The abundance patterns of metal poor stars in the Milky Way

Research Field
Galactic Archaeology/First stars

Project Suitability
Third year, Honours
Masters

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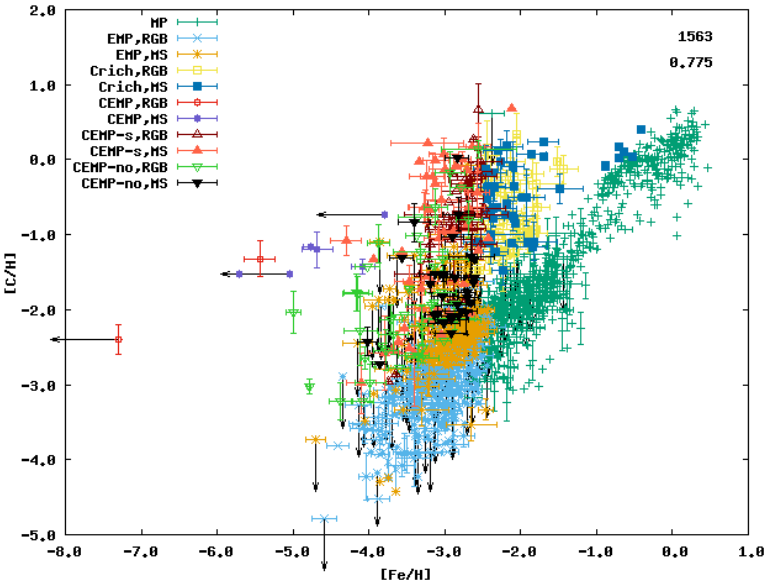
One of the main challenges in astrophysics is to detect the first stars formed in the Universe. The ideal candidates are old stars that are usually identified by their low metal content in the absence of reliable age measurements. Metals (elements heavier than helium) are produced in the final stages of the life of a stars, and are expunged in supernovae explosion at the death of stars, and therefore significant metal enrichment in the Universe requires multiple cycles of star formation. Since the pristine gas in early Universe lacked metals, therefore lower the metal content of a star, older it would be. Furthermore, the metal poor stars carry chemical imprints of processes that occurred in early galaxies, and thus also provide a window to the mechanism of formation of galaxies.

The catalogues of metal poor stars have expanded enormously, with a few stars that were known in 80s to thousands that are known today. Even more are going to be detected by powerful surveys such as the GALAH, SkyMapper and GAIA. With the advent of the data, statistical study of abundance patterns of metal poor stars has been made possible.

The project would aim to compile sets of metal poor stars from known catalogues, and then to do a statistical study of their chemical abundances. A particular emphasis will be to identify peculiar trends that do know follow the expectations from standard chemical evolution models. And then further: (i) explore the origins of peculiar trends (ii) develop chemical tags to constrain the ages and spatial locations of stars in the Milky Way

For example, one intriguing trend is the relatively high amount of carbon found in a group of metal poor (iron poor) stars (see the black, blue and red points in the figure underneath). The origin of these unusual carbon enhanced stars is an active area of investigation. Many more interesting chemical patterns can be recovered from the existing and upcoming data, and the origin of those trends need to be investigated both with statistical and modelling techniques.



Metal poor stars in the Milky Way: image created from the SAGA database (Suda et.al. 2008)