2010/ 2nd six weeks
extra credit

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Otto Stern

Otto Stern, a German scientist, won the Nobel Prize for Physics in 1943. He was an instructor and researcher in theoretical physics. Otto also had an interest in chemistry as well. His combined knowledge in both fields led him to discoveries in quantum physics. Stern accomplished efforts despite hardships in Germany during his time period. With the combination of his knowledge and experiences he influenced modern physics.

Otto Stern was born to a Jewish family in Sohrau, Germany which is now Zory, Poland. His family consisted of millers and grain merchants and was very prosperous. His parents, Oscar Stern and Eugenie Rosenthal, moved their five children, two boys and three girls, to Breslau in 1892. Otto attended school here but also continued his learning outside of school with scientific books and other resources. He continued his education at several universities where he became interested in both chemistry and physics. Stern also worked with other important scientists of the time including Albert Einstein. He taught at a number of German Universities and was appointed an associate professor at Rostock where he taught theoretical physics. Then Stern taught physical chemistry at the University of Hamburg. In opposition to Hitler, he decided to leave for the United States. Carnegie Institute of Technology employed him until 1945 when he retired.

At the time, physico-chemistry was becoming very popular in Germany. Scientists such as Nernst and Haber were making groundbreaking discoveries in the subject. Abegg, however, was the scientist that had the biggest influence on Otto Stern. This influence guided Stern to complete an experiment concerning kinetic theory and osmosis. This along with later experiences guided Stern to his chosen field of study.

Such an experience includes when Otto Stern was drafted into the army during World War I. He worked on the Russian front for meteorological work. The work at low temperatures sparked his interest in thermodynamics and the Nernst Theorem (a theorem considering the lowest energy states of matter). His time in the army also gave him experience with the new invention of molecular beams. He used these beams for experiments and later used the new vacuum technology. These experiments marked the beginning of his discoveries.

He began his research in Frankfurt, Germany. At the time, molecular beams were still primitive, but the new technology interested Stern. All of his beams were made by himself or his pupils. His first experiment dealt with the velocity of particles. Einstein assisted Stern to find the first molecular speeds.

Experience with molecular beams contributed to his main research. Stern could measure speeds of gases and their angular momentum with atoms traveling at low pressures without collisions within the beam. He used this method to test a prediction of quantum theory. By using silver atoms, he tested the magnetic moments and the orientations they take in a magnetic field. This is known as space quantization. Stern worked with Walter Gerlach to test the theory. They predicted that silver atoms only have two orientations in the field. Then they pass silver atoms through a nonuniform magnetic field and watched as it split into two beams. This experiment added to the validity of the quantum theory which is why Stern received the Nobel Peace Prize in 1943.

The Prize not only was given for this research but other experiments as well. Using similar techniques, Stern measured the magnetic moment of protons and proved that molecules contain wavelike properties. Before his discovery, scientists didn't think single particles could

have magnetic moments. The unexpected results are what make this accomplishment Stern's most notable. It was completed during his tenure at Hamburg.

The experiment demonstrates spatial orientation of both atomic and subatomic particles when affected by magnetic polarity. Using a molecular beam, neutral silver atoms were directed through a set of slits, through a magnetic field, and onto a cold glass plate. The electrically neutral silver atom serves as a magnet. The electrons cause a spin with a north and south pole.

Most scientists thought the project was a waste of time. This discovery changed the view of physics and added to quantum mechanics. The results, however, were not fully appreciated because quantum physics were already accepted in society.

Stern's new findings had made him famous in the scientific community. He found himself traveling worldwide conducting research and teaching students abroad. Berkeley offered him a position to continue his research. This position interested Stern due to his fondness of peers there, but it was lost when he was forced to emigrate from Germany due to his religion becoming incompatible with Nazi rule.

His new found place in the United States at Carnegie Institute of Technology did not hinder Stern's research. He helped improve molecular beam laboratory and even discovered new information concerning density and X-ray irradiation. He perfected use of molecular beam research which had come a long way from its primitive status at the beginning of Stern's scientific career.

After once again being called to war, Stern finally retired in Berkeley. Although he visited Europe frequently, Stern never returned to his home country of Germany or collected his pension. He cut of ties to show his disgust for Nazism. Instead, he lived the rest of his life in Berkeley along with two of his sisters. Stern never married but made himself easily accessible to

students and colleagues who needed him. On August 17, 1969, Otto Stern died of a heart attack, but his accomplishment remained and changed the world of physics.

Otto Stern's experiment had a huge influence on modern physics. Scientists began using similar techniques and accepted the idea that some atoms' nuclei have angular momentum. This momentum is what is responsible for the structure. His findings also influenced Isidor Rabi's experiment. He showed that by changing the magnetic field, the magnetic momentum will change states. This experiment's results contribute to technology such as Magnetic Fesonance Imaging which is found in hospitals today. Norman F. Ramsey built off of Rabi's experiment. He looked to increase interaction time with the field. The sensitive frequency in radiation is used in atomic clocks today. One of these includes the polarized hydrogen clock developed by Ramsey himself. Not only did Stern's research contribute to further experimentation but also proves quantum mechanics. The spin discovered by Stern is the most direct evidence to it.

Overall, Otto Stern was a very influential figure for modern physics. He went against public opinion to discover new elements of quantum physics. By conducting experiments with molecular beams, technology he discovered during the war, Stern was able to redefine modern physics. Although he was forced to leave Germany, he continued a prosperous career in the United States and continued to assist other scientists into his retirement. Otto Stern won the Nobel Prize for Physics in 1943 for his discovery of the magnetic moment of the proton; a prize worthy of a discovery that changed the way scientists look at modern physics today.