cameras are used to locate and reenter the bo hole – an action described by Dr. Baldwin as "roughly the equivalent of threading a needle miles away."

In drilling Hole 504B, the researchers had to use this method many times. In the last 40 days of drilling, a steel and tungsten-carbide bit bored vertically through 1,200 feet of hard rock.

According to Nick Shackleton of Cambridge University, a world authority on the Late Quaternary (the geology of the last million and a half years), rocks and sediments from the deep oceans can be used to explain the basic causes of climate variability.

"We are building up not just a description of past climate, but a detailed understanding of the mechanism of climate change," Dr. Shackleton says. "As we get better and better at it, we learn more about how the earth's climate system works. That is helping to improve the models we are using to predict future change."

In January, Allan Kemp of Southampton University told a London conference of earth scientists concerned with ODP that, by using an electron microscope to examine under-ocean rock samples, researchers may soon be able to create a year-by-year record of world weather patterns going back a million years.

Tony Rosell of Bristol University says the study of fossilized algae in undersea sediment promises to yield a detailed record of the earth's temperatures as ice caps advanced and retreated and sunspots waxed and waned.

Mr. Rosell uses the term "biomarker" to describe chemicals contained in marine algae trapped beneath the earth's crust.

Study of the biomarkers, he says, should indicate the amount of CO_2 in the atmosphere and even the temperature of the sea when the algae died.

sound waves for cooling. Hofler remarked that the biggest bottleneck in developing this principle for practical use is a shortage than in enlightening students. He notes that they parade an array of concepts in particle resea and other areas of "modern" phys- surely would produce physicists who can work on a revolutionary type of refrigeration.

The Man Who Tried to Build Hitler's Bomb

By Simson L. Garfinkel

WHY would Werner Heisenberg, a Nobel Prize-winning physicist generally critical of the Nazi regime, work day and night for more than six years to perfect Adolph Hitler's atomic bomb? That is the basic question posed in "Uncertainty," David C. Cassidy's mammoth account of Heisenberg's life and science.

Born in 1901, Heisenberg entered the University of Munich in 1920. The first quarter of the 20th century was a time of upheaval in the world of physics. Simple experiments in the laboratory were producing results that could simply not be explained.

World War I had exacted a heavy price on the German spirit and economy. In large part, German science was supported only by the philanthropy of foundations in the United States. For Heisenberg and his peers, science was a way to regain a measure of the international prestige their country had lost.

Today, Heisenberg is best known as the discover of "The Heisenberg Principle," a law of physics that says it is impossible to know with certainty the position and speed of a particle. It – and the theory of quantum mechanics necessary to derive it – earned him a Nobel Prize for Physics at the age of 32.

But Heisenberg's world turned upside down on Jan. 30, 1933, when Hitler came to power. Like most other German intellectuals of his time, Heisenberg remained silent as the Nazis assumed control of the German state. Cassidy convincingly shows why: After Germany's dismal failure in World War I, which had enjoyed near-universal support among German academics, the professors had decided to stay far away from the political arena. Used to the upheavals of the Weimar Republic, they assumed that the Nazis would be out of power before the end of the year. It proved to be their undoing.

In the first round of firing, any professor with a trace of Jewish heritage was summarily dismissed. Soon the Reich became intolerant of the theories made by Jewish physicists. Foremost on the hate list was Albert Einstein, whose general theory of relativity was deemed incompatible with the Nazi's "Deutsche Physik." Teaching relativity or merely mentioning Einstein's name was an offense that could land one in a concentration camp.

Soon, even Heisenberg's non-Jewish peers were fleeing Germany. But Heisenberg stayed.

The Nazis did not reward his patriotism. Despite his Nobel Prize, Germany's new rulers looked down on his physics. He was viciously attacked in an SS periodical in 1937 for harboring the "spirit of Einstein." A prestigious appointment was repeatedly dangled before him and withheld because he clung to relativity and quantum theory.

That all changed 15 days after

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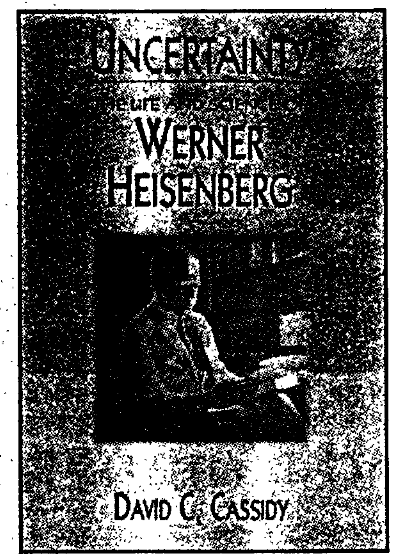

UNCERTAINTY:
THE LIFE AND SCIENCE OF WERNER HEISENBERG
By David C. Cassidy
W. H. Freeman
669 pp., $29.95

Hitler marched into neutral Poland, marking the start of World War II. Physicists from all over the country were drafted to join the "Uranium Club," Germany's secret project to develop an atomic weapon. For Heisenberg, it was his chance to rehabilitate himself in the eyes of the Nazi leaders and save German theoretical physics. He became the scientific head of the project.

Heisenberg was convinced that an atomic bomb could not be made before the end of the war, but that didn't stop him from working feverishly to develop the "irresistible offensive weapon" that he had promised his masters. Until the very last days of the war, he was hard at work trying to make his atomic pile "go critical." That was all he needed to make the plutonium Germany so desperately needed.

In the end, the Nazis failed to develop the atomic bomb for two main reasons: In their insane quest for German "purity," they ignored, forced out of their country, and killed some of the greatest minds in nuclear physics. Nevertheless, the Nazi atomic bomb might still have succeeded under Heisenberg's genius alone if the Nazi officials had simply given him the money and materials for which he pleaded. It is the stuff of megalomaniacal nightmares.

Cassidy's work is uneven at best. His description of Germany in the 1920s reads as little more than a long litany of violent events. His descriptions of Heisenberg's physics are all but impenetrable without three years of college physics.

Far more interesting is the way Cassidy shows the contradictions between Heisenberg's statements after the war and his actions under the Reich. By planting one foot squarely in politics and the other in science, Cassidy brings to light a world of fascinating facts and details in this most uncertain life.

■ *Simson L. Garfinkel is a freelance writer who specializes in science and technology.*