

PHYSICS COMMUNITY

Bohr-Heisenberg Symposium Marks Broadway Opening of *Copenhagen*

It was a rather unusual Sunday matinee crowd gathering on the sidewalk outside New York's Royale Theater on 26 March. Among those waiting to see a preview performance of Michael Frayn's *Copenhagen* were more than a hundred physicists, historians, and science journalists.

The play, which has been running in London for two years, revolves around the still controversial visit of Werner Heisenberg to the home of Niels Bohr in German-occupied Copenhagen in September 1941. After the war, Heisenberg and Bohr offered conflicting recollections. Was Heisenberg, as Bohr remembered it, trying to ferret out information about Allied efforts to build fission weapons? Or was he, as he later claimed, trying to suggest to the physicists in Britain and America, through Bohr, that both sides should abjure this deadly quest? Frayn makes much of the analogy between quantum uncertainty, as thrashed out between Heisenberg and Bohr in earlier and happier Copenhagen days, and the uncertainty of memory and motivation.

The senior member of the audience was probably the 93-year-old Hans Bethe, who headed the Los Alamos theoretical group during the war. The attendance of so many scientists and writers at this preview performance was organized by physicist Brian Schwartz of the Graduate Center of the City University of New York in connection with "Creating Copenhagen," a symposium on the historical events and their theatrical interpretation held the following day at the Graduate Center's new home on Fifth Avenue.

The symposium began with background talks on quantum theory and nuclear physics. Then came the history session: Bethe gave a talk entitled "Why the Germans Did Not Achieve an Atomic Bomb." Historian David Cassidy, author of *Uncertainty*, a Heisenberg biography, gave his assessment of the play as history. Gerald Holton, professor of physics and history at Harvard, spoke about the relationship between Heisenberg and Einstein.

Particularly touching were John Wheeler's personal reminiscences of

▶ Why did Heisenberg visit occupied Copenhagen in September 1941?

Bohr. The two first met in 1934, just after Bohr's son Christian drowned while sailing with his father. (The play uses this tragic accident to poignant effect.) Days after hearing of Otto Hahn's discovery of fission, Bohr



HANS BETHE AND GERALD HOLTON

visited Wheeler at Princeton in January 1939, where together they worked out the special role of the tiny isotopic admixture of U^{235} . In the play, Bohr says repeatedly that he and Wheeler had shown in 1939 that a fission bomb was a practical impossibility. Therefore Heisenberg's oblique hint that he was working on a bomb came to Bohr as a devastating shock. Heisenberg was, in fact, head of the German uranium project.

In answer to a question after Wheeler's talk, about how Heisenberg was received by American and refugee physicists on his first postwar visit to America, he only managed to say, "I had visited Auschwitz." Then, tears welling in his eyes, Wheeler silently waved the question away.

Why the Germans failed

Bethe's talk was more matter-of-fact. The Germans, he said, had failed to realize that graphite was the appropriate moderator for a uranium reactor, because Walther Bothe, the acknowledged authority, claimed it was unsuitable. "And Germans did not challenge authority," said Bethe, who left Germany in 1933. In America, Hungarian refugee Leo Szilard,

talking in 1942 to the chemical engineers who manufactured commercial graphite, discovered that the offending impurity was boron, and that enough of it could be removed to make graphite bricks sufficiently pure for reactors. In Germany, with its hierarchical ways, Bethe asserted, no physicist would have deigned to consult a chemical engineer. Once you have working reactors—something Heisenberg and his colleagues never achieved during the war—you can make fissile plutonium, which, unlike U^{235} , can be separated chemically. In the play, Heisenberg admits explaining this to lower-echelon German army officers and technocrats. But, he claims, he kept this crucial insight from armaments minister Albert Speer, who had to decide on the priority assigned to the uranium project.

"Heisenberg was *not* thinking about an atomic bomb," said Bethe categorically. Bethe reached this conclusion by reading the transcription of the "Farm Hall tapes," the secret eavesdropping, by their British jailers, on the German nuclear scientists comfortably imprisoned in an English country manor at the end of the European war. The many errors in Heisenberg's explanatory first lecture to his fellow detainees shortly after they learned of Hiroshima, Bethe concluded, made it clear that he had not been working on bomb physics. Among other mistakes, Heisenberg's estimate of the requisite critical mass of U^{235} for this first lecture was too big by more than an order of magnitude.

If Heisenberg did attempt to calculate the critical mass in earlier days—itsself an unsettled historical issue—the fact that he got it wrong puts him in good company. Session cochair Spencer Weart reminded the audience that even Fermi got it wrong. "The first to get it right," he said, "were Peierls and Frisch" in England.

Cassidy gently chided Frayn for failing to mention in the play that Heisenberg made morally questionable "cultural" visits to several other cities, besides Copenhagen, under Nazi occupation.

Holton told of the young Heisen-

berg's trip to Leipzig in 1922, to hear Einstein talk. But Nazi protesters were so threatening, even in those early days, that Einstein cancelled, fearing for his safety. Holton also told of Heisenberg's 1926 conversation with Einstein about the new quantum mechanics. As Heisenberg remembered it, Einstein chided: "You don't seriously believe that a theory must restrict itself to observables. Perhaps I did use this sort of philosophy, but it's nonsense. Only the theory decides what one can observe."

Ghosts on stage

The evening session was devoted to a discussion of the play with Frayn and director Michael Blakemore. The English playwright became famous for his rollicking comedy *Noises Off*. His university degree was in philosophy. Frayn's interest in the 1941 Copenhagen encounter was first aroused by Thomas Powers's book *Heisenberg's War*, which takes a more sympathetic view of the physicist's wartime role than does Cassidy.

The play imagines a posthumous rehashing of the events by the ghosts of Heisenberg, Bohr, and his wife Margrethe. Their recollections, often conflicting, flit back and forth over 25 years—from Bohr's first encounter with the brilliantly brash young Heisenberg to their unbearably strained reunion in Copenhagen after the war. Margrethe, serving almost as a Greek chorus, is much the harsher judge of Heisenberg. Finding that Frayn's Margrethe was very far from the woman she had known so well, Bethe's wife Rose asked how he had arrived at this portrayal. In response, Frayn pleaded artistic license.

In the New York production, Bohr and Margrethe are played by Philip Bosco and Blair Brown. Michael Cumpsty, who plays Heisenberg, came to the talks by Bethe, Wheeler, and the historians, presumably to learn more about the terribly enigmatic man he is portraying.

At the symposium, Nancy Green-span, who's preparing a biography of Max Born, showed me a photocopy of a 1947 letter from Born to his son Gustav, describing a postwar conversation with Heisenberg: "His philosophy of life is definitely somewhat infected by Nazi ideas. He has a kind of 'biological' creed, 'survival of the fittest,' applied to human relations, and seems to regret more that the Germans have not turned out to be the fittest, than what we regard to be the sad and regrettable things."

BERTRAM SCHWARZSCHILD

UK Ends Site Stalemate by Sending Synchrotron South

The UK's new synchrotron x-ray source will be built at the Rutherford Appleton Laboratory near Oxford, the British government announced on 13 March, ending a bitter battle over the siting of the planned facility (see PHYSICS TODAY, January, page 50).

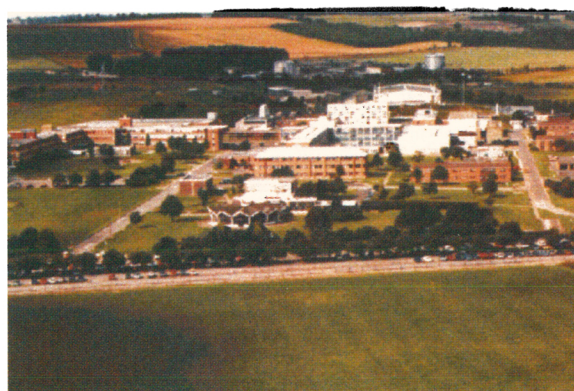
In his announcement, science minister David Sainsbury said that Rutherford was chosen over the competing site, Daresbury Laboratory, which lies some 160 miles to the northwest and is home to the country's existing synchrotron, "after a careful analysis of scientific, technical, operational and financial issues and the views of the funding partners." The implication is that the UK's partners in the \$275 million synchrotron—the Wellcome Trust and the French government—would have withdrawn their support had Daresbury won out. A government press officer elaborated: "We needed to secure funds. We couldn't go ahead without the others."

Actually, it's hard to tell who bullied whom about where to build the synchrotron. Early on, the Wellcome Trust pressed for an open site competition. But the UK government offered up only the two sites, and then last summer said the new synchrotron would be built at Rutherford. That's when Daresbury scientists mounted a campaign to site the facility at their own lab. Subsequently, the Wellcome Trust, a major funder of human genome research, threatened to pull out of the project if it didn't go to Rutherford, which it prefers because of the biomedical companies clustered nearby. The French government officially had no site preference, but said it would participate only if the Wellcome Trust remained on board. (French scientists, for their part, are still lobbying to resurrect plans to get a synchrotron on their own soil. Their hopes were raised by the 24 March ousting of science minister Claude Allègre; see story on page 53.) The site decision remained stalled for months.

The plan now is to keep the Daresbury facility running for seven years—overlapping with the new synchrotron's expected start date by about two years. The government is also looking into options for boosting

the scientific and economic base in the northwest, including possible future uses of the Daresbury site. "I think there is great relief in the user community that we can go ahead with the synchrotron," says Gordon Walker, who oversees both the Daresbury and Rutherford labs for the UK's Central Laboratory for the Research Councils.

That's not how people at Daresbury see it, though. "The mood here is angry," says Andrew Hopkirk, a Daresbury scientist and staff representative. "Had there been a competition [for the site], many here would have reacted professionally. But that



RUTHERFORD APPLETON LABORATORY in Oxfordshire prevailed in a drawn-out battle over where to site the UK's new synchrotron.

was short-circuited, hence all the upset. It appears that rationality was not the most significant part of the decision-making process." Daresbury employees aren't alone in being disgruntled: Six of the 35 scientists recently consulted by the government have written to Prime Minister Tony Blair claiming they weren't allowed to state their site choice—Daresbury.

Meanwhile, notes Hopkirk, several Daresbury scientists and engineers have resigned, and others are scouting for new jobs. If too many of them take their expertise out of the country, building the new machine could become a problem.

A reversal in the site decision is unlikely. And, once the project finally goes ahead, the UK will get a much bigger and better synchrotron than was intended before the Wellcome Trust and the French government signed on.

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