Popular Science Summary

"She used to dream of the sun,
the stars and the moon."

14-year-old girl by Laura Aviana

In greenlandic myths, our ancestors rise to the heavens and are perpetuated as stars, forever watching over us. Although astronomy has proven that stars are complex balls of gas, just like our Sun, there is one thing astronomy and greenlandic myths agree on: stars are a window to the past.

13.7 billion years ago, the simplest elements were formed; hydrogen and helium. Stars are formed of these elements, fueled by hydrogen. The temperature inside stars allows for a process called *nucleosynthesis*, where hydrogen is burned into helium, releasing energy as heat. This process occurs during the lifetime of a star, until the star burns all the hydrogen inside.

The strongest tool of an astronomer is light. Light can be split into its constituents, known as *spectroscopy*. In the 1850s, Gustav Kirchoff explained that the dark lines in our Sun's spectrum, also known as the Fraunhofer lines, are related to the material present in the atmosphere. Elements on the surface of a star absorb specific colors, creating darker lines in the spectrum of light.

Elements are formed in different environments. The elements in the periodic table are arranged according to the number of protons in the nucleus of an atom. In the core of stars, elements can be formed up until iron, the 26th element in the periodic table. With similar formation processes in stars, the periodic table can be split in four groups. The elements lighter than iron are divided into the *odd*-elements, which are odd-numbered, and α-elements, which are even-numbered. In the periodic table, the elements around iron are referred to as *iron-peak* elements, named due to their abundance in our Solar System. Elements heavier than iron are formed through a process called *neutron-capture*, where the nucleus of an atom grows by capturing the free neutrons, which is also a building block in a nucleus. Which elements are formed inside stars are also dependent on the mass of the star, because the mass determines the temperature inside stars.

The mass of a star determines the fate of a star. More massive stars have shorter lives, as they burn their hydrogen faster. The short-lived, massive stars form heavier elements, enriching our Galaxy through a spectacular explosion, known as a *supernova*. The material ejected by stars are building materials for the next generation of stars. Yet, the more abundant type of stars - much like our Sun - can live as long as the age of our Universe today. These long-lived, lower-mass stars enrich our Galaxy later, allowing us to analyze how the dust, that forms stars, has changed since the beginning of the Milky Way.

The cycle of stars forming from dust created by stars means that younger stars contain more heavier elements. As a star contains the information of their birth environment, observing several stars of different ages can tell us how their birthplace - the dust in our home Galaxy - has formed and evolved.

In this thesis, I have analyzed the composition of 291 giant stars in the neighborhood of our Sun to investigate how our Galaxy has evolved. These stars have been observed with Apache Point Observatory Galactic Evolution Experiment, APOGEE, measuring giant stars in the infrared wavelength. Giant stars are very bright, making it possible for us to see those that are more distant in our Galaxy. The dust, expelled by the death of stars, is transparent to infrared light. 14 elements of the four element-groups are measured in these 291 stars in this work. The abundances of the different groups show that they are formed in similar ways inside stars. These abundances also show that the lower mass stars are enriching our Galaxy later due to their long lifetimes. I show that a careful analysis of abundance measurements give better results, and this gives a better insight to how our Milky Way has evolved.