Project Proposal

Stars' Lifespan-Mass Relation

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1 Introduction

The intent of this proposal is to outline the approach I will take to analyze and visually represent stars of varying masses and their corresponding lifespans. Stars generally express an inversely proportional, exponential (decay) relationship between their mass (M), which is directly proportional to their luminosity that increases as the star's size increases, and their expected lifespan (T). In my project, I will visualize both the mass-luminosity relationship ($L \propto M^{3.5}$) and the lifespan-mass relationship ($T \propto 10^{10}/M^{2.5}$) of the stars I will analyze.

I will also include spectral classifications (O, B, A, F, G, K, M, L) which are primarily based on the stars' surface temperatures but also have correlations to their mass, luminosity, age, and the Hertzsprung-Russell Diagram.

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2 Data Source

To observe, analyze, and visualize this phenomenon, I will use data from the SIMBAD database. I queried 50 arcmin around Proxima Centauri and saved the list in a link and as an ASCII. I will organize, filter, and process the data and visually represent them via plots on a graph.

I will also refer to the Hertzsprung-Russell Diagram.

https://www.astro.keele.ac.uk/jkt/debcat/
https://arxiv.org/pdf/astro-ph/0010586.pdf

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3 Equation to Fit Data

To fit my data, I have two main models that will potentially represent my data:

Inverse Correlation Model

$$y \propto k/x$$

- k = constant
- x = independent variable

This is a standard inverse correlation/variation model in statistics. If the data represents an inverse relationship, this will be the expected equation to fit the data.

A relevant equation is:

$$T \propto 10^{10}/M^{2.5}$$

- T = star's lifespan in years
- 10^{10} = our Sun's lifespan, 10 billion years
- M = star's mass relative to the Sun (ratio)

This is a more specific equation (and the main equation that will be utilized in this project) that intakes a star's mass relative to our Sun and multiplies it by 10^{10} years, the Sun's lifespan, to calculate the star's expected lifespan. It is derived from Einstein's equation $E=mc^2$, the definition of luminosity L = E/t, and the mass-luminosity equation $L \propto M^{3.5}$.

Exponential (Decay) Model

$$f(x) = a \cdot e^{-kt}$$

- a = starting value (constant)
- k = rate of decay
- t = time

If the data represents an exponential decay, the exponential model would best fit the data. This is also a possibility for the visualization of the data because of $M^{2.5}$.

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5 Data Filtering

To ensure a clean representation of the data, I will remove outliers (if any). I may also exclude stars without a spectral classification from the SIMBAD data I'm using.

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6 Data Fitting to Models

To determine which model equation best matches the data, I will fit the data with the inverse correlation model and the exponential decay model to analyze which one the data best represents.