

Science and the Staging of *Copenhagen*

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*To Amanda Helfer: Less is more and more is less. It could always be worse and Remember that in the big scheme of things, it does not really matter.*

*-Alexandra E. Riley*

## ***Copenhagen: The History of the Play***

The historical context behind the play *Copenhagen* is fundamental to the understanding of the story of the play. Set in Denmark in 1941, the meeting between Bohr and Heisenberg is years in the making. Bohr is physicist who is half Jewish and living in Denmark under protection. Bohr's most famous work is the theory of complimentary. This is the idea of the dualistic nature of a particle having both wave and partial properties. Heisenberg is German and working on the German atomic bomb. Heisenberg's major contribution to the science community was the theory of uncertainty. Uncertainty is describing the nature of finding and locating the particle when in orbit of the atom.

At the time of the meeting between these two greats in Copenhagen, Denmark was an occupied country and with one man a Dane and the other from the occupying country Germany, these two once friends were sworn political enemies as the world was at war. With the uncertainty of tomorrow waiting at every corner, those who could protect themselves did. Heisenberg was able to secure a spot as a professor in Germany and Bohr was working with his institute in Denmark while being protected by the government. Margrethe, Bohr's wife, would often do many of his transcripts for him, typing them up. This allowed for Bohr to practice explaining theories and concepts of physics in layman terms so that the public as well as the scientific community may understand his science.

Both Physicists were a part of the golden age physics, the 1920's and 1930's. While Bohr was a more experienced physicist in the field, Heisenberg was a new comer

and in need to guidance. Bohr took Heisenberg under his wing and helped him find his path in science and both worked well together formulating theories and building up the world of quantum mechanic; together they defined the era of quantum mechanics. Out of this mentor relationship grew a very found father son relationship between the two. They both highly reprised the other for their opinions and guidance and would often talk out their new theories and difficulties there around wit each other.

### ***Copenhagen: The Science of the play***

*Copenhagen* is a one the most an aforementioned plays when it comes to the matter of science in the theatre. The premise behind the play of speculating as to the nature and intent of some of the greatest minds in science is ground breaking. The purpose for Michael Frayn, the author of *Copenhagen*, for writing the play is to discover what really took place in the meeting between these two great minds and how their conversation changed the history of the world. Frayn, by writing *Copenhagen*, takes his audience back to the end of an era with the meeting of Werner Heisenberg and Neils Bohr in Copenhagen in nineteen forty-one. Niels Bohr, a native of Denmark, was the mentor of Werner Heisenberg and his father figure during the golden age of physics in the nineteen twenties and thirties. The setting of the play has Niels Bohr still in Denmark working in and around his institute in Copenhagen. Bohr is most famous for his theory of complimentary in which he states that a particle has dualistic qualities and thus behaves like both a particle and a wave. In the play, Heisenberg currently holding a seat as a professor in Germany and also working as lead physicists on the German atomic bomb project. Heisenberg left his mark on the scientific community with his theory of

uncertainty which discussed the position of an electron and states that if one knows the position of an electron then they cannot know the velocity and vice versa. With both scientists competing in the same field and now citizens of warring countries, this then unfortunately now makes the two old friends sworn political enemies.

Thus, the objective Frayn has for this play, takes on a whole new meaning. For the subject matter, when viewed in its proper historical context, helps the audience to understand why figuring out what occurred during the meeting between these two greats more intriguing and important for further understanding of history and how the science of the atomic bomb plays a role. The way in which Frayn approaches this subject is through the science and work of the two main characters themselves. It is important to note that in the play there are three characters and one who plays a very central role who has not been introduced thus far. Bohr's wife, Margrath is included in much of the meeting and plays a pivotal part in the play. Frayn uses her as the link to the audience and those outside the scientific community. For it is mentioned many times in the play that "plain language," must be used. To put the science in plain language for Margrath is to put it in plain language for the audience as well. Thus creating a bridge between the scientists, their science and the ability of the audience to understand what Bohr and Heisenberg are talking about. Besides the plain language inserted for Margrath and the audience, it is noted early on that what much of the play is, is science,

**Heisenberg:** So what was Bohr? He was the first of us  
All, the father of us all. Modern atomic physics began when  
Bohr realized that quantum theory applied to matter as well  
As to energy. 1913. Everything we did was based on that  
Great insight of his.  
(pg. 5)

Whether it is pure fact or suggested by the characters speech and action, science dominates the play.

Ultimately the science of the play is centered on Heisenberg's uncertainty principle and Bohr's theory of complementarity. This defuses into every aspect of the play from the script to the performance to the audience. I will discuss the latter two later; as for the script, the science is seen best in the script in the ways the characters behave in accordance to how a particle may behave as described by their separate theories. Bohr sees science as politics while Heisenberg talks in uncertainty especially with regards to the relationship, time spent and language spoken in regards to Bohr,

**Heisenberg:** ...and secondly because you were one of  
The very few people in Europe who were prepared to have  
Dealings with Germany. The war had been over for four  
Years, and we were still lepers. You held out your hand to  
Us. You've always inspired love, you know that. Wherever  
You've been, wherever you've worked. Here in Denmark.  
In England, in America. But in Germany we worshipped  
You. Because you held out your hand to us.  
(Pg. 21)

Even the way the play is set up around the characters with the three retellings of the story focusing on each of the characters perspectives is the equivalent of listening and watching the replication of an experiment. It is in the manor and way that the science transcends the play which makes the play the over whelming force that it is. More then the science in the script though, it is the way the science interacts and is acted out by the characters on stage which leaves the most lasting impression on the audience.

**My Research:**

My research is looking at all the scientific aspects of the play and to expand upon the means by which the science reaches through the stage, the acting and finally the audience helping to enhance their experience of the play. From here I set off to look at the basic make up of the staging of the play. Originally I wanted to look at the original production notes for the play itself of the major productions in London and New York. What I found was that this was an impossible task. Broadway does not release information like this and I do not have any special connections to the theater which would allow me to get the production notes. This left me revamping my topic a bit over time trying to find what I could reasonably manage to get done but without compromising my thesis. What I settled on is to look at *Copenhagen* with the little gathered information that I have and then add in from my own perspective of what I would do if I were the director. In both cases I want to analyze the strong and weak points of the production in accordance to the text. I also want to look at how the absence of typical theatrical measures, gestures and props ultimately ends up being a better for this particular play. I want to accomplish this by comparing the productions known to what could happen if too much gets involved in the production. It is once all this is established that I want to look into how the science overlaps onto this.

When looking at the productions there is one thing, which becomes quite obvious. The way the science is put on the page is enacted on the in the same capacity. This requires a lot of enacted metaphor to take place on stage in plan view of the audience. Actors shift, walk continuously and speed up or slow down depending on where the text takes them and what is being explained. There are passages in the text, which use

metaphor to explain the main works of the two men, the uncertainty principle and the complimentary principal.

For the second part of my paper, I want to look at how all these minute actions and changes on the part of the actors allows for the science on the page to be more easily understood by the audience. I want to look at how these actions help put the science in plain language for the audience and expand upon what is on the page with a creative interaction on the visual representation. My research in this area will mostly come from what I have found on the first part on my paper with supplements from a few articles. There is a lot written on the basic science of the play and yet very little that ties in the action and production of the play as a way of explaining the science. Where there are holes I plan to insert my own interpretation and am fine acknowledging that it is my own interaction, opinion, analysis or thought when necessary. To me, this does not weaken my argument because so much of my paper already, to this point, will have incorporated my own analysis of what is being discussed in a very personal fashion. The last part of my paper will be no exception on how the audience receives processes all that has been presented so far.

In the last part of my paper I want to take all that I have discussed and see how this affects the audience. I want to see how the further understanding of the science by the audience can further there experience of the play. I want to look into how they also interoperate the science in the play after seeing it and how this affects the science in the play through the audience's role in the action of the play. From here I will look into how this may apply beyond *Copenhagen* and to other plays. I also want to do my own analysis on how the audience may view the play especially when looking and



understanding the science. In the end I want to put this altogether to see how the science builds on every aspect of the play and at the end, lands in interpretable minds of the audience.

### ***Copenhagen: Staging Science***

In this section I want to look at *Copenhagen* and the various parts and intricacies of staging from the materials down to the general production. Also I want to see how that will look on stage with choreograph and the content of the play. I want to begin with the stage itself and how it is set up; its shape and props used and there function. From what I can gather in all the major productions, London, New York and L.A., the stage was created as a mental structure in the shape of a circle which may or may not have some sort of lit floor underneath. This circle structure with the actors on it mimics an atom and highlights the scientific structure. This illuminates the stage as an atom cloud with the actors acting like electrons orbiting the nucleus.

From here, there are also the booths or cubes of seating directly behind or sometimes all around the stage in which some of the audience sits. These booths are also slightly elevated as to give the audience a view of the play and all the action which takes place that allows the audience to view the play in a special fashion. For many of those who have seen the play, these booths look similar to jury boxes allowing them to serve as a double feature of the play. The audience then themselves becomes the jury and they become inadvertent participants within the play. From here we go onto look at the props, this is very important more for the lack of their use and importance than the opposite. In this very elaborate play, there are only three props besides the stage itself. These are the

chairs; three chairs for three characters that will be revolving around the stage and the action all being in the hot seat at one time or another.

On this basic stage, are added three important facets of the play, the actors themselves. As I have alluded to before, the actors themselves become the props of the play as they interact between the stage and the script making the link between the two and illuminate the major themes of the play. The play starts with all the main characters on stage at once. There is no lead in; no lights or sound that precede the action of the play. The minute the lights go on, the characters are all on stage and the lines are delivered and the play starts. This allows for the audience to be exposed to all aspects of the play at once. Which is important because the lighting of the play is very subtle but in itself very important, for the lighting shifts with each telling of the story. The main light focuses on the character that is currently telling their version of the story while the whole time keeping all the characters lit to some extent throughout the entire time. The inaction the lighting effects have, on top of the shape of the stage allows for the audience to view the action of the play as inside an atom.

From here I want to look at how this minimalist staging of the play is more advantageous than a more traditional theatrical staging of the play. To do this I want to look at how I would stage this play in a more theatrical fashion. To begin, a more traditional staging would mean a much more involved set. Instead of just three metal chairs on stage, a more traditional staging would have to include at least two sets. On a basic traditional stage, the first setting would have to be of the house Bohr lived in as this were the majority of the action of the play takes place. The other setting would be one an outdoor scene with a gravel parkway for Bohr and Heisenberg to walk along. For the

Bohr's living room I would have traditional 40's living room furniture, probably of the British persuasion and for lighting, two lamps on stage along with the basic stage flood lighting. For the pathway and outdoor scene, I would have a wooded park backdrop painted and then a few prop trees and lampposts on stage as well as a gravel path laid so that the audience could hear the crunch of the gravel. The lighting would be much dimmer and provided solely by the main lights on stage.

Along with a theatrical stage, more traditional theatrical actors would be required as well. Instead of mimicking an atom and having the direction of the characters being the biggest part of the action, the actors would have to be more grand with their gestures and more aware of their surroundings; on a circle stage, you can walk forever, on a traditional stage, the best that can be done is to pace back and forth. While this staging may be an interesting one to play around with, ultimately, it is too much for this play and detracts from it.

With the way the sets are put together, the actors would have to be cued on and off stage and sets switched almost constantly. Unfortunately, the text of the play moves much too quickly for this to be a reality. Also, as I mentioned above, the shape of the stage dampens movement. Another constraint on a staging like this is the idea of time in the play. All the characters are dead and looking back on their lives and at some points the scenes are taking place in the 1920's and still others in the 1940's or any point in time between. It would be impossible to make sets for all allegorical scenes in the play and even with the main two sets, the only indication of time switch would be in the text and that is not enough to drive a stage performance. Now, this is not necessarily bad because, that is what was done with the original staging of the play. The audience had to follow

time through the text rather than getting a visual stimulus through the set change, but the difference being that they were not thrown off by the setting or back drop as those were absent.

While there is not necessarily a problem with more theatrical actors, instead it is the way they would have to interact with one another in a traditional staging would throw off the beauty of the play. The beauty being how science transcends every aspect of the play and in the current staging of the play, all that is required of the actors is simply walking and some simple miming tasks like opening doors etcetera. With the staging being this minimalist thought, the science is persevered in the actors and the shape of the stage. Thus, it is the content, speed and timing of the play which make a more traditional staging of the play not as beneficial to the play itself as a minimalist production in which the science is preserved.

### ***Copenhagen: Science in Action***

There are two pivotal scenes in the play in which the science is fully expressed in all aspects of the play. The first one is in the first act and shows the atomic structure and uncertainty principle to the audience. This is the “papal progress” scene.

**Bohr:** You remember when Goudsmit and Ulenbeck did spin?

**Heisenberg:** There’s this one last variable in the quantum state of the atom that no one can make sense of. The last hurdle...

**Bohr:** And these two crazy Dutchmen go back to a ridiculous idea that electrons can spin in different ways.

**Heisenberg:** And of course that first thing that everyone wants to know is, what line is Copenhagen going to take?

**Bohr:** I’m on my way to Leiden, as it happens.

**Heisenberg:** And it turns into a papal progress! The train stops on the way at Hamburg...

**Bohr:** Pauli and Stern are waiting on the platform to ask me what I think about spin.

**Heisenberg:** You tell them it's wrong.

**Bohr:** No, I tell them it's very...

**Heisenberg:** Interesting.

**Bohr:** I think that is precisely the word I choose.

**Heisenberg:** The train pulls into Leiden.

**Bohr:** And I'm met at the barrier by Einstein and Ehrenfest. And I change my mind because Einstein- Einstein, you see? I'm the Pope- He's God- because Einstein has made a relativistic analysis, and I resolve all my doubts.

**Heisenberg:** Meanwhile I'm standing in for Max Born at Gottingen, so you make a detour there on your way home.

**Bohr:** And you and Jordan meet me at the station.

**Heisenberg:** Same question: what do you think of spin?

**Bohr:** And when the train stops at Berlin there's Pauli on the platform.

**Heisenberg:** Wolfgang Pauli, who never gets out of bed if he can possibly avoid it...

**Bohr:** And who's already met me once at Hamburg on the journey out...

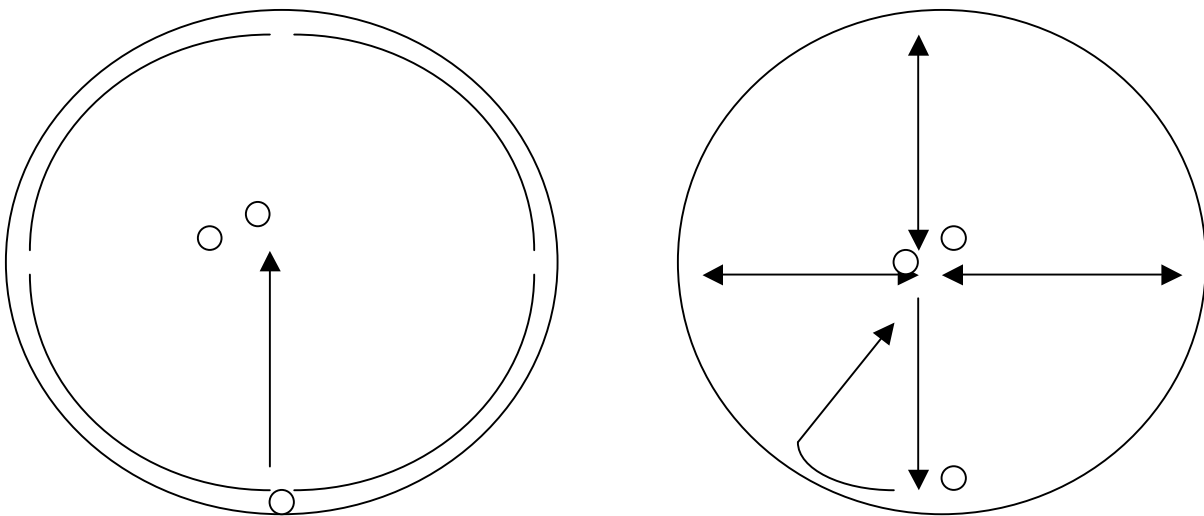
**Heisenberg:** He's traveled all the way from Hamburg to Berlin purely in order to see you for the second time round...

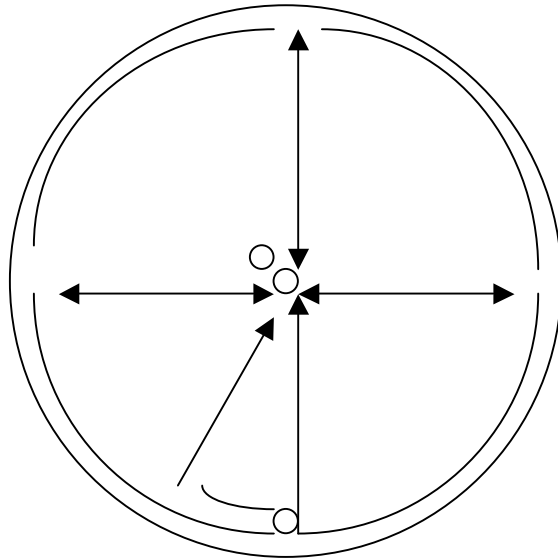
**Bohr:** And find out how my ideas on spin have developed en route.

**Heisenberg:** On those years! Those amazing years! Those three short years!

While this scene allows for the community of scientist of the time to really take shape in the play, this scene plays a larger part in explaining the concept of the uncertainty principle to the audience. By Heisenberg trying to find Bohr along his trip on the train he is demonstrating how an electron acts within an atom. One minute you think you have found the electron and then it is gone again. Thus, showing how uncertainty allows scientists to locate an electron but, once found they cannot know the velocity of the electron and vice versa. In the scientific world this is only the ideal situation as in reality scientists can only guess as to the probability of the location of the electron. By putting one of the central scientific theories in plain language and the action of the play allows for the science of the play to be more accessible to the audience.

To take this a step further, given the information on staging, one can try to image how this might be staged. I think it would be very intriguing to have Bohr walking around the perimeter of the stage and have Heisenberg walking from the middle several times to meet him as a stand in for all the physicists being mentioned in the text. I would have Bohr start at the bottom and go clockwise around the circle with Heisenberg meeting him a fourth of the way in standing in for Pauli and Stern. Then returning to the center of the stage and meeting Bohr at the top of the stage standing in for Einstein and Ehrenfest and returning to center; meeting Bohr three quarters of the way through standing in for Max Born and Gottingen and returning to the center. Then finally meeting him at the bottom of the stage, were Bohr began, standing in for Pauli again. At this point, this is the second time Bohr as meet Pauli yet he alludes to “meeting him en route.” So, to facilitate that, after Bohr meets Pauli the second time, immediately head for the center of the stage while Heisenberg takes the place of Bohr in orbit going clockwise until about one sixth of the way in then himself turning towards center stage and having him meet Bohr there. See Fig. 1-1.





It is important to have an idea of how this may play out on stage to fully comprehend and appreciate the gentle way Frayne has woven the science into text and action and then into something, which can then be turned into a visual stimulus.

The next scene, which is of great importance, is near the end of the play where Frayn again created uncertainty in the text while also introducing the theory of complimentary.

**Heisenberg:** Listen! Copenhagen is an atom. Margrethe is its nucleus. About right, the scale? Ten thousand to one?

**Bohr:** Yes, yes.

**Heisenberg:** Now, Bohr's an electron. He's wandering about the city somewhere in the darkness, no one knows where. He's here, he's there, and he's everywhere and nowhere. Up in Faelled Park, down at Carlsberg. Passing City Hall, out by the harbour. I'm a proton. A quantum of light. I'm dispatched into the darkness to find Bohr. And I succeed, because I manage to collide with him...But what's happened? Look – he's been slowed down, he's been deflected! He's no longer doing exactly what he was so maddeningly doing when I walked into him!

**Bohr:** But, Heisenberg, Heisenberg! You also have been deflected! If people can see what's happened to you, to their piece of light, then they can word out what must have happened to me! The trouble is knowing what's happened to you! Because to understand how people see you we have to treat you not just as a particle, but as a wave. I have to use no only your particle mechanics, I have to use the Schrödinger wave function.

**Heisenberg:** I know- I put it in a postscript to my paper.

**Bohr:** Everyone remembers the paper- no one remembers the postscript. But the question is fundamental. Particles are things, complete in themselves. Waves are disturbances in something else.

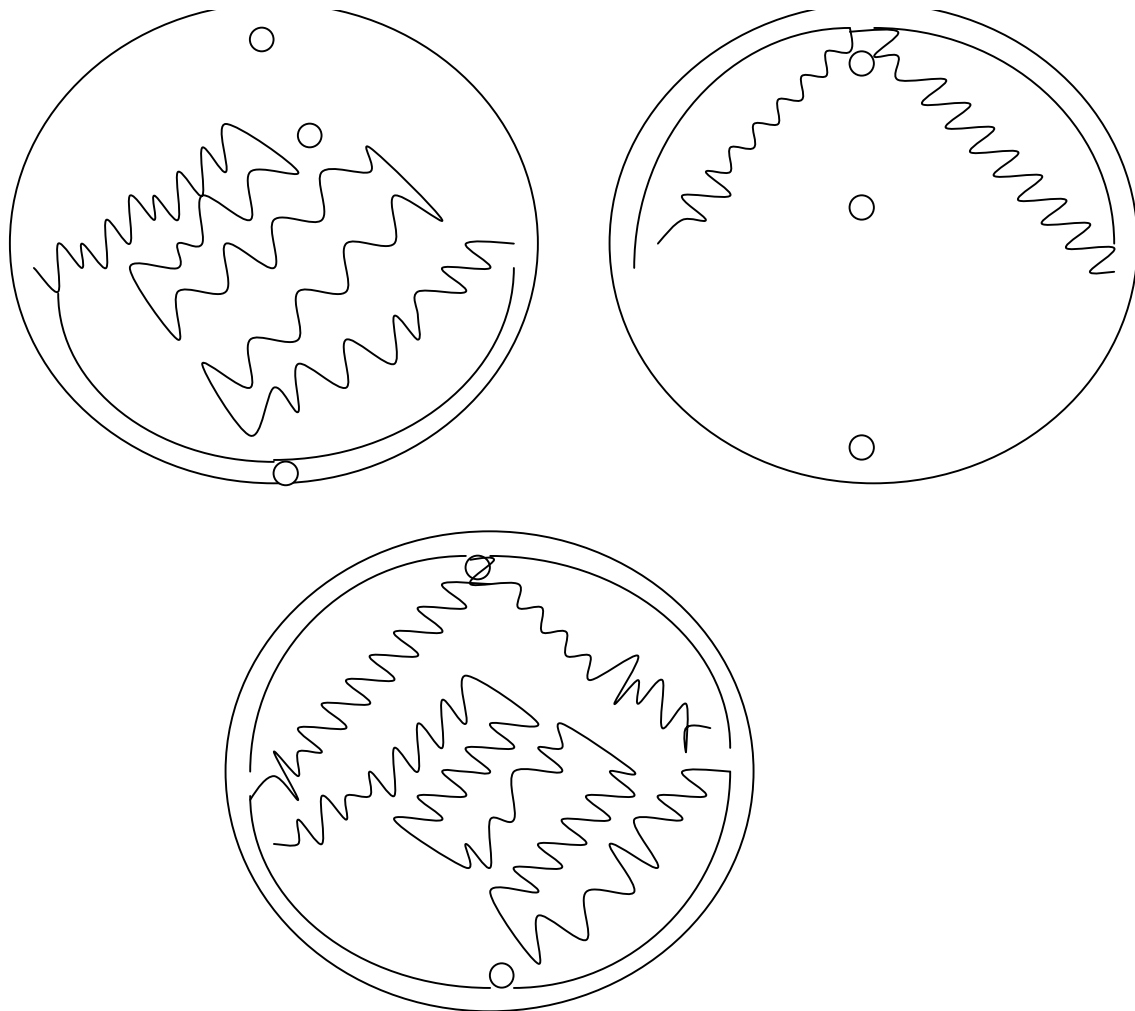
**Heisenberg:** I know. Complementarity. It's in the postscript.

**Bohr:** They're either one thing or the other. They can't be both. We have to choose one way of seeing them or the other. But as soon as we do we can't know everything about them.

**Heisenberg:** And off he goes into orbit again. Incidentally exemplifying another application of complementarity. Exactly where you go as you ramble around is of course completely determined by your genes and the various physical forces acting on you. But it's also completely determined by your own entirely inscrutable whims from one moment to the next. So we can't completely understand your behaviour without seeing it both ways at once, and that's impossible. Which means that your extraordinary peregrinations are not fully objective aspects of the universe. They exist only partially, through the efforts of me or Margrethe, as our minds shift endlessly back and forth between the two approaches.

To try and stage this then I would want to create a pattern on the stage where initially Bohr is in orbit acting like an electron again and Heisenberg is weaving a little bit on stage making a wave pattern with his path left behind. I would have Bohr start at the bottom of the stage again with Margrethe in the middle and Heisenberg up top of the stage. I would have Bohr proceed to his right and start walking the orbit around the stage again with Heisenberg weaving towards him and colliding with him about a sixth of a way through the circle. I would then have Heisenberg directly deflected into the orbital at about one third of the way through the circle with Bohr then beginning to weave his way up to the top of the stage by weaving back and forth on the stage. Once Heisenberg starts on the "there he goes..." part of the scene, I would have Heisenberg and Bohr nearly miss each other at the top of the stage and Bohr would turn to his left and start his orbit while Heisenberg began to weave his way from the bottom to the top of the stage. See Fig. 1.2.





Again, Frayn has managed to weave science into the play in such a way that it is easy replicated on stage with simple movements. His ability to weave together the two theories of Bohr and Heisenberg allows for a greater appreciation of what they accomplished for those who are not approaching this play from a science background. I think it is very important to note how Frayn has his characters act like electrons and particles and by fills in holes for the audience to create an amazing visual stimulus. All this alludes to necessity of the staging of the science to further the understanding of the audience and how they then affect the play with their own individual backgrounds.

## ***Copenhagen: The Interpretation of the Audience***

It is hard to stream line an interpretation of what the audience may see in the play as each audience member is bring to the play their own background and way of viewing the world. For the intentions of this paper though, I will focus on two primary types of audience members. The first is those members of the audience who have a scientific background. They will innately understand the play from this science standpoint much better then those without a science background. Yet, they cannot all by Physicists. So, the minimalist production of the play has to help enlighten their understanding of the play to some extent.

For these audience members, what probably helps them the most is the simple explanation of the history of the science, the scientists themselves and the science itself which is found in the dialog of the play. The language gives them all the information they need because they understand the scientific jargon of the play to begin with. Yet, does their viewing the play change the play for them; one might imagine that for the scientific mind, they would focus in on the science and get caught up in the science so much that they miss the play. That is they might get become so involved with mentally double-checking the science in their head, that they miss how the science transcends the play and what intricate visuals the science creates on stage.

I think it is very plausible that the audience member with a scientific background might be more likely to miss the humanitarian developments of the play and the intricacies with which the play presents the audience. While they know science, this type of audience is going to solely focus on the theories and the language because that is

simply how they think. They are much more analytical and streamlined when it comes to science. If they get caught up in this frame of mind during the performance of the play, they will not be able to see how the science weaves and out of all aspects of the play. Those with scientific minds are more likely to not look as analytically at the creative aspects of the play when science is present.

Then there are those who do not have that firm scientific background, these audience members are the majority of those who are viewing the play. These are the common people, or the “just like everyone” else people who are coming to see the play because they like the plot or heard it was a good performance. These are the people who the science is built into the play for.

Instead of having all these people try their best to understand without the scientific part of the play, the science is explained piece by piece so that they may enjoy the entirety of the play itself. As we started with the physical stage and worked our way from the text on up, it is easy to see that the science is everywhere. While words are coming out of the mouth of the actor, the action being described is being played out on stage simultaneously. Thus, if the audience member works better with words, the backstories are built into the play for those who work better visually there is the visual transformation which is the action of the play. Thus, allows those of us in the audience without a background in science to grasp the action of the play more fully.

Now, I am not suggesting that this mere act of words and visualization is enough for an audience member to walk away from the play understanding all the history and theory behind quantum mechanics. Yet, for the purpose of the play, it allows the person to learn what is needed. The audience member is given the opportunity to learn about

who Neils Bohr and Werner Heisenberg are and what they contributed to society. By the end of the play, the audience member will at least know what uncertainty is and what complimentary theory is as they are stated and reenacted several times on stage. They will be able to understand what a pivotal role Margrethe played in the physics world of the 1920's through the 1940's and how this allowed quantum mechanics to be put into a play in the first place. Simply, because the audience member will understand the power of plain language.

Plain language will be their way of connecting to the play. They will be able to find their way to the middle of the play without missing the science or the more humanitarian side of the play and work their way back out. In plain language the audience, upon leaving the theatre, will be able to explain to other non-science persons what the play was about and how the science played a role in the plot. Plain language is tool with which Frayn allows his audience members to understand science from the beginning to the end. From the text to the staging to the visual replications on stage, because of plain language the audience will never be lost. In fact, it may be safe to say that a person coming to the play with no scientific background will fair better because they will not focus on just one aspect of the play, but will be able to view the play in its entirety.

### ***Copenhagen: The Conclusion***

The science of staging a play in and of itself is very intricate. The work which goes into props, settings, lighting, timing and endless rehearsals is immense. Yet, in the end it

yields a sweet reward. For *Copenhagen*, it is this staging which allows the play to be the success it is today. It allows for the audience to gain a full appreciation and understanding of the play in a way which may have originally seemed impossible given the subject matter. For a play on quantum mechanics, Michael Frayn has been able to create a play in which even those of us who do not care about science can get lost.

With the science seeping into every aspect of the play, it is impossible to escape. Yet, it is this impossibility which allows the play to resonate with the audience. From the script to the stage itself and the action taking place, the audience is getting constantly bombarded with science. They are constantly being reminded of what quantum mechanics is and why it is so important. Since the science is so important to the play, having it explained in such depth is a necessity and the power of plain language throughout the play becomes clear to the audience. Frayn has managed to link all of this together in the most intricate of ways, and because of it, he has been able to teach his audience the science they need to know to understand the heart of the play making *Copenhagen* the hit it is today.

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