Distributional Differences in Iron Equivalent Widths Among Supernova Progenitor Candidate Stars and Stable Spectral Mirrors

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Galactic formation is not fully understood, and supernovae are essential in current models; however, despite significant advances in understanding, there remains limited precision and efficiency in pre-supernova progenitor identification, which is crucial to improve supernova understanding. Thus, this study aims to determine whether the distributions of iron absorption line strengths between progenitor candidate stars and mirror stars with similar spectral type and luminosity classifications are distinct, hypothesizing that they will be due to iron's unique position as the final element in natural nucleosynthesis. Thirty-two high-resolution spectral measurements were analyzed, comprising sixteen progenitor candidates and sixteen spectral mirrors, calculating the equivalent widths of 228 Fe I, Fe I*, Fe II, or Fe II* absorption lines using a Simpson's approximation program and ISPEC. Kolmogorov-Smirnov and Anderson-Darling testing revealed with a confidence greater than 99.9% that the populations feature distinct distributions. Additionally, a Gamma Generalized Linear Mixed Model (GLMM) was executed in JASP to compare the mean line strengths between the two populations, discovering that there was no statistically significant difference - suggesting that the variations in distribution could not be explained by variations in the populations' overall metallicities (Fe/H). The results of this study suggest a physical process that is affecting the iron absorption distributions in progenitor candidates, though to explain such is beyond its scope. This research could be used to inform a novel approach to pre-supernova candidate identification, which would increase the number of observational studies and lead to a better understanding of galactic formation as a whole.

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