Arno Penzias is an astrophysicist who was born April 26, 1933 in Munich Germany. His parents, Justine and Karl Penzias ran a leather business in Munich. During World War II, he was deported to Poland and then was sent to England with his younger brother in 1939. He was sent to England through the kindertransport rescue operation, which transported young Jewish children out of Nazi controlled areas. After his parents were able to escape to England, they moved the whole family to America in 1940 where they settled in the garment district. Six years later, he became a naturalized citizen of the United States. Arno Penzias graduated from Brooklyn Technical high school in 1951, and continued his education at The City College of New York. He entered CCNY as a chemical engineering major, but switched to physics his freshman year after attending a physics lecture. After graduating from CCNY, he served in the U.S. Army Signal Corps for two years as a radar officer, where he learned about radios. From this, he got a research assistantship in the Columbia University Radiation Laboratory, which was involved in microwave physics. In 1956, Penzias enrolled in Columbia University, and received his doctorate from there in 1962.

This experience with radios helped him with his job and research at Bell Telephone Laboratories in Holmdel, New Jersey. During his time at Bell Telephone Laboratories, Penzias began monitoring radio emissions from a ring of gas around the Milky Way. His research partner, Robert Woodrow Wilson, and him were bothered by the background noise they detected but could not explain. They thought it was the pigeons nesting in the antenna throat, however, once they got rid of the birds, they continued to detect the background noise. This background noise was less energetic than the radiation given off by the Milky Way, and it was isotropic. Their first hypothesis was that the radio noise came from New York City, but they soon rejected this hypothesis. After continuing their research into the source of this noise, they concluded that it came from background noise called microwave radiation. Penzias and Wilson also contacted another scientist, Robert Dicke, to see what his opinion was on where the background noise came from. He agreed that the background noise could be from background radiation predicted by cosmological theories. This discovery of microwave radiation helped support the big-bang model of cosmic evolution. While conducting this important research that would lead to winning a Nobel Prize, Penzias took on a teaching position at Princeton. During his time at Princeton, he felt he learned more from his students than he could have taught them. For this research, they split half of the 1978 Nobel Prize for Physics between themselves and the other half went to a Soviet physicist, Pyotr Leonidovich Kapitsa. However, Kapitsa's research was not related to the research Wilson and Penzias conducted.

After receiving the Nobel Prize, Penzias wanted to continue his research. However, the large horn antenna that he had built was being used in the ECHO satellite project. The ECHO satellite was the first passive communications satellite that reflected microwave signals. Since his large antenna horn was being used, he built a smaller, fixed antenna in order to search for a line emission from the interstellar OH molecule. From this, he discovered uniform microwave radiation, which suggested residual thermal energy in the universe. Throughout his research,

Penzias went to other physicists to check his work. He wanted to make sure that his research was accepted, and he wanted to make sure that his data was accurate. Two of these researchers were George Field and Gerhard Hertzberg. Penzias had forgotten about his research into the topic of the line emission from the interstellar OH molecule until George Field reminded him of it. Penzias' research into this topic became the first encounter with the primordial radiation throughout the universe. In recent years, scientists say that this uniform microwave radiation is due to the big bang. While conducting new research, Penzias was also able to trace the distribution of deuterium in the galaxy. This trace was evidence of the cosmological origin of that element, which is important because deuterium is the only element whose origin comes exclusively from the explosive origin of the Universe. This element became known as "Arno's white whale." Out of all of the things Penzias researched, he thought that the most challenging aspect was measuring the radiation intensity from our galaxy at high latitudes.

Arno Penzias installed a liquid helium source at a known temperature and Wilson built an elaborate switch that could be set to the cold load or the antenna. He built this so that they could compare the temperatures. With the antenna pointing upward, they found that the antenna was about three degrees warmer than expected. This was similar to another scientist's findings, but Penzias and Wilson's data was more accurate. The first data showing this anomaly was May 20, 1964, which has become known as the day Big Bang radiation was discovered. However, they did not realize the significance of their findings, and for a year, they believed their antenna was just picking up too much noise. They were so concerned with this noise; they spent the year trying to get rid of it. It was important that Penzias and Wilson collaborated with each other because Penzias was a physicist and Wilson was an astronomer. Their different backgrounds allowed them to research astrophysics, and forced them to collaborate more. Collaboration was a major part of their research, and they even asked other scientists for their opinions. Penzias took collaboration very seriously, and was enthusiastic about sharing his research with others. He carried this enthusiasm for collaboration throughout his life by teaching others, and assisting in research and development start up companies.

His research on the origin of the elements began with an understanding of their build-up from their common component parts such as protons or neutrons. The first step was to determine plausible build-up processes, and then the necessary conditions they require were determined. Once this information was found, the goal was to find the sites for the nuclear reactions. This research begun before Arno Penzias' time, in the 1930's, however, by the end of the 1960's, a more complete theoretical framework of the origins of the elements was found. There were two main points of views during this time period. One point of view was that the elements were made in the stars of the galaxy and then thrust back into space to provide raw material for new suns and planets. The second point of view was that a conglomerate of nuclear particles was cooked into the existing elements before the stars were formed. This was called the pre-stellar state, which is associated with an early hot and condensed stage of the expanding universe. After much research throughout the years, there was still a question of radiation as a detectable microwave phenomenon. Penzias and Wilson's research into the background

microwave radiation at Bell Laboratories helped to bridge this gap. Penzias and Wilson's research inspired more research. For example, D.W. Sciama used their research as a baseline for his work on his paper, *The Limits of Space and Time: Exploding Black Holes and the Origin of the Universe*. The most important part of Penzias' research that Sciama used was that the excess radio noise that was found was one hundred times greater than would be expected from combining together the radiation from all previously known radio sources.

He went on to become the director of Bell Radio Research Laboratory in 1976, and continued on to be vice president of the company in 1981. However, once he reached these higher up positions, he had to stop his personal research in astrophysics because he no longer had the time. While he was vice president, AT&T and the U.S. Department of Justice broke up the Bell system. The broken up Bell system became new, smaller research organizations and became what is now known as the AT&T phone company. After AT&T acquired Bell Laboratories, Penzias retired and worked with start-up research and development organizations in Silicon Valley. He also went on to write a book called, *Ideas and Information* in 1989.

In addition to winning the Nobel Prize, he was elected as a Fellow of the American Academy of Arts and Sciences in 1975. In 1977 Penzias and Wilson received the Henry Draper Medal of the National Academy of Sciences. Penzias then received the International Center in New York's Award of Excellence. Then, in 1998, he received the IRI Medal from the Industrial Research Institute. Penzias has a son, David, and two daughters, Mindy and Laurie. He currently works with New Enterprise Associates as a venture partner. Similar to his work with research and development organizations in Silicon Valley, New Enterprise Associates invest in companies that are in various stages of development.

References

“Arno Allan Penzias.” *HowStuffWorks.* HowStuffWorks.com, n.d. Webs. 20 Nov. 2014.

"Arno Penzias - Biographical". *Nobelprize.org.* Nobel Media AB 2014. Web. 1 Oct 2014. <http://www.nobelprize.org/nobel_prizes/physics/laureates/1978/penzias-bio.html>

"Arno Penzias". *Encyclopædia Britannica. Encyclopædia Britannica Online.* Encyclopædia Britannica Inc., 2014. Web. 30 Sep. 2014 <http://www.britannica.com/EBchecked/topic/450516/Arno-Penzias>

"Arno Penzias - Facts". *Nobelprize.org.* Nobel Media AB 2014. Web. 1 Oct 2014. <http://www.nobelprize.org/nobel_prizes/physics/laureates/1978/penzias-facts.html>

"Arno Penzias - Nobel Lecture: The Origin of Elements". *Nobelprize.org.* Nobel Media AB 2014. Web. 1 Oct 2014. <http://www.nobelprize.org/nobel_prizes/physics/laureates/1978/penzias-lecture.html>

Bernstein, Jeremy. "Out of My Mind: The Birth of Modern Cosmology." *The American Scholar* 55.1 (1986): 7+. *JSTOR*. Web. 20 Nov. 2014.

“Penzias, Arno (1933-)-Research Article from World of Earth Science.” *BookRags.* BookRags, n.d. Web. 20 Nov. 2014.

Sciama, D.W. “The Limits of Space and Time: Exploding Black Holes and the Origin of the Universe.” *Daedalus* 106.3 (1977): 33-40. *JSTOR*. Web. 20 Nov. 2014.