QUANTUM THEORY AND THE SOCIAL SCIENCES

TEORÍA CUÁNTICA Y CIENCIAS SOCIALES

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Abstract

There is a solid growth of quantum theory in that there is quantum physics, quantum chemistry, quantum biology, and a robust technology based on quantum behaviors and effects – to name but the most solid examples of the development and enhancement of quantum science. Quantum science is by and large the most robust theory, ever. However, to date there is a gap between quantum physics and the social sciences, for very little has been said about their interplay. This paper discusses the importance of a relationship between quantum science and the social sciences, and the entailment of such a relation. It offers a brief state-of-the-art, and discusses the very significance of quantum social science.

Keywords: Quantum physics; social and human sciences; epistemology; complexity.

Resumen

Asistimos a un sólido crecimiento de la teoría cuántica dado que existe la física cuántica, la química cuántica, la biología cuántica, y tecnologías robustas basadas en comportamientos y efectos cuánticos - para mencionar los ejemplos más sólidos del desarrollo y profundización de la ciencia cuántica. La ciencia cuántica es de lejos la teoría más robusta jamás habida. Sin embargo, a la fecha, existe un abismo entre la ciencia cuántica y las ciencias sociales,

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ya que muy poco se ha dicho sobre esta relación. Este artículo discute la importancia de las relaciones entre la ciencia cuántica y las ciencias sociales y las implicaciones de esa misma relación. Se ofrece un estado-del-arte y se discute el significado de las ciencias sociales cuánticas.

Palabras clave: Física cuántica; Ciencias sociales y humanas; Epistemología; Complejidad.

Introduction

Whereas quantum theory (QT) has solidly grounded in the field of the so-called natural sciences, a gap persists as to the relation between QT, and the social and human sciences. There is to-date not just quantum physics, but also quantum chemistry, quantum biology, and a number of applications of quantum principles to engineering and technology, as well as on the study of materials and matter. As it has been overly stated around the world, nearly one third of the world economy depends or is based on quantum physics – at large. However, there persists a wide gap between quantum science and the base of society at large.

This paper aims at overcoming the gap. In order to do so, it firstly offers a brief state-of-the-art concerning the relationships between QT and the social sciences. The goal thus consists in pointing out that there is already some work that has been undertaken in the interplay. At the same time, as a contrast, it shows the normal or current approach of work and research in the human and social sciences. Speaking in general, the social sciences are pre-quantum sciences – languages, approaches, and methods. If they are lucky, one can at best say that the social sciences are relativistic.

The core of my argument will be based on the very recognition that, provided that there are more than fourteen different interpretations of quantum mechanics (QM), rather than this being a handicap, it represents a wonderful circumstance for the upcoming of quantum social science. This, I claim, will the very goal of this paper.

The arguments that support the claim are as follows: first, a short state-of the art regarding the interplay between QT and the social and human sciences will be provided. Such an argument helps

provide the ground toward a new kind of social sciences. Secondly, as a contrast, the current state of work and research in the human and social sciences will be presented that allows claiming that these sciences are to be acquainted, to say the least, about QT. The third argument assesses that there are over fourteen different interpretations of quantum mechanics (QM) and that this is a wonderful circumstance for both enriching and transforming the social sciences. Finally, the claim will be made about the meaning and sense of quantum social sciences, and what this entails. In the end, some conclusions will be drawn.

1 A brief state-of-the art about the interplay between QT and the social sciences

Against all odds, the link, or the interface between quantum theory and the social sciences is rich and wide at a very first glance. The disciplines or sciences addressed by quantum science are the following: philosophy, economics politics, anthropology, international relations, psychology, history, urban studies, the theory of rational choice, geography, and literature. Conspicuously, there appear also some reflections on methodology of the social sciences based on quantum theory. Table one shows the topics and references. All references are listed in the bibliography. Some references cross various disciplines or sciences.

The table 1 can be taken as a sort of state-of-the art about the relations between social and human sciences and quantum science. One punctual remark: in literature, the closest approach – an inner one, in fact, is L. Durrell, the author of The Alexandria Quartet. There is no explicit mentioning of quantum physics in the novel, as it has been pointed out in Ph. D. thesis ([31]) that assesses how a palimpsest of time Durrell's work can be overly seen. Nonetheless, there is a chapter in literature on its own named "quantum fiction". It is namely fiction that deals with all possibilities. V. Bonta (1958-2014) is said to have opened up this genre with her novel Flight: A Quantum Fiction Novel (1996).

As it can be seen, the conditions are mature enough to claim that there exist quantum social sciences, to date even though it appears to be an amorphous and in-process development

TABLE 1. *Social and Human Sciences Connected to Quantum Science.*

Sciences or disciplines	**References**
Philosophy	Aerts, et al., 2009 [1]; Anders and Wiesner, 2011 [2]; Grandy, 2010[3]; Garritz, 2013 [4] ; Heelan, 1995 [5]; Zizek, 2008 [6]
Politics	Lawson, 2012 [7]
International Relations	Wendt[8], Crasnow, 2016 [9]
Psychology	Aerts et al., 2016[10]; Bawden et al., 2015[11]; Camparo and Camparo, 2013[12]; Gonçalves, 2015 [13]; Khrennikov, 2015 [14]; Wichert, 2016[15]; Zohar and Marshall [16]
Sociology	Zohar and Marshall [16]
Economics	Karsten, 1990[17]; Haven, 2015[18]; Haven and Khrennikov, 2013[19]; Khrennikov, 2015[14]; Khrennikov sand Haven 2007[20]; Lawson, 2012
History	Wayne, 2014 [21]
Anthropology	Lawson, 2012[7]; Sorensen, 2012 [22]; Wolf-Meyer, Cochran, 2015 [23]
Theory of Rational Choice	Haven and Khrennikov, 2013 [19]; Khrennikov, 2015[14]; Khrennikov and Haven 2007[20]; Khrennikova, 2012[24]; Wu, 2011[25]
Geography	Smith, 2016 [26]
Urban studies	Arida, 2002 [27]
Literature	Durrell, 1962[28]; Bonta, 1996[29]; Wedin, 1971
Social methodology	Haven Khrennikov, and Robinson 2017 [30]

Source: Own elaboration

(Maldonado, 2017)[32]. If so, the entire panorama of the social and human sciences, not to mention of the scientific arena as a whole, is currently radically changing. Such a state stands in sharp contrast with the normal state of affairs within the field of the human and social sciences.

2 The normal or current work in the human and social sciences

The standard life of the social and human sciences (SHS) is almost entirely devoted to the study and criticism of authors, schools, methods, and techniques. Thus, most of the life of social and human scientists are about discussions around this or that author, one school over the others, about which scientific methods are preferable or most appropriate, and which techniques are more suitable to the fields and objects of study and research. The main concern in

the SHS seems to be concerned with discussions about qualitative or quantitative methods – and in its best about mixed or hybrid methods (Smelser, 2013; Berg and Lune, 2011[33]; Somekh and Lewin, 2004[34]; Riessmann, 2007).

The discussion, hence, runs about the suitability of qualitative over quantitative methods, and vice versa. Many times it is also about the convenience of hybrid methods, or the updating of certain schools of thought, and the like. Within the human sciences, many discussions are about the narratives, the linguistic turn, and the meaning of ontological versus methodological individualism, when not about the significance of holism, structures, and contexts, for instance.

I would like to say it straightforwardly thus: the social and human sciences were born under the lights or the shadow of classical mechanics ([35])Ṫo a large extent their language is physicalist namely, about "state", "mass", "force", "action and reaction", "inertia", "free fall", "resistance", "empowerment", not to mention "structure", "dynamics", "process", and many others. As the history and sociology of science have put it openly, the social sciences were originally the project of the bourgeoisie to understand and make possible its own world, and its own understanding of the social reality – very much like the very origin of the novel, in a different context. Both the origins of the novel and of the SHS took place in the 19th Century. Since then, though, the world has changed enormously.

Taken within the framework of the scientific revolutions, if the social and human sciences do well, they might at best be relativist – in the sense of Einstein's theory of relativity. This means the social sciences are stuck in the discussion about the relative perspective of a human scope in relation to others. More recently this can be easily illustrated with the regional studies, the social and cultural studies in their large variety and depth. However, the truth is that most of them remain largely classical (classical mechanics).

All in all, the social world is based on all kinds of relations, ideas (beliefs), and actions and opportunities. These seem to be the factors that trigger actions and initiatives. Not accidentally

the very first origins of quantum social science are rooted in the meaning and importance of the mind (Zohar and Marshall; Wendt, for instance).

3 The manifold interpretations of quantum mechanics: an opportunity

A good but brief understating of quantum physics brings out the fact that it can be condensed in three layers, so to speak: quantum mechanics, quantum waves, and entanglement. The first refers to the understanding of particles; the second is concerned with the behavior of waves (photons), and entanglement is the way that makes it clear that thinking about quantum phenomena is properly thinking in terms of relationships, correlations, links, and linking. Thereafter, quantum physics is a nodal science, if you wish.

Now, quantum mechanics is nothing else than a very refined mathematical apparatus aimed at explaining the "weird", "spooky" (Einstein), and non-local character of subatomic particles – for example, the interaction of a wave with itself (as in the double-slit experiment originally set about by Young). As it is well known, though, very often particles are exchanged into waves or behave as waves, and waves become particles or behave as particles. Schrödinger's equation expresses best the nature of waves.

Furthermore, entanglement, an idea originally brought forward by J. Bell consists in the fact that it is not each particle or wave, what is important, but the intertwining of two, three or more particles. Thus, the connection remains a real albeit the particles behave non-locally. Quantum mechanics has been the subject of numerous interpretations. Table No. 2 illustrates the many interpretations of quantum mechanics, to date.

As it can be clearly seen, such is an absolutely unique situation in the history of science and philosophy, at large. Never before had science and the world witnessed a circumstance of a plurality of interpretations about a model. Along the history of science and philosophy at most two interpretations were existing, prevailing and in dispute – for instance, idealism versus materialism, rationalism,

TABLE 2. *Interpretations of Quantum Mechanics.*

Interpretation	**Author**
Classification adopted by Einstein	Albert Einstein, 1905
Ensemble interpretation, or statistical interpretation	Max Born, 1926
The Copenhagen interpretation	Niels Bohr, 1927
von Neumann / Wigner interpretation: consciousness causes the collapse	John von Neumann 1932; Eugene Wigner 1967
Quantum logic	Garrett Birkhoff, John von Neumann, 1936
Broglie–Bohm theory	Louis de Broglie, 1927; David Bohm, 1952
Many worlds	Hugh Everett, 1957
Stochastic mechanics	Edward Nelson, 1966
Many minds	H. Dieter Zeh, 1970
Modal interpretations of quantum theory	B. van Fraassen, 1972 and 1974; Bryce DeWit, 1970;, Dennis Dieks, 1988, and others
Consistent histories	Robert Griffiths, 1984
Objective collapse theories	Girardhi-Rimini-Weber, 1986; Penrose interpretation, 1989
Transactional interpretation	John Cramer, 1986
Relational quantum mechanics	Carlo Rovelli, 1994
Quantum information theories	Charles Bennett, Peter Schor, 1998
Branching space–time theories	Mark Sharlow, 2006
Time-symmetric theories	Ognyan Oreshkov and Niolas Cerf, 2015
Other interpretations	

Source: Own elaboration

and empiricism – when the case was not between names and schools; for example, Plato and Aristotle, Kant and Hegel, or structuralism and functionalism. The examples and range can be extended at will.

To be sure, the multiple interpretations of quantum mechanics are to be grasped as the strength of the theory and not a weakening feature. Such multiplicity allows for a wide variety of interpretations. However, the plurality of interpretations should by no means be taken as a relativistic property, and definitely, it does not mean that the researcher can take any of the probabilities if he/she will in spite of the others. Instead, the variety of interpretations is to be grasped as a strong and vital characteristic, in that it entails that any of the interpretations find its own sense in the horizon of the other, different, interpretations. As a result,

we have a wide weave that becomes suggestive, although it has not been exactly the main subject of reflection among quantum scholars and researchers.

Now, the social and human sciences are as varied as any other family of sciences, and diversity, f. i., cultural diversity, is one of the main features and basis of this group of sciences and disciplines. As a consequence, it can be safely argued that the multiple interpretations of quantum mechanics do enhance the interplay between quantum science and the human and social sciences. Moreover, different social and human sciences can fit, so to speak, into various interpretations, and others into different ones. Yet, as it is well known, nothing impedes that the very social and human sciences contribute with one more interpretation. Such was indeed the case with B. van Fraassen's contribution or M. Sharlow's interpretation about the branching space-time, for example.

Let us put it straightforwardly thus: How would the social sciences benefit from QT? The question leads us to the next section.

4 What does it mean quantum social science?

It is my contention that quantum theory will not merely contribute to the social and human sciences. That is, for example, the understanding and methods of the social sciences will not be better or more accurate. More radically, quantum science will transform them SHS.

Both historically, sociologically and culturally new sciences are being born that correspond to the emergence of a new social class. Sociologist M. Castell moves along a similar claim. According to Castell, the transition from the post-industrial capitalism to the information society corresponds with the appearance of a brand new social class. Such a new social class does not have the means of production and does not need to have them, any longer. Yet, it is a new social class that produces the wealth of a new society. Such is the information society were information at large is the new basis upon which both the quality and the dignity of life are warranted.

The argument could be brought further on to the knowledge society, and to networks society – something that supersedes Castell's own claim. In any case, Castell argues that he does not have a name for the newly emerging social class that helps shape the information society.

In a dialogue that goes far beyond the extension and interest of this paper, Z. Bauman on one side, U. Beck on the other side, and also additionally from a different standpoint S. Sassen – all of them notable sociologist –, argue that each of them has a name for the new social class that is arising with the information, the knowledge and the network societies, correspondingly.

Being as it may be, the truth is that normal human social sciences remain epistemologically and ontologically empirically naive, for they assess that there are "realities" that exist already "out there" to which the researcher must go in order to explain them. This can be illustrated by usual arguments within these sciences and disciplines when they speak about "going to the field", practicing ethnology or "participative-action research", or having internships in a given place, and so on. It is as if there existed a given reality, external and different from the subject to which the scientist should go as a source of meaning and significance. Zizek has warned against such a posture (Zizek, 2013 ; particularly see Chapter 14: "The Ontology of Quantum Physics").

Those normal or standard methods and approaches of the human and social sciences forget a core claim already originally made by P. Jordan and N. Bohr, namely that the very act of observation both creates and modifies the observed object. That is exactly the problem of measurement, a key topic in the framework of quantum science. In other words, it is the fact that the physical reality of an object depends on how we choose to observe it.

A most notable characteristic of quantum science appears then. It is the fact that physics is about what we can say about nature. In contrast with Aristotle or Galileo, for example, physics is nowadays not about the reality of the world anymore, but about what we know and can speak of the universe and the world. Along the history of

physics and philosophy that led to the distinction between primary qualities and secondary qualities, the very nature of the qualia, and the discussion about how matter supersedes consciousness or vice versa – according to the school or author preferred.

As a consequence of the recognition that physics is about what can be said and known about the universe, ontology and epistemology are, in the context of quantum science, one and the same thing. It is hereafter not possible any distinction and even less a hierarchy between them both.

More radically, it should be noted that nothing in the spirit and letter of quantum theory allows claiming that there is a distance or a difference between the macroscopic and the microscopic universe. There are macroscopic quantum phenomena such as Einstein-Bose condensate, superconductivity, or the laser rays. More exactly almost all spearhead technology is based on quantum behaviors, or quantum phenomena – from computing to electricity, from electromagnetism to laser rays, and from artificial intelligence to artificial life, for example.

I shall claim that the quantum realm refers to microscopic times, whereas the classical world corresponds to macroscopic times. Table No. 4 shows such a correspondence.

TABLE 3. *Quantum and Classical World and Microscopic and Macroscopic Time*

The Microscopic Universe	**The Macroscopic Universe**	**Complexity**
Mili = 10^{-3}	Kilo = 10^{3}	Second = 1/60 m
Micro = 10^{-6}	Mega = 10^{-6}	Minute = 1/60 h
Nano = 10^{-9}	Giga = 10^{-9}	Hour = 60 m
Pico = 10^{-12}	Tera = 10^{-12}	Day = 24 h
Femto = 10^{-15}	Peta = 10^{-15}	Week = 7 day
Atto = 10^{-18}	Exa = 10^{-18}	Month = $\sim$ 30 day
Zepto = 10^{-21}	Zeta = 10^{-21}	Year = $\sim$ 365 day
Yocto = 10^{-24}	Yocta = 10^{-24}	Million Year = 10^{-6} year
	Bronto = 10^{-27}	Billion Year = 10^{12} year

Source: Own elaboration

The most important, the most sensitive, the most compelling, and the most fundamental processes for human livings arise from

microscopic times but are then translated of depicted, so to speak, on the macroscopic level. Phenomena, systems, behaviors, and dynamics such as health, sickness, attention, love, hate, sleep, awakening, hunger, thirst, imagination, grasping, insight, understanding, and many other do happen in microscopic time scales, but are then reflected later on the macroscopic world. The trouble with some of them is that "later on" could be in some cases already too late.

The microscopic time scales are truly speedy, vertiginous indeed, whereas the macroscopic time scales are really slow.

Undoubtedly, the human and social sciences were born and largely remained within the framework of the macroscopic time scale. Their concerns were framed within the scope of days, years or a century, for example. Nonetheless, to date, the social and human sciences remain to a large extent blind, deaf and mute vis-à-vis the microscopic time scales. The key point is that no human or living process is to be properly understood without also considering the microscopic time scales.

Moreover, scientifically, philosophically and culturally, the "real time" is nowadays and at every moment more and more the microscopic times. This can easily be confronted with the time and processes of security systems, electronic systems, computational systems, and many others. The world is currently based always more upon the microscopic time scales, and the macroscopic time scales are recognized as being important but slow.

Life at large, i.e. physical-chemical, physiological thermodynamic and metabolic processes all take place very fast in mini, micro, nano, pico, femto or atto time scales. Such is most notably the very arena of quantum biology and quantum chemistry. Thus, for instance, this is the way the immune system, the brain processes, or the hormonal dynamics, take place, as it happens. Life is grounded, biologically, but also recently also culturally, on microscopic times – only that those times are translated, if allowed, into macroscopic dimensions when reflected by social and human dynamics, structures, processes, and problems.

The human and social sciences should be acquaintedwith, and know, the microscopic universe. If so, the social and human sciences are transformed. The name for such a change is called quantum social sciences.

Conclusions

The main problem in science and most notably in the interplay between the natural sciences at large and the social and human sciences is the quantum divide. As it is well known, on the one side, the world consists of particles, waves, and their relationships. On the other side, the conventional reality consists of phenomena such as houses, trees, people, animals. and plants, for example. Necessarily, the quantum divide is to be overcome, absolutely.

Among the communities of physicists, mathematicians, and cosmologists the effort to overcome the quantum divide comprises theories such as string theory, quantum gravity, quantum loops, branas and m-branas, and quantum chaos, mainly. Some of the best minds around the world are currently striving with some of them. The motto for such strife is the unification between the theory of relativity and quantum physics.

This text has argued in a different direction, namely that an interplay should be possible between quantum science and the human and social sciences. To say the least, quantum science expresses or extends into five realms, thus: as quantum physics, as quantum biology, as quantum, chemistry, as all spearhead technologies, and now also as the social quantum sciences. The outcome is certainly not a minor achievement. I wish to say it is the most enthralling and challenging path that is open in front of us all.

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