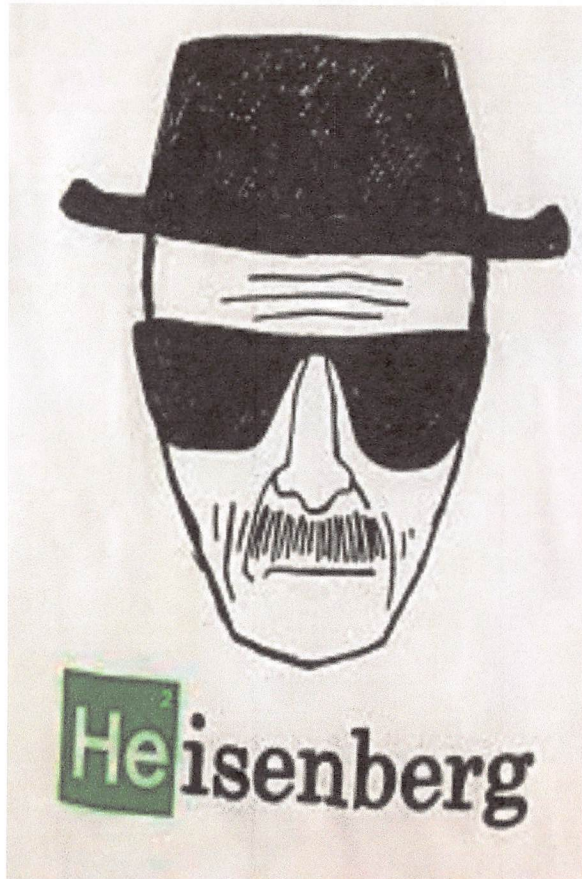


# ***The Heisenberg Certainty Principle***

***Sphex Club Meeting***

***October 17, 2019***

***Kevin G. Smith***



- Heisenberg –the name connotes intelligence and perhaps something a little ominous.
- The pop culture hit Breaking Bad appropriated the ominous overtones of the name Heisenberg.
- Nazi Germany's leading theoretical physicist in charge of developing Germany's nuclear power and atomic bomb.
- Heisenberg was brilliant, gifted and he failed.

# Heisenberg's "Uncertainty" Principle

Mathematically we describe the uncertainty principle as the following, where 'x' is position, 'p' is momentum and 'h' is Planck's Constant:

$$\Delta x \Delta p > \frac{h}{2\pi}$$

This is perhaps the most famous equation next to  $E=mc^2$  in physics.<sup>(1)</sup> It basically says that the combination of the error in position times the error in momentum must always be greater than Planck's constant.

The combination of position, energy (momentum) and time are actually undefined for a quantum particle until a measurement is made (then the wave function collapses).

***So What Does This Equation Have to do with This Presentation?***

***The Difference Between the Billiard Balls of Newtonian Physics and the Subatomic Behaviors in Quantum Physics***



*NOTHING*

**I know nothing about quantum mechanics, ...or do I. How do you know what I don't know if I tell you I don't know it?**

# ***The Heisenberg Certainty Principle***

***In December 1944 One Thing Was Certain –***

***Nazi Germany was Nowhere Close to Developing the Atomic Bomb***

***...and the person who concluded this after talking with Heisenberg was:***

1. American
2. Jewish
3. A catcher for the Boston Red Sox

***Would You Believe Me If I Told You***

# ***The Certainty of German Science***

- Of the 100 Nobel Prizes awarded between 1901 and 1932, 33 were awarded to Germans.<sup>(2)</sup>
- Among these scientists were Max Planck.
- Lise Meitner, an Austrian, and German chemist, Otto Hahn, discovered nuclear fission in 1938.
- Planck's work formed the basis of Neils Bohr's work.
- Einstein was a member of the Prussian Academy of Science (until 1933)
- ...and Germany had Heisenberg, Nobel Prize winner for "the creation of quantum mechanics."



***In the Early 1930's There Was One Country Well-Positioned to Develop Atomic Power – Germany***

# ***The Certainty of Werner Heisenberg:*** **1901 – 1976**

- Born in southern Germany, the second child of a secondary school teacher of classical languages.
- Excelled at math, music and table tennis.
- Studies physics and math in Munich under Arnold Sommerfeld.
- From 1924 – 1927 works closely with Niels Bohr in Copenhagen.
- 1927 named the head of Leipzig's Institute of Theoretical Physics.
- Nobel Prize awarded in 1932 (receives it in 1933). <sup>(3)</sup>
- Well connected with the physics world.



# ***So Why Did Germany Fail so Completely?***

***The inevitable consequence of several key decisions made by the Nazi nuclear program:***

1. Nazi racial policies destroyed scientific programs
2. Nazis never embraced quantum physics
3. Wehrmacht focused on rockets instead of nuclear efforts
4. Heisenberg alerted Allies to Germany's nuclear efforts
5. Nazi efforts focused on the wrong neutron moderator
6. The Reich decentralized its nuclear program

***What Moe Berg Discovered was the Inevitable Result of a Failed Regime***

# ***1. Racial Policies: The Dismantling of German Science***

## ***Chasing out the best and brightest***

- April 7, 1933, Hitler initiates a new civil service requirements forbidding “non-Aryans” from holding civil service jobs.
- Einstein resigns from the Prussian Academy of Science.
- Within the first year of these laws, 2,600 scientists leave Germany.
- Of these 2,600 scientists, 20 won Nobel Prizes, 54 became fellows of the Royal Society, 10 received Knighthoods.
- 1,700 of these scientists come to America.<sup>(4)</sup>



***A Brain Drain of Epic Proportions***

## ***2. Rejection of Quantum Physics: Deutsche Physik = Pseudoscience***

### ***The Reich attacks theoretical physics itself***

- Philipp Lenard – a Nobel laureate in physics – deeply suspicious of theoretical physics.
- He and another Nobel laureate, Johannes Stark, campaign to discredit Einstein and recent theoretical physics as “Jewish Physics.”
- Start a campaign to make physics more German and “Aryan” – Deutsche Physik.<sup>(5)</sup>

***Dismissal of Relativity and Quantum Mechanics***

## ***2. Rejection of Quantum Physics: Heisenberg's Struggles***

**Heisenberg is personally attacked and vilified by the Reich.**

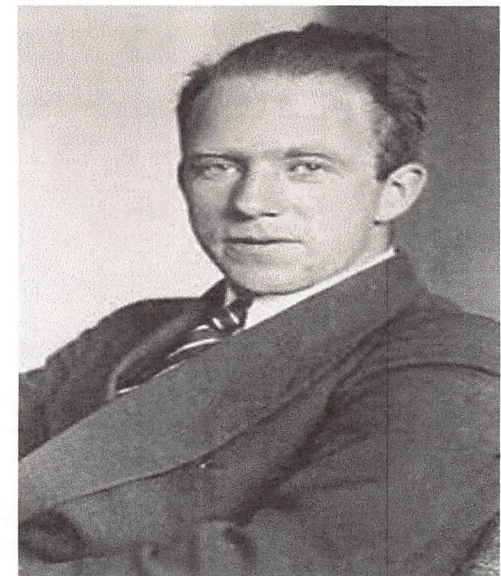
- He is a theoretical physicist studying the very type of physics branded as “Jewish.”
- 1937 SS Journal article by Johannes Stark calls Heisenberg a “White Jew” – that is an Aryan who espouses Jewish ideas.
- Munich University drops his appointment, and the SS opens an investigation into his conduct.
- Himmler personally takes over the investigation.
- 8 months later Himmler clears Heisenberg while writing him to be more politically aware.<sup>(6)</sup>

***“Mit Freundlichem Gruß, und Heil Hitler!”***

### **3. Rockets, Not A-Bombs: The Uranverein**

#### ***The Uranium Club***

- In April 1939, Germany starts Uranverein Project.
- First efforts stall due to the start of the war.
- Efforts focus on nuclear reactor work for power production and uranium isotope separation.
- Work divided between 9 institutes, setting their own objectives.
- In 1942, the Wehrmacht puts efforts into Wernher von Braun's rocket program and de-emphasizes nuclear work.<sup>(7)</sup>



## ***4. Heisenberg Reveals German Efforts: The Copenhagen Meeting***

### ***Student Returns to the Master***

- Heisenberg makes a fateful decision to meet with Niels Bohr – fall of 1941.
- Meeting's purpose to suggest a quid pro quo – “We won't work on it if you don't work on it.”
- The meeting is a disaster. Bohr never forgave Heisenberg for the meeting.
- Heisenberg reveals 3 key things:
  1. Germany is working on a bomb
  2. Heisenberg is playing the lead role
  3. They can do it
- Bohr immediately passes this information to the Allies.<sup>(8)</sup>

# *Copenhagen*

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## ***5. America Mobilizes with the Right Moderator: A Refugee Scientist***

### **2 Key Contributions to America's nuclear war effort**

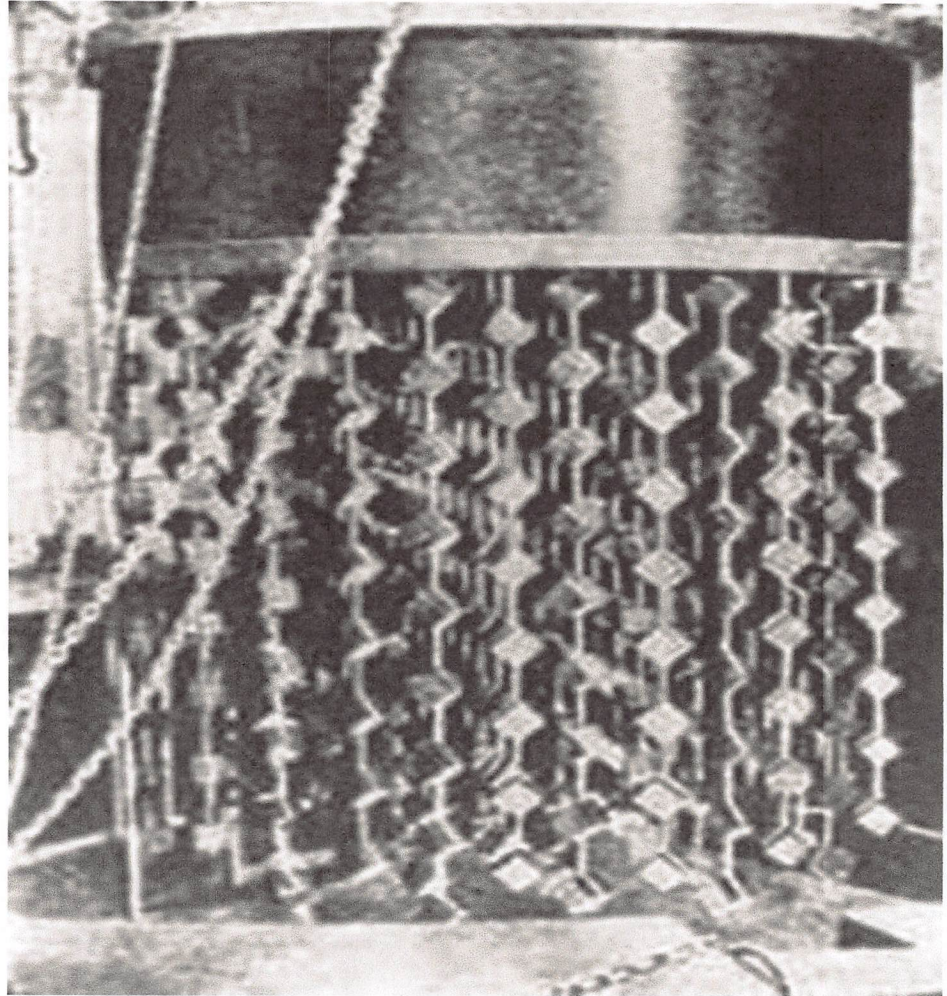
1. August 1939, Leo Szilard pens letter for Einstein's signature warning of a German nuclear weapon project and the need for a US program.
2. Working with Fermi, he uses pure graphite as a neutron moderator for sustaining nuclear fission.
  - The Germans, not recognizing problems with impure graphite, focus on heavy water as their neutron moderator.
  - The Germans never achieve a self-sustaining reaction during the War.<sup>(9)</sup>



**Leo Szilard**

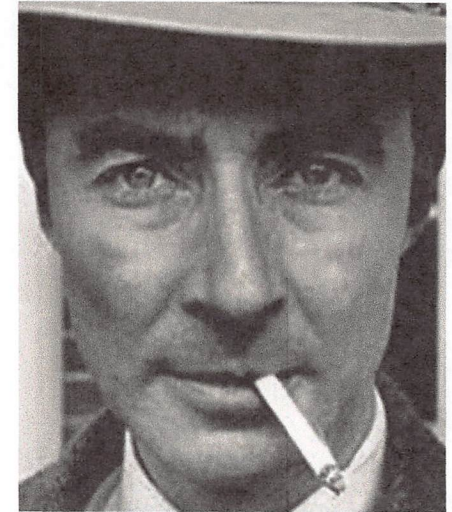
# *German Reactor*

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## **6. *Centralized Effort and Focus: The Manhattan Project***

- Centralized, clear objectives and run with a level of secrecy and purpose rarely seen on a project of this scale
- Run by General Groves a hands on security fanatic.
- Employed 125,000+ people, including 6 future Nobel Prize winners (not Oppenheimer).
- Driven by a fear of the Germans getting there first.
- 1943 – Niels Bohr visits the project leaders in New Mexico and passionately expresses concerns about German (specifically Heisenberg's) bomb efforts.
- Concerns about Heisenberg's abilities so great that Groves sets up a separate mission to deal with Heisenberg.<sup>(10)</sup>



Robert Oppenheimer

# ***Dealing with Heisenberg's Brain: The Alsos Mission***

- September 1943 effort to coordinate foreign intelligence on enemy nuclear activity.
- Consisted of military, scientific and intelligence personnel.
- Groves goes to William ("Wild Bill") Donovan founder of the OSS to discuss Alsos "sensitivities."
- Unwritten objective how to deal with Heisenberg's brain.<sup>(11)</sup>



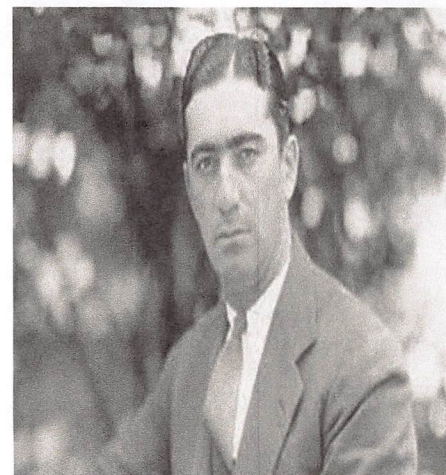
**Oppenheimer and General Groves**

***Finding the Right Man for the Job - Enter Moe Berg***

# ***Morris Berg: 1902 – 1972***

## ***Scholar, Sportsman and Spy***

- The youngest of 3 children born to Ukrainian Jewish immigrants.
- Photographic memory, and his love was baseball.
- Completed two semesters at NYU and transferred to Princeton at age 16.
- Considered the best baseball player in Princeton history.
- Studied languages and spoke and read German, Latin, Greek, French, Spanish, Italian, and Sanskrit.
- Wanted by the Giants and Dodgers, but skips spring practice with the Dodgers to attend Columbia Law School.
- An all-star catcher selected to all-star teams travelling to Japan on good will missions.
- Leaves baseball in 1941 and joins the OSS in 1943.<sup>(12)</sup>

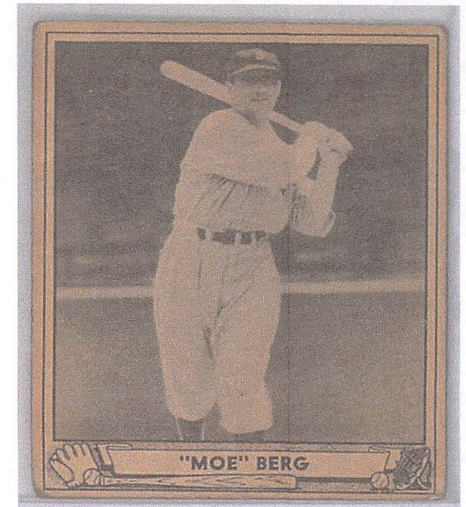


**Moe Berg**

***Who is this Guy, and Can this Be True?***

# *Morris Berg: Sportsman*

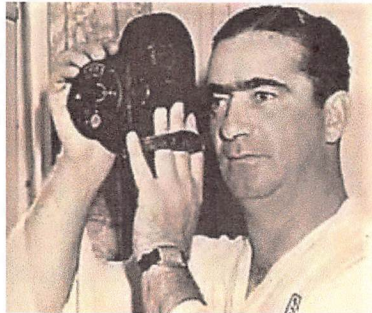
- White Sox pick him up – hits .311, 72 RBI's.
- 1927 Moe fills in as catcher, and the rest is history. He makes pitchers better, and the pitchers love him.
- Injured in 1930, plays little, graduates from Columbia and works at Wall Street law firm.
- Goes back to baseball when Indians pick him up. By 1932, he is considered one of the best catchers in baseball.
- 1932 & 1934 he takes trips to as part of baseball All Star team that includes Gehrig and Ruth.
- '34 he is with the Red Sox and catching and coaching Ted Williams.
- The players love him, and he is a complete character.<sup>(13)</sup>



*Speaks Seven Languages and Can't Hit in Any of Them*

# Morris Berg: Spy

CIA's Website Says the following: <https://www.cia.gov/news-information/featured-story-archive/2013-featured-story-archive/moe-berg.html>

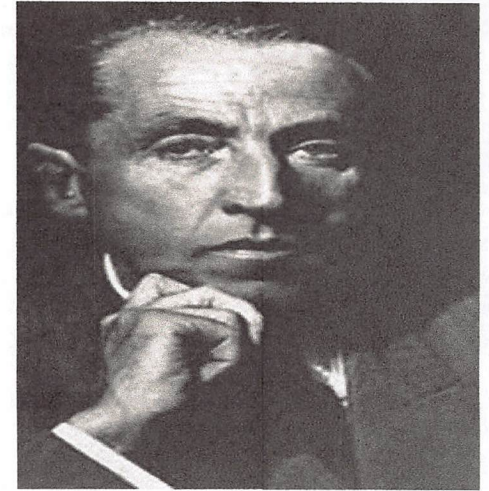


- Berg's entrance into the field of intelligence began when he, Babe Ruth, Lou Gehrig and other baseball greats formed an all-star team and traveled to Japan in the mid-1930s for exhibition games.
- Proficient in Japanese, Berg talked his way into one of the tallest buildings in Tokyo. He climbed to the rooftop alone and used a movie camera to film the capital city's shipyards. Reportedly, the US used Berg's footage to plan bombing raids over Tokyo in World War II.
- Following the attack on Pearl Harbor in 1941, Berg initially joined the White House's new Office of Inter-American Affairs but left for the Office of Strategic Services (OSS) in 1943. He became a paramilitary officer and carried out various intelligence operations in Europe, including parachuting into Yugoslavia to evaluate resistance groups.
- By 1945 Berg had been tasked to determine whether Nazi Germany was close to having a nuclear weapon. Using his language skills and charm, he managed to locate and chat with Werner Heisenberg, a top physicist in the Third Reich. Berg accurately determined that the answer was "no."
- Berg stayed with the OSS until it dissolved in 1945. Afterward, he served on the staff of NATO's Advisory Group for Aeronautical Research and Development.
- Before his death in 1972, Berg said, "Maybe I'm not in the Cooperstown Baseball Hall of Fame like so many of my baseball buddies, but I'm happy I had the chance to play pro ball and am especially proud of my contributions to my country. Perhaps I could not hit like Babe Ruth, but I spoke more languages than he did."<sup>(14)</sup>

# ***Morris Berg: Alsos***

## ***The Lecture, the Dinner and the Walk Around Zurich***

- Berg teaches himself quantum physics from books.
- In 1944, Berg is working his way through Italy looking for physicists.
- By end of November 1944, part of Alsos, after capturing German scientists in Strasbourg, believes that Germans do not have a program.
- Berg does not know this and continues working with Allied asset Paul Scherrer, Swiss physicist who has invited Heisenberg to Zurich in December '44.
- Scherrer was troubled that Heisenberg was a Nazi, and gets Berg into the lecture.
- Berg's orders are to shoot Heisenberg if, during the lecture, it becomes clear that Germany is close to developing a bomb.
- He listens to an incomprehensible lecture on matrix theory with a pistol and cyanide capsule in his pocket.
- Scherrer sits Berg next to Heisenberg at a dinner. The two leave together walking Zurich's streets. Berg concludes Germany is nowhere close to a bomb.<sup>(15)</sup>



**Paul Scherrer**

***Berg Lets Heisenberg Live***

# ***Post-War: Operation Epsilon***

## ***The Germans Knew Nothing about how to build a Bomb ...or did they?***

- 1945 Heisenberg and 10 other German scientists are taken to an English estate where their every word was recorded from July 3, 1945 – January 3, 1946.
- Purpose of this was to determine how close Nazi Germany had come to constructing the bomb.
- The Germans tried to show Allies their superior knowledge.
- They do not believe the news of Hiroshima.
- The transcripts then show the development of what eventually became their narrative – they never really tried due to their moral misgivings.
- ...and yet, Heisenberg had clearly been thinking about bomb design.<sup>(16)</sup>

# ***The Aftermath: What is and is Not Certain***

## ***Heisenberg –***

- ***While it is certain that Germany was not close to developing the bomb, it's not certain whether Heisenberg withheld his efforts to make sure it did not happen.***
- ***His role and real motivations are largely unknown, ...and thus we are full circle – there is a lot of uncertainty about Heisenberg.***
- Bohr and Goudsmit and many physicists do not believe Heisenberg's self-serving statements.

## ***What is Certain is that he:***

- Returned to Germany in 1946, going right back to work.
- Observers say he had a perpetual depression.
- He is appointed to head the Max Planck Institute.
- Extensively travelled and lectured, working on field theory.
- Continues the story that German physicists did not develop the bomb for moral reasons.
- Dies peacefully at his home in Munich in 1976.<sup>(17)</sup>

# ***The Aftermath: What is and is Not Certain***

***Berg was in many ways an enigma and a mystery.***

***Few knew him well, yet he maintained what appeared to be close and lifetime friendships with physicists he worked with in Europe and his baseball connections.***

***The post-war years also certainly did not hold the excitement of his earlier exploits.***

- Berg resigns from the OSS in 1945. Holds some piecemeal jobs with the CIA.
- He appears to be unemployed for most of the post-war years.
- Last years spent as a vagabond relying on the kindness of others (his brother, in particular).
- Uncertain as to what he is doing and how he is getting by.
- He declines to accept a Medal of Freedom awarded to him by the CIA.
- Efforts to get back into the CIA and do work for the US and Israel are unsuccessful.
- Health problems take their toll, and Moe dies on May 29, 1972.
- ***Ever the Baseball man, his last words were...***<sup>(18)</sup>

***“So how did the Mets do Today?”***



***They Beat the St. Louis Cardinals 7 – 6***

# Appendix – Footnotes

1. "Uncertainty Principle," [http://abyss.uoregon.edu/~js/21st\\_century\\_science/lectures/lec14.html](http://abyss.uoregon.edu/~js/21st_century_science/lectures/lec14.html)
2. Medawar, Jean; Pike, David (2000) New York, Arcade Publishing, Hitler's Gift, p. 3.
3. Cassidy, David, (2009), New York, Bellevue Literary Press, Beyond Uncertainty, pp. 21, 56, 78, 159.
4. Hitler's Gift, p. 27, 62, 68.
5. Deutsche Physik," [www.en.Wikipedia.org/wiki/Deutsche\\_Physik](http://www.en.Wikipedia.org/wiki/Deutsche_Physik)
6. Powers, Thomas, (1993), Boston, de Capo Press, Heisenberg's War, p. 41.
7. Heisenberg's War, pp. 131 – 150.
8. Heisenberg's War, pp. 122 – 126.
9. "Leo Szilard," [https://en.Wikipedia.org/wiki/Leo\\_Szilard](https://en.Wikipedia.org/wiki/Leo_Szilard)
10. "Manhattan Project," [https://en.Wikipedia.org/wiki/Manhattan\\_Project](https://en.Wikipedia.org/wiki/Manhattan_Project)
11. "Alsos Mission," [https://en.Wikipedia.org/wiki/Alsos\\_Mission](https://en.Wikipedia.org/wiki/Alsos_Mission)
12. Dawidoff, Nicholas (1995), New York, Vintage Books, The Catcher Was a Spy.
13. The Catcher Was a Spy.
14. "Moe Berg: Sportsman, Scholar, Spy," [www.cia.gov/news-information/featured-story-archive/2013-featured-story-archive/](http://www.cia.gov/news-information/featured-story-archive/2013-featured-story-archive/)
15. Heisenberg's War and "Paul Scherrer," [https://en.Wikipedia.org/wiki/Paul\\_Scherrer](https://en.Wikipedia.org/wiki/Paul_Scherrer)
16. Beyond Uncertainty; Heisenberg's War; and "Operation Epsilon," [https://en.Wikipedia.org/wiki/Operation\\_Epsilon](https://en.Wikipedia.org/wiki/Operation_Epsilon)
17. Beyond Uncertainty.
18. The Catcher was a Spy