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Quantum Theories and Modernism: Complementarity in Virginia Woolf, William James, Henri Bergson, and Niels Bohr

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In their 1976 collection of essays on modernism, Malcolm Bradbury and James McFarlane characterise modernism in the context of its times:

> Modernism […] is the one art that responds to the scenario of our chaos. It is the art consequent on Heisenberg's 'Uncertainty Principle', of the destruction of civilization and reason in the First World War, of the world changed and reinterpreted by Marx, Freud and Darwin, of capitalism and constant industrial acceleration, of existential exposure to meaninglessness or absurdity. (Bradbury and McFarlane 27)

While the confident use of the first-person plural now seems dated, I suspect that, outside the field of literature and science, the claim that modernism is consequent on Heisenberg's Uncertainty Principle remains current. Bradbury and McFarlane's first-person plural confidently unites all readers in a single pronoun and also has the effect of minimizing the distance between the years of modernism – given as 1890-1930 in the subtitle to their collection – and the mid 1970s. The chaos experienced by the modernists is also our chaos.

The problem – the first of many – is that if "consequent" implies a causal relation, the chronology does not work. The physicist Werner Heisenberg (1901-1976) first articulated the idea of uncertainty relations in a paper in 1927 (Heisenberg "Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik" ["The Physical Content of Quantum Kinematics and Mechanics"]), long after the crucial innovations of modernist literature, not to mention modernism in other media. However, Bradbury and McFarlane should not be dismissed entirely. The durability of their claim and others like it suggests that they identified a partial truth: that there are important similarities between Heisenberg's ideas, as well as those of other physicists such as Niels Bohr and Erwin Schrödinger, and the formal experiments of modernism. The causality, however, is more complex than they imply. Setting aside the possibility that the two developments were merely coincidental, there appear to be some common causal factors. The present article will focus on some of them in the fields of psychology, philosophy, and literature, with illustrative examples from Virginia Woolf's *Mrs Dalloway* (1925), and with a particular focus on the idea of complementarity.

Like Heisenberg's uncertainty principle, Niels Bohr's idea of complementarity was articulated too late to be a causal influence on high modernism. Bohr introduced the idea on 16 September 1927 in a lecture to physicists at the International Physics Congress, in Como, Italy; the lecture was printed in English in April 1928 (Bohr "The Quantum Postulate"). Nevertheless, its core idea is a suggestive one: that different pictures of the nature of matter might not be contradictory, but instead complementary; or, more generally, that different forms of knowledge might complement each other; that both/and might replace the exclusive logic of either/or. The idea of complementarity had significant antecedents in psychology and philosophy, with

William James and Henri Bergson being crucial figures. And it is important to keep in mind the epistemic value of literature in preparing a space for such ideas.

Quantum Theories

As chronology matters, and as even the phrase "quantum theory" is ambiguous in the early twentieth century, a recapitulation of key events is necessary. Within the domain of physics, Heisenberg's Uncertainty Principle is a consequence of Max Planck's 1900 discovery that energy exists in finite minimal units, quanta. Planck's discovery required a new model of the atom, and prompted the first phase of quantum theory. In 1913 Niels Bohr and Ernest Rutherford devised a model of the atom that took Planck's discovery into consideration. By July 1926 their model of the atom was being referred to in scientific circles as the "Old Quantum Theory" (Flint 48). The new quantum theory begins in 1925 with Heisenberg's "Über quantentheoretische Umdeutung kinematischer und mechanischer Beziehungen" ["Quantum-Theoretical Re-interpretation of Kinematic and Mechanical Relations"] of September 1925 and Niels Bohr's paper at the Scandinavian Mathematical Congress, Copenhagen, published in English in December 1925 as "Atomic Theory and Mechanics." The crucial papers in terms of cultural reception are the 1927 ones referred to earlier: Heisenberg's from March 1927 and Bohr's September 1927 paper at Como. Heisenberg's paper introduced the uncertainty relation, while Bohr's introduced the more general notion of the principle of complementarity.

There are of course many other fine details that one could add to this account of the 1920s and 1930s, such as the alternatives of matrix mechanics and wave mechanics, questions about whether uncertainty is an intrinsic property of nature, and Einstein's reluctance to accept uncertainty; but the foregoing will be sufficient to outline the ways that the quantum theories, old and new, entered into literary culture and into literary history. Quantum theories reached literary writers in non-technical forms in non-specialist publications, but the chronology of the old and new quantum theories' popularisation is a complex one. The incremental nature of developments in the field meant that quantum theory was never an *event* in the way that the discovery of x-rays or the experimental proof of Relativity Theory were. In *The Nature of the Physical World* (1928), an important and best-selling summary of the new physics and its philosophical implications, A. S. Eddington compares quantum theory to a building under construction, to be entered by the expositor only very cautiously (211).

In the U.K., between 1919 and 1923, Planck's theory, Bohr's model of the atom, and the dual nature of light can be found mentioned in generalist journals such as the *Athenaeum*, its successor the *Nation and Athenaeum*, and the *Spectator* (Anon., "Physical Chemistry"; Sullivan, "Unsolved Problem"; Sullivan, "Atomic Theory"). It is possible that some literary readers and writers encountered ideas from the new physics in literary works as well as in generalist or specialist journals. Ideas about the old quantum theory found their way into a monologue in Aldous Huxley's novel *Those Barren Leaves* (1925), where the scientist Calamy explains how the behaviour of light is explained by one theory and the behaviour of electrons in the atom by another "entirely inconsistent with it." (Huxley 345; see also Bradshaw). Although Calamy does not imply that one of the models must be wrong (the logic of either/or), he does not suggest that the two models might be complementary to each other.

The new quantum theories also appeared in generalist journals and other non-scientific arenas. An anomalous but interesting case in 1928 is a quotation from Bohr's "Atomic Theory and Mechanics" in the pages of the relatively conservative *Poetry Review*. The author was the poet and critic Michael Roberts, who was unusual among

his literary peers in that he had studied Chemistry at King's College, London, and Mathematics at Cambridge. He quoted Bohr's remark that the new model of the atom presented "a limitation of our usual means of visualization"; mathematical representations were to be preferred to mechanical models. Moreover, Roberts's example of the limits of visualization paraphrased Heisenberg's idea of uncertainty: "It is impossible," wrote Roberts, "to visualize an electron which can foresee the future and, if it has a position, is neither still nor in motion, and if it is still or in motion, has no position" (Roberts 438).

If Roberts, lured into a distracting anthropomorphism, provides a summary of uncertainty less crisp than later accounts, he may be excused for having fewer examples to draw upon. In the same month in the *Spectator*, J. B. S. Haldane was more precise: "We cannot determine accurately both where a particle is and how fast it is going, and the quantum is our unit of uncertainty" (Haldane 726). The publication of Eddington's *The Nature of the Physical World*, also in November 1928, occasioned other similarly succinct summaries of uncertainty in literary and generalist periodicals (C.P.S.; Sainsbury).

Knowledge of the new quantum theories filtered into literary writing and the conceptualisation of reading, writing, and imagination. Jonathan Bate has suggested that William Empson's knowledge of quantum theory enabled the interpretative move in his *Seven Types of Ambiguity* (1930), whereby a definitive choice between interpretations was replaced by the acceptance of radically conflicting alternatives. Catriona Livingstone has argued that when Woolf writes in a letter in July 1930 of jumping from her orbit, she is thinking of quantum leaps, not moving between planetary orbits (Livingstone 6). Building on primary evidence such as this and on contextual evidence about the circulation of ideas about quantum theory, Livingstone is able to argue persuasively that Woolf's accounts of observation and personal identity in *The Waves* (1931) and other works in the 1930s draw from quantum theory.

The fact remains that such events post-date the establishment of literary modernism. Bradbury and McFarlane's account was shaped, I suspect, by the several book-length accounts of the new physics and its philosophical implications published after the Second World War, rather than by an examination of the evidence from the 1920s and 1930s. After 1945, many of the innovative physicists of the 1920s repositioned themselves as public intellectuals (Carson). Among their books are Louis de Broglie's *The Revolution in Physics* (1953); Schrödinger's *Science, Theory and Man* (1957), a reissue, with one addition, of *Science and Human Temperament* (1935); Heisenberg's *Physics and Philosophy* (1958) and *The Physicist's Conception of Nature* (1958); Schrödinger's *Mind and Matter* (1958), the 1956 Tarner lectures; Bohr's *Atomic Physics and Human Knowledge* (1958); and Heisenberg's *Physics and Beyond* (1971).

Heisenberg's 1958 books are of particular importance in terms of the stories we tell about modernism. In 1965, in a major anthology of primary sources for literary and cultural study, *The Modern Tradition*, Richard Ellmann and Charles Feidelson, Jr., gave space to Heisenberg alongside more frequently named figures such as Marx, Freud, Darwin, Nietzsche and Frazer. Ellmann and Feidelson reprinted about 3300 words from *The Physicist's Conception of Nature* as part of a subsection called "indeterminacy"; they gave the extracts the title "Non-Objective Science and Uncertainty" (Ellmann and Feidelson 444). Heisenberg is lucid and quotable. Heisenberg's theatre metaphor, derived from Bohr, has attracted particular attention from critics:

> Science always presupposes the existence of man and, as Bohr has said, we must become conscious of the fact that we are not merely observers but also actors on the stage of life. (Heisenberg in Ellmann and Feiderson 446)

If one myth about science in the Cold War era was one of cold detachment – the sort of detachment that could create weapons of mass destruction – then Heisenberg's text provides the basis for a counter-myth, one in which science is inextricably immersed in nature. These accounts of quantum theory enable stories about science in which it is no longer objective and in which it is, in Evelyn Fox Keller's words "more humble" in its relation to the world (Nadeau 62). These constructions merge readily with the stories that are commonly told about literature's epistemic virtues, especially in the post-Romantic era: that literature is in some sense more aligned with subjectivity than objectivity; that it is sensitive to nature; that it has an ethical openness to the other. The commonest reference points for such stories are William Wordsworth's phrase (in the poem "The Tables Turned") about a "meddling intellect," "we murder to dissect" (Wordsworth 48) and John Keats's account in *Lamia* of a "cold philosophy" that would "[u]nweave a rainbow" (Keats 431).

In literary criticism and history, the post-war accounts of quantum theory are incorporated into a generalised account of pre-1939 modernity, of which Bradbury and McFarlane's introduction is a prime example. In literary history and criticism, this modernity is invoked in two ways. Firstly, it establishes a context for modernist writing, one in which the conditions of knowledge have radically altered. Writers are aware of the observer effect. They are open to the possibility that two kinds of knowledge might be complementary rather than mutually exclusive. They are aware that knowledge is embedded in a medium, whether material, for the physical sciences, or linguistic, for literature. Secondly, and more specifically, the physical theory provides an analogy for various kinds of uncertainty in modernist texts: in fiction and drama, the uncertainty that might shape one character's knowledge of another; and in all texts, the uncertainty that might affect us as readers, whether in relation to phrases, situations, or literary form. Modernist writing – characterised very broadly – embraces disjunction and parataxis; if there are hierarchies between the disparate parts of a text, they are not always explicitly signalled; the relations of parts need to be inferred by the reader and constructed; one reader's construction may differ from another's. In Virginia Woolf's often-quoted phrase, "the accent falls a little differently" (Woolf, "Modern Novels" 35); but, to an extent that she does not acknowledge, where it falls is left for the reader to decide.

It has been argued, by way of objection to the critical practices of historicist literature and science, that when scientific ideas are incorporated in literature, they are no longer recognisable as science. As John Limon stated it: "Writers of fiction cannot assimilate science into their work – except for a few secondhand doctrines that are deprived of scientific force or, in fact, identifiability […] when metaphorized" (23). There is a serious methodological concern behind such objections, but they can become so radically sceptical as to inhibit the discovery of any connections between forms of knowledge; Cousin's doctoral thesis (UnQuantum Woolf: The Many Intellectual Contexts of *To the Lighthouse*'s Metaphorical Wave-Particle Binary, 2022) is a strong instance of scepticism towards all literary-critical engagement with quantum theory. The serious concern is that, on the basis of a small fragment of evidence, we might construct a network of connections which is wholly a projection of our desire to find science in literature. One response to Limon's objection is that the work is never wholly autonomous: its meaning-making potential is always sustained by the reader's

knowledge of narrowly literary conventions and of a wider range of cultural references, including science. The same is true of a scientific paper: many of the conventions and practices of science and of the specific field to which the paper contributes remain tacit in the text.

In this regard, the literary reception of quantum theory is no different from the literary reception of other sciences: certain themes within the science are adopted by certain writers, other aspects of the science – most obviously its mathematical formalisms – are left untouched. A non-exhaustive list of key themes within the old and new quantum theories in the period 1900-1930 includes: the irreducible quantum; continuity / discontinuity (including the quantum leap); wave-particle duality; uncertainty and the observer effect; indeterminacy; and complementarity. The idea of the "observer effect" is articulated in the 1920s and 1930s but the compact phrase apparently emerges only after 1945, when it begins to circulate in the social sciences: the first instance of the phrase that I have located comes in an anthropological article (Firth 35n13). It is not possible to examine all of these quantum themes here, nor their post-1945 developments. The existing critical literature exists on two levels: general accounts of the cultural context, which, like Bradbury and McFarlane's *Modernism*, refer to quantum theories and quantum physicists in general terms without precise chronologies and accounts that engage more meticulously with specific concepts. Donley and Friedman, for example, write sweepingly that "indeterminacy and related themes" are crucial to the "tone and structure" of "much important 20th-century literature"; the final phrase does not distinguish between 1905 and 1935, though immense changes occurred in the interval (128). Baker, in an account which echoes Bradbury and McFarlane, writes of the "conceptual possibilities of both time and space" being refigured by Einstein and Heisenberg (3). Of the more meticulous accounts, Albright's *Quantum Poetics*, though bearing a promising title, focuses on the idea that that modernist poetics was characterised by a search for the "elementary particles" or the "minimum unit" of poetry, by analogy with Planck's quantum of energy (Albright 24, 114); complementarity, uncertainty, indeterminacy, and the observer effect are scarcely mentioned. Crossland gives considerably more attention to complementarity, distinguishing it from dualism, reading the gender binary of Woolf's *Orlando* (1928) in relation to it, and acknowledges the fine-grained chronology of the concept's emergence in the 1920s. Like the present account, Crossland's follows Holton in connecting Bohr's physics to William James's psychology, but it does not aim to trace the connection further back. Eames focuses on the problems of visualizability raised by quantum theory, but discusses complementarity in relation to Wallace Stevens (194).

Uncertainty and the 'Stream of Consciousness'

We can come to concrete examples of uncertainty in literary works by way of an anti-modernist, C. S. Lewis. In 1942 Lewis argued that attempts to depict the unconscious mind were contradictions in terms (131). For Lewis, there was nothing especially real about the chaos of "the mere stream of consciousness" in Joyce's *Ulysses* and other modern works. He argued that the introspective analysis of the unconscious was a fallacy, and he drew a comic analogy with a policeman who stops the traffic and then considers the stillness to be highly suspicious (131). The "very nature" of "unfocused consciousness" is "that it is not attended to." He continued:

> Inattention makes it what it is. The moment you put it into words you falsify it. It is like trying to see what a thing looks like when you are not looking at it.

> You cannot make a true picture of that no-man's-land between the visible and the invisible which exists on the edges of our field of vision, because just in so far as you make a picture you are bringing it into the centre. (Lewis 132)

Lewis does not mention quantum mechanics, but both the analogy of the policeman and the phrase about the observed unobserved – "trying to see what a thing looks like when you are not looking at it" – are suggestive of the observer effect. Moreover, to readers sympathetic to modernism, Lewis exactly summarises one aspect of what modernist writers were trying to do: capturing states that hovered between thought and feeling, or between feeling and mood, or between conscious and unconscious.

For Virginia Woolf and many novelists contemporary with her, the verb "to feel" (and similar verbs) is a useful tool, when placed in contrast with direct speech and with other verbs that indicate conscious thought and firmly held beliefs. In Woolf's *Mrs Dalloway* (1925) "to feel" conjures ambiguous states and does so particularly intriguingly when combined with a simile or metaphor. For example:

> Mrs. Dalloway raised her hand to her eyes, and, as the maid shut the door to, and she heard the swish of Lucy's skirts, she felt like a nun who has left the world and feels fold round her the familiar veils and the response to old devotions. (Woolf, *Mrs Dalloway* 26)

The first instance of the verb ("she felt") is the important one, though the second one within the nun-simile contributes. The essential ambiguities here concern whether Clarissa's feeling is something she is fully conscious of, and whether the simile is articulated by Clarissa or by some vestigial narratorial voice. The almost artless repetition of the verb in the simile is interesting because, by yoking together two distinct meanings of "to feel," it reminds us that feeling can be a tactile sensation – the feeling of the veils – or an emotional and spiritual one occasioned by familiar rituals; if as readers we had reached a singular interpretation of the meaning of "she felt," our confidence is called into question by the second instance of the verb. C. S. Lewis might object that Woolf has brought such feelings to the centre of our vision, but in doing so she has maintained an ambiguity about what we are seeing; the status of these feelings might differ from reader to reader, and even from reading to reading.

Constructions like this one not only create situations of uncertainty for the reader, but also suggest the existence of multiple consciousnesses within a single character, with the possibility that such consciousnesses exist in complementary relations to each other. Elsewhere Woolf's characters more explicitly articulate ideas of non-exclusivity, non-identity, and multiplicity. Clarissa, for example, is committed to a mode of reasoning in which one interpretation does not necessarily exclude another:

> She would not say of any one in the world now that they were this or were that. She felt very young; at the same time unspeakably aged. She sliced like a knife through everything; at the same time was outside, looking on. (Woolf, *Mrs Dalloway* 7-8)

The novel also provides a fuller account of Clarissa's sense of her personal duality in the scene where she sits in front of a mirror:

> How many million times she had seen her face, and always with the same imperceptible contraction! She pursed her lips when she looked in the glass. It was to give her face point. That was her self – pointed; dartlike; definite. That was her self when some effort, some call on her to be her self, drew the parts together, she alone knew how different, how incompatible and composed so for the world only into one centre, one diamond, one woman who sat in her drawing-room and made a meeting-point. (Woolf, *Mrs Dalloway* 33)

In this instance the contrast felt by Clarissa is reducible to a long-established one between the public persona and private feelings, but the language in which it is articulated, of something fluid being concentrated into something proverbially hard, is a relatively new one. Woolf could not have developed these ideas from the physics that postdated her novel, but her novel is nevertheless posing important epistemic questions. It is asking the reader whether things that we feel or register unconsciously should have the status of knowledge; it is asking the reader what we really know. Physics was not her source, but it is possible, that she drew on psychology, literature, and philosophy. To explore those possibilities, it is instructive to consider the place of complementarity in works by William James and Henri Bergson.

William James and Complementarity

The themes that characterise quantum mechanics had begun to emerge in psychology in the late nineteenth century, and because psychology exchanges ideas readily with fiction, they had also begun to emerge in literature. In tracing the connection from psychology to physics, the crucial document is the interview that Thomas S. Kuhn conducted with Niels Bohr on 17 November 1962, part of a project of gathering first-hand sources for a history of quantum physics. In the interview Bohr, then 77, was asked whether he had read philosophy early in his career:

> I read some, but that was an interest by [and here Bohr suddenly stopped and exclaimed] – oh, the whole thing is coming [back to me]! I was a close friend of Rubin [a fellow student, later psychologist], and, therefore, I actually read the work of William James. William James is really wonderful in the way he makes it clear – I think I read the book, or a paragraph, called . . . No, what is that called? it is called "The Stream of Thoughts," where he in a most clear manner shows that it is quite impossible to analyze things in terms of – I don't know what to call it, not atoms, I mean simply, if you have some things . . . they are so connected that if you try to separate them from each other, it just has nothing to do with the actual situation. I think that we shall really go into these things, and I know something about William James. (Holton 137)

As Gerald Holton notes, Bohr is alluding to James's *The Principles of Psychology* (1890), and was clearly interested in further discussing James's influence, but the evidence provided by the interview remains tantalising: the next day the Danish physicist unexpectedly died. There is other corroborating evidence of Bohr's interest in James, but also a degree of dispute over when he first read the psychologist. In the interview Bohr recalled it as being in 1905 or shortly afterwards, and certainly before 1912; but others have argued that it was in 1932 (Holton 138). If we accept Bohr's own account, then it is clear from the quoted passage that James's work encouraged an acceptance of holism and a scepticism towards atomism. In the *Principles of Psychology*, James also articulated the problem of introspection in terms that anticipate

C. S. Lewis's objection to modernist narration, and that also anticipate the physicists' observer effect: "The attempt at introspective analysis in these cases is in fact like seizing a spinning top to catch its motion, trying to turn up the gas quickly enough to see how the darkness looks" (1:44). Movement cannot be seized; the darkness cannot be observed without being altered.

Crucially, Holton also notes that, in *The Principles of Psychology*, in the chapter immediately prior to "The Stream of Thought", James had discussed cases of "hysterical anaesthesia" investigated by the French psychologists Pierre Janet and Alfred Binet (Holton 140-142). In one such case, the experimental subject known as Lucie was understood to have a "primary" or "normal" consciousness and a "secondary" one; the primary consciousness could be encouraged to become selectively blind to certain phenomena (such as certain numbered cards), while the secondary consciousness was alert to those phenomena and not to other things. From these examples, James drew the conclusion that the different aspects of a consciousness were *complementary*: "Give an object to one of the consciousnesses, and by that fact you remove it from the other or others" (James, *The Principles of Psychology*, quoted in Holton 142). Bohr's argument about our knowledge of the physical world was based on the implicit analogy that at sub-atomic scales our knowledge of one aspect of an entity was complementary to our knowledge of another; our knowledge of velocity was complementary to our knowledge of position.

Accounts of dual or double consciousness were widespread in both French and English: while much of the research originated in France, it was rapidly disseminated in English in both technical and non-technical forms. For example, Eugène Azam's "Amnésie périodique, ou doublement de la vie" ["Periodic Amnesia, or Doubling of Life"], first appeared in a French scientific weekly, the *Revue Scientifique de la France et de l'étranger*, in May 1876, and was summarised in English by Henry J. Slack in October of the same year in the *Popular Science Review*; in turn, Slack's account of Azam provided one of the many cases discussed by Richard Proctor in 1877 in *The Cornhill Magazine*.

Dissemination in the medium of fiction and drama must also be noted, and the debts of Robert Louis Stevenson's writing to psychological accounts of double consciousness have been noted by several critics: not only *The Strange Case of Dr Jekyll and Mr Hyde* (1886), but also his earlier play (co-authored with W. E. Henley), *Deacon Brodie, or, The double life* (1880) and the short story "Markheim" (1885) (Reid, Stiles). In this context, William James's enthusiasm for Stevenson's writing is intriguing, even if the works of Janet and Binet provided a sufficient basis for the idea of complementarity. From two letters to his sister Alice from 8 August 1886 and 27 September 1886 can be deduced that William James and his wife, Alice Howe Gibbens James, read *Kidnapped* (1886) in August and September 1886 (James, *The Correspondence* 156, 158). William read Stevenson's "A Chapter on Dreams", which describes the creative process that led to the composition of *The Strange Case of Dr Jekyll and Mr Hyde*, on its first publication in January 1888, as is apparent from a letter to Alice Howe Gibbons James of 29 January (James, *Correspondence* VI: 593). He read the essay "The Lantern-Bearers", very probably on its publication in February 1888, and certainly by April 1888 when he praised it, in a letter to his brother Henry James, as "one of the most beautiful things every [sic] written" (James, *Correspondence* II: 85); he later described it, in another letter to Henry on 6 August 1895, as "the true philosophy" (James, *Correspondence* II: 373). In April 1888 he also read his brother's essay on the Scottish author, as can be deduced from a letter from 19 April (James, *Correspondence* II: 85). His response to *The Strange Case of Dr Jekyll and Mr Hyde* is

not recorded, but he sent a copy to Alice Howe Gibbens James in March 1888, which implies that he considered it worthwhile reading (James, *Correspondence* VI: 599).

William James's ideas about complementarity draw on such literary resources. Although *The Principles of Psychology* was apparently the work read by Niels Bohr, the idea emerges elsewhere in James's work. As noted above, Stevenson's "The Lantern-Bearers" was a particular touchstone for James, and it was one of the literary works quoted at length in his essay "On a Certain Blindness in Human Beings" (1899). Stevenson's essay makes a case for romance as a literary mode in the face of the prevailing preference for realism, but its implications are wider. It begins with an anecdote of how, in his boyhood, Stevenson and his friends would gather together with bull's-eye lanterns tied to their belts and concealed beneath thick cloaks.

> The essence of this bliss was to walk by yourself in the black night; the slide shut; the top-coat buttoned; not a ray escaping, whether to conduct your footsteps or to make your glory public: a mere pillar of darkness in the dark; and all the while, deep down in the privacy of your fool's heart, to know you had a bull's-eye at your belt, and to exult and sing over the knowledge. (Stevenson, "The Lantern-Bearers" 253)

In this account the individual does not possess a split consciousness as such, but is conscious of the discrepancy between his external appearance and his private feelings. As Stevenson goes on to explain, the seemingly stolid person may have a poet within them:

> His life from without may seem but a rude mound of mud; there will be some golden chamber at the heart of it, in which he dwells delighted; and for as dark as his pathway seems to the observer, he will have some kind of a bull's-eye at his belt. (Stevenson, "The Lantern-Bearers" 253)

There will always be a contrast, Stevenson proposes, between what an external observer will see, and the report that the observed subjects would themselves give:

> To the ear of the stenographer, the talk is merely silly and indecent; but ask the boys themselves, and they are discussing (as it is highly proper they should) the possibilities of existence. To the eye of the observer they are wet and cold and drearily surrounded; but ask themselves, and they are in the heaven of a recondite pleasure, the ground of which is an ill-smelling lantern. (Stevenson, "The Lantern-Bearers" 255)

The external observer will always miss the joy, and "to miss the joy is to miss all" (Stevenson, "The Lantern-Bearers" 256). In "On a Certain Blindness", quoting this phrase, James comments:

> Indeed, it is. Yet we are but finite, and each one of us has some single specialized vocation of his own. And it seems as if energy in the service of its particular duties might be got only by hardening the heart toward everything unlike them. Our deadness toward all but one particular kind of joy would thus be the price we inevitably have to pay for being practical creatures. (James, "On a Certain Blindness" 240-41)

Whereas in Stevenson's essay there was a clear contrast between the superficial view of the realist observer and the inner truth of romance, James's commentary on Stevenson steers his ideas in the direction of pragmatism: he implies that any point of view would derive from a "single specialized vocation" and would thus be blind or dead to other points of view. In the conclusion, James remarks that "neither the whole of truth nor the whole of good is revealed to any single observer, although each observer gains a partial superiority of insight from the peculiar position in which he stands" (James, "On a Certain Blindness" 264). James does not say that the "peculiar position" of one observer might be complemented by another, and so stops short of the position of complementarity, but he brings us to the verge of it. Commenting on "On a Certain Blindness" when it was reprinted in 1899, James went slightly further, saying that the truth is too great for any one actual mind […] to know the whole of it. The facts and worths of life need many cognizers to take them in" (James, *Talks* v).

If one cannot draw a straight line of influence from quantum mechanics to modernist literature, then one can certainly draw a line from both of them back to William James's *The Principles of Psychology*. However, other lines complicate the picture: a line of influence from the double consciousness case-studies of the 1870s directly to William James, but also from the case-studies to gothic fiction, notably *The Strange Case of Dr Jekyll and Mr Hyde*, and thence to James; from the case-studies, perhaps, to Stevenson's "The Lantern-Bearers", and from that essay to William James's account of multiple complementary observers; from gothic fiction, and from James, to modernist literature.

Henri Bergson and Complementarity

This is by no means the whole story. Tracing the word "complementarity" in English, the earliest instance arises in the context of economics, where it stands in a contrastive relation to substitution: some new technologies substitute for others, or for human labour, while others stand in a relationship of "complementarity and interdependence" with human labour or with other forms of technology (Davenport). In this context, however, the complementarity does not describe two interconnected forms of *knowledge*. The *Oxford English Dictionary*'s earliest recorded use of the word at present comes from Arthur Mitchell's 1911 translation of Henri Bergson's *L'Évolution créatrice* (1907), where it renders the occurrences of Bergson's "complémentarité" ("complementarity", *OED*). Given Bergson's influence on early modernism, the passages are of some interest. In the first, complementarity is a version of the idea of harmony in nature; it is a form of harmony which admits local disharmonies, while finding harmony in the statistical average:

> The species and the individual thus think only of themselves—whence arises a possible conflict with other forms of life. Harmony, therefore, does not exist in fact; it exists rather in principle; I mean that the original impetus is a *common* impetus, and the higher we ascend the stream of life the more do diverse tendencies appear complementary to each other. Thus the wind at a street-corner divides into diverging currents which are all one and the same gust. Harmony, or rather "complementarity," is revealed only in the mass, in tendencies rather than in states. (Bergson, *Creative Evolution* 53-54)

In this instance, the complementary currents of the stream of life are not complementary ways of knowing. In Mitchell's translation, the term "complementarity" also appears in the Index, pointing to no fewer than twenty-six locations in the text, even though the

word itself appears only in two passages. Mitchell's index in effect interprets the text in relation to a word that Bergson had used only occasionally. The most interesting passage in relation to the present investigation is one indexed as "Complementarity […] of intuition and intellect" (Bergson, *Creative Evolution* 398). Bergson outlines the shortcoming of physics: it cannot understand time as "invention"; restricted to a "cinematographical method" it isolates each moment in time from all others, like individual frames in a cinema film. Physics is typical of intellect. As a kind of knowledge, intellect is not without value: it enables us "to foresee the future" and makes us "in some measure masters of events." But there ought to be, says Bergson, "a second kind of knowledge": one that is useless, practically speaking, but which will hold reality "in a firm and final embrace." This is intuition. Without using the word "complementarity" itself, Bergson speaks of this "second kind of knowledge" as "complet[ing] the intellect and its knowledge of matter" and being "complementary" to it (Bergson, *Creative Evolution* 361-62).

Bergson's duality builds on the well-known distinction between *le temps* and *la durée* [time and duration] established in his earlier work, *Essai sur les données immédiates de la conscience* (1889), known in English as *Time and Free Will* (1910). In that book, although the two modes of apprehension of the passage of time are seen as complementary, Bergson also establishes an evaluative hierarchy in which duration is the truer form of time. If complementarity implies parity between the complementary modes of knowledge, then the relation between time and duration allowed it only grudgingly, by conceding a practical value to time.

Bergson was to develop this binary further in *Matière et mémoire* (1896), translated into English as *Matter and Memory* (1911). In this work, Bergson develops a model of mind in which it exists between two poles, those of memory and perception. Sydney Waterlow provided a concise exposition in a 1912 review of Bergson's principal works:

> My mental life may vary from a state which contains almost nothing but perceptions, to one which contains almost nothing but memory. At one end of the scale is the state of things that occurs when I react to an imminent danger, as to a sudden blow threatening my eye. Here there is no memory, but a close approximation to pure perception; my mental life is narrowed down to a point and consists solely of a reflex action caused by my brain-process. But normally my mental life is immensely wider than the actions which correspond, point to point, with brain-process. At the other end of the scale is the diffused mental state which, when we merely remember or are sunk in reverie, includes no perception of a present object; and, by a process which he describes as one of dilatation and contraction, our minds range through all the stages between these two extremes. (Waterlow 166)

As with the relation of clock-time and duration, the two psychical states serve different purposes, and exist as complementary forms of knowledge. Bergson does not directly describe them as such, though he does draw on the concept when explaining the relation between two psychical mechanisms, "association of similarity" and "association of contiguity": "they represent the two complementary aspects of one and the same fundamental tendency, the tendency of every organism to extract from a given situation that in it which is useful" (Bergson, *Matter and Memory* 217-18).

It is also notable that Bergson cites Pierre Janet at several points in *Matter and Memory*, referring to his *Automatisme psychologique* ["Psychological Automatism"]

(1889) and *L'état mental des hysteriques* ["The Mental State of Hysterics"] (1894); both works contain accounts of Lucie and of other case studies; he also cites James's *Principles of Psychology*. In considering the different forms that memory loss can take, Bergson argues that some memories which are "apparently destroyed" are in fact present but lacking the conditions necessary for their actualisation (Bergson, *Matter and Memory* 150, 151). Bergson summarises examples of temporary memory losses from Forbes Winslow's *On Obscure Diseases of the Brain* (1861): a man who selectively "forgot" the letter "F", and another who forgot – but only temporarily – languages he had learned and poems he had written. Bergson remarks: "we cannot avoid noticing the analogy between these phenomena and that dividing of the self of which instances have been described by Pierre Janet: some of them bear a remarkable resemblance to the 'negative hallucinations' and suggestions with *point de repère*, induced by hypnotizers" (Bergson, *Matter and Memory* 151).

Bergson's account of the duality of matter and mind, and of time and duration, also forms part of the network of ideas about complementarity. I have suggested elsewhere that Virginia Woolf's account of Clarissa Dalloway at her dressing-table, giving her face "point", drawing parts together, bears the imprint of Henri Bergson's ideas about the personality "narrowing down" for the purposes of action or undergoing "dilatation" when asleep or relaxed (Bergson, *Matter and Memory* xiv; see also Whitworth 125-26). Although Woolf, responding to an academic inquirer in 1932, categorically denied ever having read Bergson, her saying so does not exclude her having read second-hand accounts of him, or having heard them in conversation (Woolf, *Letters* V: 91). Sydney Waterlow, author of the review quoted earlier, was part of Woolf's social circle, and had proposed marriage to the then Virginia Stephen in 1912, the year of his review-essay on Bergson. His account of dilatation and contraction seems particularly close to Woolf's in *Mrs Dalloway*, not to mention other works.

Although in the scene at the dressing-table, Clarissa does not face the kind of extreme threat envisaged by Waterlow, such as damage to the eye, but rather the emotional strain of presenting a personality in public, elsewhere we see something closer to the question of survival. In the third paragraph of the novel, Clarissa is in what Waterlow called a "diffused mental state" (166), a state of reverie, thinking first about Bourton and then about Peter Walsh. With the fourth paragraph, there is an abrupt transition: "She stiffened a little on the kerb, waiting for Durtnall's van to pass" (Woolf, *Mrs Dalloway* 4). The London traffic is an imminent danger; Clarissa's stiffening may be read as a reflex action, a focusing of attention for the purposes of survival. Bergson's complementary conception of personality informs Woolf's shifts of narrative focus between the interior and the exterior and her characters' sense of self.

Conclusion

Although they conjure an evocative cloud of causal factors in the formation of modernism, Bradbury and McFarlane, writing for a non-specialist readership, over-simplify. A full account of modernism needs not only the uncertainty principle but also complementarity and the observer effect, not to mention x-rays, the spatial fourth dimension, and relativity theory; it needs not only Freud but also William James and Henri Bergson. The eclipse of James as a significant formative force in the modernist movement is partly due to the prestige of Freud in the period 1945 to 1980. The eclipse of Bergson may be traced to the moment when modernist writers identified their work with 'classicism' and placed themselves in opposition to Bergson's supposed Romanticism (Levenson 80-88, 208-10). By the 1970s physics held greater epistemic prestige than Bergson's philosophy. Moreover, as noted earlier, several innovative

physicists of the 1920s had repositioned themselves as public intellectuals. It seems possible that invoking Bergson in the context of complementarity became taboo; his presence was permitted only in discussions of time, where his distinction of *le temps* and *la durée* could scarcely be avoided.

If it is difficult to establish the lines of causality, that is in part because critics in the post-war era relied on retrospective accounts such as Heisenberg's *The Physicist's Conception of Nature* rather than the primary texts available to the modernist writers themselves; such primary texts provide us with finer-grained chronologies and more nuanced reception evidence. However, the difficulty is also due to the extent that literature had anticipated some of the themes of the quantum theories. As noted earlier, literature is alive to the respects in which knowledge is embodied in particular media and in particular knowers. The observer paradox is nothing new to it. That modernist literature, like modernist painting, drew attention to its medium, was suggested in the period itself, for example in Viktor Shklovsky's 1917 reference to literature "roughening" its verbal surface (27), or T. S. Eliot's 1921 reference to the modern poet needing to "dislocate" language into his meaning (670). Later, Eagleton would broadly characterize the modernist work as one that "thickens its textures" (392), and although Butler would criticise the hyperbole of Eagleton's account (273), he himself wrote of the way that in modernist painting there was "an oscillation between brush stroke as object in itself and as representation of something other," a contradiction that denies the "transparency of the medium" and draws attention to the "language of the work" (76). A literature that foregrounds its verbal medium, as much modernist writing does, is aware that knowledge may be embedded in its medium. As regards the theme of complementarity, late Victorian gothic literature, drawing on psychology and psychopathology, had anticipated the theme of complementary forms of knowledge, although, unlike the physicists, it typically placed contrasting states of consciousness in a hierarchical relation: above and below, or man and beast. Modernist writing absorbed some of those ideas, realising them at the level of its conception of self and of narration rather than the level of event. Clarissa Dalloway at her mirror is not Dr. Jekyll in his laboratory, but they are distantly related.

After the mid 1920s, aspects of modernist literature might more plausibly be said to be consequent on the new quantum theory. It would require a further study to determine whether distinctive forms of literary indeterminacy or complementarity emerge in the late 1920s and beyond. The difficulty inherent in such a study would be to differentiate between the kinds of literary indeterminacy and complementarity that had emerged prior to 1925, and later kinds that drew on a knowledge of physics. One could more readily investigate the discourse of literary criticism and polemic and examine when authors and reviewers began unambiguously drawing on the terminology of quantum theory to understand literary experimentation. However, given the rich mixture of conceptual materials in play, the question of whether and how quantum theory entered the texts themselves would remain more difficult to determine.

Works Cited

Albright, Daniel. *Quantum poetics: Yeats, Pound, Eliot, and the Science of Modernism*. Cambridge UP, 1997.

Anon. [J. W. N. Sullivan]. "Physical Chemistry." *Athenaeum* no.4652, 27 June 1919, p. 528. Anonymous contributions to the *Athenaeum* identified using the editor's marked copies held at City University, London.

Azam, E. "Amnésie périodique, ou doublement de la vie." ["Periodic Amnesia, or Doubling of Life"] *Revue Scientifique de la France et de l'étranger*, 2e serie, 5e année, no.47, 20 Mai 1876, pp. 481-89.

Baker, Houston A., Jr. *Modernism and the Harlem Renaissance*. U of Chicago P, 1987.

Bate, Jonathan. "Words in a Quantum World." *Times Literary Supplement*, no. 4919, 25 July 1997, pp. 14-15.

Bergson, Henri. *Creative Evolution*, tr. A. Mitchell. Macmillan, 1911.

---. *Matter and Memory*, tr. Nancy M. Paul and W. Scott Palmer. George Allen and Unwin, 1911.

Bohr, Niels. "Atomic Theory and Mechanics." *Nature*, vol. 116, 5 December 1925, pp. 845-52.

---. "The Quantum Postulate and the Recent Development of Atomic Theory." *Nature*, vol. 121, 14 April 1928, pp. 580-90.

Bradbury, Malcolm and James McFarlane. "The Name and Nature of Modernism." *Modernism, 1890-1930*. Penguin, 1976.

Bradshaw, David. "The Best of Companions. J. W. N Sullivan, Aldous Huxley, and the New Physics." *Review of English Studies*, vol. 47, no. 187, 1996, pp. 352-68.

Butler, Christopher. *Early Modernism: Literature, Music, and Painting in Europe, 1900-1916*. Clarendon Press, 1994.

Carson, Cathryn. *Heisenberg in the Atomic Age: Science and the Public Sphere*. Cambridge UP, 2010.

"Complementarity". *Oxford English Dictionary*, 3rd edition. Online at oed.com. Consulted 23 June 2023.

Cousin, Xavier. ' UnQuantum Woolf: The Many Intellectual Contexts of *To the Lighthouse*'s Metaphorical Wave-Particle Binary.' Phd thesis, Durham University, 2022.

Crossland, Rachel. *Modernist Physics: Waves, Particles, and Relativities in the Writings of Virginia Woolf and D. H. Lawrence*. Oxford UP, 2018.

Davenport, H. J. "Proportions of Factors--Advantage and Size." *The Quarterly Journal Of Economics* 23, no. 4, 1909, pp. 593–617.

Eagleton, Terry. "Capitalism, Modernism and Postmodernism." *Modern Criticism and Theory: A Reader*, edited by David Lodge, Longman, 1988, pp. 385-98.

Eddington, A.S. *The Nature of the Physical World.* Cambridge UP, 1928.

Eliot, T. S. "The Metaphysical Poets." *Times Literary Supplement*, no.1031, 20 October 1921, pp. 669-670.

Ellmann, Richard and Charles Feidelson, Jr., editors. *The Modern Tradition: Backgrounds of Modern Literature*. Oxford UP, 1965.

Firth, Raymond. "Religious Belief and Personal Adjustment." *The Journal of the Royal Anthropological Institute of Great Britain and Ireland* 78, no. 1/2, 1948, pp. 25–43.

Flint, H. T. "The New Quantum Theory." *Science Progress in the Twentieth Century*, vol. 21, no. 81, July 1926, pp. 48–56.

Friedman, Alan J., and Carol C. Donley. *Einstein as Myth and Muse*. Cambridge UP,

1985.
Haldane, J.B.S. "Physics declares its Independence." *The Spectator*, 141, no.5328, 17 November 1928, pp. 725-26.
Heisenberg, Werner. "Über quantentheoretische Umdeutung kinematischer und Mechanischer Beziehungen." ["Quantum-Theoretical Re-interpretation of Kinematic and Mechanical Relations"] *Zeitschrift für Physik*, vol. 33, 1925, pp. 879-893 [received July 29, 1925, published September 1925].
---. "Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik." *Zeitschrift für Physik*, vol. 43, 1927, pp. 172-98; ["The Physical Content of Quantum Kinematics and Mechanics"] in *Quantum Theory and Measurement*, edited by John Archibald Wheeler and Wojciech Hubert Zurek, Princeton UP, 1983, pp. 62-84.
Holton, Gerald. *Thematic Origins of Scientific Thought: Kepler to Einstein.* Harvard UP, 1973.
Huxley, Aldous. *Those Barren Leaves*. Chatto & Windus, 1925.
James, Henry. "Robert Louis Stevenson." *Century Illustrated Magazine*, 35, no.6, April 1888, pp. 869-79.
James, William. "On a Certain Blindness in Human Beings." *Talks to Teachers on Psychology*, Henry Holt, 1899, pp. 229-264.
---. *The Principles of Psychology*, 2 vols. Henry Holt, 1890.
---. *The Correspondence of William James*, edited by Ignas K. Skrupskelis and Elizabeth M. Berkeley. UP of Virginia, 1992-2004, 12 vols.
Keats, John. "Lamia" in *The Complete Poems*, ed. John Barnard, 2nd edition, Penguin, 1977, pp. 414-33.
Levenson, Michael H. *A Genealogy of Modernism: A Study of English Literary Doctrine, 1908-1922*. Cambridge UP, 1984.
Lewis, C.S. *A Preface to Paradise Lost*. Oxford UP, 1942.
Limon, John. *The Place of Fiction in the Time of Science: A Disciplinary History of American Writing*. Cambridge UP, 1990.
Livingstone, Catriona. *Virginia Woolf, Science, Radio, and Identity*. Cambridge UP, 2022.
Nadeau, Robert. *Readings from the New Book on Nature: Physics and Metaphysics in The Modern Novel*. U of Massachusetts P, 1981.
Proctor, Richard. "Dual Consciousness." *The Cornhill Magazine* 35, no.205, January 1877, pp. 86-105. Authorship identified using the *Wellesley Index*.
Reid, Julia. *Robert Louis Stevenson, Science, and the Fin De Siècle*. Palgrave Macmillan, 2006.
Roberts, Michael. "On Mechanical Hallelujahs, or How Not to Do It." *Poetry Review*, 19, no.6, November-December 1928, pp. 433-38.
S., C.P. "The Laws of Nature." *Nation and Athenaeum*, 44, 29 December 1928, pp. 469-70.
Sainsbury, Geoffrey. "The Nature of the Physical World." *New Adelphi*, 2 no.4, June 1929, pp. 355-59.
Shklovsky, Viktor. "Art as Technique." *Modern Criticism and Theory: A Reader*, edited by David Lodge. Longman, 1988, pp. 16-30.
Slack, Henry J. "What is the Meaning of Human Personality?" *Popular Science Review* 15, October 1876, pp. 389-97.
Stevenson, Robert Louis. "A Chapter on Dreams." *Scribner's Magazine*, vol. 3, no.1, January 1888, pp. 122-28.
---. "The Lantern-Bearers." *Scribner's Magazine*, vol. 3, no.2, February 1888, pp. 251

56.
Stiles, Anne. "Robert Louis Stevenson's *Jekyll and Hyde* and the Double Brain." *Studies in English Literature, 1500-1900*, vol. 46, no. 4, 2006, pp. 879-900.
Sullivan, J. W. N. "The Atomic Theory: Atoms Immaterial." *Spectator*, no. 4966, 1 September 1923, pp. 280-81.
---. "An Unsolved Problem." *Nation & Athenaeum*, 29, 30 July 1921, pp. 660.
Waterlow, Sydney. "The Philosophy of Henri Bergson." *Quarterly Review*, no. 430, January 1912, pp. 152-176.
Whitworth, Michael H. *Virginia Woolf*. Oxford UP, 2005.
Woolf, Virginia. "Modern Novels." *The Essays of Virginia Woolf*, edited by Andrew McNeillie and Stuart N. Clarke, 6 vols., Hogarth, 1986-2011, vol. 3, pp. 30-37.
---. *Letters of Virginia Woolf*, edited by Nigel Nicolson and Joanne Trautmann Banks. Hogarth, 1975-1980, 6 vols.
---. *Mrs. Dalloway*, edited by Anne E. Fernald. Cambridge UP, 2015.
Wordsworth, William. "The Tables Turned" in *William Wordsworth*, edited by Stephen Gill, Oxford UP, 2010, pp. 47-48.