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WHAT'S QUANTUM GOT TO DO WITH IT?: ENGAGING THE NEW SCIENCES IN CRIMINOLOGY AND CRIMINAL JUSTICE¹

Abstract: Contemporary social sciences are rooted in Isaac Newton's ontology. This interdisciplinary article advocates an engagement with the new sciences, particularly quantum theory and quantum holography. It focuses particularly on the field of criminology, which amongst the social sciences stands as the most obstinate in a time when new thinking to deal with the crime problem is most compelling. It offers possible changes in our methodological approaches. It advocates a transformative justice as a replacement to "criminal justice" and "restorative justice."

Key words: criminology, quantum theory, quantum holography, transformative justice, restorative justice

INTRODUCTION

The objective of this paper² is to encourage engagement with the new sciences (quantum mechanics, holography) in criminology, particularly focusing on ontology and epistemology. Classic social sciences are still based on Newtonian ontology (static time, space, materiality, authorship, objectivity, locality, linear causality). It is time for rethinking our core assumptions. Sociomateriality, for example, based on quantum theory has already made considerable appearances in other disciplines, unlike criminology. Applications will be provided to the quantitative and qualitative realm. Quantum decision-making (quantum logic/probability), much discussed in other disciplines, has yet to find engagement in contemporary criminology. We also offer possible contributions in the development of a transformative justice.

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1 Awarded title, "Bernard J. Brommel Distinguished Research Professor."

2 An earlier version of this paper was presented at the Annual Meeting of the American Society of Criminology, Chicago, Illinois, November 17–20, 2021.

This work has been substantially influenced by physicist-turned-philosopher Karan Barad (2007), political scientist Alexander Wendt (2015), and those working in quantum holography (Pribram, 2004; Bradley, 2011; Di Biase, 2021).

The use of quantum and/or quantum holography in criminology has been sparse, but includes applications in: critical criminology (Milovanovic, 2014a, 2014b); detecting terrorist identity signatures (Bradley, 2011); charismatic groups (Bradley, 1999); intuition (Bradley, 2010); sociology of law (Milovanovic, 2022: chapter 12); law (Tribe, 1989; Kuttner, 2011; Kelsey, 2013; Marlow, 2016; Milovanovic, 2018); social justice (Capeheart and Milovanovic, 2020: chapter 9); and decision-making in law (Jaeger and Trueblood, 2019). There have been engaged applications of quantum mechanics in philosophy, sociology, neuroscience, informational sciences, and in quantum biology.

CORE MODELS

Two foundational explications are necessary for orientation to quantum mechanics and quantum holography. They provide a key entrance to each's respective field. In quantum mechanics it is the "double-slit" experiment. In holography, we have a simple projector exposition, as well as a foundational study by Nobel Prize winner Dennis Gabor (1946).

Quantum mechanics. The key fundamental conceptualization is the "double-slit" experiment,³ first imagined by Young in 1801 and published in 1803, but given greater thought and consistent experimental verification over the years since the dynamic founding years of the 1920s.⁴ After much theoretical debate (via thought experiments), including, noteworthy, those between Einstein and Niels Bohr (Kumar, 2011), empirical studies began to be devised by the mid-1990s testing core propositions.

In the double-slit experiment two slits are cut into a barrier (first screen) and on the other side a recording medium (second screen). A light beam (or electrons)⁵ passes through the two slits and forms a characteristic wave interference pattern on the recording medium on the other side. Where they overlap, high with high (amplitudes), we have an interference pattern. On the recording medium we notice dark and light bands, the bright light bands representing the interference patterns. Thus, represented here are wave-forms (wave functions, ψ). Now if one were to introduce some measurement or observation at the point of the two slits what one will

3 This and next cited in Milovanovic, 2022.

4 For further clarification of the double-slit experiment and its variations (quantum erasure, delayed choice), it is advisable to watch the following videos before continuing: <https://www.youtube.com/watch?v=xo176uIPmbY>; https://www.youtube.com/watch?v=8ORLN_KwAgs&t=7s; <https://www.youtube.com/watch?v=l8gQ5GNk16s>.

5 Larger and larger beams are being employed, presently including over a 2,000-atom molecule with anticipation of using a living organism (tardigrades: about a millimeter wide). Thus, supporting the idea that the quantum effects do indeed have affects all the way up (see, for example, Ball, 2021, "How Big Can the Quantum World Be? Physicists Probe the Limits," <https://www.quantamagazine.org/how-big-can-the-quantum-world-be-physicists-probe-the-limits-20210818/>, 11.4.2021).

find is that the recording medium will no longer display interference patterns/wave-forms, but two distinct patterns; in other words, particle-forms. Said in another way, observation or measurement collapses the wave-form into a particle (object) form. Remove the measurement/observation, and the interference pattern returns.⁶ This has been translated as consciousness collapses the wave function, even though, at best an “abstract ego” was posited doing the observation. We respond with offering Schema QD as that abstract ego.

Moreover, in the productive exchanges, often as thought-experiments, between Albert Einstein, a vehement critic of quantum mechanics – God does not play dice! – and Niels Bohr – don’t tell God what to do! –, a founding figure of its key axioms in the 1920s, Bohr, argued that understanding the double-slit experiment and the collapse of the wave function must incorporate the total physical (experimental) arrangement (apparatus) including the discourse with which the experiment is constructed and expressed. Thus, the material and discursive are co-constitutive,⁷ a material-discursive practice (see also Barad, 2007) in explaining the wave function; that is, how the wave-form collapses into the particle-form. The concept, apparatus, accords with Foucault’s *dispositif*, and Deleuze and Guattari’s (1987) notion of assemblages, and best conceptualized by Hjemslev’s quadripartite notion of semiotics (expression and content, each by substance and form) (see Deleuze and Guattari, 1987). Accordingly, we can envision the legal apparatus, and its nested forms, e.g., court apparatus, police stationhouse apparatus, interrogation room apparatus, etc., each with its distinct material-discursive practices.

Quantum holography. A hologram⁸ is an interference pattern whereby an emitting wave from some “object” (“object beam”) intersects with a light source, and all is encoded in some medium (see for example, Workman, 2013). By shining a light (“reference beam”) back on the medium one can reconstruct the original image; in fact, anywhere one shines the light on the medium (“nonlocality”) the image re-appears in full form. A simple experiment explains holography (Pribram, 2014; Bradley, 2010). Take an old slide projector, put a picture slide into it, take out the lens, and no-thing appears on the screen, only a lit-up surface. Place a pair of eye glasses in the light ray cone and the image reappears on the recording screen, and everywhere you point the eye glasses. The lesson: information is stored nonlocally; the light ray (an optic array, Gibson, 1969) encodes information; a lens (one’s eye) decodes this information into recognizable form.⁹

6 Variations of this (also see depictions on YouTube, Note 3) include the quantum erasure experiments where, *after* the electron/light beam has passed the slits, and even when it has already been recorded on the medium as a particle-form (two bands), with eliminating the observation/measurement observation/measurement, the interference pattern returns on the recording medium (an interference pattern). Implications here is, in marked contrast to the Newtonian ontology, that time is not fixed, that “things” can be recorded differently *after* the event has supposedly occurred. Things are never final.

7 Deleuze and Guattari’s (1987) notion of “double articulation” is assimilable.

8 See also Milovanovic, 2022.

9 This extends to all our senses (sight, touch, taste, hearing, and smell, as the traditional five, but many others have been recognized); lenses transform electromagnetic wave-forms, oscillations, emitted by all “objects” into patterns or forms, technically Fourier transforms. The lens of the eye

Dennis Gabor is the founder of holographic theory, beginning in 1946 with acoustics (he was measuring information embedded in transatlantic cable signals, specifically the smallest space in which a meaningful message can be discerned). His “Theory of Communication” was to make use of Heisenberg’s uncertainty principle (one cannot at the same time accurately measure momentum and location). He demonstrated how slices, or cuts (“gaussian envelopes”) from the intersections of the frequency domain and spacetime are constrained “quanta of information,” or “logons” (Korpel, 1982). His “time-frequency diagram” portrays the perpendicular axes of time and frequency and various possible intersections, cuts in signal wave-forms expressing informational units (logons). The much-employed Fourier transform (method for converting real time happenings into its frequency components),¹⁰ however, is sequential; it does not deal with both (time and frequency) simultaneously which must also include Heisenberg’s uncertainty principle; hence, the Gabor transforms (“wavelets,” see for example, Devleker, 2020). QH is also about the indeterminacy of superposition in contrast to the more deterministic classical holograms (correspondence between image, hologram, and recall). In other word, the QH wave-form encodes superposition (possible probabilistic states); that is, Schrödinger-like dynamic holograms (Laszlo, 1997, 2003). Extending on Gabor, this means that any information cell in his time-frequency diagram encodes superposition. Thus, the field of quantum holography.

Implications for the social sciences and criminology. Arguably, the key influential work for researchers in the social sciences has been Karan Barad’s *Meeting the Universe Halfway* (2007). Building on Barad’s (2007) “agential realism,” space, time, and materiality do not pre-exist the (co-constitutive) “intra-actions” that collapse the wave function, providing one materialization (boundaries, properties, identities, capabilities) from the several in a state of simultaneous possibilities called “superposition,” a “cloud of possibilities.” These are represented by the wave function (ψ); humans are wave functions (“human beings as quantum systems,” Wendt, 2015). The neologism, intra-action (Barad, 2007), counters the use of “interaction,” the latter assuming static identities that are in need of explanation. Different encounters and contexts – particularly shaped by apparatuses or assemblages – produce different intra-actions, and thus different realities. Thus, rendering a before and after, cause and effect are problematic. This finds verification in numerous empirical studies of variations of the double-slit experiments, the “quantum erasure” and “delayed choice” experiments. These studies indicate the forward linear causal arrow in time does not hold. Notions of criminal responsibilities, for example, must be re-thought. Responsibility is not a quality one has or owns, but is performatively enacted in context producing particular materializations. Useful here for comparison is Marlow’s (2016) version of quantum criminal responsibility compared to a more developed

for example transforms what is out there into spacetime flows (see Pribram 2014: 101–102). This Fourier transform is further translated at the back of the eye, carried along the optic nerve to the holonomic brain for further processing.

10 A reverse Fourier transformation, in turn, reverses the process, from the frequency patterns / interference patterns to visual images.

quantum approach by Barad (2007: 178; 2010: 261; 2012), Milovanovic (2018)¹¹ and Higgins (2021). Higgins (ibid.: 279), for example, drawing from indigenous science and a quantum interpretation, argues “response-ability invites conception of subject that is distributed along, within, and throughout the relationships through which we are co-constituted.”

Holography, concerns how information is stored, accessed and decoded. A hologram is an interference pattern. Throw two stones in a pond. Note where the waves intersect. Take two passing ships at sea. Where their waves intersect, we have interference patterns that encode information about the ships (or stones), their weights, directions, speed, etc.¹² This information is stored non-locally, meaning it does not reside in a distinct location but is spread out in some medium, sometimes referred to as the zero-point field, and called the “in-formation” field. A sugar-sized cube can holographically store all the information of the Library of Congress. All is fundamentally interconnected and only “cuts” (collapse of the wave function) produce momentary materializations from the multiple possibilities that simultaneously exist (“superposition”). All phenomena emit wave forms and hence are subject to forming interference patterns. Social sciences, including criminology, lack specificity as to the location, and the wherewithal of the process of accessing and decoding information. Consider a high crime street corner setting (context). The “techniques of neutralization” offered by the classic study by Sykes and Matza (1957) can be conceived as holographically encoded information within this field.

Holographic theory offers mechanisms (transaction model, and subsequent developers of a “phase conjugate adaptive resonance,” Pcar) by which this information is accessed and decoded (see, respectively, Cramer, 2015; Mitchell and Staretz, 2011).¹³ Traditional deterministic holography assumes this process of decoding is linear; quantum holography, on the other hand, following Heisenberg’s “uncertainty principle,” argues holograms are continuously in-process, and that the “cuts,” or collapse of the wave function are uncertain (Gabor, 1946). Consider Gabor’s (1946) work that indicates that “cuts” in electromagnetic wave forms represent quanta of information subject to Heisenberg’s uncertainty model; that is, with a “cut” we materialize static information, but its movement through spacetime, however, remains a “cloud of possibilities” (superposition).¹⁴ Counter to the incorporation of Newtonian ontology by contemporary criminology where ultimately a determinist universe prevails, a “clockwork universe,” instead, probabilities rule.

11 See also Milovanovic’s (2022) more developed statement.

12 Similarly, consider playing a musical instrument and where frequency patterns constructively overlap, we have interference patterns and harmonics. This leads to Di Biase (2009: 659–650), building on the work by Karl Pribram on the holographic structure of the brain, influenced in turn by Gabor, in suggesting “the music is not in the piano, but in the resonating field that surround it, so our memories and consciousness are not in the brain, but in the holographic information field that surrounds it.”

13 This can be associated, with more, as an operationalization of Barad’s notion (neologism) of “intra-action,” rather than the traditionally employed “inter-action” that assumes already what needs to be explained.

14 Consider, for example, the various identities (superposition) visited during the course of the day and how one may be materialized in context at a particular time.

Agency in Criminology. Conventional social sciences and criminology lack an agent (subject), conspicuously absent in the recently emergent post postmodernism and posthumanism. We offer one approximation, schema QD, which builds on a de-oedipalized Lacanian model.

Here, agency is a wave function. This can be diagrammed by a four-cornered entity: ego (image of self); Other (the person through whom one sees oneself); Organized/Community Other (normative orders);¹⁵ and ideal-ego (imagined ideal ego). Together, they form an inter-relational matrix having a distinguishable rest state. The space enclosed by the four components represents “réalité (see Lacan, 1977); a quantum approach (“diffractive reading”) interprets it manifesting by a reverse Fourier Transformations (Di Biase, 2009: 660) producing virtual images. With perturbation, different configurations of matrix values emerge; thus, we can speak of a human represented as a dissipative matrix. As in Jacques Lacan (1977), the agent is drawn out over all four corners simultaneously. The range of possible matrix values varies and remains in superposition existing simultaneously as possibilities until collapse. A person, in other words, in the normal everyday state exists in superposition with co-existing multiple possibilities of expression, ψ ; that is, virtual possibilities (dissipative matrices). Consider, for example, various identities in criminal justice: free citizen (with multiple possible states in the instance until a collapse), person of interest, suspect, defendant, felon, ex-felon. When perturbed in encounters, a distinct matrix with distinct values for each component emerges. They take distinct values in relation by way of intra-active performative enactments¹⁶ that both shape and are shaped by the realities materialized. This is equivalent to the collapse of the wave function. Consider, for example, the impact on the wave form (superposition) of the pronouncement: “Guilty!”

Each matrix is the basis of a distinct signature wave that encodes its characteristics (information) and is constantly being emitted outward. The signature wave is embodied in an “I,” a subject that can take up residence in material-discursive practices. It is this wave that engages other waves and accesses the holographic information field. The “transaction model” (Cramer, 2015; Mitchell and Staretz, 2011)¹⁷ provides the mechanism as to how emitters and absorbers, intra-actively constitute realities; in other words, material-discursive practices performatively enact everyday realities. Contemporary criminology all too often falls back to a Newtonian ontology of fixed objects, space, time and material to appreciate complexities in being human.

15 Conceptualized as an entangled, that is, a shared normative order. The more immediate organized community Other, borrowing from George Herbert Mead, can be distinguished by a more abstract generalized other which is more macro-level. We could also posit the existence of structured discursive subject-positions, often referred to as social roles, that offer structural locations within which an “I” can take up temporary residence in narrative constructions.

16 Performative can be traced to speech act theory where saying is doing, incorporated in Judith Butler’s (1990, 1993) work on gender identities.

17 The notion of phase conjugate adaptive resonance, an offshoot of the transaction model, posits some emitting wave being absorbed by a receiver, who returns information back to the source along the same pathway in establishing a standing wave, with no time passage. With repetition and a certain degree of intensity, the superposition state collapses at the source of emission (Mitchell and Staretz, 2011).

SPAWNINGS AND APPLICATIONS

Quantum mechanics has given birth to a number of developments including providing an alternative model of logic and probability to classical forms in understanding decision-making in law (see Busemeyer and Bruza, 2013; Jaeger and Trueblood, 2109), e.g., in jury decision-making. It also offers an alternative in understanding questionnaire construction and witness recollections. In quantum mechanics asking the question is the measurement that induces the collapse of the wave function to one from the many possibilities in superposition, unlike traditional research that assumes a pre-given position exists and only has to be discovered. Empirical research, for example (e.g., pick up any issue of the journal of *Criminology*), too often is enthralled with linear trajectories as in “path analysis”; quantum mechanics offers clouds of possibilities (superposition, ψ) in movement, more “lines of continuous variation” (Deleuze and Guattari, 1987).

Classical probability (CP) assumes a well-defined subject (particle) with clear boundaries, properties and capabilities locatable in static spacetime coordinates, and action that follows linear trajectories. CP also assumes well defined beliefs and well-defined preferences (Wendt, 2015: 166–167). Quantum probability (QP) assumes only superposition and context effects; that reality itself, including agency, time, space, and materiality do not pre-exist intra-active (co-constitutive) performative enactments by way of material-discursive practices. Trajectories don't exist; rather, at each instance, collapse of the wave function produces a rendition of “reality.” QP responds to the anomalies and paradoxes found in CP (e.g., order effects, conjunction fallacy, disjunction fallacy, preference reversals, etc., see review of literature and accessible statement by Jaeger and Trueblood, 2019; Wendt, 2015: 154–173). It has been found that QP overcomes these anomalies in assuming superposition, wave functions, and collapse.¹⁸

Thus, for example, Max Weber's classical statement on formal rationality in law can be countered by substantive irrationality, partly acknowledged in recent movements away from rational choice theory in criminology to a “bounded rationality,” or a situational rationality. Going further, QP supports an “unbounded rationality” developed by some QP theorists (Wendt, 2015: 167).¹⁹ In this view, “when questions are incompatible and thus classical rationality is impossible there simply is no normative standard of rationality. All rationality in such situations is contextual and particular” (Wendt, 2015: 168). In this view, a more subjective construction of rationality needs to be considered on how decision-making takes place, “by reference to how people themselves define success as they try solve problem in their lives” (Wendt, 2015: 168). Certainly, the challenge is before us to construct a form of rationality that is genuinely connected to the human condition.

18 Consider police lineups, either sequential or collective and the ordering effects (Jaeger and Trueblood, 2019). Or consider multiple charges and how each are viewed by the juror. Order counts. The early resolutions (collapse of the wave function from otherwise superposition state) sets the context for the resolution of the next.

19 In this view, subspaces exist, abstractly defined as Hilbert spaces, each of which can be the loci of decision-making, thus a form of substantive rationality, and subspaces can be incompatible, inconsistent or contradictory, loci for decision-making making for a substantive irrationality; thus, defying principles of formal rationality as a basis for decision-making.

Another area of application (diffractive methodology, Barad, 2007)²⁰ is comparing the criminal justice system (CRJ), to restorative justice (RS), and to transformative justice (TJ). CRJ can be conceived of as an assemblage, an apparatus, more akin to Foucault's *dispositif*, offering more limited or more expansive affordances, that shape identities via intra-actions and the collapse of the wave function. Particular identities of the offender, for example, are performatively enacted in material-discursive practices in various encounters and stages of processing.²¹ Alternatively, RJ begins an alternative in making agency more multicomplex and subject to co-constitutive constructions that increase capabilities, not reduce them as experienced by both the victim and offender in CRJ.

TJ, by engaging the macro *and* micro, goes beyond the more limited foray by RS, particularly articulated in approaches such as “conflict transformation” and “transformative mediation.” It is a call for the creation of new identities (Woolford, 2020) that acknowledge quantum entanglements. Quantum approaches to mediation have seen some initial engagement in the work of Kuttner (2011) and others in law (Kelsey, 2013; Tribe, 1989). The work by Maruna on a “redemptive based justice” and desistance theory is in accord and ripe for a diffractive reading through quantum holography particularly in identity constructions recognizing the fluid dissipative matrices that evolve in context, and the need for assemblages that provide affordances that liberate, enhance, and expand the development of capabilities. It is a call for de-investing in harms of reduction and repression and for the expansion of greater capabilities through “good encounters”²² that invest in the materialization of desire as production.²³ Engagement with quantum mechanics sensitizes us to the diverse possibilities (superposition) of human agency, with recognizing the necessity of going beyond the anthropocentric bias (Capeheart and Milovanovic, 2020: chapter 7), the latter of which remains as a yet unexplored focal point of diffractive reading with quantum mechanics and quantum holography. Embraced, in short, is Derrida's and Barad's call for a “justice-to-come.”

Thus, there is a need to: (1) engage quantum decision-making, (2) recognize a quantum-based mind and consciousness, (3) move away from mere metaphor or analogy, or statements of “quantum-like,” and (4) begin to articulate the quantum mechanisms of mind/consciousness as it related to quantum-based decision-making.

- 20 We embrace Barad's (2007) call, developed from the feminist work of Donna Haraway, for a “diffractive methodology” which is reading quantum mechanics and quantum holography through particular theories to note their co-constitutive possibilities and what are also excluded. That is, we produce interference patterns, a space in which novelty, surprise, and emergents can unfold for the development of new insights.
- 21 Each encounter in justice systems is understood as having access to a relatively bounded sphere of holographically encoded information, subject to accessing and decoding by way of a context-shaped QD signature wave representing an “I” enacted in performative material discursive practices.
- 22 Space limitations preclude a fuller discussion of “good encounters.” The philosophical basis is derived from synthesizing Spinoza, Nietzsche, Deleuze and Guattari. See, for example, Milovanovic's (2022) application to “credible messengers.” Good encounters increase capabilities and entanglements and leave a trace in the social fabric (quantum holographic field).
- 23 Desire as production is from Deleuze and Guattari's work, and is a counter to desire read “lack.” Desire is associated with actualizing capabilities, defined as the ability to affect and being affected.

Quantum holography, addressing how information is stored, accessed, decoded and acted on, goes beyond traditional research in specifying the process as a complex, dynamic, and emergent. Karl Pribram (2014) in neuroscience and his followers have produced considerable amount of research on the operation of the quantum holographic brain. Raymond Bradley (2011, 1999, 2010), who wrote with Pribram, has applied quantum holography to terrorist identities, the nature of solidarity, the wherewithal of entrepreneurial intuitive practices, and alternative possibilities in human relations, the latter leading to alternative intuitions as to the nature of a transformative justice.

CONCLUSION

Quantum mechanics has generated considerable momentum in the development of new insights in other fields but yet criminology remains rather oblivious to the tools it has provided. Our foray is intended to be a provocation. The new sciences have offered a new basis for understanding ontology. The Newtonian ontology remains embedded in social sciences, and is quite apparent in criminology. We must go beyond rehearsing contemporary paradigms in criminology. Engagement with the new sciences promises a new beginning in understanding crime, decision-making, probability theory, methodology, and possible insights into TJ. Quantum holography provides a new understanding of how information is stored, accessed, and decoded. The direction is clear.

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„ŠTA ĆEMO SA KVANTIMA?“: UPOTREBA NOVIH NAUČNIH METODA U KRIMINOLOGIJI I KRIVIČNOM PRAVOSUĐU²⁴

REZIME

Savremene društvene nauke imaju svoj osnov u ontologiji Isaka Njutna. Ovaj interdisciplinarni članak zagovara saradnju sa „novim naukama“, posebno kvantnom teorijom i kvantnom holografijom. Rad se posebno fokusira na oblast kriminologije, koja se najviše opire promenama u vremenu kada je novo razmišljanje o problemu kriminaliteta neophodno. Predlaže i moguće promene u metodološkom pristupu koji se u kriminologiji koristi. Članak se zalaže za transformativnu pravdu kao zamenu za „krivičnu pravdu“ i „restorativnu pravdu“.

Ključne reči: kriminologija, kvantna teorija, kvantna holografija, transformativna pravda, restorativna pravda.

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24 Tekst koji je dobio nagradu pod nazivom “Bernard J. Brommel- Uvaženi profesor istraživač.”