include the undeniable fact of our own existence. Obviously, if our world were as it is independent of whether the mind exists or not, it would be equal to one where mental beings such as octopuses, humans, whales, dogs, cats and perhaps current or eventually artificial intelligence do not emerge. But obviously, that world is not ours. It might be the same in terms of atoms and electrons, but it is not the same in terms

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of the obvious and undeniable fact of the existence of mental beings. But what can replace standard realism, preserving its virtues, but without falling into its weaknesses? Here is an idea like this:

> Reformed Realistic Metaphysical Thesis: the world is, in general, as it is, regardless of how one thinks it is. Yet the way the world is known is itself a part (but never the whole) of the world. The things of nature, sometimes mental and sometimes not, to which we pretend to refer with our scientific theories, make our theories true or false (Restrepo Echavarría, 2023, p. 88).

This realistic thesis can recognize the fact of the existence of galaxies and atoms prior to our existence, the possibility of error, correction and critical thinking, without eliminating our own existence as mental beings, philosophers, educators, researchers, scientists, without eliminating sciences such as physics, psychology and others, without eliminating ethics and the possibility of mental causation, at a minimum cost to the Occam knife (Restrepo Echavarría, 2023).

Modern physics also has challenges for our conception of ourselves as free beings and morally responsible for our actions. From the perspective of modern physics, it seems that we are purely vehicles of forces beyond our control and whose future has been determined since before we were born, excepting the occasional possible quasi-random movements of quantum physics. However, looking at physics to identify freedom is the wrong level, just as it would be the wrong level to identify intelligence. Freedom as self-government suggests that freedom and moral responsibility exist at a higher level that adds physical components in psychobiosocial systems, involving our intelligence, knowledge, social opportunities and increasing in proportion to the elimination of domination (Vargas, 2013; Bunge, 2016).

Sankey (2010) argues that science repositions, refines and more generally does not displace common sense. In this case, we can see that it is. From these reflections emerges a philosophical-scientific view of ourselves as organized pieces of the universe with capacities of reasoning, knowledge and degrees of freedom and moral responsibility, that we look at the stars, thus becoming an instance of the universe itself, looking at itself. When there are such beautiful, ethical, meaningful, and truth-oriented philosophical and scientific views, the incoherence of anti-realism becomes irrelevant. Although there is still the need to explore and know the interactions between the positions related to realism and freedom with modern physics, advancing in the construction of this integrative vision is the proposal of this work.

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