On Quantum Realism: Tracing the Physicalist Thesis in Quantum IR

Molina Obedman, Yuval

ON QUANTUM REALISM: TRACING THE PHYSICALIST THESIS IN QUANTUM IR

MA Thesis *(Afstudeerscriptie)*

written by

Yuval Molina Obedman

under the supervision of Dr. Karen Smith, and submitted to the Board of Examiners in partial fulfillment of the requirements for the degree of

Master of Arts in International Relations

Global Conflict in the Modern Era

Universiteit Leiden

Members of the Thesis Committee:
Dr. Karen Smith (supervisor)
Dr. Salvador Santino F. Regilme Jr. (second reader)

Submitted on:
August 31, 2023

Word count:

12,813 (excl. bibliography, footnotes)
14,818 (excl. bibliography, incl. footnotes)
17,824 (incl. bibliography, footnotes)

ABSTRACT

In recent years, especially since Alexander Wendt's 2015 *Quantum mind and social science*, a timid yet promising body of literature, building from a range of post-structuralist and new materialist theory, has sought out to disentangle the ubiquity of the "Newtonian imagery" (Murphy, 2019) and its effects in social theorizing in IR. However, sustained attention to *Quantum Mind* has led many to associate this bourgeoning field with Wendt's own philosophical claims, despite a great number of rich and varied contributions. Despite Wendt's attempts to the contrary, his adoption of "quantum realism" (Murphy, 2021) poses substantial risks to the kind of anti-positivism quantum social science claims to spearhead. In this thesis, I explore the reasons why Wendt's take on human subjectivity entails a transcendentalist position unwarranted by his attempt at a 'flat' ontology. As I argue, his reliance on analytical philosophy of mind leads him to effectively adopt a physicalist position which he now rebrands as naturalism. This inherent contradiction allows to trace Wendt's metaphysical allegiances to the unsuspected legacy of logical empiricism in their insistence on the language of physicalism and the Unity of Science thesis.

ACKNOWLEDGMENTS

The present thesis is the result of several months of research into how experimental insight about quantum phenomena has been integrated in recent years within the new materialist framework initiated by feminist philosopher Karen Barad in the social sciences and humanities. It follows from a (modest) dive into philosophy of technoscience as part of the Research Master's in Philosophy of the University of Amsterdam, which I completed in August 2022. As part of this program, my thesis followed the correlation between the development of different claims in philosophy of technoscience and weapons research development since World War II. In a way, my previous thesis was in part more IR than it was philosophy, and the opposite may perhaps hold true for the present work. In any case, my interest in the inherent social conditions of natural scientific inquiry is in turn replicated in the present thesis, except the other way around and from a slightly tweaked perspective. Instead, I shift the focus to how certain remnants of the natural sciences exert a covert influence in current social science, even in theories recently heralded as "post-classical," in more than mere methodological accounts. While I remain unsure of whether I would like to pursue quantum IR in further research, it has been a very fruitful project that will positively inform many endeavors to come.

I would like to thank my supervisor, Dr. Karen Smith, for being there every step of this long journey; for her truly infinite patience across the years; and for her unwavering intellectual and personal support throughout very difficult times. I'd also like to appreciate Dr Salvador Santino F. Regilme Jr.'s generosity in agreeing, twice, to second-read this thesis. Thank you as well to physicist Tadeo Bergerot, and some anonymous others, for proof-reading and reviewing the parts of this thesis I am less academically acquainted to. This work would not be complete without my family, including my parents, siblings, Yara Yuri Safadi, and my emotional rock, Ida Linda (O. B. L.) Brown.

Lastly, I wish to dedicate this thesis to my former therapist Valeria Girela, who passed away recently. Your warmth, professionality, assistance, and intellectual prowess helped pave the way for the eventual completion of this project, among many others, during the three years of our relationship. Thank you.

TABLE OF CONTENTS

1. INTRODUCTION

In recent years, especially since Alexander Wendt's 2015 *Quantum mind and social science*, a timid yet promising body of literature has begun to coalesce around the possibility of 'quantizing' International Relations (from now on, IR), that is, the application of fundamental concepts of quantum mechanics to the discipline. Significant uses of quantum mechanics in analogy to the social world date as far back as the inception of this strand of physics itself,[1] finding fertile ground in the cognitive sciences during the second half of the 20th century, following some renown physicists' suggestion that quantum physical processes are not only analogical to thought processes (Bohm, 1951), but that the difference between the two might be "only in degree but not in kind" (cf. Dyson, 1979, p.249; also, Penrose, 1989).

In IR, quantum approaches encompass recent attempts at coming to terms with the transformations brought about by quantum technology, quantum theory, and quantum science on both IR's common objects of study as on our understanding of the discipline itself. Whereas one could readily assess the relevance of issues such as quantum supremacy without adopting a quantum approach, proponents of the 'quantum turn' feel tempted to interrogate the classical terms employed to explain such phenomena in tune with fundamental quantum theory and its developments in scientific fields adjacent to–and outside of–physics, including biology, chemistry, information theory, and psychology (see Der Derian, 2020). Early examples of quantum theory in political science and IR are scarce and disconnected, mostly seeking to integrate its experimental results "to the established, and more easily comprehensible, sciences of biology, eugenics, geography, psychology, or classical physics—[which] provided a more familiar description of reality" (Waters, 2022, p.55). In turn, the current 'quantum turn' is distinctly directed against the epistemological and ontological grip held by classical physics in social theory since at least the turn of the 20th century, when early positivism and, soon thereafter, the covering law model of scientific explanation would hold the key to their claim to science. Building from a range of post-structuralist and new materialist philosophy, especially the work of feminist metaphysician and physicist Karen Barad, quantum IR scholars have thus sought out to disentangle the ubiquity of the "Newtonian imagery" (Murphy, 2019) and its effects in social theorizing across the field's reigning positivism/post-positivism (Lapid,

[1]Notable early quantum physicists such as Niels Bohr (1933) and Erwin Schrödinger (1944) had already sought to underscore the value of quantum mechanics for thinking about the nature of living organisms, mostly in relation to biology, psychology, and genetics.

1989; Sylvester, 1993), explaining/understanding (Hollis & Smith, 1990) and rationalism/reflectivism (Keohane, 1989) paradigmatic divides.

1.1. Problem statement

There has been substantial backlash against how quantum mechanics has been used and abused in recent years (Waldner, 2017; Little, 2018). Even those critical of the influence of the Newtonian order are unwilling to accept that post-classical social theory should be equated with quantum social science (Jackson, 2016b; Kratowich, 2022). From a broader perspective, notable reproaches have been directed toward quantum IR, accusing it of representing a novel instance of science envy and of robbing the social sciences of their unique objects of inquiry. Furthermore, many of the distinctive breakthroughs of quantum IR are not necessarily novel to scholars working within a wide range of theoretical traditions, most notably post-structuralism (Major-Poetzl, 1983; Plotnitsky, 1994; and Akrivoulis, 2002), critical realism and complexity theory (Grove, 2020; Albert & Bathon, 2020), and a great number of non-Western traditional thinking (Burgess, 2018; Fierke, 2019; Nair, 2019). These are relevant concerns that should be addressed thoroughly but should not be taken to be exhaustive of the issues at hand.

Moreover, sustained attention to *Quantum mind and social science* has led many to associate the bourgeoning field of quantum IR with Wendt's own philosophical claims, despite a great number of rich and varied contributions.[2] Some regard these claims as a form of "quantum realism" (Murphy, 2021) which, despite Wendt's attempts to the contrary, poses substantial risks to the kind of anti-positivism quantum social science claims to spearhead. Thus, regardless of whether Wendt's rendition of what is otherwise a truly sensational interdisciplinary effort is accurate or not, Wendt's call to quantize IR is strained by an apparent contradiction permeating his recent work. A conservative reading of physicist and feminist philosopher Karen Barad leads Wendt to assume a contradictory position that both effectively critiques *and* reinforces Cartesian metaphysics in his attempt to "unify physical and social ontology within a naturalistic, though no longer materialist, worldview" (Wendt, 2015, p.283). In so doing, Wendt succeeds, once more, in marking a disciplinary break by jumping from the privileging of ontology over methodology, the latter having dominated the field's meta-theorical discussions until the advent of constructivism and critical realism, to his new-found

[2] This is acknowledged by both Wendt and Der Derian (2020) in their introduction to the 2020 *Security Dialogue* issue on quantum IR.

interest in metaphysics. But, once more, Wendt's account fails at taking the implications of his own thesis through to its logical end. In feeling the need to provide a realist, physical grounding to the quantum-inspired insight of feminist new materialism, Wendt's Cartesian anxiety is manifested through his use of quantum mind theory and analytical philosophy of mind, effectively countering the potential of much of his theorizing.

1.2.Research aims and questions

Broadly, the present work discusses recent attempts at adopting a quantum framework in the social sciences, particularly in IR theory, while addressing some of the resulting criticisms and raising some others. Therefore, the chief aim of this thesis is to assess, first, whether despite critical contributions the quantum view's insistence on the language of physics reintroduces a classical view of the social world that other philosophical traditions have already effectively challenged to varying degrees of success. With this, I do not mean to reconstruct quantum IR as the latest iteration of science envy in the discipline. Rather, I am concerned with what the current, diverse ways that quantum theory is being inscribed within IR can tell us about the nature of the discipline and its constant reformulation in light of developments in the social sciences and the natural sciences, not because I believe them to constitute a continuum as the physicalist thesis would have it, but because it opens a window into what STS scholar Lorraine Daston refers to as "the dynamic world of what emerges and disappears from the horizon of working scientists" (cf. Daston, 2000, p.1). A necessary step in this direction entails acknowledging the remarkable diversity present in current quantum IR scholarship as well as the great potential of many quantum approaches. I do this critically, without easily dismissing the possibility that a quantum approach should perhaps not be taken at all and that the theoretical virtues afforded by quantum mechanics might not outweigh their disadvantages after all.

Hence, what follows is an interrogation of quantum realism as it has been developed in IR theory in the course of the past two decades, assessing its adequacy in explaining the social world as well as its theoretical shortcomings in light of traditional attempts at aligning social scientific theories to the ontological, epistemological, and methodological commitments of physics. I focus is put on, but not limited to, Wendt's *Quantum mind and social science*, as the foundational book on quantum realism in IR. Wendt's presumed contradiction has been partially articulated in different forms since the publication of *Quantum Mind* (see, for instance, Allan, 2018; Jackson, 2016b; Kratochwil, 2022; Michel, 2018; or Zanotti, 2018). While I mostly agree with their takes, my aim is to further articulate this contradiction as part of the century-old grip exerted, in different ways and shapes, by logical empiricism and, in particular, two pillars of their philosophical edifice: the language of physicalism and the Unity of Science thesis. The main target is, thus, to tackle the following question: *In what ways can we say that quantum realism embodies a new form of physicalism?* While this effort will open more questions than provide any answers–and given the constraints of this work–I shall address cursorily the following sub-question: *Is this a focalized critique or does it extend to other attempts to integrate quantum theory to IR?*

1.3.Theoretical/analytical framework

The theoretical framework of this thesis pivots around some of the most salient contributions of quantum theory to the field of IR, which I review in length in the next chapter. A key point of departure is what most quantum IR scholars see as a radical break with the 'classical' (i.e., Newtonian) worldview of physics that is mirrored in many of the basic social science assumptions about the social world. As should follow from the next chapter, this is not necessarily the case with *all* recent quantum approaches, especially those only applying quantum mathematical formalism to model social phenomena (Aerts & Aerts, 1997; 2022; Khrennikov, 1999; Busemeyer, 2013). In this thesis, my object of study is the kind of quantum realist approach to social scientific inquiry embodied by those working within the identity/quantum consciousness approach in quantum IR (Wendt, 2005; 2015; 2022).

In turn, the analytical framework of this thesis is a philosophy of (social) science approach, with a special focus on the question of physicalism vis-à-vis related notions such as materialism and naturalism. The rationale for this approach comes from, first, an ambition to assess the ontological implications of adopting a quantum mechanical view on the social world and, second, the explicit positioning of the quantum framework within broader debates in philosophy of science (via analytic philosophy of mind) by many quantum IR scholars.

Broadly, a philosophy of science approach helps bring transparency to shared scientific practices by elaborating the logical consequences of embracing particular positions on issues such as scientific ontology, epistemology, or choice of methods. But, as some have pointed out, a philosophy of science approach permits above all to take on issues of methodology as a "philosophical ontology" (Jackson, 2016a, p.35) or "applied ontology and epistemology" (Yanow and Schwartz-Shea, 2015, xvii) in its own right, with the aim to overcome what philosopher Charles Taylor has called the "epistemological construal" of knowledge, namely, the mechanistic view that science is but a process of passive reception of impressions from the external world (cf. Taylor, 1995, 11–15). However, the relationship between the philosophy of social science and IR is not so straightforward as to render the relevance of these questions self-evident for the task at hand. After all, what constitutes science and whether IR can or should be considered such is an ongoing debate within the field (Wight, 2013; Jackson, 2016a). When discussing issues of philosophy of social science in the context of IR, several questions arise: Is IR a science? If so, does it need a philosophy? And what questions in the philosophy of social science are distinctive to IR?

Critical voices often question whether IR has the intellectual resources to engage in these issues, or even its utility altogether.[3] A different point of contention is whether it should fall on philosophy *or* science to provide the sort of legitimation claimed on its behalf, oftentimes fueled by the belief that such inquiries hinder more conducive forms of knowledge production (Gunnell, 1998; Skocpol, 1987). This notwithstanding, engaging with the issue of quantum IR from a philosophy of science perspective follows different rationales. It situates the question within a century-old interrogation of the relationship between the natural sciences and the social sciences, and, more broadly, between the natural and the social from a meta-scientific perspective. In turn, this allows for an examination of the social in the physical and the physical in the social in ways that transcend traditional methodological debates, while framing the issue within an enduring interdisciplinary scholarly conversation about the role(s) of the material in, through, and for the social.

1.3.1. Concepts: Physicalism, Materialism, Naturalism

There seemed to be a consensus among early practitioners that IR could and should be a science.[4] As with other social sciences, this was driven by the belief that the prognostic prowess of the natural sciences could be, if done right, reproduced and applied to the social world. This

---

[3] For a detailed historical overview of the question of science in IR, see Wight (2013), as well as Kratochwil (2006).

[4] Some commentators even argue for the existence of a scientific realist IR tradition *avant la lettre* dating as far back as Thucydides' discussion of the Peloponnesian War in the fifth-century BC (Tellis, 1996), all the way to Machiavelli's republicanism (see Pocock, 1975; or Skinner, 1983; Pettit, 1989), and Hobbes and modern political philosophy. Interwar idealist authors seemed to agree on the role of science as a cornerstone of human progress, too, despite E. H. Carr's claim to the contrary (1946, p.14). Even Hans Morgenthau's rejection of a science of IR was ultimately rooted in the belief that IR was already governed by the objective laws of human nature as disclosed by biology, not social science (Morgenthau, 1946; Wight, 2013, 33). Interestingly, as Wight notes, none of these early authors paid much attention to what they understood science to be in the first place (*Ibidem*, 34; Kratochwil, 2006), in correlation to the philosophy of science's then state of infancy as a discipline proper.

was a basic assumption behind the discussions first held by the First Vienna Circle in the years prior to World War I. At the theoretical minimum, logical empiricists were committed to two intimately related planks upon which their edifice was erected, the most relevant of which is the unity of science thesis.[5] The prospects of a 'unified science' required not a unity of axioms or laws that could be applied across scientific disciplines, but rather the existence of a unity of *language* in science (Carnap, 1938) or "Universal Jargon [sic]" (Neurath, 1946, 81). This common language would allow all scientific propositions across disciplines to be, in principle, expressed and translated into a single idiom, without prejudice to the actual terminology employed by scientists in their various subdisciplines (cf. Carnap, 1934). The unifying jargon of all sciences is that of *physicalism*. In his *Logical Syntax of Language* (1937[1934]), Carnap argues:

> "The thesis of *physicalism* maintains that the physical language is a universal language of science—that is to say, that every language of any subdomain of science can be equipollently translated into the physical language. From this it follows that science is a unitary system within which there are no fundamentally diverse object-domains, and consequently no gulf, for example, between natural and social sciences. This is the thesis of the *unity of science*" (320).

This is the language that C. G. Hempel (1994[1942]), Carnap's *protégé*, had in mind when proposing his covering-law model of scientific explanation in the context of the social sciences, according to which an explanation is scientific if and only if it can be deduced from a set of statements including no less than one general scientific law.[6] [7] The logical empiricist's reliance on language required that only 'internal' questions pertaining to an empirically verifiable matter of fact should be 'meaningfully' posited, and 'external' questions regarding, say, the existence of material objects at all is absurd and should be reframed instead as a purely practical issue regarding the adoption of one linguistic 'framework' or another (see Stroud, 1984). In other words, Carnap and his acolytes endorsed a type of 'empirical realism' coupled with metaphysical anti-realism–more akin to Kant's transcendental idealism than to classical realism (Alai, 2023).[8] In fact, W. V. Quine's triumphal case for metaphysics in *Two Dogmas*

[5] The other one is the rejection of metaphysics. For a comprehensive take on the link tying both theses, see Frost-Arnold (2005).

[6] Subsequently, the problem of individual and social action, including the discussion over the nature of agency, began to be framed within the relation between reasons, in the case of intentional explanations, and Humean causes, in the case of law explanations, which had occupied many philosophers of language in the first half of the century.

[7] And while the social sciences might not have been a central concern for logical empiricists (see Uebel, 2003), positivism played a decisive role at a moment when the covering law model of scientific explanation held the key to their claim to science.

[8] The idea that logical empiricism is at its core an anti-realist position is held by many IR scholars working within a philosophy of science approach. For instance, Patomäki and Wight (2000, p.217) have claimed that the "post-

of Empiricism (1951) came as a response to Carnap's use of the Kantian analytic/synthetic distinction and famously denounced physicalism as itself a metaphysical thesis.[9]

The question of physicalism has since then been taken up by analytic philosophers of mind, seeking to answer what Chalmers (1995) has popularly referred to as "the Hard Problem of Consciousness," i.e., how to explain subjective experience in a world of physics. Today, most metaphysicians adhere to some form of (*a posteriori*) non-reductive physicalism (see the survey authored by Bourget and Chalmers, 2014). To make things simple, whereas reductive physicalists argue that all processes involving minds and bodies must necessarily be explained in terms of physical forces (Papineau, 2002; 2009; Poland, 1994),[10] which entails some form of monism, non-reductive physicalists uphold property dualism, according to which mental properties can be traced back to neurobiological properties but are not entirely reducible to them. Non-reductive physicalism is at the basis of emergent materialism (or emergentism), which posits the irreducibility of mental phenomena as resulting from high degrees of complexity in material systems, with differing opinions regarding the existence and role of mental causation (Martinich and Sosa, 2008, pp.64-5).

Broadly speaking, it is widely held in analytic philosophy that all versions of physicalism express a form of scientific materialism, despite both notions referring to different things. Despite the term materialism dating back to the 17th century in the English language, it

---

Kantian-Humean 'problem-field'" of IR stems out of what they deem to be a deep-seated philosophical anti-realism shared by both positivism and post-positivism. For them, the resulting metaphysical structure is defined exclusively by either 'the experienced' (for the positivist) and language/discourse (for the post-positivist), thus failing to acknowledge "a world prior to the emergence of humanity [as] a condition of possibility for that emergence."

[9] For Quine, the possibility of putatively *a priori* parts of our knowledge cannot be grounded on a fundamental epistemological difference between analytic and synthetic truths. Rather, he saw all cognitive endeavors, whether seemingly independent from experience or not, as resting on our experience as a whole and justified only by its ability to make us deal with the world better. In this line, every single theory, scientific or not, is "ontologically committed" to the objects making up the conceptual scheme that render such interpretation possible at all, including "the most commonplace ones" (Quine, 1963, p.10). In other words, "a theory is committed to those and only those entities to which the bound variables of the theory must be capable of referring in order that the affirmations made in the theory be true" (14). This effectively challenges Carnap's distinctions between internal/external questions; analytic/synthetic statements; and the empirical/metaphysical.

[10] Reductionism, classically defined along Ernest Nagel's model of reduction, is one of the core historical issues of the methodology of the social sciences (Mantzavinos, 2009). According to Nagel (1969), reductions require that the categories of the 'reduced' science be identified with categories of the 'reducing' science via "bridge laws," so that any regularities derived from the reduced science can be redescribed as regularities of the reducing science. This model, which was the standard logical empiricists's deductive-nomological model of explanation, viewed reduction as a relation between theories rather than individual facts. Since reductive physicalism, in a way similar to eliminative materialism, holds that the properties of any entity are determined by those of its physical parts, the success of any social science will depend on its capacity to study the object of inquiry as *prima facie* equitable with physical objects.

is an ancient metaphysical thesis about which 19th-century neo-Kantian philosopher Friedrich Lange said, "is as old as philosophy, but not older" (1925[1865], 3). In contrast, the term physicalism was devised in the 1930s by Neurath and Carnap as a linguistic thesis, even though most contemporary philosophers today employ it as a metaphysical one. Additionally, physicalism underscores a formal link to physics and the physical sciences, whereas scientific materialism refers historically to the view that everything *is* matter, ignoring the physical but not purely material nature (in the traditional sense) of forces such as gravity–and therefore rendering materialism an outdated scientific thesis.[11] In turn,

> "Physicalism encompasses matter, but also energy, physical laws, space, time, structure, physical processes, information, state, and forces (…). [E]ven abstract concepts such as mathematics, morality, consciousness, intentionality, and meaning are considered physical entities, although they may consist of a large ontological object and a causally complex structure" (Stoljar, 2023).

In this light, physicalism emerges in analytic philosophy as a qualified form of materialism, despite the great variety of versions that both notions may adopt. On the other hand, recent interest in scientific materialism within the continental tradition has led to what is known today as new materialisms. An interdisciplinary, theoretical, and politically engaged field of inquiry, new materialisms are loosely inspired by the work of French philosopher Gilles Deleuze and coalesced at the turn of the millennium on a number of philosophical movements. These range from those underscoring metaphysical realism vis-à-vis the Kantian "'correlationist' credo" (Mackay, 2007, p.4)–[12]including Quentin Meillassoux's speculative materialism or Graham Harman's Object-Oriented Ontology–to the more politically charged feminist new materialisms, influenced by feminist science and technology studies, environmental philosophy, transgender and queer studies, postcolonial theory, and affect studies. It is within this latter framework that the present thesis is inscribed, and which has significantly influenced the quantum turn in IR, specifically through Wendt's interpretation of the work of feminist new materialist Karen Barad.

Finally, it is relevant to note how physicalism and (new) materialism differ from naturalism. Naturalism is commonly associated with a wide array of metaphysical theses that started arising in the early modern era of philosophy rejecting the dominant supernaturalism advanced by both Medieval Christian scholastic and Islamic natural philosophy. It comprises a great

---

[11] For an account of the challenge to materialism posed by quantum mechanics and chaos theory, see Gribbin and Davies (1991).

[12] Namely, the Kantian axiom that philosophy must limit itself to investigate the 'conditions of experience' due to the impossibility to know things 'in themselves.'

number of schools that sought to come to terms with the fabric of the natural world outside the scope of religion and in tune with the scientific developments of the time, including, but not limited to, early modern French materialism, ius-naturalism, empiricism, German idealism, and late modern German materialism. As Papineau (2021) notes, naturalism was taken up in the 20th century by American analytic philosophers like John Dewey, Ernest Nagel, Sidney Hook, and Roy Wood Sellars, who sought to align academic philosophy more closely with science by differentiating between ontological and methodological naturalism. In this context, methodological naturalists claim that philosophy and science are essentially immersed in the same enterprise, sharing similar ends and methods (*Ibidem*) but focusing on different questions. In this sense, both Carnap and Quine are naturalist philosophers, except that Carnap is not interested in ontological claims while for Quine ontological naturalism follows from the adoption of methodological naturalism.[13] Apropos of Quine, oftentimes naturalism is taken as a synonym of what he termed 'naturalized epistemology,' namely, a cluster of views concerned with the theory of knowledge that seeks to integrate studies of knowledge acquisition to natural scientific methods and away from traditional philosophical questions.[14] While there is no consensus on how to conceive the connection between philosophical investigation and empirical natural science exactly (see Rysiew, 2021), naturalism in epistemology is one of the dominant strands of contemporary analytic epistemology, with a very rich number of ramifications.[15] On the continental side of things, there have been relevant attempts in recent years at 'reclaiming' philosophical naturalism while challenging the 'metaphysics of representation' (Barad, 2007; Rouse, 2002; 2004), that is, the conceptual distinction between the physical processes commonly associated with the natural world and the scientific practices through which we 'access' this world. This takes part of an ongoing trend in new materialism and, more concretely, post-humanist studies seeking to offer an affirmative alternative to the dualist naturalist paradigm (Braidotti, 2015; Dolphijn and van der Tuin, 2012), often recurring to the conceptual possibilities afforded by quantum mechanics (Plonitsky, 1994; Dolphijn, 2016; Kirby, 2013).

---

[13] Some would argue that this position makes Carnap an anti-naturalist (see Rouse, 2002).
[14] For Quine, this meant re-characterizing epistemology as a "chapter of psychology" (cf. Quine, 1969, p.82).
[15] For a taxonomy, see the ones suggested by Goldman (1994, pp.301-4) or Feldman (2012).

1.4.Research Design and Methods

The present thesis explores some of the most salient ways that quantum approaches have been integrated into contemporary IR scholarship under the suspicion that, despite claims to the contrary, it may fall back into the age-old traps of physicalism in its different iterations, as outlined above. To do this, I engage in a ‘broad’ interdisciplinary effort (Klein, 2010) in which several fields of inquiry perceived to be non-neighboring are mobilized, among them critical IR, philosophy of (social) science, and (chiefly Copenhagen interpretations of) quantum physics as applied to the social sciences. Aware of the shortcomings that such heterogeneity entails, particularly concerning quantum mechanics, I have complemented the use of primary texts in physics with the work of others seeking to provide clarity to those outside its immediate scope of expertise. In this sense, I take note of Jaksland’s (2021) advice that one should aim to be neutral with respect to disputed issues within the relevant disciplines, which in this case I apply only to quantum physics. With the rest of the literature, I focus on in-depth written textual content analysis from a purely interpretative approach, making this a fundamentally conceptual qualitative study.

The central aim is to provide a modest contribution to recent attempts at integrating the insights of quantum mechanics into social science research, and in particular IR, from a philosophy of (social) science approach, and, more broadly, to contemporary philosophy of science approaches to the social sciences; philosophy of (social) science approaches to IR; and critical IR theory. With this, I hope to promote innovation and creativity in present IR theory scholarship while stressing the need for borrowings from non-neighboring disciplines in a more critical manner (not to suggest this should not be done at all). With regards to the philosophy of (social) science, the reader should observe lengthy allusions to analytic philosophical debates, despite the author’s intellectual allegiance with new materialist philosophy as developed in recent years by scholars working within the continental tradition. I do this out of a firm belief that this supposed divide can, and should, be bridged, if only in the form of constant dialogue and ensuing self-reflection.

As a final note, an earlier version of this thesis followed this introduction with a very detailed critical overview of the question of naturalism in IR by taking special care to dissect how scholars of different traditions have attempted to make sense of its evolution along different developments in the philosophy of (social) sciences and the historical ontological and meta-epistemological issues that followed. My aim was to make explicit what appeared to be a solid commitment to entity realism in 'mainstream' IR across the decades, from logical empiricism to critical realism. This chapter was scrapped in the months prior to the final draft and replaced with an account of the most salient contributions of quantum theory to the social sciences and a more comprehensive overview of the role of quantum mechanics in IR literature before the advent of the so-called 'quantum turn.'

1.4.1. Limitations and delimitations

As a final note, this thesis constitutes an exploratory study that, building from the disciplinary experience of the philosophy of the social sciences, seeks to shed light on what it means to say that the social reality is fundamentally quantum in recent quantum IR literature. For many scholars working in this field, particularly quantum realists and those adhering to the metaphor approach, the argument consists of dual movement, starting with a denunciation of the "Newtonian imaginary of IR" (Murphy, 2021) and its ontological–what Laura Zanotti (2019) has called "Newtonian substantialism"–and epistemological constraints. Tracing Newtonian physics in IR, as others have done (Cohen, 1994; Akrivoulis, 2002; Zanotti, 2019; Wendt, 2005; 2015; Murphy, 2021), is not a core aspect of the present study, nor is it to compare the applications of quantum theory to the contributions of previous critical IR theories, however fascinating and prolific this endeavor might prove to be (see Murphy, 2021, pp. 1-17; 2022; Grove, 2022; Waters, 2022). I focus instead, through the lens of physicalism, on the second movement, that is, the emergence of quantum approaches as a self-evident alternative. With this, I am to examine whether quantum approaches, with a particular focus on quantum realist IR, can constitute another instance of physicalism and, if so, whether this poses a problem for future critical IR. An eventual critical contribution to the quantum momentum in IR should follow from this analysis, but this should be only to the degree of success accomplished in revealing quantum IR not as an "epistemological break" (Bachelard, 1986[38]) from past paradigms but as integrated within the broader narrative of scientific ontology in IR theory and the philosophy of the social sciences. Moreover, the reader will perhaps note a privileging of scientific ontology over other relevant issues in philosophy of science, such as epistemology and, to a lesser extent, ethics. This is a choice made for the sake of clarity and noting the obvious formal constraints of this work, but in no way does it mean that the author takes ontology as a domain in isolation or indifferent to epistemological or ethical concerns. Both epistemological and ethical issues are an inherent aspect of doing ontology, just as epistemological and ethical work bear implicit ontological assumptions. In this line, I cannot but praise the incipient "epistemological-ontological-ethical framework" developed by Karen Barad (2007), which I am only able glance at here.

To conclude, in laying out the theoretical shortcomings of quantum realism, it should follow that an analogical use of quantum theory, one deploying quantum mechanics in social theory without concerning oneself with ontological claims of any kind, might be preferable. Whether this aligns with my views or not remains to be determined, but I remain partial to further explore this possibility in future research.

1.4.2. Chapter outline

This thesis is comprised of an introduction, two chapters, the resulting conclusion, and a bibliography. Following this introduction, the second chapter, entitled 'The 'quantum' in quantum IR,' includes an outline of some of the building blocks of quantum theory necessary to understand the conceptual novelty of the quantum leap into the social sciences. A second subsection details some of these contributions in the social sciences prior to the emergence of quantum IR as a distinct body of scholarly literature. The following chapter, entitled 'Quantum Realist IR: Physicalism Rebound?', focuses instead on recent attempts at developing a quantum realist account of the social domain within IR theory while assessing some of the benefits and shortcomings such endeavor faces. The chapter ends with some possible directions for future research, followed by a summary of the totality of the study by way of conclusion.

2. THE QUANTUM MOMENTUM IN IR: CONCEPTS AND HISTORY

The theoretical framework of quantum physics has gained slow but steady momentum in the social sciences during the past two decades, ranging from global politics and economy to diplomacy, behavioral economics, psychology, finance architecture, media studies, and IR. As mentioned in the introduction, this transfer was spearheaded by early quantum physicists' efforts to interpret the results of their research outside its classical domain of inquiry. For instance, early applications in psychology include complex and diverse accounts of quantum consciousness, which, often overlapping with different forms of quantum mysticism, have ranged from those taking quantum effect as necessary for consciousness to function to the more general idea that some cognitive phenomena can be more effectively explained by quantum information theory and quantum probability than by the prevalent mechanistic approaches.

Recent interest in quantum theory in the social sciences has led to some prolific historical accounts regarding what Harrington (2022) has termed the 'quantum transposition' (for more, see Grove, 2022),[16] namely, the different forms of quantum transfer attempted during the 1930s and 1940s by early quantum physicists themselves. While this is a fascinating endeavor, one seeking to challenge linear and monolithic narratives regarding the supposed distance between the disciplinary history of physics and those of the humanities and social sciences, I wish to focus instead in this chapter on the historical and conceptual contributions of quantum mechanics to the field of IR. I shall start by laying out some of the most salient conceptual developments in quantum mechanics, followed by some early examples of the adoption of quantum theory to IR scholarship and fields adjacent to it, followed by a brief overview of the present picture.

[16] Harrington (2022), for instance, groups these contributions in a four-category typology: epistemic, ontological, formalist, and rejection. Belonging to the epistemic category, he includes figures such as Niels Bohr, Wolfgang Pauli, and Max Born, who believed that quantum physics offered paramount perspectives into the construction and sharing of human knowledge. Others, such as Werner Heisenberg, argued for the necessity to embrace the ontological shift brought about by the quantum revolution in the 'human' sciences, meanwhile physicists like Max Born were doubling efforts, says Harrington, by positing that quantum mechanics opened a pathway into probabilistic explanations and predictions concerning social and individual behaviour in a way resembling mathematical formalism. Finally, Harrington credits Albert Einstein, John von Neumann, and Erwin Schrödinger for notably rejecting, with differing views, the existence of a necessary connection between the epistemic, ontological, or formal possibilities offered by quantum physics and the human sciences.

2.1.Basic Concepts in Quantum Mechanics

While there are many interrelated lines of inquiry in the social sciences to which quantum mechanics makes essential contributions, most classifications focus on the questions of discreteness, space/time, causality, and scale (cf. Grove, 2022**)**. In classical physics, the possibility to measure the interaction between objects is warranted by its assumed separateness with a fixed location in spacetime and pre-existing properties and boundaries. This view espouses in turn a clear-cut separation between the knower and the known and between the object of inquiry and the apparatuses of measurement. In contrast, quantum equations struggle relating to simple, nameable 'things' and their enduring 'properties.' For instance, wave-particle duality, namely, the possession by physical entities of both particle-like and wave-like features,[17] begs the question of in what ways can a quantum entity be considered discrete if, following Niels Bohr's complementarity principle, any knowledge of atomic and subatomic entities requires an account of both wave and particle properties.[18]

However, the relationship between the mathematical operations or experimentation underlying quantum mechanics and the physical nature of the objects under inquiry is very much still a matter of *interpretation*, for quantum mechanics equations make no unequivocal references to the configuration or form of physical reality *prior* to precise measurements:

> "Of course, it isn't simple to say 'instead of following macroscopic behavior, *quanta* work like this...' because while the empirical facts are well established, the words we would use to describe them are tied to specific interpretations. Given a single scenario involving an electron in a laboratory, one physicist might be comfortable describing its behavior by saying 'the position of an electron is intrinsically undefined, all we know is that it behaves as if it were in many places simultaneously.' Describing the same physical scenario, another might say 'an electron is a spread-out entity that does not have a single location.' Or, 'the electron always has a single, definite location, but knowledge of that location is deeply impossible.' Or even, 'many parallel universes exist, and in each of those, a copy of the same electron exists at a different place' (cf. Schaffer and Barreto Lemos, 2021, pp.15–6).

The aforementioned seems justified by several key related concepts stemming from quantum events. One is the *observer problem*, which dictates that the sole act of measurement and observation of microscale systems introduces a disturbance so limiting that it conditions the

[17] As stemming from Albert Einstein's experiments with light (cf. Einstein and Infeld, 1938, 262–3).
[18] For Bohr (1928), the duality of wave-like and particle-like properties was but another example of the complementarity between cause and effect and between space and time, a view foundational of the Copenhagen interpretation of quantum mechanics as well as the work of Karen Barad and Alexander Wendt.

state of the measured system fundamentally (Dirac, 1967, p.4).[19] This is one of the main reasons why it is often said that quantum events are random–it may be impossible to fully predict the outcome of an experiment because it is always physically disturbed at some level in the act of measuring. Quantum *randomness* refers to the statistical manifestation of a system's indeterminacy. In turn, quantum *indeterminacy* refers to the impossibility to infer a unique collection of values from a given state of a system for all its measurable properties. In other words, quantum indeterminacy refers to a necessary incompleteness in the description of a physical system, expressed by a probability distribution on the set of outcomes of measurements of an observable. In this sense, indeterminacy is often viewed as information, or lack thereof, inferred to be present in an individual quantum system prior to measurement (cf. Jaeger, 2017a). While randomness and indeterminacy are generally taken as given in quantum experiments, how they relate to physical reality is very much contested to this day (i.e., subject to an interpretation of quantum mechanics; see Braginski and Khalili, 1992).

Another primary feature of quantum mechanics is the phenomenon of quantum *entanglement*.[20] In simple terms, entanglement means that certain aspects of one particle of an entangled system correlate on aspects of the entire system, no matter how far apart their particles are or what lies between them (see Peres, 1993). In other words, it is a special type of relationship that binds a group of particles together in a way such that the quantum state of each particle of the group cannot be described independently of the state of the rest.[21] This means that they cannot be considered individual particles but rather an inseparable whole, since one constituent cannot be fully accounted for without the others. This concept is better understood in reference to other foundational notions of quantum mechanics, such as superposition, non-locality, and correlation. In quantum theory, *superposition* is the ability of

[19] Proponents of the Copenhagen School interpretation of quantum mechanics argue that measurement is that which creates definiteness in the system being measured (cf. Barad, 2007).

[20] Erwin Schrödinger, often credited with coining the term (cf. Kumar, 2009, p.313), went as far as to define entanglement as "*the* characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought" (Schrödinger, 1935, p.555). Schrödinger's early definition came as a response to the Einstein–Podolsky–Rosen (EPR) paradox, a thought experiment carried out by Albert Einstein, Boris Podolsky and Nathan Rosen arguing that the description of physical reality provided by quantum mechanics is incomplete (cf. Einstein *et al.*, 1935). It was not until 1949 that, for the first time, the phenomenon and validity of entanglement was formally established at Columbia by Chien-Shiung Wu and her graduate student Irving Shaknov (cf. Wu and Shaknov, 1950). However, researchers have been divided about its existence until at least the 1970s.

[21] It is said that a system is entangled if the measurement of physical properties (i.e., position, momentum, spin, polarization) of one of the entangled particles is perfectly correlated with all the other particles.

a given quantum system to be in multiple states at the same time.[22] Superposition cannot be directly observed; it is only possible to observe the subsequential value after measurement. While the state of a composite system is always expressible as a superposition of products of states of local constituents, this is not the case in entangled systems. On the other hand, *non-locality* is a violation of the principle of locality in classical physics, which states that an object can only be directly influenced by its immediate surroundings. According to this principle, a point *a* can exert an influence on point *b* if and only if something in the space between them mediates the action (i.e., a wave or particle carrying the influence through the space between point *a* and *b*). This is not necessarily the case in quantum mechanics, whereby action at a distance is indeed possible even when the particles are so far apart that any classical interaction would be impossible. Thus, specific measurements of any one particle can impact the outcome of corresponding measurements on another entangled particle, even light years apart.[23] For Einstein and some of his colleagues, non-locality was implausible because, as established by special relativity, nothing can travel faster than the speed of light (cf. Einstein *et al.*, 1935). However, Bell test experiments are consistent with non-locality,[24] driving adherents of the Copenhagen interpretation to argue that the speed of light limit does not apply because there is no information, force, or work being communicated between entangled particles. This means that the connection between entangled *quanta* is not causal, as classical mechanics would have it–it is a (non-causal) non-local correlation. Because of the inherent randomness of quantum properties, correlations are typically expressed in averages of many measurements, given that the properties themselves are not permanent until they are measured. Whether entanglements effectively disprove causality in quantum mechanics is, too, a highly contested issue with many different interpretations.

---

[22] This is particularly relevant in quantum computing, for instance. In classical computing bits can be expressed as either 0 or 1; this is the case with quantum bits (or qubits), too, except that prior to measurement they can also be in a coherent superposition of both 0 and 1 simultaneously.

[23] Whether this clearly entails a violation of locality is still highly contested. For instance, adherents to the many-worlds interpretation of quantum mechanics reject non-locality, arguing that quantum events split the universe into multiple universes. This means that scientists measuring non-locality are in fact observing the effects of alternate universe versions of themselves measuring the same particles (Rubin, 2001; Tipler, 2014).

[24] A Bell inequality test is a real-world physics experiment based on a theorem proposed in 1964 by John Stewart Bell. According to his theorem, no physical theory of hidden local variables (hidden variables that satisfy the condition of being consistent with local realism) can ever replicate all the predictions of quantum mechanics. These experiments typically involve the observation of one pair of entangled particles (mostly photons) and measurement of certain state of each, to then compare the outcome to the prediction of local realism vis-à-vis quantum mechanics (cf. Clauser *et al*., 1969). Attempts to experimentally confirm violations of the Bell inequalities led to physicists John Clauser, Alain Aspect, and Anton Zeilinger being awarded the 2022 Nobel Prize in Physics.

This leaves us with the issue of scale. It is often said that quantum mechanics only applies to the subatomic scale, above which quantum phenomena *decohere* into the macro world of classical physics. While quantum entanglement refers to the superposition of shared physical states between two or more particles, coherence signifies the superposition of two or more interfering waves (cf. Adesso *et al*., 2017) found in objects that have wave-like properties (which, following the tenet of wave-particle duality, might very well be *every* object). Now, because quantum systems are never fully isolated from their environment, the more exposed they are to it, the faster they become entangled with a larger network of components, which effectively suppresses quantum interference effects, making quantum phenomena prohibitively hard to observe. This mechanism is commonly called *de*coherence, a theoretical mechanism employed to make sense of the quantum-to-classical transition, that is, why a quantum system starts to obey classical probability rules after being exposed to its environment (i.e., observation). It represents the fragility of non-classical superposition states and how easily they degrade into the familiar probability rules of the classical world, but in no way offers an explanation about the supposed 'emergence' of the classical world of our experience from the 'basic' quantum nature (Schlosshauer, 2005; 2019).[25] While the concept of decoherence is not necessarily tied to any one particular interpretation of quantum mechanics, it nevertheless often finds itself at the center of the problem regarding the relation between quantum and classical physics and is thus frequently invoked to support or debunk various theories and interpretations. For instance, proponents of the Copenhagen school, following Heisenberg (1983[1927]) and, especially, Neumann (2018[1932]), argue that decoherence plays a role in wavefunction collapse, that is, when an observer exacts a measurement of a quantum system, it is said that the superposition of the basis states of that system immediately 'collapses' into one single (classical) state with a well-defined value of a given measurable quantity. While decoherence simply signals the loss of different possible values for a given quantity of states, the Copenhagen interpretation argues that it *explains* the collapse of the wavefunction into another wavefunction for a state in which that quantity has an unequivocal value.

[25] Even the most uncontroversial scientific works err on the idea that the quantum world represents a primary, foundational dimension from which the 'objective' dimension of our everyday life emerges. This has sparked serious engagement by philosophers of physics, physicians, and metaphysicians alike on issues regarding fundamentality, ontological dependence, realism, and indeterminacy (see the recent volume *Quantum mechanics and fundamentality: Naturalizing quantum theory between scientific realism and ontological indeterminacy,* edited by Valia Allori in 2022).

Not without controversy, wavefunction collapse is often used to explain why quantum behavior is seldom seen at the macroscopic scale, despite this being described as a non-physical phenomenon by most of its proponents (see Jaeger, 2017b):[26] when introduced to a larger environment, the isolated particles' wave-like properties interfere in a disjointed (read: *in*coherent) fashion and average away to zero on the macroscopic scale. In other words, the superposition of different states still exists, but coherence is, as Kiefer and Joos (1999, 5) point out, "delocalized into the larger system," meaning that, in principle, decoherence could in principle be reversed. Thus, classical properties are not inherent features of macroscopic objects but are generated by the environment. Moreover, Zurek (2003) coined the term 'quantum Darwinism' to explain the process by which different quantum phenomena decohere into the same classical states in different moments and places. According to him, the similarities attested by different local observers after quantum-to-classical transition is due to some quantum states being more resilient to decoherence than others (*pointer* states) as well as their capacity to create replicas in the environment, thereby subject to measurement (and, consequently, providing the basis of objective observations of phenomena).

Now, critics of those using quantum mechanics in social scientific settings often raise concerns over scale-jumping. In reality, there is no clear-cut criterion for when a system should count as macroscopic. But as long as the individual parts are behaving randomly, it is improbable that they will act in a coordinated manner. However, this does not mean that large-scale coherent states are impossible. Macroscopic quantum effects have been documented in studies regarding the superconductivity of materials, involved in quantum levitation–also known the Meissner effect (Encyclopaedia Britannica, 2018)–as well as superfluidity and Bose-Einstein condensation (see Annett, 2005). Moreover, notable cases for the current relevance of quantum superpositions at the macroscopic level are to be found in quantum biology, particularly regarding possible quantum effects in the navigational mechanisms of migrating birds, which may allow them to see Earth's magnetic field (Cai *et al*., 2010; for more on quantum biology, see Al-Khalil and McFadden, 2014).

In sum, quantum physics is a broad academic field with over a hundred years of experiments and interpretative efforts on its back–impossible to review in a work of these characteristics. Naturally, this translates into a widely pluralist body of literature embracing

[26] For some, this means a transition from the potential to the actual, that is, an increase of knowledge and not a kinematical concept subject to dynamics (Kiefer, 2003).

complexity, paradox, and uncertainty, which are in themselves powerful tools of critique with rich implications for other fields. But just how far are we willing to go? Many go about their lives without ever paying any explicit attention to quantum mechanics or simply believe it holds no relevance outside its original field of application. Others see underlying social value of quantum physics as an essential component in a number of critical technologies of today of great economic and ethical significance, such as computers or nuclear weapons. Most importantly for the present purposes, a growing number of researchers have come to see the theoretical developments of quantum mechanics as a departing point in reformulating many of the fundamental notions about reality that we acquire as inhabitants of the macroscopic realm. Logically, this has taken many forms in recent years, from those using quantum theory as stimulating metaphors and analogies about issues outside of the lab to those seeking to integrate, to varying degrees and forms, the social world into more encompassing quantum ontologies. What follows is a brief overview of how the latter tendency has developed historically in IR and fields adjacent to it, followed by a sketch of the current quantum turn in IR and its effort to overcome the grip of Newtonian physics in the social sciences.

2.2. Historical Examples of Quantum Theory in IR

In IR, the influence of Newtonian physics is palpable in a great number of analogies used to make sense of the international reality. As Waters notes, this ranges from scholarly views of states as billiard balls or as superorganisms and fields to the employment of game theory in modelling conflict as well as in studies of nuclear deterrence (Waters, 2022, p.49). Indeed, Wendt is not the first to claim that the epistemological and ontological underwriting of the social sciences, including IR, has been largely modelled after that of classical physics. While this a bold statement, one which remains largely understudied by contemporary social studies of science, scholarship on the history of the social sciences shows how the trajectory of disciplines like economics, sociology, and political science were initially shaped by the metaphors of motion and conservation principles of classical physics (cf. Elster, 1975; Gordon, 1991; Cohen, 1994; Mirowski, 1988; 1989; and Murphy, 1995), following wider efforts at establishing them as distinct fields of scientific inquiry on their own right.[27] This results in

[27] While a full rendition of this connection falls outside the scope of this thesis, a few historical notes are due. For instance, Thomas Hobbes already treats polities as bodies subject to the laws of motion advanced by physicist-astronomer Galileo Galilei in his 1655 treatise *De Corpore* (cf. Duncan, 2021). As historians of science like Elster (1975) and Murphy (1995) have shown, this tendency crystallizes in the 18th century with the rise of economics vis-à-vis theoretical and mathematical physics.

several fundamental assumptions which, as J. B. Murphy has suggested, pervade seemingly disparate disciplines like evolutionary biology, operations research, engineering, neoclassical economics, and political science:

> "First, classical mechanics demonstrates the optimality of nature. The trajectories of particles always minimize some quantity; nature is perfectly efficient in this Leibnizian best of all possible worlds. Second, classical mechanics makes prediction possible by abstracting causal relationships from the path-dependence of history; hence the Laplacian dream of perfect knowledge of the future based on present conditions alone" (Murphy, 1995, p.158).[28]

In 1928, the then president of the American Political Science Association (APSA), William Bennett Munro, already underscored in its annual meeting the need to draw on the novel developments in physics to "discover the true purposes and policies which should direct human action in matters of government" (Munro, 1928, pp.2-3; see Harrington, 2022). But, as Waters notes, the normative ambiguity of the quantum revolution lacked sufficient normative edge for the incipient political science and IR to ground their claim to science, rendering "quantum an unappealing object for integration or imitation (…) compared to the established, and more easily comprehensible, sciences of biology, eugenics, geography, psychology, or classical physics—[which] provided a more familiar description of reality" (Waters, 2022, p.55).

Thus, while atomic weapons have bound quantum themes to IR since World War II, it was the Cartesian-Newtonian paradigm which prevailed in the discipline itself, with some disparate and isolated informal analogies across the decades.[29] But this is not the full image: contemporary scholars have sought to re-evaluate the origins of the current quantum IR movement, which has resulted in a much more colorful picture. An early effort to include quantum mechanics into IR theory came from Hans Morgenthau's *Scientific Man vs. Power Politics* (1946), where he problematizes the limited idea of science in the social sciences and timidly hints at the possibility of re-grounding IR via a quantum perspective. Waters (2022) also highlights the work of James Robinson and Martin Landau in the late fifties and sixties, who sought to demonstrate the role of Newtonian physics in political theory, as well as Hannah Arendt's inclusion of quantum mechanics in her phenomenological take on the relationship

---

[28] Naturally, the pivotal impact of Leibniz and Laplace in theoretical and mathematical physics speaks of the theological origin of these assumptions. After all, variational calculus was highly influenced by Leibniz, whose mathematical input was contingent on the belief that the world at hand is already always the perfect solution to a problem in constrained optimization (cf. Leibniz, 1965, §§53–55).

[29] For instance, former US Secretary of State George P. Shultz coined the term 'quantum diplomacy' in a 1998 lecture hoping to cast new light on social phenomena in a world of rapid transformations and uncertainty. For a more recent interpretation of this idea, see Der Derian (2011).

between physics and human agency in *The Human Condition* (cf. 1998 [1958]; seen in Waters, 2022, p.58). Other examples listed by Waters include Quincy Wright and R. J. Rummel, in the context of social field theory, across the sixties and seventies, and the quantum politics study group at the University of Hawaii in the early eighties, most notably the work of Glen Schubert, Ted Becker, Tim Dolan, and Jim Dator.

2.3. The 'quantum turn': literature, differences, and shortcomings

There are three major approaches that contemporary quantum social scientists have adopted in recent times (Tesař, 2015; Höne, 2017; Orrell, 2021):

a. *Instrumental* (Höne, 2017)*, modelling* (Orrell, 2021), *or analogical/quantum reasoning* (Tesař, 2015) *approach:* Commonly taken by proponents of quantum cognition, the modelling approach has produced prolific contributions since the 1990s, it mostly includes scholars using the mathematical formalism of quantum theory to better model cognitive phenomena over models based on traditional classical probability theory (Aerts & Aerts, 1997; Khrennikov, 1999; Busemeyer, 2013). Quantum cognition uses a quantum-theoretic framework for modelling purposes only, identifying quantum structures in cognitive phenomena without presupposing the existence of microscopic quantum processes in the human brain (Aerts & Aerts, 2022) or necessarily deriving any ontological claims about social reality being quantum-like (Haven and Khrennikov, 2013, p. xviii).[30] While prolific, these approaches are still very focalized and it remains to be seen whether they would hold under different experimental settings (Tesař, 2015) or outside the limited scope of decision models. What is more, the absence of clear ontological positions–which some view as being "agnostic about reality" (cf. Wendt, 2015, 71–72), thwarts the coherence of such models in terms of internal validity.

b. *The metaphor approach*: Generally taken by those using metaphors drawn from quantum theory as cognitive tools aimed at providing better interpretations of social objects so as to render intelligible other objects, features, and properties (Montuschi, 1996). This approach benefits from the epistemological power of quantum theory without claiming any ontological correspondence between the social and the quantum

[30] Topics in quantum cognition include quantum-like models of information processing, decision-making, probability judgments, knowledge representation, or semantic analysis and information retrieval, with profuse applications in the field of behavioural economics.

domains. Some argue that the use of quantum theory as a metaphor for the social world could cause the sort of hermeneutical social absorption necessary to develop a new social paradigm such as the one established by Newtonian physics in the social sciences (Zohar and Marshall, 1994; Akrivoulis, 2002). Interestingly, this would entail a shift of focus from what the social world *is* like to what it *could be* potentially like. Common critiques are directed at the ambiguity of such a thesis, especially concerning the process of social absorption and the formation and power of concepts.

c. *The identity approach*:[31] It is most often derived from the quantum mind hypothesis, and therefore closely connected to the development of quantum theory itself. Niels Bohr is often considered its forerunner, along with John von Neumann and Eugene Wigner. In IR, it is the approach adopted by those seeking to expand the argument that the brain and consciousness in general are based on quantum processes (Penrose, 1994) to facts about the nature of the social world (Wendt, 2015; Pan, 2020).[32] Common criticisms range from the view that the microcosm of the quantum scale does not produce measurable differences at the social scale and is therefore socially irrelevant (Hollin et al., 2017; Holzhey, 2021; in IR, see Waldner, 2017), to the fact that, be that as it may, there is no authoritative interpretation of quantum theory to draw from.

Despite this not being an exhaustive categorization, it is helpful to see the issue at hand as part of what Murphy (2021) calls the “analogy-versus-actuality” debate.[33] Now, recent interest in quantizing IR, especially from authors working within the latter two approaches, is often credited to interdisciplinary feminist scholar Karen Barad’s 2007 trailblazing book *Meeting the Universe Halfway*. With a PhD in theoretical physics themselves, Barad draws from the “philosophy-physics” of Niels Bohr and the Copenhagen interpretation of quantum mechanics to claim that “matter and meaning are not separate elements” (2007, p.3) and that the indeterminacy of properties of objects is a fundamental ontological aspect of their constitution. For Barad, intelligibility and materiality are not predetermined aspects of the world, but rather entangled ‘agential’ performances. Thus, phenomena or objects do not precede their *inter-*

[31] Otherwise called the ‘physicalist’ approach by Orrell (2021), albeit the author does not explain in what ways this might be the case.

[32] The most notable example is the Orchestrated objective reduction (Orch-OR) hypothesis, which establishes that consciousness begins at the quantum level inside neurons, rather than the traditional view that it derives from connections between neurons (see Penrose, 1994).

[33] Although Murphy groups together quantum modelling approaches and metaphor approaches as part of the analogical end.

action, but emerge as such by virtue of material-discursive practices through which the cut between one another is differentially enacted (*intra*-action). This account, which they term 'agential realism,' is thus directed at challenging "the presumed inherent separability of subject and object, nature and culture, fact and value, human and nonhuman, organic and inorganic, epistemology and ontology, and material and discursive" (333).

Barad enlarges Butler's notion of performativity to examine the materialization of bodies by inspecting not only the power of speech and social factors on human bodies but also decisive material dimensions such as material agency, constraints, and exclusions in shaping non-human as well as human bodies. Thus, boundary-making practices emerge not simply as human-based linguistic practices but as attributes of the world in its differential becoming. At the core of this project is Barad's substitution of the representationalist notion of reflection for a methodology grounded on the quantum notion of diffraction, as introduced to feminist philosophy by Donna Haraway:

> "Diffraction patterns record the history of interaction, interference, reinforcement, difference. Diffraction is about heterogeneous history, not about originals. Unlike reflections, diffractions do not displace the same elsewhere, in more or less distorted form thereby giving rise to industries of metaphysics. Rather, diffraction can be a metaphor for another kind of critical consciousness at the end of this rather painful Christian millennium, one committed to making a difference and not to repeating the Sacred Image of Same" (1997, p.273).

Their resulting take on realism is one in which phenomena, understood as "entangled material agencies," triumph over entities, indicating the "ontological inseparability of agentially intra-acting components," and where intra-action is defined as a "radical reworking of the traditional notion of causality" (2007, 333). Subsequently, Barad's account is an "ethico-onto-epistemology" of knowing *in* being, where the scientist is always part of the apparatus. This leads, in turn, to an extended Foucauldian understanding of power relations that allows to account not only for the particular formations of bodies, subjectivities, and identities but also for the changing relations between

> "the materialization of space, time, and bodies; the incorporation of material-discursive factors (including gender, race, sexuality, religion, and nationality, as well as class, but also technoscientific and natural factors in processes of materialization; the iterative (re)materialization of the relations of production; and the agential possibilities and responsibilities for reconfiguring the material-social relations of the world" (335).

In this context, objectivity emerges as "a matter of accountability to marks on bodies" (*Ibidem*). It does not revolve around a relation of absolute exteriority but a relation of exteriority within phenomena. Pregnant with different possibilities for the world's becoming, the enactment of boundaries and constitutive exclusions present us with questions of responsibility and accountability. Moral issues must be thought of in terms of what comes to *matter*, understood in every sense of the word, as Barad suggests.

While Barad's undertaking has sparked enormous attention into the potential of quantum theory, its most successful application is best represented by the pioneering work of IR scholar Alexander Wendt's 2015 book *Quantum mind and social science,* which has truly ignited a profound and lasting conversation around the application of quantum theory to IR. Wendt, staple-of-constructivism-turned-quantum-realist, already took care in dissecting and problematizing much of his prior theorizing in his essay '*Social Theory* as Cartesian Science' (2005). He admits that not only did his constructivism fail at positing a *via media* between positivism and interpretivism, as well as realism and idealism, but it in fact amounts to no more than "an attempted synthesis [of oppositions] (…) which now appear as aspect or moments of a larger whole" (2005, p.179). This larger whole, he argues, is underpinned by an implicit allegiance to Cartesian dualism, which underscores the "materialist" worldview of classical physics fundamentally informing social science (excepting some post-structuralist approaches).

I shall better present the quantum realist argument in the next chapter. But to conclude this chapter, I shall summarize the case for a quantum approach to IR as consisting of two movements. On the one hand, we have a denunciation of the Cartesian/Newtonian legacy. Wendt (2005, p.187) originally located this influence in five basic metaphysical-like assumptions common to most positivist and interpretative positions in IR:

> "1) that the elementary units of reality are physical objects (**materialism**); 2) that larger objects can be reduced to smaller ones (**reductionism**); 3) that objects behave in law-like ways (**determinism**); 4) that causation is mechanical and local ([local] **mechanism**); and 5) that objects exist independent of the subjects who observe them (**objectivism**?)."

To these some add 6) the idea that all social phenomena can ultimately be explained in terms of individuals (methodological **individualism**); and, mostly in the positivist front, the already stressed 7) Cartesian **dualism** (Burtt, 2003; Tesař, 2015). On the other have, we have different attempts at replacing the naïve ideas of Newtonian social science drawing from quantum mechanical concepts such as non-locality, entanglement, decoherence, superposition, and indeterminacy.

Naturally, it is a different thing to use quantum theory the tackle the problems arising from the ubiquity of Newtonian imagery and its effects in social theorizing than saying that quantum theory was right all along and that the both the natural and the social have always been quantum.

The next chapter focuses on the second argument, mainly through the work of Wendt and other scholars with like-minded views.

3. QUANTUM REALIST IR: PHYSICALISM REBOUND?

Both quantum physics and critical IR scholarship has proceeded in hopes of new conceptual territory, unsatisfied with the contradictions of their predecessors and their inability to account for uncertainty. However, the application of quantum physics in critical IR would not have been possible if not for the articulation of the quantum within poststructuralist feminism and queer theory (Haraway, 1997; Barad, 2007). Realist quantum IR, thus, shares many, if not all, of the ontological, epistemological, and ethical foundational tenets of the former while enjoying the "rigor" afforded to it by a naturalistic approach (Wendt, 2005, p.214). This is, in fact, stressed by Wendt, who has repeatedly called for a "quantum postmodernism" able to ground the post-structuralist emphasis on 'becoming' over 'being' on natural science (rebranded now as 'wave' over 'particle') (2005, p.181). Yet, whether it is preferable to imagine a quantum postmodernism over a postmodernism able to account for quantum phenomena does not follow naturally, or at least not in the way Wendt intended. Thus, the present chapter focuses on problematizing Wendt's strand of scientific quantum ontology by assessing its implications and potential shortcomings.

Drawing himself from Barad's work, Wendt's quantum-inspired argument starts at the level of the individual, claiming that hardcore methodological debates in the social sciences such as positivism vs. interpretivism, idealism vs. materialism, and individualism vs. holism are rooted in Cartesian metaphysics, that sees 'mind' (*res cogitans*) and 'body' (*res extensa*) as two irreducibly distinct substances. Against this, Wendt embraces a panpsychist ontology, "according to which matter has an intrinsically subjective aspect at the sub-atomic level" (Wendt, 2005, p.187). This argument stems from his identification of wave-particle dualism with the mind-matter dichotomy, which allows him to assert that mind and matter are "continuous all the way down" (2015, 119).

Wendt seeks to enlarge this thesis to the social by extending the quantum consciousness hypothesis across the agent-structure debate, asserting that the agent-structure relation is not "a process of causal interaction over time, but a non-local, synchronic state from which both are emergent" (Wendt, 2015, 260) thanks to quantum entanglement. Under this light, both agent and structure are "co-emergent (…) superposed states," meaning "potentialities rather than actualities" only becoming "real realities" through the mesh of material-discursive practices resulting from their interaction with other agents and structures (2015, 265-6) due to wave-function collapse.

Wendt, not unlike Barad, is not interested in using physics “as a mirror metaphor for thinking about a variety of different issues” (Barad, 2011, p.445). In fact, he is in favor of developing a “quantum social physics”, one in which social science is not determined by physics but, rather, underdetermined by it as the metaphysical constraint par excellence (Wendt, 2005, p.215). This means embracing that “the social (and all other) sciences are subject to physics constraints: no entities, relationships or processes posited in their inquiries should be inconsistent with the laws of physics” (2015, 7), that is, quantum physics. In practice, this ontological position surpasses the apriorily defined properties of scientific objects, on the one hand, as well as the causally deterministic nature of nature which, as Zanotti (2019, p.155) duly notes, makes the (im)possibility of predicting the future no longer an epistemological issue but an ontological one. As Kessler (2018, pp.83-4) shows, this does not prevent Wendt from resorting to analogies in his argument with statements like “language is like light” (Wendt, 2015, p.223) and others comparing quanta to speech acts (2015, 235).

3.1. Wendt’s philosophical ontology: a critique

Unlike Barad, who wishes to reposition the human within a network of entangled intra-actions between the human and the non-human, Wendt insists on developing a theory of consciousness and human free will through non-local causation. As I argue, Wendt interprets agential realism rather conservatively, and is therefore forced to assume a contradictory position that both effectively critiques and reinforces Cartesian metaphysics. This is because, in Wendt’s rendition of panpsychism, “mind and matter constitute a *duality*, not a dualism, one that (…) emerges from an underlying reality that is neither causal nor material” (2015, p.31; emphasis my own). The quantum universe is not material, then, but it is still physical. Quantum mechanics allows scientists to “unify physical and social ontology within a naturalistic, though no longer materialist, worldview (283). He further characterizes this ontological position as a form of neutral monism (93) subsuming his version of panpsychism. However, both approaches entail different metaphysical allegiances.

Neutral monism is a metaphysical theory in the philosophy of mind that posits a single underlying reality that is not mental or material but different altogether (‘neutral’). It is not a novel position; in fact, its most fervent defender was Austrian physicist and philosopher Ernst Mach who, at the turn of the 20th century, argued that what makes particular sensible qualities ‘mental’ and/or ‘material’ are the extrinsic causal-functional relations that elements bear to other elements, not their specific intrinsic characters (Wishon, 2021, p.132). He was the first to posit the type of unified science and rejection of metaphysics later championed by logical empiricists (Banks, 2013; Romizi, 2012), albeit from a marked realist perspective,[34] and has been recently connected to scientific constructivism *avant la lettre* (Riegler, 2012). As a metaphysical thesis, neutral monism has received a wide array of critiques, from Lenin's accusation of reactionary idealism (cf. Lenin, 1908, pp.48-9) to Quine's (1995) reduction of neutral monism to mere mentalism. More recently, Chalmers (1996) has compared this position to the kind of property dualism present in non-reducible physicalist approaches, which seems reinforced by Wendt's assertion that the distinction between mental and material is epistemic, not ontological (2015, p.93), yet arises as a result of quantum decoherence. However, Wendt then qualifies this position by reconfiguring the Cartesian distinction between mind and matter in arguing that mind, now consciousness, can be found "all the way down (…) *in* matter" (Wendt, 2015, p.112; emphasis in original). As Thomas Nagel has said, "Panpsychism is, in effect, dualism all the way down" (2002, 231). This is further justified by Wendt's identification of subjectivity, and therefore consciousness, with quantum coherence, which, as Zanotti (2019, pp.159-60) insinuates, is both an idealist and (Newtonian) substantialist move at its core.[35] This is because Wendt's fixation with the fundamental physics of consciousness is irrelevant unless we take social science as capable of doing something that his own argument of quantum entanglement states is impossible, without prejudice to the importance of intentionality in social theory (see Jackson, 2016b). Paradoxically, Wendt is no stranger to neither:

> "Given that physicalism bases itself on physics, this raises the question of what 'physical' means. [Quantum physicists] Hiley and Paavo Pylkkänen argue that the quantum world is still "physical," but its physicality is 'subtle' and thus 'mental.' As such, they see Bohm's theory as an 'objective idealism': idealist because it posits mentality as irreducible and objective because this mentality exists independent of people" (Wendt, 2015, p.87).

This position is further reinforced by Wendt's rendition of human will as the driving force behind ontological closure, which he equates to "the force that collapses wave functions into particles" (139) (i.e., measurement). According to Wendt, "Conceived as a collapsing of wave

---

[34] In fact, the first Vienna Circle was originally called the Ernst Mach Society, founded in 1928 by the likes of Rudolf Carnap and Otto Neurath and later joined by other soon-to-become notable Vienna Circle philosophers, such as Philipp Frank and Moritz Schlick. While the work of Mach has historically been discarded on the basis of its influence on logical empiricism, recent critical engagements demonstrate the extent to which the Vienna Circle diverted from Machist scientific philosophy by focusing instead on modern logic and linguistic interpretations of science (see Banks, 2013; Stadler, 2021).

[35] While Zanotti does not use the term physicalism, her use of the notion of substantialism entails a form of physicalism as developed in the introduction of this thesis.

functions, the choices we make, our actual agency is not generated by an underlying (efficient) causal order at all, but is precisely a rupture or 'perforation' of that order" (2015, p.188). While his overall enterprise seeks to defy the liberal conception of human beings as isolated agents capable of effecting linear change in reality, Wendt never actually challenges its classical tenet, namely, the centrality of (free) Will as a fundamental and ontologically distinct feature of human consciousness. In fact, he defines Will as "inherently free," and inverts mechanical or efficient causation, as that which "explains in a temporally forward manner," by embracing what Aristotle referred to as final causation (teleology), the type of causal link that "explains backward" (177), as the fundamental power of the Will. Agency, thus, is attributed only to the human subject as the sole possessor of final causal powers, that is, the capacity for "advanced action" (181-2):

> "Measurement induces a 'two-way contract between future and the past,' such that the collapse is not complete until the future 'confirms' the past. (…) In bridging the gap between our superposed insides and the classical world outside, decisions create for a moment order out of chaos, and combined with the experience with which it is correlated, therefore meaning for the subject. This may be seen as a form of 'downward causation,' since decisions are made at the level of the whole, to which the body's parts respond. But it is downward causation 'without foundations,' since, as a superposition, the state from which decisions emerge is a potentiality rather than actuality" (*Ibidem*).

Furthermore, he describes "Cognition, Will and Experience" (sic) (143) as the three essential traits of the subjectivity of living beings, which diverges from the consciousness of non-human and non-living entities as a difference in degrees and not in kind (115). Again, this view is rendered incongruent by Wendt himself in two ways. First, due to his own assertion that such difference is, at the same time, both substantive and normative:

> "[M]y proposal implies a sharp distinction between life and non-life, both substantively and normatively. While in my panpsychist view matter at the quantum level is latent with life, it only becomes life when organized into quantum coherent wholes. When there is no quantum coherence, as in thermostats or computers, matter is dead, and as such does not have agency or other intentional properties – causal powers yes, but not agency" (147).

And second, following from this, due to his inevitable privileging of the human subject–and thus anthropocentrism–exacerbated by a recourse to the panpsychism of Leibniz's (1965) monads and pre-established harmony between the material and mental realms (minus God):

> "[T]he world of private experience in and through which each organism lives - what von Uexküll called its '*umwelt'* – is unique. [It] suggests a picture of organisms reminiscent of Leibniz's monads, each living in, and making choices based on, its own, inaccessible bubble of experience - though unlike in his model, organisms here have 'windows' that allow them to interact with the world. Nevertheless, the uniqueness of *umwelten* gives this ontology an irreducibly subjectivist aspect" (142).

This view already foreshadows the limitations of Wendt's rendition of human subjectivity, supported by his famous statement that "human beings are literally walking wave functions" (154). Wendt draws from quantum brain theory to argue that the brain has an internal structure capable of producing quantum coherence even when its constant interaction with the environment forces it to decohere repetitively. It is by virtue of this coherence that, according to him, we are able to experience this "complexity in a unitary way, as *I*" (119), in the unification and amplification of "the otherwise fleeting experiences of its parts (…) into the experience of a whole and retained as memory" (124).[36] While an assessment of the accuracy of Wendt's rendition with regard to neuroscience falls out of the scope of this thesis, and further out of my area of expertise, this view has strong preliminary implications from a philosophy of science perspective.

For instance, in comparing the human brain to a quantum computer, Wendt resurrects the classical physicalist tenet found in logical empiricism that everything subject to scientific inquiry can, and should, be described via mathematical formalism: "[J]ust as for the particle in the cloud chamber, an outside observer could in principle write a single equation to describe our behavior" (119). Moreover, by adhering to the individualism of this vitalist physicalism, Wendt effectively undermines his otherwise holist ontology. A possible explanation for this contradiction is given by Michel (2018), who argues that Wendt's translation of physics to social science effectively conflates what is fundamentally a scientific ontology with a philosophical ontology, that is, he seeks to extend ontological claims about beings to claims about Being without proper justification. On the one hand, we have a proposal regarding the nature of the social world; on the other, a claim as to the world's fundamental nature (Jackson, 2011a; b). In this context, the passages where Wendt connects consciousness with the collapse of the wave-function, thereby emerging as the actualization of potentialities, ontological primacy is given to the pure amalgam of potentialities and thus subjectivity and consciousness as processes of individuation remain ontologically secondary. However, Wendt's ultimate ambition is to foreground subjectivity and consciousness as ontological, which renders him "stuck on a scientific ontological level dealing with substances while at the same time acknowledging that substances no longer have ontological primacy" (Michel, 2018, p.124). Kratochwil (2022, p.175) locates a similar contradiction, in which Wendt's revolutionary

[36] Wendt goes on to trace the human unconscious to the potentialities of the superposition of brain waves, elsewhere defined as "a decoherence-free sub-space of the brain within which quantum computational processes are performed" (2015, p.95).

claims against deciding *ex ante* what knowledge *is* by field-independent criteria are outdone by his "transcendental move" from physics to metaphysics.

In sum, Wendt's insistence in providing an all-encompassing theory of what there is, and what it is like, by resurrecting panpsychism forces him to adopt a physicalist position which he now rebrands as naturalism. Strawson, commonly credited for re-popularizing panpsychism in contemporary analytic philosophy of mind, argues that, as a metaphysical stance, it is "physicalist by definition, and it's straight-up realist about everything that comprises what we ordinarily think of as the physical world" (Strawson, 2020, p.319). Naturally, this entails a different metaphysical allegiance than that of reductive physicalism (or eliminative materialism, for that matter) and non-reductive physicalism (including property dualism and emergentism). Rather, Strawson and Wendt's physicalist panpsychism sees the objects of physics as inherently experiential without prejudice to its physics-tractability by mathematical formalism, in a way reminiscent of Quine (cf. 1951). I do not think Wendt would disagree with this view. An immediate counterargument would be that neither takes the physics-tractability of the physical object as the sole condition under which it can be posited as physical. Yet, this condition needs to be fulfilled, if only in principle, in order to qualify as such, leaving us to the kind of representationalism that Barad seeks to discredit.

3.1.1. Feminist 'ambivalence' and scientific universalism

Notwithstanding the direct connection between feminist and queer perspectives on science and quantum social science, a great deal of the political commitments that are so explicit in the former appear implicit, if at all, in quantum IR. Sjoberg (2020), for instance, in response to Zanotti, questions the value-added of a quantum ontological critique, arguing against the repurposing of Barad's explicitly political and ethical feminist elaborations by quantum IR scholars, as well as what she sees as a neglect to address the challenges posed by its consecration of science. While resorting to Barad's work "implies necessary political commitments in intra-agential ethics" nowhere do quantum IR scholars provide "a basis for their necessity" (2020, p.133). She continues:

> "I am left to believe, then, that quantum ontologies do not *necessarily* share feminisms' normative commitments, even if [quantum scholars do]. (…) Relatedly, it strikes me as a problematically gendered feature of disciplinary sociology in IR and cognate disciplines that many of the ontological, epistemological, and ethical arguments that feminists have made appear to be more credible when they are packaged differently, particularly in more scientific terms and with less use of the vocabularies of feminisms. This is not Zanotti's fault, per se, but in many

> ways, it is her problem – what work is the language of physics doing in creating authority?" (*Ibidem*).

This is a compelling argument, especially in light of Wendt's Nietzschean re-inscription, via Schopenhauer, of will "as power," which Zanotti, too, has critiqued for reproducing traditional attributes of masculinity while associating Cognition and Experience with the traditional feminine attributes of passivity (Zanotti, 2019, p.106). In words of Wendt himself:

> "Cognition and Experience are passive and reactive in the sense that they reflect rather than create reality; their direction of fit to the world is one of world to mind. Will, in contrast, is active and purposeful, a drive that imposes itself upon, and thus changes, the world" (Wendt, 2015, p.116).

But, from a broader perspective, there is something to be said about the insistence of quantum social science to operate within strict naturalistic frameworks. Feminist philosophers of science have long argued against the pull exerted by calls to science in excluding particular knowledges, intentionally or not, while privileging others in turn (Haraway, 1988), as well as in empowering the privileged to speak for everyone (notoriously, see Spivak, 1988). In this sense, there seems to be a general lack in quantum IR, or at least in realist approaches, of the critical conscience necessary to hold ourselves accountable for the values and interests that mold the range of decisions that makes for our research practice, including its situated partiality, and the very choice of our research questions (Wylie, 2012). For an approach whose theoretical power and innovation relies on an ideological critique of Newtonian substantialism, it remains to be seen whether quantum social science is able to create a shift of consciousness that is genuinely emancipatory and capable of disrupting dominant schemas or, in turn, remains "just more ideology, in the pejorative sense" (Haslanger, 2007, p.89). This is particularly relevant given that quantum social science, including quantum IR, as many of their practitioners admit, are not making any substantial contributions that have not been already developed in detail by different philosophical traditions, both in the West and elsewhere. As Sjoberg well puts it,

> "The very complexities that make it seductive are the ones that are both conceptually unnecessary (we can understand relationality, contingency, and uncertainty without quantum physics) and politically problematic (given the gendered and raced implications of reading science as authority, and the lack of clear and necessary political commitment)" (2020, 136).

The second point is particularly poignant in the face of quantum realism, as, despite Wendt's best efforts, by embracing quantum mechanics as the true foundation of social ontology we find ourselves back under the grip of positivism and its logic of subsumption, rendering impossible the kind of self-reference so relevant for feminist thinkers. This link is, in fact, not merely accidental: as Kessler (2018, p.85) insinuates, Wendt seeks to build a model first and then have future research assess its validity. In so doing, he forces social reality into a prefabricated semantic grid in a way comparable to the efforts of Carnap and other logical empiricists, who sought to employ the language of physicalism as the cornerstone of the Unity of Science thesis. Interestingly, none other than Ernst Mach, forefather of Vienna Circle, had already defended that the great virtue of neutral monism is that it offers a unified perspective from which to undertake all scientific inquiry:

> "What I aimed at was merely to attain a safe and clear philosophical standpoint, whence practicable paths, shrouded in no metaphysical clouds, might be seen leading not only into the field of physics but also into that of psycho-physiology" (Mach 1886, p.47; seen in Stubenberg and Wishon, 2023).

However, the will to reduce everything to a single, unitary world is misguided, as it fails to account for the ontologies of different interacting worlds (Kratochwil, 2011; 2022) and, especially, the different ways of making sense (in and) of them (also Michel, 2018). Here I must side again with Kratochwil when he says that:

> "Since the notion of science as a mirror of the 'world' is shot through with metaphysical understandings that do not withstand closer scrutiny, the 'solution' for understanding the social world does not lie in a theory of the whole, but in finding an appropriate vocabulary for analyzing meanings and actions taking place in historical time" (Kratochwil, 2022, p.179).

All in all, it seems that most of Wendt's theoretical shortcomings stem from the undue burden placed by the realist claim of quantum theory. This would mean that an analogical or metaphorical approach can still be of great value for future research in quantum IR. Wendt himself has been welcoming of others reading his work from an analogical perspective, "as nothing more than a source of inspiration and potentially useful tools" (Wendt, 2022, p.200). While quantum IR is still a burgeoning field, other IR scholars have already started to engage with quantum theory while, at the same time, critically assessing eventual allegiances to the philosophical shortcomings of realist quantum social theory as briefly illustrated in this thesis. This might permit to re-encounter a variety of ideas that are concurrently new yet inestimably old, and to rediscover our indeterminant, entangled presence within larger planetary networks without obfuscating the worldly differences of gender, class, ethnicity, species, space, and time, in relation to the nature of human agency (Allan, 2018), non-Western philosophies (Burgess, 2018; Fierke, 2019; Nair, 2019), security (Mitchell, 2014), or climate change (O'Brien, 2016) and the Anthropocene (Harrington, 2020), among many others (pressing) issues.

4. CONCLUSION

In sum, in this thesis I sought to develop an inherent contradiction permeating quantum realist IR through a close reading of Alexander Wendt's *Quantum Mind and Social Theory* (2015). In particular, I argued that by resurrecting panpsychism (coupled with neutral monism), Wendt offers an all-encompassing theory of what there is, effectively adopting a physicalist position which he now rebrands as naturalism. His reliance on classical philosophers of science and analytical philosophy of mind alike renders possible to trace his physicalist endeavor as part of the legacy of the First Vienna Circle in their insistence on the language of physicalism and the Unity of Science thesis. To do this, I started by laying out the analytical framework, namely, a (feminist new materialist conception of the) philosophy of science approach. This brief enterprise was followed by a chapter in which the theoretical framework of quantum mechanics is concisely discussed, along with several relevant examples of its adoption in IR and IR-adjacent fields before and after the current 'quantum turn.' In the final chapter, I presented Wendt's main quantum-infused arguments and proceeded to explore the reasons why his take on human subjectivity entails a transcendentalist position unwarranted by his attempt at a 'flat' ontology. It is true that Wendt's quantum realist claims do not align exactly with those of logical empiricism. After all, logical empiricists were not concerned with ontological claims about nature, focusing instead on a naturalist methodology (a distinction that Quine famously discredits), whereas Wendt seeks to derive his naturalist methodology from a naturalist ontology, first. However, a comparison can be drawn between Wendt's and Austrian philosopher of science Ernst Mach's panpsychisms, the latter being the first to posit the type of unified science and rejection of metaphysics later championed by the Ernst Mach Society (soon renamed as the First Vienna Circle; see footnote 36).

As a general takeout, it should be stressed that, at its core, quantum mechanics is a practical set of equations and mathematical formalisms, so quantum phenomena are only accessible as a translation of measurement apparatuses into the language understood by scientists. As physicists Schaffer and Barreto Lemos (2021) suggest, scientists are thus always confronted by a kind of 'language boundary,' meaning that some information is lost in the process of translation by necessity. The non-technical relevance of quantum mechanics is gargantuan as we continue to see in the ways it is increasingly entangled within several different traditions in an increasing number of fields. But, ultimately:

> "The way that quantum physics obliterates thingness is in the way that it undermines our ability to use language, and the thought structures associated with it (like narrative), to label and describe what we observe in nature when we test its behavior on small scales. It has more to do with *a breakdown of our ability to represent reality in ways that feel like they make intuitive sense, leaving us with equations and recipes but no clear understanding of what they actually mean*" (Schaffer and Barreto Lemos, 2021, p.24).

While quantum-inspired readings of social phenomena may empower many to better articulate radically different pictures of how reality can be outside of classical physics, 'nature' may never give us any satisfying surrogates for the credulous notions we are compelled to forfeit. That is perhaps the great critical potential of quantum social science to which we should aim.

5. BIBLIOGRAPHY

Adesso, G., Plenio, M. B., & Streltsov, A. (2017). Quantum coherence as a resource. *Review of Modern Physics*, 89(4).

Aerts, D. & Aerts, S. (1997). Applications of quantum statistics in psychological studies of decision processes. In B. C. van Fraassen (Ed.), *Topics in the foundation of statistics*. Springer, Dordrecht.

Aerts, D. & Aerts, J. (2022). Human perception as a phenomenon of quantization. *Entropy*, 24(9).

Alai, M. (2023). Scientific realism, metaphysical antirealism and the no miracle arguments. *Found Sci* 28, 377–400.

Allan, B. B. (2018). Social action in quantum social science. *Millennium*, 47(1), 87–98.

Al-Khalili, J. & McFadden, J. (2014). *Life on the edge: The coming of age of quantum biology*. London: Bantam Press.

Albert, M., & Bathon, F. M. (2020). Quantum and systems theory in world society: Not brothers and sisters but relatives still? *Security Dialogue*, 51(5), 434–449.

Allori, V. (Ed.). (2022). *Quantum mechanics and fundamentality: Naturalizing quantum theory between scientific realism and ontological indeterminacy*. Cham: Springer.

Akrivoulis, D. E. (2002). *The quantum politics metaphor in international relations: Revising American Newtonianism*. University of Kent at Canterbury. PhD thesis.

Annett, J. F. (2005). *Superconductivity, superfluids, and condensates*. Oxford: Oxford Univ. Press.

Arendt, H. (1998 [1958]). *The Human condition*. University of Chicago Press.

Bachelard, G. (1986[1938]). *The formation of the scientific mind: A contribution to a psychoanalysis of objective knowledge*. Beacon Press.

Banks, E. C. (2013). Metaphysics for positivists: Mach versus the Vienna Circle. *Discipline filosofiche,* 23(1), 57-77.

Barad, K. (2007). *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Durham, NC: Duke University Press.

Barad, K. (2011). Erasers and erasures: Pinch's unfortunate 'uncertainty principle.' *Social Studies of Science*, *41*(3), 443–454.

Bohm, D. (1951). *Quantum theory*. Prentice Hall.

Bohr, N. (1928). The Quantum postulate and the recent development of atomic theory. *Nature* 121, pp.580–590.

Bohr, N. (1933). Light and life. *Nature*, 131, pp.421–423.

Bourget, D. & Chalmers, D. J. (2014). What do philosophers believe? *Philosophical Studies,* 170(3), pp.465-500.

Braginski, V. & Khalili, F. (1992). *Quantum measurements*. Cambridge University Press.

Braidotti, R. (2015). The posthuman in feminist theory. In: L. Disch & M. Hawkesworth (eds.), *Oxford Handbook of Feminist Theory*. Oxford University Press.

Busemeyer, J.R. (2013). Introduction to quantum probability for social and behavioural scientists. In L. Rudolph (Ed.), *Qualitative mathematics for the social sciences: Mathematical models for research on cultural dynamics*. Routledge, 75–103.

Burgess, J. P. (2018). Science blurring its edges into spirit: The quantum path to *Ātma*. *Millennium*, 47(1), 128–141.

Burtt, E. A. (2003). *The metaphysical foundations of modern science*. Mineola, N.Y: Dover Publications.

Cai, J., Guerreschi, G., & Briegel, H. J. (2010). Quantum control and entanglement in a chemical compass. *Phys. Rev. Lett*. 104, 220-502.

Carnap, R. (1934[1932]). *Unity of science*. London: Kegan Paul.

Carnap, R. (1937[1934]). *Logical syntax of language*. Chicago: Open Court.

Carnap, R. (1938). Logical foundations of the unity of science. In *International Encyclopedia of Unified Science*, 1(1). Chicago: University of Chicago Press, 42–62.

Carr, H. (1946). *The twenty years crisis, 1919–1939*, 2nd edn. London: Macmillan.

Chalmers, D. (1995). Facing up to the problem of consciousness. *Journal of Consciousness Studies,* 2(3), 200–219.

Chalmers, D. J. (1996). *The conscious mind: in search of a fundamental theory.* New York: Oxford University Press.

Clauser, J. F.; Horne, M. A.; Shimony, A.; & Holt, R. A. (1969). Proposed experiment to test local hidden-variable theories. *Physical Review Letters,* 23(15), pp.880–884.

Cohen, I. (1994). Newton and the social sciences, with special reference to economics, or, the case of the missing paradigm. In P. Mirowski (Ed.), *Natural Images in Economic Thought: Markets Read in Tooth and Claw (Historical Perspectives on Modern Economics*, pp. 55-90). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511572128.003

Daston, L. (2000). Introduction. In L. Daston (Ed.), *Biographies of Scientific Objects*. Chicago: Chicago University Press.

Davis, P. & Gribbin, J. (1999). *The matter myth.* Viking.

Der Derian, J. (2011). Quantum diplomacy, German–US relations and the psychogeography of Berlin. *The Hague Journal of Diplomacy*, 6(3-4), pp.373-392.

Der Derian, J. (2013). From war 2.0 to quantum war: The superpositionality of global violence. *Australian Journal of International Affairs,* 67(5), pp.570–585.

Dirac, P. A. M. (1967). *The principles of quantum mechanics*. Oxford University Press.

Dolphijn, R. & van der Tuin, I. (2012). *New materialism: Interviews and cartographies*. Open Humanities Press.

Dolphijn, R. (2016). Critical naturalism: A quantum mechanical ethics. *Rhizomes: Cultural Studies in Emerging Knowledge*, 30. https://doi.org/10.20415/rhiz/030.e12

Duncan, S. (2021). Thomas Hobbes. In: Zalta, Edward N. (ed.), *The Stanford Encyclopedia of Philosophy*. Stanford University. [Retrieved 2021-02-24].

Dyson, F. (1979). *Disturbing the universe*. Basic Books.

Einstein, A., Podolsky, B. & Rosen, N. (1935). Can quantum-mechanical description of physical reality be considered complete? *Physical Review*, 47(10), pp.777–780.

Einstein, A. & Infeld, L. (1938). *The Evolution of Physics*. Cambridge University Press.

Elster, J. (1975). Leibniz and the development of economic rationality. *Chair in Conflict and Peace Research*. University of Oslo.

Elster, J. (1989). *Nuts and bolts for the social sciences.* Cambridge: Cambridge University Press.

Feldman, R. (201). Naturalized epistemology. In: Zalta, Edward N. (ed.), *The Stanford Encyclopedia of Philosophy*. Stanford University. Retrieved at: https://plato.stanford.edu/archives/sum2012/entries/epistemology-naturalized/>

Encyclopaedia Britannica (2018). Meissner effect. *Encyclopedia Britannica*. https://www.britannica.com/science/Meissner-effect

Fierke, K. M. (2019). Contraria sunt complementa: Global entanglement and the constitution of difference. *International Studies Review*, 21(1), 146–169.

Frost-Arnold, G. (2005). The large-scale structure of logical empiricism: Unity of science and the elimination of metaphysics. *Philosophy of Science*, 72(5), 826–838.

Goldman, A. (1994). Naturalistic epistemology and reliabilism. *Midwest Studies in Philosophy*, 19, 301–320.

Gordon, S. (1991). *The history and philosophy of social science.* New York: Routledge.

Grove, J. (2020). Bringing the world back in: Revolutions and relations before and after the quantum event. *Security Dialogue*, 51(5), 414–433.

Grove, J. (2022). A quantum temperament for life a dialogue between philosophy and physics. In: A. Wendt & J. Der Derian, *Quantum International Relations: A Human Science for World Politics.* Oxford University Press.

Gunnell, J. G. (1998). *The Orders of discourse: Philosophy, social science and politics*. Oxford: Rowman & Littlefield.

Haraway, D. (1988). Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist Studies*, *14*(3), 575–599.

Haraway, D. (1997). *Modest-Witness@Second-Millennium.FemaleMan-Meets-OncoMouse: Feminism and technoscience*. New York: Routledge.

Harrington, N. T. (2022). Quantum mechanics and the human sciences: First encounters. In: A. Wendt & J. Der Derian, *Quantum international relations: A human science for world politics.* Oxford University Press.

Harrington, C. (2020). A quantum anthropocene? International relations between rupture and entanglement. In J. Pereira, & A. Saramago (eds), *Non-human nature in world politics. Frontiers in international relations*. Springer, Cham.

Haslanger, S. (2007). "But mom, crop-tops are cute!" Social knowledge, social structure and ideology critique. *Philosophical Issues*, 17(1), 70-91.

Haven, E. & Khrennikov., A. (2013). *Quantum social science*. Cambridge, UK: Cambridge University Press.

Heisenberg, W. (1983[1927]). The actual content of quantum theoretical kinematics and mechanics. *NASA Technical Reports Server*.

Hempel, C. G. (1994[1942]). The function of general laws in history. In M. Martin & L. C. MacIntyre (Eds.), *Readings in the Philosophy of Social Science*. The MIT Press.

Hollis, M. & Smith, S. (1990). *Explaining and understanding International Relations.* Oxford: Clarendon Press.

Holzhey, C. F. E. (2021). Emergence that matters and emergent irrelevance: On the political use of fundamental physics. In: *Materialism and Politics*. ICI Berlin Press, pp. 253–268. https://doi.org/10.37050/ci-20_14

Höne, K. E. (2017). Quantum social science. *obo* in International Relations. doi: 10.1093/obo/9780199743292-0203.

Jackson, P. T. (2016a). *The conduct of inquiry in international relations: Philosophy of science and its implications for the study of world politics*. London, Routledge.

Jackson, P. T. (2016b). Fundamental grounding. *Perspectives on Politics*, 14(4), 1153-1157.

Jaeger, G. (2017a). Quantum randomness and unpredictability. *Fortschritte der Physik,* 65(6-8). https://doi.org/10.1002/prop.201600053

Jaeger, G. (2017b). 'Wave-Packet reduction' and the quantum character of the actualization of *potentia*. *Entropy*, 19(10), 513.

Jaksland, R. (2021). Norms of testimony in broad interdisciplinarity: The case of quantum mechanics in critical theory. *J Gen Philos Sci,* 52, pp.35–61.

Keohane, R. (1989). *International institutions and state power*. Boulder, CO: Westview.

Kessler, O. (2018). The mind-body problem and the move from supervenience to quantum mechanics. *Millennium,* 47(1), 74-86.

Kiefer, C. (2003). On the interpretation of quantum theory—from Copenhagen to the present day. In: *Time, quantum and information*. Berlin, Heidelberg: Springer Berlin Heidelberg, pp.291-299.

Kiefer, C. & Joos, E. (1999). Decoherence: Concepts and examples. In: Blanchard, P., Jadczyk, A. (eds) *Quantum future: From Volta and Como to the present and beyond.* Lecture Notes in Physics, 517. Springer, Berlin, Heidelberg. https://doi.org/10.1007/BFb0105342

Kirby, V. (2013). *Quantum anthropologies: Life at large*. Durham: Duke University Press.

Khrennikov, A. (1999). Classical and quantum mechanics on information spaces with applications to cognitive, psychological, social, and anomalous phenomena. *Foundations of Physics*, 29(7), 1065–1098.

Klein, J. T. (2010). A taxonomy of interdisciplinarity. In R. Frodeman, J. T. Klein, & R. C. D. S. Pacheco (Eds.), *The Oxford handbook of interdisciplinarity* (1st ed.). Oxford: Oxford University Press.

Kratochwil, F. (2011). The human perspective in international relations. In F. Kratochwil (ed.), *The puzzles of politics: Inquiries into the genesis and transformation of international relations*. Abingdon: Routledge.

Kratochwil, F. (2022). The strange fate of the morphed 'rump materialism': a comment on the vagaries of social science as seen through Alexander Wendt's Quantum mind and social science. *International Theory*, 14(1), 169–182.

Lange, F. (1925[1865]). *A history of materialism*. London: Routledge.

Laplace, P. S. (1902[1814]). *A philosophical essay on probabilities*. New York: J. Wiley.

Leibniz, G. W. F. (1965). *Monadology and other philosophical essays*. Macmillan.

Little, D. (2018). Entangling the social: Comments on Alexander Wendt, Quantum mind and social science. *J Theory Soc Behav*, 48, 167–176.

Mackay, R. (2007). Editorial introduction. *Collapse* 2(1), 3–13.

Mantzavinos, C. (Ed.). (2009). *Philosophy of the social sciences: Philosophical theory and scientific practice.* Cambridge: Cambridge University Press. doi:10.1017/CBO9780511812880

Michel, T. (2018). Of particles and humans: The question of 'human being' in Alexander Wendt's Quantum mind and social science. *Millennium*, 47(1), 114–127.

Mirowski, P. (1988) *Against mechanism*. Rowman & Littlefield.

Mirowski, P. (1989). *More heat than light: Economics as social physics, physics as nature's economics.* New York: Cambridge University Press.

Mitchell, A. (2014). Only human? A worldly approach to security. *Security Dialogue*, 45(1), 5–21.

Montgomery, A. H. (2016). Quantum mechanisms: Expanding the boundaries of power, space, and time in global security studies. *Journal of Global Security Studies* 1 (1), 102-106.

Montuschi, E. (1996). Metaphor in social science. *Theoria*, 11(25), 49-61.

Morgenthau, H. J. (1946). *Scientific man vs. power politics*. Chicago, IL: University of Chicago Press.

Munro, W. (1928). *Physics and politics—An old analogy revisited*. American Political Science Review 22, no. 1: 1–11.

Murphy, J. B. (1995). Rational choice theory as social physics. In J. Friedman (Ed.), *The rational choice controversy: Economic models of politics reconsidered.* Yale University Press.

Murphy, M. P. A. (2021). *Quantum social theory for critical international relations theorists: Quantizing critique*. Cham, Switzerland: Palgrave Macmillan.

Murphy, M. P. A. (2022). On quantum social theory and critical international relations. In: A. Wendt & J. Der Derian, *Quantum International Relations: A human science for world politics.* Oxford University Press.

Nagel, E. (1961). *The structure of science*. New York: Harcourt, Brace & World.

Nair, S. (2019). Is Nāgārjuna's *Śūnyavāda* complimentary to quantum field theory? In: Bhatt, S.R. (eds) *Quantum reality and theory of Śūnya*. Springer, Singapore.

von Neumann, J. (2018[1932]). *Mathematical foundations of quantum mechanics*. Princeton University Press.

Neurath, O. (1946). After six years. *Synthese,* 5, 77–82.

O'Brien, K.L. (2016). Climate change and social transformations: is it time for a quantum leap? *WIREs Clim Change,* 7, 618-626.

Orrell, D. (2020). The value of value: A quantum approach to economics, security and international relations. *Security Dialogue*, 51(5), 482–498. https://doi.org/10.1177/0967010620901910

Pan, C. (2020). Enfolding wholes in parts: Quantum holography and international relations. *European Journal of International Relations*, *26*(1_suppl), 14–38.

Papineau, D. (2002). *Thinking about consciousness*. Oxford: Oxford University Press.

Papineau, D. (2009). Physicalism and the human sciences. In C. Mantzavinos (Ed.), *Philosophy of the Social Sciences: Philosophical Theory and Scientific Practice* (pp. 103-123). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511812880.010

Papineau, D. (2021). Naturalism. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy*. Metaphysics Research Lab, Stanford University. Retrieved from https://plato.stanford.edu/archives/sum2021/entries/naturalism/

Patomäki, H. & Wight, C. (2000). After post-positivism? The promises of critical realism. *International Studies Quarterly*, 44, 213–237.

Penrose, R. (1989). *The emperor's new mind: Concerning computers, minds and the laws of physics*. Oxford University Press.

Penrose, R. (1994). *Shadows of the mind: A search for the missing science of consciousness*. Oxford University Press.

Peres, A. (1993). *Quantum theory: Concepts and Methods*. Kluwer.

Pettit, P. (1989). The freedom of the city: A republican ideal. In A. Hamlin & P. Pettit (Eds.), *The Good Polity*. Oxford: Blackwell Publishers.

Plotnitsky, A. (1994). *Complementarity: Anti-epistemology after Bohr and Derrida*. Durham: Duke University Press.

Pocock, J. (1975). *The Machiavellian moment: Florentine political thought and the atlantic republican tradition*. Princeton, N.J.: Princeton University Press.

Poland, J. (1994). *Physicalism: The philosophical foundations*. Oxford University Press.

Riegler, A. (2012). Constructivism. In L. L'Abate (ed.), *Paradigms in theory construction*. New York: Springer.

Romizi, D. (2012). The Vienna Circle's "scientific world-conception": Philosophy of science in the political. *HOPOS: The Journal of the International Society for the History of Philosophy of Science*, 2(2), 205-242.

Pylkkänen, P. (2014). Can quantum analogies help us to understand the process of thought? *Mind & Matter*, 12(1), 61–91.

Quine, W. V. (1951). Main trends in recent philosophy: Two dogmas of empiricism. *The Philosophical Review*, 60(1), 20-43.

Quine, W. V. (1969). Epistemology naturalized. In W. V. Quine, *Ontological Relativity and Other Essays*. New York: Columbia University Press, 26–68.

Quine, W. V. (1995). *From Stimulus to Science.* Cambridge: Harvard University Press.

Rouse, J. (2002). *How scientific practices matter: Reclaiming philosophical naturalism*. University of Chicago Press.

Rouse, J. (2004). Barad's feminist naturalism. *Hypatia* 19(1), pp.142-162.

Rouse, J. (2007). Social practices and normativity. *Philosophy of the Social Sciences* 37(1), pp.46-56.

Rubin, M. A. (2001). Locality in the Everett interpretation of Heisenberg-picture quantum mechanics. *Foundations of Physics Letters*, 14 (4), pp.301–322.

Rysiew, P. (2021). Naturalism in epistemology. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy*. Stanford University. Retrieved from https://plato.stanford.edu/archives/fall2021/entries/epistemology-naturalized/>

Schaffer, K. & Barreto Lemos, G. (2021). Obliterating thingness: An Introduction to the "what" and the "so what" of quantum physics. *Foundations of Science,* 26, pp.7–26. https://doi.org/10.1007/s10699-019-09608-5

Schlosshauer, M. (2005). Decoherence, the measurement problem, and interpretations of quantum mechanics. *Reviews of Modern Physics*.

Schrödinger, E. (1935). Discussion of probability relations between separated systems. *Mathematical Proceedings of the Cambridge Philosophical Society*, 31(4), pp.555–563.

Schrödinger, E. (1944). *What is life?* Cambridge, UK: Cambridge University Press.

Shultz, G. P. (1998). Diplomacy, wired. *Hoover Digest*.

Sjoberg, L. (2020). Quantum ambivalence. *Millenium*, 49(1), 126-139.

Skinner, Q. (1983). Machiavelli on the maintenance of liberty. *Politics*, 18, 3–15.

Skocpol, T. (1987). The dead end of metatheory. *Contemporary Sociology*, 16(1), 10–12.

Spivak, G. C. (1988). Can the subaltern speak? In: C. Nelson & L. Grossberg (eds.), *Marxism and the Interpretation of Culture*. Basingstoke: Macmillan, 271–313.

Stadler, F. (2021). Ernst Mach and the Vienna Circle: A re-evaluation of the reception and influence of his work. In J. Preston (Ed.), *Interpreting Mach: Critical Essays* (pp. 184-207). Cambridge: Cambridge University Press.

Stoljar, D. S. (2023). Physicalism. In E. N. Zalta & U. Nodelman (Eds.), *The Stanford Encyclopedia of Philosophy*. Metaphysics Research Lab, Stanford University. Retrieved from https://plato.stanford.edu/archives/sum2023/entries/physicalism/

Strawson, G. (2020). What Does 'Physical' Mean? A prolegomenon to physicalist panpsychism. In W. Seager (ed.), *The Routledge Handbook of Panpsychism*. New York: Routledge, 317–39.

Stroud, B. (1984). Internal and external: Meaningful and meaningless. In *The Significance of Philosophical Scepticism*. Oxford University Press.

Stubenberg, L. & Wishon, D. (2023). Neutral Monism. In E. N. Zalta & U. Nodelman (Eds.), *The Stanford Encyclopedia of Philosophy*. Metaphysics Research Lab, Stanford University. Retrieved from https://plato.stanford.edu/archives/spr2023/entries/neutral-monism/

Tellis, A. J. (1996). Political realism: The long march to scientific theory. In B. Frankel (Ed.), *Roots of Realism*. London: Frank Cass.

Tesař, J. (2015). Quantum theory of international relations: approaches and possible gains. *Human Affairs,* 25, pp.486–502.

Tipler, F. J. (2014). Quantum nonlocality does not exist. *Proceedings of the National Academy of Sciences*, 111(31), pp. 11281-11286.

Uebel, T. (2003). Twentieth-century philosophy of social science in the analytic tradition. In S. P. Turner & P. A. Roth (Eds.), *The Blackwell guide to the philosophy of the social sciences*. Blackwell Publishing.

Waldner, D. (2017). Schrödinger's cat and the dog that didn't bark: Why quantum mechanics is (probably) irrelevant to the social sciences. *Critical Review* 29(2), pp.199-233.

Waters, J. (2022). Mind, Matter, and Motion: A genealogy of quantum entanglement and estrangement. In: A. Wendt & J. Der Derian, *Quantum International Relations: A human science for world politics.* Oxford University Press.

Wendt, A. (2005). Social Theory as Cartesian Science: An auto-critique from a quantum perspective. In: S. Guzzini & A. Leander (Eds.), *Constructivism and International Relations: Alexander Wendt and his critics*. New York: Routledge, pp.178–235.

Wendt, A. (2015). *Quantum mind and social science: Unifying Physical and Social Ontology*. Cambridge, UK: Cambridge University Press.

Wendt, A. (2022). Why IR scholars should care about quantum theory, part II: Critics in the PITs. *International Theory, 14*(1), 193-209.

Wight, C. (2013). Philosophy of social science and International Relations. In W. Carlsnaes, T. Risse & B. A. Simmons (Eds.), *Handbook of International Relations*. SAGE Publications Ltd.

Wishon, D. (2021). Radical empiricism, neutral monism, and the elements of mind. *The Monist*, 104, 125–151.

Wu, C. S. & Shaknov, I. (1950). The angular correlation of scattered annihilation radiation. *Physical Review*, 77(1), p.136.

Wylie, A. (2012). The Feminism Question in Science: What does it mean to "do social science as a feminist"? In S. Naggy Hesse-Biber, *Handbook of Feminist Research: Theory and Praxis*. Thousand Oaks, CA: SAGE, 544-556.

Yanow, D. & Schwartz-Shea, P. (2015). *Interpretation and method: Empirical research methods and the interpretative turn.* Second edition. New York: Routledge.

Zanotti, L. (2019). *Ontological entanglements, agency and ethics in International Relations: Exploring the crossroads*. New York: Routledge.

Zohar, D. & Marshall, I. N. (1994). *The Quantum Society. Mind, physics and a new social vision*. London: Bloomsbury.

Zurek, W. H. (2003). Decoherence, einselection, and the quantum origins of the classical. *Reviews of Modern Physics*, 75 (3), 715–775.