Charles Olson and the Quest for a Quantum Poetics

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Abstract
This paper investigates the ways the American poet Charles Olson helped twentieth-century writers create a "quantum poetics" that could reflect the discoveries of modern relativity theories and particle physics. In the first third of my paper, I show how Olson's seminal essay "Projective Verse" advances a method of reading poetry which draws from Einstein's special theory of relativity. In the second third of my paper, I discuss the ways Olson drew from quantum mechanics in his poetry and prose. There I also show how Olson's writing invites readers to construct a method of reading rooted in physicist Niels Bohr's principle of "complementarity." In the final third of my paper, I show how Olson used Einstein's theory of a unified field model to theorize poetry as a unified field of action.

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At some point between 1928 and 1930, William Carlos Williams wrote that in the modern age there was "a subtle loss of dignity in saying a man is a poet instead of a scientist" (*The Embodiment of Knowledge* 51). Williams wasn't the only one to make this observation. In his 1927 volume *Science and Poetry*, I.A. Richards also suggested that poetry had lost its place in the age of science. There Richards confesses that although he feels hopeful about the future of poetry, a "more representative modern view is that the future of poetry is *nil*" (15, emphasis in original). Rather than lament this state of affairs, Williams and his fellow writers realized they would need to address the science and technology that had become vital to American culture. This would require the development of a new poetics, a poetics that could draw upon the revolutions introduced by twentieth-century relativity theories and particle physics. If they wanted to remain a significant force in the age of Einstein, American poets would need to develop a quantum poetics.

Recent scholarship has charted the development of such a poetics. Patricia Monaghan introduced the term "quantum poetics" in her dissertation of the same name, where she analyzed the ways Wallace Stevens, Linda Gregg, and other American writers incorporated ideas from modern physics into their poetry. Daniel Albright attempted a similar task in his own *Quantum Poetics*, where he examined the work of Yeats, Pound, and Eliot in light of their studies of physics. Other scholars such as Stephen Carter and Wayne Kobylinski have also explored the ways twentieth-century poets drew upon the sciences to theorize poetry.[i] Each of these scholars has provided significant insights into the ways writers worked to create a body of poetics that could mirror the discoveries of modern physics. None of the extant scholarship on quantum poetics, however, has examined the significant contributions Charles Olson made to that body of poetics. Despite Peter Middleton's observation that "Olson probably had a deeper understanding of the transformations of knowledge brought about by science than any other poet of his

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and science (221).[ii] By examining the ways Olson helped his peers establish a poetics founded upon insights from physics, this study seeks to reexamine the ways twentieth-century writers worked to make poetry relevant in a scientific age.

I. Einstein Comes to America: Poetic Responses to Special Relativity

American writers who patterned their poetry on the work of physicists were, in one sense, participating in a longstanding tradition. In his preface to the first edition of Leaves of Grass, Walt Whitman suggested that the best of poetry has always been founded on scientific grounds: “Exact science and its practical movements are no checks on the greatest poet but always his encouragement and support. . . . [Scientists] are not poets, but they are the lawgivers of poets and their construction underlies the structure of every perfect poem” (220). If writers in the twentieth-century wished to construct their poetry on solid scientific grounds, they would have to turn to the most famous of twentieth-century scientists: Albert Einstein.

In their book on Einstein, Alan Friedman and Carol Donley show how Einstein's physics opened up a “pandora's box” of revolutionary concepts for the modern world (8). Their study examines the ways public discussions in early twentieth-century America “began to wrestle with the new concepts of relativity, of indeterminism, of an expanding universe, [and] of the hypothetical—rather than absolute—nature of scientific laws” (8). Fueled by a “relativity industry” of popular accounts detailing modern physics, even those without training in the sciences began discussing Einstein's work (Friedman and Donley 17). Writing in the midst of these discussions, Wyndham Lewis observed that “the layman . . . knows more about Relativity physics than any layman has ever known about the newtonian [sic] cosmology” (141). As the American public discussed the shrinking rulers and slowing clocks of Einstein's cosmology, it became clear that the old concepts of Newtonian space and time were no longer adequate for modern experience. In short, to quote Bertrand Russell, Einstein's physics “demanded . . . a change in our imaginative picture of the world” (9). American poets attempted to paint this new picture.

Many poets writing in America during the first half of the twentieth-century were at least familiar with popular accounts of Einstein's work. Print sources such as *The New York Times, Scientific American*, *Popular Science Monthly* and a host of other periodicals published non-technical explanations of Einstein's physics for lay audiences, and by the 1920s, even arts journals like the *New Republic* and *Contact* regularly published analyses of Einstein's ideas (Steinman 58-61, Friedman and Donley 10-17). Reading these publications, poets came to understand that in Einstein's physics, space and time were no longer the rigid things they were for Newton. While in the Newtonian world the length of an object and the duration of an event were well-defined quantities, in the Einsteinian world length and duration were variables that change as one's velocity changes. In the world of Einstein, spaceships shrink as they approach the speed of light, and clocks aboard those ships slow to a crawl.

Poets were quickly attracted to these startling predictions of Einstein's work. Reflecting on the loss of absolute space and time, W.H. Auden wrote, “all our intuitions mock / The formal logic of the clock,” (36) and Robert Creeley wrote, “now I got space and / time like a broken watch" (413). While Einstein makes occasional appearances in the work of Auden and Creeley, other poets developed even closer ties to the physicist's work. Archibald MacLeish's long poem "Einstein," for instance, sustains an extensive meditation on relativity. Louis Zukofsky translated a popular biography of Einstein and discussed the physicist's work in his correspondence with William Carlos Williams, who shared Einstein's work with other American poets. In many of his lectures and essays, Williams drew attention to the ways Einstein's theories had changed the world, and he asked poets to acknowledge those changes in their writing. In one paper he read to a gathering of poets, Williams asks: "How can we accept Einstein's theory of relativity, affecting our very conception of the heavens about us of which poets write so much, without incorporating its essential fact—the relativity of measurements—into our…poem[s]?" (Selected Essays 283). Williams attempted to help his fellow poets embrace Einstein's theory by developing a system of poetics that could reflect the "relativity of measurements" he found in special relativity.

As Williams knew, Einstein's 1905 theory of special relativity was in essence a theory of measurements. According to Einstein's theory, the length of an object is a more fluid attribute than our every-day perceptions lead us to believe. While in everyday life, objects appear to have well-defined shapes and sizes, special relativity predicts that the shape and size of an object are dependent on the relationship between objects and observers. In particular, an object's shape and size are dependent upon the relationship between that object's velocity and the velocity of an observer. If, for instance, a poet who is stationary on earth were to observe a rocket heading towards the earth at an extraordinarily high velocity, that rocket would appear to shrink, or "contract." However, observers on the rocket would find that nothing about their vessel had changed; they would find instead that the earth appears to be egg-shaped. According to the theory of special relativity, both sets of observations are correct. Although the observers cannot agree about the length of the ship or the shape of the earth, both of their measurements are correct within their respective frames of reference.

Einstein's special relativity also predicted that the observer on earth and the crew on the rocket would disagree about certain measurements of time intervals. What seemed a short duration of time for an observer aboard the rocket could seem an eternity for an observer on earth. In order to account for these disagreements, Einstein's special relativity synthesized space and time into a single "space-time" unit and then showed how physicists can use this unit to account for differences in measurements from different frames of reference.

For many poets, the revolutionary concept of Einsteinian space-time necessitated a rethinking of poetic space and time. Before the twentieth-century, discussions of the spatial and temporal dimensions of poetry were dominated by analyses of fixed syllable patterns. After Einstein's special relativity, however, it became increasingly common for poets to abandon fixed metrics in favor of more fluid poetic constructs. In order to help poets conceptualize their writing in terms of Einstein's special relativity, William Carlos Williams developed his own fluid poetic metric and called it "the relativistic or variable foot" (*Selected Letters* 335). As Lisa Steinman has shown, Williams developed his variable foot as a direct response to Einstein's physics, for he believed his body of poetics could be only as “valid as it is a part of the world . . . of Einstein” (qtd. 76 Steinman). Denise Levertov, a lifelong friend of Williams, showed how the variable foot links the space and time of a poem in a way that loosely resembles Einsteinian relativity.[iii] According to Levertov, the variable foot refers to the idea that each line of poetry ought to be read for the same duration of time. In other words, it should take a reader as long to read a line with one word in it as it does to read a line with twelve words in it. Reading a poem in this manner, one must stretch out or lengthen the pronunciation of certain words while foreshortening or contracting the pronunciation of other words. Like in Einstein's special relativity, where rockets and planets stretch and shrink as they move through space-time, in variable foot poetics, words stretch and shrink as they move through the poem. Take the following selection from Williams's poem “St. Francis Einstein of the Daffodils” as an example:

> April Einstein has come
> to liberate us
> [. . .]
> April Einstein
> [. . .]
> has come among the daffodils
> shouting
> that flowers and men
> were created
> relatively equal. (*Collected Poems* 131)

If one reads each of these lines for the same duration of time, certain words must be read swiftly while others must be read slowly. For instance, the first time we come to Einstein's name, it appears in a line with three other words beside it, and thus must be read fairly quickly. The second time we encounter his name, however, there are fewer words in the line, so we must stretch out our pronunciation of the word “Einstein.” In this way, Einstein appears stretched and contracted as a reader moves through the poem, much like objects appear stretched and contracted in the world described by special relativity.

In his seminal essay “Projective Verse,” Charles Olson built upon the work of Williams to develop a method of reading that was more faithful to Einstein's special relativity than the variable foot was. Shortly before writing “Projective Verse,” Olson read Einstein's *Essays in Science*, a text which deeply influenced his early writing. We find traces of Olson's fascination with Einstein in his letters from the “Projective Verse” period, where he shares his enthusiasm for special relativity with his friend and sometimes lover Frances Boldereff.[iv] We also find traces of Olson's interest in Einstein in his inaugural lecture at the Black Mountain College, where he told his audience: “Time and space are in the relation of a parabola, plane to cone. Nor I nor Einstein would want to disentangle them” (“Notes” 2).[v] Indeed, in “Projective Verse,” Olson advances a system of poetics in which space and time are as “entangled” as they are in Einstein's special relativity. There he writes: “if a contemporary poet leaves a space as long as the phrase before it, he means that space to be held . . . an equal length of time” (*Collected Prose* 245).

A brief analysis of the conclusion to Olson's poem "Incunabula, 1958" provides a vivid illustration of this concept:

love by word of mouth,
    ,love,
        love by mouth
            (Collected Poems 485)

Following the method of reading set forth in "Projective Verse," we read the first line of this phrase and then pause. We then examine the second line of the poem and note that it is preceded by a blank space as long as the first line. According to Olson, this blank space is meant to signify a duration of silence in the work. Because this blank space is "as long as the phrase before it," we should understand that the poet "means that space to be held" for a duration of time equal to the length of time it took to read the first line. After holding that silence, we read the phrase ", love," before pausing again. Once more, because the third line is preceded by a blank space as long as the first two lines, we should hold a silence for a duration equal to the amount of time it took us to read "love by word of mouth / , love." Reading Olson's poem in this way, one finds that the spatial orientation of words in the text structures certain temporal relationships in the text. We therefore find that the model of reading Olson advances in "Projective Verse" helps to synthesize the spatial and temporal relationships of a poem into a unit which dimly resembles Einsteinian "space-time."

Upon further analysis, we find that Olson's formulation of poetic space-time is more faithful to special relativity than Williams's variable foot is. In variable foot prosody, a reader should spend a fixed amount of time reading each line of poetry. For Einstein, however, time is not a well-defined or fixed quantity. According to special relativity, two observers who witness the same chain of events may well disagree about the time it took for those events to occur. Unlike Williams's variable foot, Olson's poetics links space and time without requiring that either be fixed. By synthesizing poetic space and time without fixing the metric of either, Olson's poetics improved upon Williams's variable foot and helped poetry to better reflect the world described by modern physics.

Shortly before Olson wrote "Projective Verse," literary scholar Herbert Muller noted that Einstein's physics allowed artists and scientists to unite their discourses. "The all-important implication of the physicists' new view," Muller wrote, "is that it makes possible a reconciliation of…art…and science after long years of invidious specialization" (92). By translating special relativity into a method of poetic reading, Olson indeed helped poets and scientists reconcile their differences and work towards a common understanding of their shared world. When he turned his attention to quantum mechanics, Olson refined this synthesis and emerged as the unrivaled leader in the quest for a quantum poetics.

II. The Search for a Poetics of Particle Physics

If special relativity led poets to envision a world of shrinking rulers and melting clocks, quantum mechanics led them to envision a world ruled by indeterminacy, chance, and chaos. Around the turn of the century, physicists began describing the strange behavior of subatomic particles. In 1900, Max Planck showed that the world was not made up of fluid and continuous waves of energy as physicists had believed, but was composed instead of discrete and indivisible units of energy, now called “quanta.” Within three decades, physicists had discovered enough about the mechanics of quanta systems to announce a revolutionary world-view, a world-view that continues to raise provocative questions for both physicists and poets.vi By 1927, Louis de Broglie had shown that particles of solid matter behave like ocean waves, and Werner Heisenberg had announced his famous “uncertainty principle.” Remarking on these physicists' depictions of the bizarre quantum realm, Wyndham Lewis announced that mountains are now “as gaseous as a puff of smoke” (359), and physicist Sir Arthur Eddington declared that “physics is no longer pledged to a scheme of deterministic law” (qtd. Bell 26, italics in original). These results puzzled physicists as much as they puzzled poets. Reflecting on the difficulty scientists had describing the atomic realm, the physicist Niels Bohr remarked: “When it comes to atoms, the language that must be used is the language of poetry” (qtd. Harrison 123). And as atomic physicists turned to the language of poetry, poets turned to the language of atomic physics.

The chaos of atomic physics inspired many writers more than Einstein’s special relativity did. While special relativity challenged poets’ intuitive notions of length and temporal duration, the quantum mechanics of Heisenberg, Schrödinger, and others suggested that events at the atomic level are inherently unpredictable and chaotic. Observing the chaotic world-view that quantum mechanics had ushered in, the poet Robert Duncan announced that “atomic physics has brought us to the threshold” of a new epistemology (224). Duncan's declaration rang true for Dada, Fluxus, and Surrealist writers, who drew upon the indeterminacies of the new quantum epistemology to justify their use of chance procedures. Duncan's declaration rang equally true for writers like D.H. Lawrence, who found in quantum mechanics an analog of the chaos of modernity. Within the modern world, Lawrence wrote, “the electron behaves and misbehaves incomprehensibly” (950). For Lawrence and others, the unpredictability of quantum states constituted the entirety of “the considerable mess that isn't even worth the name of the universe any / more” (Lawrence 950).

Many poets learned about the chaotic world of electrons that Lawrence describes from the same sources that introduced them to special relativity. Reading those publications, poets came to discover that the quantum realm is comprised of two mutually exclusive phenomena: particles and waves. Particles, such as electrons and protons, appeared to be discrete, material objects that follow certain behavioral laws. Waves, such as electric and magnetic fields, appeared to be continuous, immaterial phenomena that follow different behavioral laws. Reading the vast literature of wave and particle theories physicists were producing, poets drew upon both models to advance their poetics.

Some poets drew from physicists' particle theories to analyze the smallest units of meaning in poetry. Daniel Albright has referred to the collection of writers who sought to analyze the “particles of poetry” as “the atomic school” of poets (5). According to Albright, this school “tends to support [the idea that] a poem's strongest meanings reside in its smallest elements—symbol, image, vortex” (5). By breaking poems down to their smallest significant units, the atomic school of poets sought to theorize the quarks, or elementary particles, of verse. Albright identifies Pound as a member of the atomic school, claiming that "the *vortex* is Pound's *quark*" with which he can describe the economy of meaning in a work of art (162, italics in original). Inspired by nature's vortices, where small whirlwinds create terrific forces, Pound sought to describe the ways the smallest particles of an artwork can generate far-reaching consequences.

While poets from the atomic school drew from physicists' particle theories, other poets drew from physicists' wave theories. Albright identifies Eliot, Yeats, and Lawrence as members of the "wave school" of poets (Albright 18, 59, 264). According to Albright, the wave school sought to mirror the fluidity and instability of ocean and radio waves in their works. Drawing alternatively from Joycean stream of consciousness, Heraclitean flux, and Bergsonian *durée*, writers in the wave school envisioned poetry as a "telepathic stream" which "unit[es] writer and reader in a state of electrical immediacy" (Albright 19).[vii]

Within the first decades of the twentieth-century, however, physicists rendered both the particle school and the wave school of poetics obsolete when they discovered that neither particle models nor wave models—taken in isolation—could adequately describe the behavior of quantum systems. Physicists came to these conclusions during their investigations of light. For centuries, light appeared to behave like a wave. Philosophers and scientists from Aristotle through Descartes argued for a wave model of light, and in his well-known double slit experiment in 1803, Thomas Young demonstrated light's wave-like properties. At the same time, however, thinkers from Democritus through Newton argued that light behaves like a particle, and in 1915 Robert Millikan demonstrated light's particle-like properties. Although physicists could not observe the discontinuous, particle-like behavior of light while at the same time observing the continuous, wave-like behavior of light, it was clear, in the words of Charles Olson, that "light is not only a wave but a corpuscle" (*Collected Prose* 124).[viii]

The French physicist Louis de Broglie generalized these results in 1927 when he suggested that *all matter* exhibits both wave-like and particle-like behaviors. If waves of light can behave like particles, de Broglie reasoned, then other matter can behave like waves. Soon it seemed that the material world was no more physical than a flash of lightning. Remarking upon the picture of the universe de Broglie painted, Wyndham Lewis wrote: "natural science, observing [massive objects, such as mountains], knows that they are only humbugging, in a sense. They are, in their degree, as liquid as the wave" (359). As Lewis knew, even mountains demonstrate what physicists call "wave-particle duality," or a combination of particle-like and wave-like behaviors. This wave-particle duality meant that a thorough description of a phenomena, whether in physics or poetry, now required a description of that phenomena's particle-like and wave-like behavior.

Olson was well aware of wave-particle duality, and drew upon that duality to help him theorize poetry. He begins this project in "Projective Verse," where he describes both the particle-like and wave-like behaviors of poetry. According to Olson, poetry exhibits particle-like behavior because it is comprised of syllables, which he deems "the smallest particle[s] of all" (*Collected Prose* 241). But poetry also demonstrates wave-like behavior, Olson insists, because poems transmit energy in wave-like ways: "A poem is energy transferred from where the poet got it . . . by way of the poem itself to . . . the reader" (*Collected Prose* 240). In Olson's analysis, a poet harnesses energy from one or several sources, then reifies that energy into particle-syllables so others can reconvert those particle-syllables back into energy. In this way, Olson theorizes poetry as a combination of particles and waves, which allows his poetics to more accurately reflect the insights of modern physics than either "particle school" or "wave school" models do.

Olson also knew that wave-particle duality meant there were fundamental limitations to what one can observe and know. Because matter exhibits both wave-like and particle-like behavior, and because one cannot observe both sets of behavior at the same time, there are fundamental limitations to our observations of quantum systems. Heisenberg's uncertainty principle represented these limitations in a mathematical form, and Olson drew upon Heisenberg's principle to theorize poetry. In his first book, *Call Me Ishmael*, Olson defines the uncertainty principle as: "Heisenberg's law that you learn the speed [of a particle] at the cost of exact knowledge of the [particle's] energy and the energy at the loss of exact knowledge of the speed" (63 *Collected Prose*). In other words, the more precisely we measure certain aspects of a particle, the less precisely we can measure certain other aspects of that particle. As a more general form of the phenomena observed in wave-particle duality—according to which we can observe either a quantum object's particle behavior or wave behavior, but not both simultaneously—Heisenberg's uncertainty principle shows that certain measurements of quantum systems are "incompatible" with other measurements, since "measurements of one will . . . necessarily disrupt the other" (Albert 7).

Olson was interested in Heisenberg's uncertainty principle because it placed limitations on what we can know. In *The Special View of History*, he explores those limitations when he connects Heisenberg's principle to the "uncertainties, mysteries, and doubts" of Keats's negative capability. "Right out of the mouth of physics" Olson writes, "one can seize the condition Keats insisted a man must stay in the midst of" (39). In Olson's analysis, it was "Heisenberg [who] gave us the wonderful words for to go with Keats' ambiguity: The Uncertainty Principle" (39). He uses Heisenberg's principle to suggest that any attempt to obtain complete knowledge about a system—to know "*both* mass and momentum, or substance & motion"—requires one to settle in "uncertainties, mysteries [and] doubts" (39, italics in original). Every attempt to completely describe a system or a poem, Olson suggests, will be met with Heisenberg's uncertainty and Keatsian mystery.

Elsewhere in his writing Olson tacitly acknowledges the impossibility of completely describing a poem by demanding that readers adopt a method of reading rooted in what the Danish physicist Niels Bohr called "comeplementarity." Bohr used the term complementarity to refer to situations in quantum mechanics where a physicist must combine two mutually exclusive phenomena in order to understand a single phenomenon. For example, one cannot observe both the particle-like behavior of light and the wave-like behavior of light at the same time; they are mutually exclusive phenomena. Nevertheless, one must combine these mutually exclusive phenomena in order to understand the way light behaves. Likewise, as we shall see, Olson's writing forces readers to construct multiple, mutually exclusive interpretations of his texts, and then to combine those interpretations into a single reading.

Take for example the demands Olson places on readers in his description of complementarity. Olson introduces the term “complementarity” in his essay “Equal, That Is, to the Real Itself,” where he uses complementarity to theorize the ways Herman Melville depicts reality. According to Olson, Melville “was…aware of the complementarity of each of two pairs of how we know and present the real—image & object, and action & subject” (*Collected Prose* 124). Here Olson suggests that Melville was aware of the fact that we come to “know…the real” by recognizing the complementarity between “image & object” as well as the complementarity between “action & subject.” Exploring these two complementarities individually helps to reveal how Olson demands readers to develop a complementarity of reading.

First Olson suggests that we come to know “the real” by recognizing the complementarity between “image & object.” In this formulation, images and objects are mutually exclusive phenomena that one must combine if one wants to know “the real”. To express the same thought in Kantian terms, one can say that the phenomenal realm (“image”) is entirely distinct from the noumenal realm (“object”), but that these mutually exclusive realms must be combined in theories of “the real.” Like Kant, who needed noumena to idealize phenomena, Olson suggests that a description of “the real” necessitates idealizations of both realms. More generally, Olson's uneasy combination of image and object means that any artist or scientist who wishes to understand the world must study both objects in the world as well as representations of those objects. Thus the artistic act of depicting objects in images becomes a complementary and necessary element of scientific discourse.

Secondly Olson suggests that we come to know the real by recognizing the complementarity between “action & subject.” In this formulation, a subject and her actions are mutually exclusive phenomena. Here Olson, like Paul de Man before him, is in search of a literal answer to Yeats's question: “How can we know the dancer from the dance?” (Yeats 215).[ix] By theorizing “action & subject” as complementary terms in Bohr's sense, Olson suggests that there is an absolute alterity between dancer and dance, while at the same time insisting that the two must be combined in our descriptions of “the real.”

Returning to Olson's sentence on complementarity, however, one finds a fundamental ambiguity at play in his adaptation of Bohr's theory. Olson's claim, again, is that Melville was aware of “the complementarity of each of two pairs of how we know and present the real—image & object, and action & subject.” In my previous paragraphs, the complementarity indeed lies between “each” of Olson's pairs; in the first case the complementarity lies between “image & object” and in the second, between “action & subject.” However, it is possible to read Olson's sentence in a second way—and this second reading leads to a radically different conceptualization of “the real.” In this second reading, one can interpret Olson's sentence to mean that “we know and present the real” by analyzing the complementarity between the combined unit (image & object) on the one hand, and the combined (action & subject) on the other.

Whereas “image” and “object” were mutually exclusive terms in the first reading, in this second reading Olson couples image and object into a single assemblage. By synthesizing image (or representation) and object (or being) in this formulation, Olson adopts a position of “strong correlationism,” wherein one “only ever ha[s] access to the correlation between thinking and being, and never to either term considered apart from the other” (Meillassoux 5). This Parmenidean synthesis of thinking and being—or word and world—is in keeping with Olson's suggestion to Robert Creeley that “the real end” of writing, “the thing worth trying to get to do, is to heave out of oneself a proper noun, or more than one, which is both so recapitulatory and so intensive that it CAUSES the past, which means makes the future” (qtd. *Vol. 9 Complete Correspondence* ix). While in the first reading of Olson's sentence image and object were mutually exclusive phenomena, here they work together as mutually constitutive aspects of “the real.”

At the same time, the second reading of Olson's complementarity synthesizes “action & subject”—which were mutually exclusive in the first reading—into a single unit. Here the dancer *just is* the dance; no radical theorizing is necessary.

Having established the combined units (image-object) and (action-subject), one can begin to think through what it would mean for there to be a complementarity between those units. Olson's suggestion seems to be that theories of “the real” must understand objective forms as mutually exclusive from subjective action. In order to theorize the complementarity in this reading, one must take up the task of phenomenology and produce a union of subject and object, a task Olson devoted great attention to.

The syntax of Olson's sentence is so obliterated that each of these readings of his sentence seems as legitimate as the other, despite the fact that one cannot maintain both readings at the same time. It seems, therefore, that the complementarity in Olson's sentence does not lie in either of the readings I've outlined but rather in *the complementarity between those readings*. That is to say, the ambiguities of Olson's writing, here and elsewhere, allow readers to construct multiple, mutually exclusive readings of his text. In order to fully explore the horizons of meaning in his writing, however, one must combine these mutually exclusive interpretations into a single reading. In this way, Olson's poetry and poetics demand readers to accept the paradoxes of conflicting readings—forcing readers to settle in the “mysteries, uncertainties, and doubts” that both Heisenberg and Keats explored.

Since the emergence of wave-particle duality and Bohr's complementarity, quantum mechanics has described a sub-atomic world where seemingly irreconcilable phenomena come together. Reading Olson's construction of a wave-particle poetics, and responding to Olson's demand for a complementarity of reading, one finds that quantum mechanics also serves as the domain within which Olson synthesizes the seemingly irreconcilable discourses of poetry and physics. In his later writing, Olson attempted to perfect this synthesis by creating a poetic analog of the holy grail of theoretical physics: the unified field theory. This long-desired theory—which would combine quantum mechanics and relativity into a single descriptive model—eluded even Einstein. Despite the fact that no physicist in his day or in ours has discovered such a theory, Olson boldly went where no poet has ever gone and derived the first unified field theory.

III. From General Relativity to a Unified Field Theory

Although Einstein played a vital role in the development of quantum mechanics, he eventually rejected the chaos which permeated physicists' descriptions of quantum systems. A devoted realist, Einstein believed the uncertainty of quantum systems was a result of our incomplete knowledge of those systems, not an inherent characteristic of the systems. According to Einstein's well known phrase, “God does not throw dice in determining how electrons should go!” (qtd. Friedman and Donley 121).

While the great names of twentieth-century physics worked to bolster the quantum theories, Einstein turned his back on his contemporaries and began the lonely quest for a new theory, a theory which could describe quantum mechanics in a deterministic model. That model would unite the fields of electricity, magnetism, gravity, and quantum mechanics into a single field, a unified field. If Einstein developed this so-called “unified field theory,” it would be the most significant discovery of his career and arguably the most significant discovery in the history of physics.

Einstein worked toward his unified theory by extending the equations he derived in his second well-known theory, the general theory of relativity. And as he worked to develop a unified field model, his general theory of relativity launched him into public super-stardom. In 1919 Sir Arthur Eddington's eclipse expedition confirmed the predictions of general relativity, and within months leading newspapers in Europe and the United States celebrated Einstein's theory.[x] In those papers, readers discovered Einstein's second revolutionary model of the universe, a model wherein space curves as mass moves through it. A simple analogy helps to illustrate this curving space: place a bowling ball on a mattress and then attempt to roll a marble past the bowling ball in a straight line; the bowling ball will curve the marble's trajectory. Similarly, in general relativity, the presence of massive objects curves space-time lines. Reading through a veritable sea of non-technical explanations of Einstein's theory, poets and artists came to embrace the bending space of general relativity as they worked to map their art onto the scientific ideas of their age.

For many poets, the bending space of Einstein's general relativity suggested a loosening up of previous conceptions of space. While the Newtonian world-view envisioned space as a rigid and well-defined entity, Einstein's space seemed elastic and flexible. Ezra Pound noted this flexibility in a letter to Zukofsky, where he discussed “the unincumbhered elasticity of Einsteinian (thak godnot GertSteinian) relativity [sic]” (*Pound / Zukofsky* 87). Thomas Hardy's “Drinking Song” expressed both the excitement and the confusion many poets felt as they grappled with this “unincumbhered elasticity”:

> And now comes Einstein with a notion--
>   Not yet quite clear
>   To many here--
> That's there's no time, no space, no motion,

Nor rathe nor late,
Nor square nor straight,
But just a sort of bending-ocean. (qtd. Albright 13-14)

Poets living in America were equally interested in the “bending-ocean” of Einsteinian space-time. E.E. Cummings comically discussed the new ideas of curved space-time in his poem “Space being(don't forget to remember)Curved,” and Ed Dorn imagined himself in “The Grand Car with the super Interior” which “Moves with a basal shift So Large / It would be a dream to feel time curve” (48). While poets such as Cummings and Dorn offered imaginative responses to general relativity, other poets used Einstein's theory to motivate philosophical arguments. Archibald Macleish, for instance, claimed that the bending space-time of general relativity meant that the universe must have always existed:

Space-time has no beginning and no end.
It has no door where anything can enter.
How break and enter what will only bend? (266)

Writers like Macleish came to realize that Einstein's general relativity was in essence a geometrical theory. Before Einstein, most scientists and philosophers believed the universe was shaped like an extended Euclidean space.[xi] Those Euclidean models employed the familiar geometry which has been taught in preparatory schools since Plato's academy. According to Einstein's theory, however, the universe is not shaped like an extended Euclidean space but rather an expanding hyperbolic, or non-Euclidean, space. Artists and intellectuals soon realized that embracing Einstein's revolutionary discovery would mean leaving the comfortable realm of Euclidean geometry for the strange world of non-Euclidean space.

Guillaume Apollinaire was one of the first to encourage artists to explore the non-Euclidean spaces of general relativity. In a lecture on Cubism, he noted that up until the modern age, “the three dimensions of Euclid's geometry were sufficient” for “great artists” (116). In the modern period, however, scientists “no longer limit themselves to the three dimensions of Euclid,” and thus, Apollinaire suggests, artists should also abandon Euclidean geometry (116).[xii] Ezra Pound later noted that many poets were “chasing fads” and heeding Apollinaire's advice, “going in for space plus relativity, or the smearing of Euclid” (*Pound / Zukofsky 267*). Pound chased the same fads in his own writing, where he often conceptualized artists as geometers. In fact, he claimed that “The difference between art and analytical geometry is the difference of subject-matter only” (*Gaudier-Brzeska* 91). In particular, Pound envisioned poets as artistic-geometers: “What the analytical geometer does for space and form,” Pound wrote, “the poet does for states of consciousness” (*Selected Prose* 362).

In order to map the consciousness of their Einsteinian world, it seemed Pound's poetic geometers would need to find a way to move beyond their old Euclidean ideas. William Carlos Williams made this injunction explicit when he announced: “Poems cannot any longer be made following a Euclidean measure, 'beautiful' as this may make them. The very grounds for our beliefs have altered” (*Selected Essays* 337). Representing the new beliefs poets like Williams held would require a non-Euclidean theory of poetry. As the leading theorist of quantum poetics, it was up to Charles Olson to develop such a theory.

Like many of his peers, Olson was critically aware that the non-Euclidean geometry of Einstein's general relativity had restructured modern thought. In his essay “On Space,” Olson even claims that the rise of non-Euclidean geometry is as significant to modern artists as the rise of perspectival theory was to those in quattrocento Florence. He laments the fact that modern artists have not yet charted the possibilities of a non-Euclidean idiom, and he attempts to correct this oversight by calling for the creation of a text which can introduce other writers to non-Euclidean geometry. “A treatise on dimensions,” Olson writes, “springing out of non-Euclidean geometry, would be as contributory to art now as Piero della Francesca's treatise on perspective was in the 15th century, out of Euclid. For art, thought and action now stem from the same questions Einstein has” (*A Modern Correspondence* 255).

In order to grapple with the questions Einstein had, Olson began theorizing the intersections of poetry and geometry in his 1946 “Verse and Geometry” notebook.[xiii] There he recorded passages from his readings of Roberto Bonola's *Non-Euclidean Geometry* and H.S.M. Coxeter's text of the same title. One of the passages in Coxeter's text that Olson recorded in his notebook helped Olson to imagine the creation of non-Euclidean geometry as a type of *poeisis* analogous to the creation of poetry. The passage came from Bolyai János, who—upon discovering a branch of non-Euclidean geometry—wrote to his father: “*I have created a new universe from nothing*” (Coxeter 10, italics in original). This passage, which Olson references throughout his later writing, led Olson to couple the productive powers of geometry with those of poetry.

In his “Verse and Geometry” notebook, Olson also took notes on the branch of geometry that would have the greatest influence on his poetics: projective geometry. As Olson came to know, projective geometry does for mathematicians what film projectors do for filmmakers. While a film projector can increase or decrease the size of its projected images, projective geometry can increase or decrease the size of geometrical objects. Like a film projector, which can shoot two-dimensional celluloid onto a three-dimensional screen, projective geometry can map objects into a space with more or fewer dimensions. And as a film projector can shoot a Euclidean triangle onto a sphere-shaped screen—thus forcing the triangle to lose its Euclidean properties—projective geometry can map objects from Euclidean space into non-Euclidean space.[xiv]

Olson drew upon these qualities of projective geometry while theorizing the ways creative works structure spatial relations. In “Equal, That Is, to the Real Itself,” he writes that Melville's *Moby-Dick* draws upon projective geometry to move between Euclidean and non-Euclidean registers. According to Olson, *Moby-Dick* has “the properties of projective space,” which allows the novel to move between “Euclidean” spaces and the non-Euclidean geometry of “elliptical” and “hyperbolic spaces” (*Collected Prose* 123).

Olson also writes that Melville used projective geometry to move between the very small and the very large. In Olson's analysis, it was through projective geometry that Melville could “reveal the very large (such a thing as his whale, or himself on whiteness, or Ahab's monomania) by the small" (*Collected Prose* 123). According to Olson, projective geometry allowed Melville to create an isomorphism between the minute typographical spaces of his text and the enormous spirit which drove Ahab's voyage.

In "Projective Verse," Olson urges his fellow poets to follow Melville's example and draw from the powers of projective geometry. In that essay, he theorizes poetry as a projection of the world onto the page, with all of the vital energy and relations of the world present in the poetic text. In projective works, Olson writes, "every element . . . must be taken up as participants in the kinetic of the poem just as solidly as we are accustomed to take what we call the objects of reality" (*Collected Prose* 243). In other words, the poet projects objects and their kinetic interrelations onto the page, where they maintain the same interrelations that they possess in the world outside of the poem. According to Olson, these objects and their interrelations "are to be seen as creating the tensions of the poem just as totally as do those other objects create what we know as the world" (*Collected Prose* 243). In this theory, projective geometry allows poets to build a bridge between word and world.

While projective geometry allows poems to become lively representations of the world, it also allows poets to map their poetry into non-Euclidean spaces. As projective geometers can map three-dimensional Euclidean space onto a four-dimensional non-Euclidean space, projective poets can also map the world into spaces with non-Euclidean dimensions. Thus Olson writes that "the projective act, which is the artist's act in the larger field of objects, leads to dimensions larger than the man" (*Collected Prose* 247). In Olson's adaptation of geometrical projection, the projective poem becomes capable of mapping our quotidian Euclidean experience into the unfamiliar dimensions of non-Euclidean geometry.

As Olson knew, Einstein used the bending non-Euclidean space of general relativity as the foundation for his unified field theory. Shortly before publishing "Projective Verse," Olson read Einstein's *Essays in Science*, a book in which he discusses his search for a unified field model. There Olson read that Einstein's unified model sought to combine the geometrical structure of general relativity with the electromagnetic and quantum fields. Olson discussed this unified field theory in a letter to Frances Boldereff, where he describes the "laws" of electromagnetic and geometrical fields, exclaiming: "it is one of the exciting things about the work of einstein [sic] and his men that they see the two laws as operating as one!" (276).[xv]

Einstein wasn't able to produce a unified field theory, but that didn't stop Olson from doing so in his poetics. In a series of essays on Creeley, Olson identifies Creeley's writing as a collection of fields where electromagnetic, gravitational, and quantum fields unite to create a unified field of action. He begins to outline this theory in his "Introduction to Robert Creeley." There Olson suggests that modern writing can be divided into two camps. In writing from the first camp, the "narrator stays OUT," stays distant from her work and allows the internal actions and objects of a piece to speak for themselves (think of literary realism). In writing from the second camp, the "NARRATOR [stays] IN," speculating, interpreting, shaping and playing with the internal actions and objects of the piece (think of symbolism, abstractionism, and literary modernism).

According to Olson, writers from the first camp create energy in their works by working the natural weight and gravity of objects and situations into a self-regulating gravitational field. A writer from this camp, Olson suggests, “lets things in and manages them so well that they get curved back by his pressure outside and make a self-existent sphere (the law is gravitation)” (*Collected Prose* 284). Writers from the second camp create energy in their works by shaping the “electromagnetic fields” of their texts. According to Olson, a writer from the second camp “takes on himself the other law the law of electromagnetism (they are recognized now to be identical) and, as center, as core to the magnetic field, he causes the things to pull in to make their shape” (*Collected Prose* 284). Here Olson announces that the law of gravitation and the law of electromagnetism “are recognized…to be identical.” This means that a poet who shapes the gravitational-geometrical energy of a work (including the geometrical distribution of words on a page) also shapes the electromagnetic energy of a work, as the two forces are in fact one.

The only thing this unified field needs to be complete is a theory of the way quantum mechanics influences the field. Olson provided this missing link a decade later. In his essay “Robert Creeley's *For Love*,” Olson suggests that Creeley's unified gravitational-geometrical-electromagnetic field makes his poems feel distinct. “[T]he force of a Creeley poem,” Olson writes, “is the going of the force back to the magneto, of the coils of which are the condition of the creation of the force, which make any of the poems and all of them distinct” (*Collected Prose* 286-7). The suggestion is that Creeley's magnetic presence shapes the force of his poems and gives them their consistency and their distinction.

Olson further suggests that Creeley's “magnetic presence” shapes the words of his poems in consistent ways. Turning to quantum mechanics, Olson compares Creeley's consistency to the consistency with which subatomic particles act in magnetic, or polarized, fields. In all of the poems Creeley wrote from 1950-1960, Olson writes, “the words . . . remand . . . to the same polarized field—the general theory of which—he, or they, are the special instance” (286). Here Olson depicts Creeley himself as interchangeable with the poetic fields he has produced, as Creeley is the source of the “polarized field” which governs the energy of his poems. For as a polarized field forces electrons to display consistent angular momentum, so too does Creeley's style intrinsically grant his words and works a characteristic “spin.”

With this addition of quantum mechanics to his analysis of Creeley's work, Olson completes his unified field theory. He recognizes the completion of his theory in a single sentence, where he writes that “one wants [Creeley's] words to mean like a special general field theory” (*Collected Prose* 286). Examining Olson's musings on physics, from his conjunction of poetic space and time to his synthesized fields of poetic lines, one finds that Olson produced a body of poetics which will, in fact, allow Creeley's words, or any poet's words, to mean like a special general field theory.

Aftermath

In his 1931 volume *Axel's Castle*, Edmund Wilson announced that literary writers were "working, like modern scientific theory, toward a totally new conception of reality" (297). As Wilson knew, that conception of reality—with its theories of relativity, its non-Euclidean geometry, and its quantum hypotheses—was in the end produced by both scientists and literary writers. For as scientists worked to produce formal models of the universe, writers and poets worked to create interpretations of those models which could become lively, vital parts of their culture. Rereading Olson's work today, one finds that he contributed significantly to the poetic appropriation of scientific concepts. From his theory of poetic reading derived from Einstein's special relativity to his demands for a complementarity of poetic thinking, Olson made modern physics an integral part of modern poetics.

End Notes

[i] Wayne Kobylinski's 2005 dissertation *Getting to X: Paul Muldoon's Quantum Poetics* explores the ways Muldoon's poetry exemplifies a number of quantum phenomena, and Stephen Carter examines "Jack Spicer's Quantum Poetics" in *Bearing Across* (41-56). A number of other scholars have also helped map the development of a "quantum poetics," even if they didn't use the phrase. Katherine Hayles's *The Cosmic Web* focuses on the impact physicists' field models had upon the work of Robert Pirsig, D.H. Lawrence, Nabokov, and Borges, and Lisa Steinman's *Made in America* sets the work of William Carlos Williams, Marianne Moore, and Wallace Stevens into dialogue with each writer's studies in modern science. Finally, Alan Friedman and Carol Donley's volume *Einstein as Myth and Muse* provides a brief history of America's reception of Einstein and an overview of the ways Euro-American writers such as Joyce, Zukofsky, and Archibald MacLeish responded to Einstein's work.

[ii] Olson does not appear in many studies of science and literature, but many Olson scholars have noted that the poet was significantly influenced by the sciences. Edward Foster, for instance, writes that "it was obviously and obsessively important for Olson to find conceptual agreement between his poetics and, say the work of the physicists Niels Bohr and Werner Heisenberg" (33). Other scholars have shown how important it was for Olson to find conceptual agreement between his poetics and other aspects of modern science, such as geometrical symmetry (Maud *Olson's Reading* 176, 257), non-Euclidean space (Clark pp. 114-5; Thomas Merill pp. 57-8; von Hallberg 188-189), topology (Butterick 202-3), and modern field theories (Carter 3-22; Bram 19-35). These studies have helped to show that a thorough understanding of Olson's poetics necessitates a thorough analysis of Olson's relationship to science.

[iii] See Levertov (22-32).

[iv] Consider, for example, Olson's references to Einstein in his letters to Frances Boldereff of 10 January, 1950; 21 March 1950; and 28 March 1950 (*Modern Correspondence* 112, 255, 276). We also find traces of Olson's interest in Einstein in letters written after the publication of "Projective Verse," such as his letter to Robert Creeley of 1 December 1951 (*Vol. 8 Complete Correspondence* 214); his letter to William Carlos Williams of November 1954; his letter to Albert Glover of 3 April 1966; and his letter to Joyce Benson of 14 June 1966 (Selected Letters 225, 357, 369).

[v] This passage comes from Olson's essay "Notes for the Proposition: 'Man is Prospective,'" a draft of which served as his first lecture at the Black Mountain in October of 1948 (see Maud *Olson's Reading* 78). He reprinted much of this early essay in his later work "On Space," which he sent to Frances Boldereff in 1949 (Olson *Modern Correspondence* 255).

[vi] Literary theorist Arkady Plotnitsky has written extensively on the philosophical questions quantum mechanics poses for poets and physicists. See, for example, his *Complementarity*, as

well as *The Knowable and the Unknowable*. In both her poetry and her scholarship, Emily Grosholz has also discussed the ways quantum mechanics continues to pose significant questions for physicists and literary theorists. See her volume *Representation and Productive Ambiguity in Mathematics and the Sciences* (126-156) and “Poems Overheard at a Conference on Relativity Theory,” cited above.

[vii]In her essay “Wave Theory and the Rise of Literary Modernism,” Gillian Beer goes so far as to claim that the wave theories which these poets drew from constituted one of the “conditions for modernism” (195). Her essay ties these wave theories to ideas of flux, oceans, auras, and Nietzsche's “sea of forces flowing and rushing together” (qtd. 209). If she was right when she said that these ideas constituted one of the conditions of modernism in nineteenth-century writing, it seems equally right to say that ideas of complementarity between wave and particle models of reality were a “condition of modernity” in twentieth-century writing. As we shall see, Olson was one of the first to begin to theorize the complementarity between wave and particle aspects of poetic energy.

[viii]Although Olson offers no citation for this quotation in his text, he draws this phrase—and much of his knowledge of quantum mechanics—from Hermann Weyl's *The Philosophy of Mathematics and Natural Science*. Olson received this text from Black Mountain musician Stefan Wolfe in 1956, and he remained attached to the book for the duration of his life. In “Equal, That Is, to the Real Itself” and *The Special View of History*, he borrowed quotations from the text without citing Weyl, and he apparently even used Weyl's text to teach a graduate seminar on Norse mythology (Maud Olson's Reading 201). He draws the above-cited quotation on wave and particle behaviors of light from Weyl 188.

[ix]De Man pursues a literal reading of Yeats's question in *Allegories of Reading*, pp. 11-12.

[x]For a summary of Einstein's rise to stardom in the public press, see Friedman and Donley pp. 10-20.

[xi]Covering the vast and complex history of theories of space prior to Einstein's general relativity in any more detail would bring us far afield of the scope of this essay. For a thoughtful and brief summary of conceptions of space leading up to Einstein's theory, see Max Jammer's *The History of Theories of Space in Physics*.

[xii]Technically, Apollinaire is addressing the rise of Minkowskian geometry in Cubist works. Minkowsky's geometry is still used to describe the space-time of special relativity, but it can't describe the space-time of general relativity. In any event, Apollinaire's essay encourages artists do adopt a non-Euclidean idiom for their work, one variety of which may be found in Minkowsky's geometry. What is relevant for my discussion above is the fact that artists and intellectuals such as Apollinaire were calling for the use of non-Euclidean idioms. In other words, the branches of non-Euclidean geometry actually adopted are less important to my argument than the fact that artists were working to conceptualize non-Euclidean spaces.

[xiii]This notebook is currently held in Olson's papers at the University of Connecticut (box 49).

[xiv]For a lengthier introduction to projective geometry, see perhaps Scott Buchanan's *Poetry and Mathematics* (53-55). Interestingly, Buchanan's 1929 text uses projective geometry to discuss the relationships between mathematics and the branch of poetry he almost calls “projective poetry.” Although there is no evidence that Olson read the volume, there are striking correlations between Olson's treatment of geometry and Buchanan's analysis of poetry.

[xv]Olson also discusses Einstein's unified field theory in his letter to Ronald Mason of 13 July 1953 (*Selected Letters* 199). Olson likely read of Einstein's ambition to create a unified field theory in “The Problem of Space, Ether, and the Field in Physics,” one of the essays contained in the book by Einstein he owned (Maud *Olson's Reading* 259). Given Olson's preoccupation with “SPACE” and the fact that Einstein's aforementioned essay is the only work in the volume whose title mentions “space,” the Einstein essay seems a likely source of Olson's insight.

Works Cited

Albert, David Z. *Quantum Mechanics and Experience*. Harvard UP, 1994.
Albright, Daniel. *Quantum Poetics: Yeats, Pound, Eliot, and the Science of Modernism*. Cambridge UP, 1997.
Apollinaire, Guillaume. “Pure Painting” *The Modern Tradition*, ed. Richard Ellmann and Charles Feidelson Jr. Oxford UP, 1965.
Auden, W.H. *New Year Letter*. London: Faber and Faber, 1941.
Beaver, Joseph. *Walt Whitman: Poet of Science*. New York: Octagon Books, 1974.
Beer, Gillian. “Wave Theory and the Rise of Literary Modernism” *Realism and Representation: Essays on the Problem of Realism in Relation to Science, Literature, and Culture*, ed. George Levine. Wisconsin UP, 1993.
Bell, Ian F.A. *Critic as Scientist: The Modernist Poetics of Ezra Pound*. London: Methuen, 1981.
Bram, Shahar. *Charles Olson and Alfred North Whitehead: An Essay on Poetry*. Bucknell UP, 2004.
Buchanan, Scott. *Poetry and Mathematics*. Philadelphia: Lippincott Company, 1962.
Butterick, George F. *A Guide to the Maximus Poems*. California UP, 1978.
Carter, Stephe.: *Bearing Across: Studies in Literature and Science*. University Press of America, 2002.
Clark, Tom. *Charles Olson: The Allegory of a Poet's Life*. Norton, 1991.
Coxeter, H.S.M. *Non-Euclidean Geometries*. Toronto UP, 1942.
Creeley, Robert. *The Collected Poems of Robert Creeley, 1945-1975*. California UP, 2006.
De Broglie, Louis. “The Wave Nature of the Electron” Nobel Lecture, December 12, 1929
De Man, Paul. *Allegories of Reading: Figural Language in Rousseau, Nietzsche, Rilke, and Proust*. Yale UP, 1982.
Dorn, Edward. *The Cycle*. West Newberry: Frontier Press, 1971.
Duncan, Robert. “Towards an Open Universe”. *The Poetics of the New American Poetry*, ed. Donald Allen and Warren Tallman. New York: Grove Press, 1973.
Einstein, Albert. *Essays in Science*. New York: Philosophical Library, 1934.
Foster, Edward. *Understanding the Black Mountain Poets*. South Carolina UP, 1994.
Friedman, Alan and Carol Donley. *Einstein as Myth and Muse*. Cambridge UP, 1985.
Grosholz, Emily. “Poems Overheard at a Conference on Relativity Theory” *Verse and Universe: Poems about Science and Mathematics*, ed. Kurt Brown. Minneapolis: Milkweed Editions, 1998.
Harrison, Edward. *Masks of the Universe*. New York: Macmillan, 1985.
Hayles, N. Katherine. *The Cosmic Web: Scientific Field Models and Literary Strategies in the Twentieth Century*. Cornell UP, 1984.
Kobylinski, Wayne. *Getting to X: Paul Muldoon's Quantum Poetics*. Diss. University of North Carolina-Chapel Hill, 2005.
Lawrence, D.H. *The Complete Poems of D.H. Lawrence*, ed. Vivian de Sola Pinto and Warren Roberts. New York: Viking Press, 1964.
Levertov, Denise. *New & Selected Essays*. New York: New Directions, 1992. Lewis, Wyndham: *Time and Western Man*. New York: Harcourt, Brace and Company, 1928.
Macleish, Archibald. “Reply to Mr Wordsworth” *Poems of Science*. ed. John Heath-Stubbs and Phillips Salman. Middlesex: Penguin, 1984.
Maud, Ralph. *Charles Olson's Reading: A Biography*. Southern Illinois UP, 1996.
Meillassoux, Quentin. *After Finitude: An Essay on the Necessity of Contingency*. Trans. Ray Brassier. London: Continuum, 2008.
Merrill, Thomas F. *The Poetry of Charles Olson: A Primer*. Delaware UP, 1982.
Middleton, Peter. “Poets and Scientists” *A Concise Companion to Twentieth Century American*

Poetry. Ed. Stephen Fredman. Blackwell Publishing, 2005. pp. 212-230.
Monaghan, Patricia. *Quantum Poetics: Science and Spirit in Twentieth Century American Poetry*. Diss. The Union Institute, 1996.
Muller, Herbert J. *Science and Criticism: The Humanistic Tradition in Contemporary Thought*. Yale UP, 1943.
Olson, Charles and Frances Boldereff. *Charles Olson and Frances Boldereff: A Modern Correspondence*, ed. Ralph Maud and Sharon Thesen. Wesleyan UP, 1999.
Olson, Charles and Robert Creeley. *Charles Olson & Robert Creeley: The Complete Correspondence*, ed. George Butterick. Vol. 8. Santa Rosa: Black Sparrow Press, 1987.
Olson, Charles and Robert Creeley. *Charles Olson & Robert Creeley: The Complete Correspondence*, ed. George Butterick. Vol. 9. Santa Rosa: Black Sparrow Press, 1990.
Olson, Charles: *Collected Prose: Charles Olson.* Ed. Donald Allen and Benjamin Friedlander. California UP, 1997.
—. "Notes for the Proposition: 'Man is Prospective'" *Boundary II*, Vol. 2, No. 1/2, Charles Olson: Essays, Reminiscences, Reviews (Autumn, 1973 - Winter, 1974), pp. 1-6.
—. *Selected Letters: Charles Olson*, ed. Ralph Maud. California UP, 2000.
—. *The Collected Poems of Charles Olson*, ed. George F. Butterick. California UP, 1997.
—. *The Maximus Poems*, ed. George F. Butterick. California UP, 1983.
—. *The Special View of History*, ed. Ann Charters. Berkeley: Oyez Press, 1970.
Pound, Ezra. *Gaudier-Brzeska*. New York: New Directions, 1970.
—. *Literary Essays of Ezra Pound*. New York: New Directions, 1968.
—. *Pound/Zukofsky: Selected Letters of Ezra Pound and Louis Zukofsky*, ed. Barry Ahearn. New York: New Directions, 1987.
—. *Selected Prose, 1909-1965*, ed. William Cookson. New York: New Directions, 1973.
Richards, I.A. *Science and Poetry*. M.S.G. Haskell House Publishers; Reprint of 1926 ed., 1982.
Rosenberg, Harold: *The Tradition of the New*. New York: Horizon Press, 1959.
Russell, Bertrand. *ABC of Relativity*. London: George Allen & Unwin Ltd. Publishers, 1964.
Sklar, Lawrence. *Philosophy of Physics*. Boulder: Westview Press, 1992.
Spicer, Jack. *The Collected Books of Jack Spicer*, ed. Robin Blaser. Los Angeles: Black Sparrow Press, 1975.
Steinman, Lisa. *Made in America: Science, Technology, and American Modernist Poets*. Yale UP, 1987.
Strehle, Susan. *Fiction in the Quantum Universe*. North Carolina UP, 1992.
Trilling, Lionel. "The Sense of the Past" *Influx: Essays on Literary Influence*, ed. Ronald Primeau. New York: Kennikat Press, 1977.
Von Hallberg, Robert. *Charles Olson: The Scholar's Art*. Harvard UP, 1978.
Weyl, Hermann. *Philosophy of Mathematics and Natural Science*. Princeton UP, 1949.
Whitman, Walt. *Selected Poems and Prose*, ed. A. Norman Jeffares. Oxford UP, 1966.
Williams, William Carlos. *Selected Essays*. New York: New Directions, 1969.
Williams, William Carlos. *The Collected Poems of William Carlos Williams*, ed. A. Walton Litz and Christopher MacGowan. New York: New Directions, 1991.
Williams, William Carlos. *The Selected Letters of William Carlos Williams*, ed. John C. Thirlwall. New York: Mcdowell and Obolensky Publishing, 1957.
Wilson, Edmund. *Axel's Castle*. New York: Charles Scribner's Sons, 1948; originally published 1931.
Yeats, W.B. *The Collected Poems of W.B. Yeats*. New York: Simon, 1989.

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