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Supernovae Distributions and their Relationships to Classes of Stars

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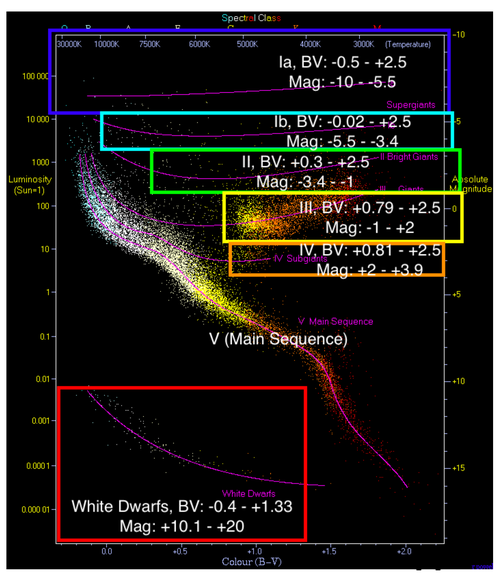
Introduction

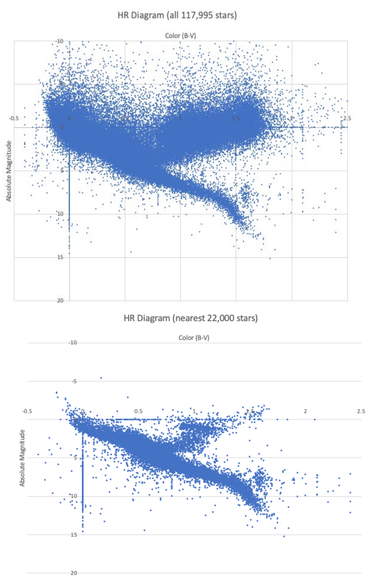
Using the NASA CNS3 Gliese Catalog of Nearby Stars [1], the Tycho-2 Catalog from the Hipparcos Satellite [3], and the Open Supernova Catalog [2], I examined correlations between the luminosity classes of stars, types of supernovae, and selection effects observed in the data. These correlations are important to investigate to better address luminosity selection effects in data, learn more about our galactic neighborhood, and better predict future supernovae explosions.

Important background knowledge: luminosity classes of stars (roman numerals, I and II, main sequence), types of supernovae (II and Ia), neutrinos produced in supernovae explosions, neutrino detectors / DUNE, matter-antimatter asymmetry

Methods

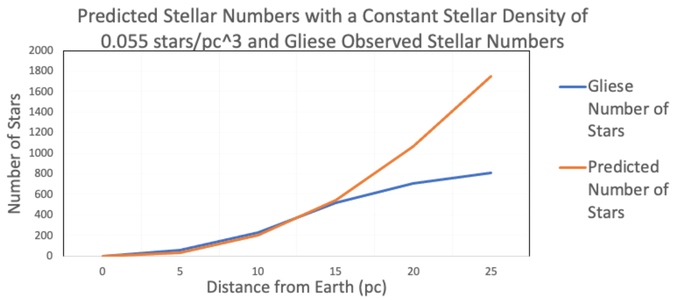
Using excel, I created graphs and diagrams to visualize the distributions of the stellar luminosity classes and supernova types at different radial distances from the Sun. Using data analysis, predictive curves were fit to examine extrapolated predictions compared to observed data. I also used the locations of stars when plotted on an HR diagrams to classify each, and based on the luminosity class, predict if that star would end its life in a supernova explosion.

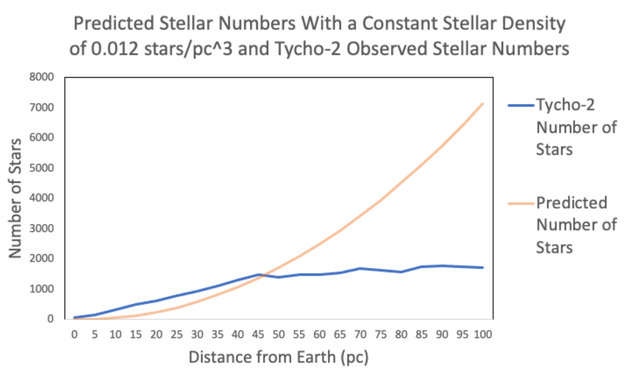




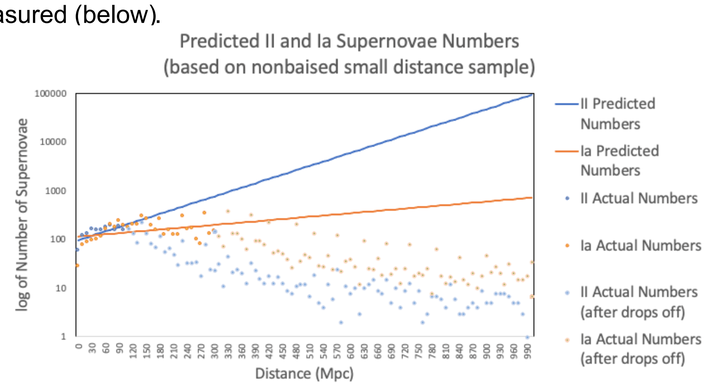
Results

When comparing the predicted stellar populations (using a constant stellar density), both the observed quantities from the Gliese and the Tycho-2 catalogs dropped off much quicker than predicted quantities after reaching certain distances (below).





The HR Diagram produced using the Tycho-2 data also shows a significantly higher quantity of giants and supergiants (lum. class I and II) that were detected relative to main-sequence stars when looking at greater distances (left). A similar luminosity bias was found when examining data from the Open Supernova Catalog; although it is predicted that there will be fewer Ia supernovae at greater distances, still a higher quantity is measured (below).



Conclusions

The deviation between the observed and predicted quantities of stars from the Gliese and Tycho-2 stellar catalogs and the Open Supernova Catalog can be accounted for by the luminosity-selection effect, which causes dimmer objects to not be properly detected at greater distances. Using only the data of observed stars, I have identified 6,849 pre-supernova stars within 10kpc, the distance the DUNE project is basing their predicted observations for neutrinos from a supernovae explosion from.

Learning how to more accurately predict future supernovae using nearby stellar data and data from observed supernovae can help us to better predict them at greater distances, which can help improve the detection of neutrinos produced in these supernovae. Better detection allows for more complete observations and a deeper understanding of neutrinos, which may unveil the mystery of the matter-antimatter asymmetry.

Acknowledgements

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