

مبدأ عدم اليقين كأداة درامية في مسرحية "كوبنهاغن" لمايكل فراين

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الكلمات المفتاحية: فيزياء الكم، المسرح ما بعد الحداثي ، النوايا، المسؤولية العلمية، قيود الوعي.

كيفية اقتباس البحث

عطية ، أزهار سهيل ، مبدأ عدم اليقين كأداة درامية في مسرحية "كوبنهاغن" لمايكل فراين،مجلة مركز بابل للدراسات الانسانية، تشرين الأول 2026،المجلد:16 ،العدد:10.

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The Indeterminacy Principle as a Theatrical Technique in Michael Frayn's *Copenhagen*

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Keywords : Quantum physics, Postmodern Theatre, Intentions, Scientific responsibility, Consciousness Limitations.

How To Cite This Article

, Journal Of Babylon Center For Humanities Studies, October 2026, Volume:16, Issue10.



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ملخص

يستكشف هذا البحث استخدام مايكل فراين لمبدأ عدم اليقين الفيزيائي لهايزنبرغ في مسرحيته الشهيرة "كوبنهاغن" (1998) كأداة درامية وفلسفية. تبدأ المسرحية باللقاء التاريخي الذي جرى عام 1941 بين الفيزيائي الألماني فيرنر هايزنبرغ ونظيره الدنماركي نيلز بور، لكنها لا تسعى إلى إعادة بناء الحدث بدقة تاريخية؛ بل تقدم تفسيرات متعددة محتملة للقاء، وتربطها مباشرةً بجوهر نظرية الكم.

يدرس البحث أربعة مستويات رئيسية لتجلي مبدأ عدم اليقين في المسرحية: اللغة والحوار: يعمل الحوار كمساحة للإمكانات، حيث يُعاد تشكيل المعنى مع كل تكرار، مما يجعل اللغة أداة لفتح آفاق لا حصر لها. البنية السردية: تُعرض أحداث اللقاء في نسخ متعددة، ويصبح السرد إعادة كتابة مستمرة للحقيقة دون خاتمة نهائية. الشخصيات: تجسد الشخصيات استعارات الكم، وتبدو دوافعها وقراراتها وكأنها تتحدى الحتمية المطلقة. البعد الأخلاقي والفلسفي: يرتبط عدم اليقين بمسؤولية العلماء في تطبيق المعرفة العلمية؛ فالعلم لا يُقدم لهم إجابات قاطعة بشأن قراراتهم الأخلاقية، بل يتركهم في مواجهة توتر دائم بين المعرفة والضمير.

يخلص البحث إلى أن مسرحية كوبنهاغن تتجاوز كونها نصًا مسرحيًا تاريخيًا لتصبح تجربة فكرية وفلسفية، تجعل المشاهد شريكًا في البحث عن المعنى دون أن تُقدّم له يقينًا مطلقًا. وهكذا، يتحوّل مبدأ عدم اليقين من مفهوم فيزيائي إلى أداة درامية تكشف حدود المعرفة البشرية وتعتقدات المسؤولية الأخلاقية في عالمي العلم والسياسة.

Abstract

In *Copenhagen* (1998), Michael Frayn uses Heisenberg's uncertainty principle in physics as a philosophical and dramatic device. The play opens with the historic meeting between German physicist Werner Heisenberg and his Danish counterpart Niels Bohr in 1941. The study does not aim to recreate the event with historical veracity. It sets forth various probable perception of the meeting. It directly connects them with the essence of quantum theory.

To manifest the uncertainty principle within the play, the study deals with four essential levels: Language and dialogue: The language functions as a tool for opening up endless possibilities. The dialogue is used as a space of possibility where the meaning changes with each repetition. Narrative structure: The events of the meeting present in different versions accordingly, the narrative becomes a rewriting of truth. There is no definitive conclusion. Characters: The characters represent quantum metaphors. Their choices and motivations appear to oppose full determination. The philosophical and ethical dimension: Science does not supply scientists with ultimate answers concerning their ethical decisions. It leaves them facing a constant tension between conscience and knowledge. Thus, uncertainty is connected with the responsibility of scientists in the utilization of scientific knowledge.

The study concludes that Frayn's *Copenhagen* is not merely a historical theatrical text. It is a philosophical and intellectual experience. It makes the viewer a partner in the search for meaning without present them eventual certainty. So, the uncertainty principle alters from being a physical concept into a dramatic device that bring out the restriction of human knowledge and the complexities of ethical responsibility in the worlds of politics and science.

Introduction

Michael Frayn's *Copenhagen* (1998) is an innovative work in contemporary science theatre. Frayn synthesizes quantum physics with drama. Thus, the scientific principles function as the structural techniques of the text. As Atiyah (2019) concludes:



Metaphors can be used to clarify a seemingly mysterious and unclear idea.... Hamlet also incorporate of two worlds...that can also be pointed out as particles struggling for equilibrium... which raise a new grasp to interpretation of the play and can also be used to clarify the scientific thought through the play or conversely. This purposed to confirm that even if a specific concept is not so clearly depicted, that does not mean, it is not present. (p. 45).

In *Copenhagen* (1998), Frayn does not deal with science as an external subject, but he makes the exploration of the epistemology of intentions the core of his dramatic work. Frayn (1998) articulates: The epistemology of intention is what the play is about. The play revolves around the enigmatic meeting between Niels Bohr and Werner Heisenberg in 1941. This historical incident is re-enacted through uncertainty, to show that human intentions cannot be determined. "The more I've explained, the deeper the uncertainty has become" (Frayn, 2000, p. 6).

Frayn utilizes the uncertainty principle as a fundamental structural metaphor that underpins the dramaturgy of the theatrical performance. This utilization is apparent in this research across four core levels:

Narrative structure: The play uses drafts re-enacting the encounter with varying scenarios, making the narrative a continuous, never-ending process of construction. This is clearly demonstrated in characters' utterances. Characters: The actors embody the theories literally, moving like atomic particles around the text's core and changing with the audience's observation. Language and dialogue: Dialogue functions as a speech act that makes the scientific principle actually happen in front of the audience, where the audience participates in the process of creating meaning. The ethical and philosophical aspect: Uncertainty is connected to scientists' ethical obligations since; it is impossible to comprehend human behaviour from a single or deterministic perspective.

Research Problem

The research problem lies in the following fundamental question: How does Michael Frayn transform the Uncertainty Principle as an abstract physical concept into a comprehensive dramatic technique that contributes to reshaping the play's narrative structure, shaping the characters' fluid identities, and exploring the ethical dimensions of scientific responsibility in light of the impossibility of achieving epistemic certainty?

The Significance of the Study

This study is significant because it demonstrates how theatre can bridge the gap between science and literature by translating sophisticated

quantum physics into a tangible and humanly intelligible dramatic language. The study examines the dramaturgical innovation of using the uncertainty principle as a structural and dramatic metaphor to reveal the limits of human knowledge and the difficulty of certainty regarding intentions, while also transforming the audience into an observer who actively participates in completing the theatrical and scientific experience.

Research Methodology

The methodology relies on an interdisciplinary descriptive-analytical approach, synthesizing literary criticism and dramatic analysis with complex physical and epistemological concepts. The analysis concentrates on extracting structural metaphors borrowed from quantum physics and transforming them into narrative and corporeal techniques, while appropriating an epistemological perspective that examines the Epistemology of Intentions and the limits of human knowledge. The methodology expands to a dramaturgical analysis of the structure of the drafts and how science is performed through the actors' embodiment of atomic particles. The analysis draws upon a critical vision that connects the play to postmodern theories and the deconstruction of history.

Literature Review

The recent academic literature reveals a consistent focus on how quantum mechanics goes beyond being a mere background context to become a dramatic structure in Michael Frayn's *Copenhagen* (1998). Critics assert that Frayn creates a comparison between physical indeterminacy and human awareness. He converts history from a fixed record into a dynamic, developing phenomenon. Considering this historical fluidity, Midia Mohammadi (2021) asserts that "the central idea upon which plays of Michael Frayn are established is that a text or event is reborn and reconstructed every time it is recited or recalled" (p. 245).

The play rejects chronological sequence. It utilizes parallel timeframes, which Amani and Pirnajmuddin (2021) conceptualize as a "*Narrative Quantum Cosmology*" "where time is not linear but recycled, and the encounter in *Copenhagen* is presented as a series of overlapping possibilities rather than a single recorded event" (p. 69).

Inevitably, this structural uncertainty impacts the scientific responsibility, political and moral realms. As Jenny Edkins (2019) argues, "recognizing the limits of our knowledge is the first step toward a more responsible and ethical engagement with the world, illustrating how epistemological modesty becomes an ethical safeguard" (p. 68).



Academic literature explores *Copenhagen* through thematic analysis, narrative non-linearity or political resonance. However, it remains a significant research gap concerning four integrated analytical frameworks that connect Heisenberg's Uncertainty Principle across linguistic speech acts, draft-based narrative mechanics, fluid character identities, and the epistemology of intention. Previous studies have separately examined these elements or restricted their focus on historical context.

To respond to this gap, this study provides a holistic dramaturgical analysis of how Frayn converts physical indeterminacy into a complete theatrical technique. It regulates both stage kinetics and the limits of human knowledge.

1.1 Science as a Tool for Reconstructing Reality

Frayn's *Copenhagen* starts from a philosophical perspective that sees history and human occurrences as uncertain phenomena, just as particles in quantum physics. Frayn does not seek to furnish a definitive answer about the peculiar historical meeting between Werner Heisenberg and Niels Bohr in 1941. Instead, he transforms the stage into a laboratory for exploring the World of Indeterminacy in which we live. The play opens in a dramatic space set after death. The historical figures transform into ghosts seeking to understand what they failed to grasp in their lifetimes. Margaret expresses this philosophical perspective at the beginning of the play, she says: "Some questions remain long after their owners have died. Linger like ghosts. Looking for the answers they never found in life. . . Some questions have no answers to find." (Frayn, 1998, p. 3). This embodies the idea of birth, Midia Mohammadi (2021) argues that Frayn's narrative essence is based on the idea of the Renewed Birth of the event:

The central idea upon which plays of Micheal Frayn are established is that a text or event is reborn and reconstructed every time it is recited or recalled. He sublimated history, physics, and various dramatic techniques into splendid drama to reflect upon the dilemmas thrown to the human in today's world of indeterminacy. (Mohammadi, 2021, p. 245).

Consequently, Frayn employs what is known as Textual Fluidity, where characters are unable to fully understand themselves. He views that "Even our own thoughts and feelings often elude us... Our intentions are often even more elusive" (Frayn, 1998/2010, pp. xvi–xvii). Thus, the historical ambiguity of Heisenberg's intention becomes a reflection of Heisenberg's physical principle. It makes doubt a narrative means of linking science to the humanities in a third culture.

From this perspective, the essential issue in *Copenhagen* lies not only in a deficiency of historical information, but in the inherent inertia of human

consciousness. Heisenberg, Bohr, and Margaret are like ghosts pursuing for understanding. They discover that intentions are dispersed by the light of awareness. Jenny Edkins 2019 suggests that this ambiguity is the very essence of uncertainty that governs human relationships, since we "cannot even access the inside of our own heads." (p. 57).

1.2. Overlapping Drafts and Narrative Quantum Cosmology

The play employs a complex dramatic structure. Linear time is replaced by a recycled time based on the principle of parallel worlds. Amani and Pirnajmuddin (2021) describe as *Narrative Quantum Cosmology*.

In fact, our main thesis is that the play offers an alternate history and brings about a myriad of counterfactuals that are tested as 'drafts.' . . . The play operates within a narrative quantum cosmology, where time is not linear but recycled, and the encounter in *Copenhagen* is presented as a series of overlapping possibilities rather than a single recorded event. (pp. 68-70).

Frayn's drafts technique presents an alternative history that tests paradoxical hypotheses. In the play, Heisenberg describes the process of delving into memory as an act that dissolves hard facts. "You open the pages [of memory], and all the neat headings and tidy jottings dissolve around you. . . You step through the pages into the months and days themselves. The past becomes the present inside your head." (Frayn, 2000, p. 7).

Halpin (2018) expresses that, "this dissolution of time makes the play a palimpsest, where facts are erased and new possibilities are written over them". (p.291). Thus, the event remains in a state of constant. The audience remains in a state of constant re-evaluation of the facts. The levels of existence reality and fiction, life and death merge to deconstruct claims of historical certainty.

2.1. The Uncertainty Ultimate Essence and the Consciousness of Limitations

The characters Bohr, Heisenberg, and Margaret are transformed from historical figures into quantitative metaphors. They embody the impossibility of attaining absolute truth. Frayn depends on a powerful scientific analogy. He describes the interaction between the three characters by using the structure of the atom; Margaret represents the nucleus, Bohr the electron that revolves around it, and Heisenberg the photon that impact Bohr. Jenny Edkins (2019) argues that Frayn draws a precise analogy between the ambiguity of particles and the ambiguity of human intentions. She asserts the act of observation always changes the nature of the observed object.



Frayn draws parallels between the impossibility of knowing certain properties of physical particles simultaneously and the impossibility of knowing people's thoughts and intentions – even our own. . . It is not just a question of not being able to get inside other people's heads – we cannot even get inside our own. Indeed, our own motivations and thoughts are perhaps the most elusive of all. (Edkins, 2019, p. 52-56).

This ultimate essence of uncertainty makes the search for motives a complex process. An idea loses its definite form and scatters as it is brought to the light of consciousness. as Heisenberg expresses in the play.

If Heisenberg is at the centre of the universe, then the one bit of the universe that he can't see is Heisenberg. . . At once the clear purposes inside my head lose all definite shape. The light falls on them and they scatter. (Frayn, 1998/2000, pp. 3, 88).

The characters realize that the present is constantly dissolving into the past. The human existence is performative. It requires the presence of the observer (the audience) to complete its identity, "without the audience, we are nothing" (Edkins, 2019, p. 62).

Frayn goes beyond historical analysis to offer a cosmic vision. He affirms that human intentions will always remain an unsolvable mystery, just as "the darkness inherent in the human soul" (Klemm, 2004, p. 292).

2.2. Responsibility in an Uncertain World

In *Copenhagen*, the uncertainty is closely connected to moral and political responsibility concerning issues of national security and mass destruction. Edkins (2019) asserts that recognizing the limits of knowledge is a political necessity to avoid conflicts arising from the politics of absolute certainty.

The final core of uncertainty in Frayn's work is not just a scientific curiosity but a political necessity. It challenges the politics of certainty that leads to conflict, suggesting instead that recognizing the limits of our knowledge is the first step toward a more responsible and ethical engagement with the world and its security challenges. (Edkins, 2019, p. 67-68).

The ethical and technical conflict reaches its peak when discussing the technical aspects of the construction of the atomic bomb, particularly the calculation of the critical mass. Frayn in his historical commentary (postscript), questions why Heisenberg failed to calculate the correct mass of uranium-235. He suggests that this failure may have attributable

to a lack of zeal or an unconscious escape from the ethical reality of building a weapon of mass destruction. Frayn (2010), emphasizes that judging actions requires understanding intentions. "Our intentions are often even more elusive. And yet, without some understanding of the intentions behind it, no human action can be judged, or even made sense of." (Frayn, 2010, p. xvii).

This dilemma creates a kind of complementarity between the scientist's role as a seeker of knowledge and his role as a responsible citizen. The Manhattan project and the German nuclear program confront scientists with the ultimate essence of moral uncertainty. Heisenberg's failure to perform the precise calculations that revealed the bomb requires kilograms, not tons, remains one of the greatest mysteries, which transforms the play into a moral tribunal.

In *Copenhagen*, science is inseparable from the political and national context. Heisenberg embodies the struggle of the German scientist. He tries to preserve German science under a destructive Nazi regime. Heisenberg's patriotic sentiment illustrates the depth of his connection to his country: "Germany is where I was born. Germany is where I became what I am. Germany is all the faces of my childhood. . . I have to know what I'm deciding for them!" (Frayn, 1998/2000, p.42).

This conflict between loyalty to one's country and responsibility to humanity reinforces the idea of integration. A single individual can be both enemy and friend at the same time, in the same way that light can be both particles and waves. Edkins (2019) asserts that acknowledging this uncertainty is a political necessity to avoid the politics of certainty that lead to widespread destruction.

Frayn argues that the world is not required to possess absolute truth, but rather to have the intellectual humility that recognizes that we are "responsible for everything and not responsible for anything." (Frayn, 2008, p. 10). He transforms uncertainty from a technical physical concept into a sober human practice that reveals the "problem of reality" as defined by Gingrich (2021). The play reflects the impact of decisions made in the midst of uncertainty:

Bohr: Before we can lay our hands on anything, our life's over.
Heisenberg: Before we can glimpse who or what we are, we're gone and laid to dust.
Margrethe: And sooner or later there will come a time when all our children are laid to dust, and all our children's children. (Frayn, 1998/2000, p. 95).



The play concludes with a reflective, funereal image. The protagonists realize that human existence requires the presence of the observer to complete its identity. Frayn provides an optimistic vision of uncertainty. He transforms it into a space for freedom and alternative representation. Edkins summarizes the exact parallel between the physical principle and human reality:

"At once the clear purposes inside my head lose all definite shape. The light falls on them and they scatter. . . Here I am at the centre of the universe, and yet all I can see are two smiles that don't belong to me." (Frayn, 1998, p. 88, as cited in Edkins, 2019, p. 58).

Man is the observer. He gives the world its meaning. He may be the center of the universe. However, he remains the only part that cannot see it clearly. The play concludes by emphasising that uncertainty is the fundamental state that protects our humanity from the rigidity of certainty. It makes the world a series of approximations deserving of protection.

By synthesising multiple critical perspectives, including Stewart's *Theatre of Uncertainties* (1999), show that the play remains an open intellectual experiment. It defies time and the authority of traditional historical narrative.

Conclusion

The study concludes that the play *Copenhagen* successfully converts the uncertainty Principle from a mere technical physical theory into a holistic existential philosophy. It explains the complicated nature of human intentions and the impossibility of reaching absolute historical truth. Michael Frayn embodies the idea of integrating possibilities through the structure of several drafts. The historical event remains fluid and reconstructed with every attempt or observation. It makes the stage a laboratory for testing possible worlds.

The results highlight the significance of the third culture notion that is established by the work. The boundaries between rigorous scientific thinking and the dramatic analysis of politics and ethics have blurred. Ultimately, the play places man at the centre of the universe not as the possessor or controller of truth. It depicts him as the observer who gives the world its meaning through his limited understanding and intellectual humility. The study affirms that uncertainty in *Copenhagen* is an essential human state. It protects man from the rigidity of certainty. It opens the door to moral responsibility in a chaotic world.



In conclusion, the study demonstrates that *Copenhagen* goes beyond being a historical narrative to become an intellectual experience that reveals the limits of human knowledge and culminates in the recognition of an ultimate essence of uncertainty at the heart of things.

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