Science, politics and morality

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Copenhagen: a new play by Michael Frayn.
Directed by Michael Blakemore.
Showing at the Cottesloe Theatre in London
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Michael Frayn's new play, *Copenhagen*, is both thoughtful and enjoyable. It succeeds in bringing important issues of history, politics, science and morality to a wider audience.

Born in 1933, Frayn worked as a columnist for the *Guardian* and the *Observer* before he turned to writing fiction and drama. Three of his plays, *Alphabetical Order*, *Make and Break* and *Noises Off* received awards for Best Comedy of the Year, and *Benefactors* was named Best Play of the Year. He has translated a number of Chekhov's plays into English, including *The Cherry Orchard*, *Three Sisters*, *The Seagull* and *Uncle Vanya*, as well as translating Tolstoy's *Fruits of Enlightenment*. Frayn's play *Alarms and Excursions* is to open in the West End later this year.

Copenhagen was the first work by Frayn to be commissioned by the National Theatre. The new play is something of a departure for him. It takes as its starting point a historic event--the visit made by the German physicist, Werner Heisenberg[1], to Neils Bohr[2] during World War Two in 1941. The two physicists, who had collaborated for so long on the development of quantum theory[3], were now on opposite sides. Bohr was half-Jewish and a citizen of occupied Denmark. Heisenberg was a professor at Leipzig in Germany, but unknown to Bohr, he had become head of the Nazi regime's project to harness atomic energy. Both men were under surveillance.

The play explores a number of issues: the possible motives for this visit, whether it could have taken a different course, and if so, whether this might have produced a different outcome to the World War, since it is known that Heisenberg broached the subject of the work being done to produce an atomic bomb. This raises the further issue of the morality of scientists working on atomic energy, which had the capability to produce a new weapon of incredible destructive power.

The means by which Frayn explores such possibilities is innovative and effective. We are in the presence of the "spirits" of Heisenberg (played by Matthew Marsh), Bohr (David Burke) and his wife, Margrethe (Sara Kestelman). They are trying, long after the events, to fathom the reasons that they followed the course they did. To do so, they replay the events in different permutations and combinations in order to examine alternatives, explaining their feelings as they do so. The effect, heightened by convincing performances by the cast, is to spirit the audience back into the presence of Heisenberg, Bohr and Margrethe, and permits the spectator to share in the protagonists' secret thoughts as they make split-second decisions that played a part in shaping history.

Heisenberg asserts that the German scientists working on the project under the Nazi regime did not want to develop an atomic bomb. They knew that a bomb was possible, but tried to keep their own research focussed on a reactor. This claim is supported by the conversations, referred to in the play, between German scientists when they were kept prisoner at Farm Hall in Britain after the war's end. (These were secretly recorded by British intelligence and transcripts have now been published.)

Heisenberg describes the horror felt by the German physicists upon learning of the detonation of atomic bombs over Hiroshima and Nagasaki by the US military. He did not believe initial reports until he heard it for himself on the BBC news.

Heisenberg recounts with bitterness the refusal of some of the scientists who had worked at Los Alamos[4] (and who had produced the atom bomb) to shake his hand on the grounds that he had tried to tried to make such a bomb for Hitler. He maintains that he only gave the Nazis sufficient signs of progress to ensure they did not turn the project over to someone who really wanted it to succeed. One possible motive for Heisenberg's visit to Bohr in 1941, explored in the play, is that he wanted an agreement with the Los Alamos scientists that they should all exaggerate the difficulties of producing atomic bombs to convince the authorities on both sides not to pursue the

project.

If this was indeed Heisenberg's intention, he did not succeed. Bohr reacted to his raising the subject of working on atomic energy with hostility, as he assumed that the other man was already leading an attempt to provide the Nazis with an atomic bomb.

The play examines the possibility that if Bohr had not reacted in this way, he might have unwittingly given Heisenberg information that would have aided Hitler in building an atom bomb. Bohr later joined the Los Alamos project, and in the play admits his feelings of guilt over the destruction of Hiroshima and Nagasaki. Heisenberg makes clear that he feels the barbarity of this act rivalled that of the Nazis.

In addition to working on the political and historical plane, the play touches on the science of quantum mechanics. There are memorable scenes in which scientific ideas--such as the nature of the atom, the "Uncertainty Principle"[5] (for whose discovery Heisenberg is best remembered) and the role of mathematics and language in developing new concepts--are tackled in an accessible and lively manner. One topic that arises concerns Heisenberg's concentration on developing the mathematics of quantum mechanics at the expense of considering the philosophical implications. Bohr did the opposite, thinking the issues through to the end, and wanting to explain the issues in words rather than mathematics alone.

The two scientists had disagreements, but they did take tremendous strides forward--the result being the Copenhagen interpretation[6] of quantum mechanics.

The play is not so much about the science itself, however, as it is about how scientific ideas can help us to understand the manifold possibilities the future holds, and how history consists of a constant transformation from this indeterminate future, through the present to a single past.

Copenhagen asserts that human motives are knowable only within definite limits. The characters in the play argue that even the past is difficult, and, in terms of motives, impossible to determine. Frayn compares the psychological difficulty of understanding motive with the difficulty in simultaneously measuring the movement and speed of subatomic particles, which is the subject of Heisenberg's Uncertainty Principle.

Although Frayn is using scientific concepts outside their proper range of application, his intention is to inspire the audience to ask questions and not accept a fatalistic and shallow view of events. The artistic device is effectively used to illustrate the uncertainties animating the play. It is also meant to urge the audience on to a consideration of the great uncertainties that lie in front of the human race. And this the piece does very well.

Notes:

1. Werner Heisenberg: German physicist, 1901-1976. Collaborated with Neils Bohr between 1922 and 1927 on a consistent theory for the physics of subatomic particles. Discovered the Uncertainty Principle in 1927. Won Nobel Prize for Physics in 1932.

2. Neils Bohr: Danish physicist,1885-1962. Developed the theory of complementarity. Won Nobel Prize for Physics in 1922.

3. Quantum theory: Theory of subatomic particles, light, etc. in which both energy and matter exist only in discrete packets or quanta, meaning that a change in the energy of a particle can only take place by emitting or absorbing a quantum of energy.

4. Los Alamos: A city of 70,000 people created in the New Mexico desert as the base of the "Manhattan Project" to build atomic bombs. An international team of scientists worked there under the direction of Robert Oppenheimer of the University of California.

5.Uncertainty Principle: Principle applying to subatomic particles that certain pairs of variables cannot both be known exactly. The more precisely one variable is defined such as position, the less precisely can another variable such as speed be established.

6. Copenhagen interpretation: In 1928, Bohr combined Heisenberg's particle theory with Schrodinger's wave theory by means of the theory of complementarity. This establishes that both the wave and particle descriptions of particles must be used to fully understand their properties. Heisenberg's "Uncertainty Principle" and complementarity are made the basis of a consistent theory, known as the Copenhagen interpretation of quantum mechanics.