Supernova Candidate List

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Motivations

Prepare for a galactic supernova by extending current RSG catalogues and combined in accurate measurements so progenitor can be found quickly

Make use of current methodology to finding RSGs while also altering it so that it can be applied to a wider sample

Methodology drawn from
    arXiv:1905.03744
    arXiv:0503179

General Methodology

1. Set Up

All galactic spectral catalogues → Gaia + Rest + RUWE → Parallax cuts applied → Match to 2MASS photometry → Spectral types adopted

2. Derived Parameters

Ks intrinsic
Used MWdust to calculate extinction

Stellar radii, Mbol, and Luminosity calculated
done based on recommendations of arXiv:1905.03744

Teff Values assigned
Based on spectral types

3. Setting up RSG Parameter Space

Mbol and stellar class cuts established

Luminosity (Mbol) vs Teff plotted against stellar tracks of massive stars
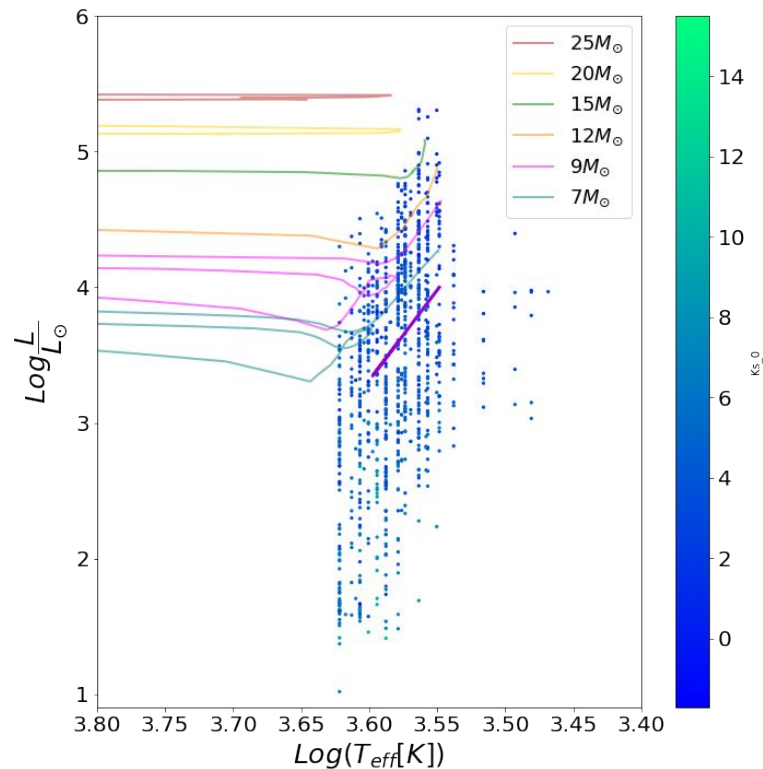
Gold, Silver, & Bronze standards set

4. Sample Dynamics

Gold, Silver, & Bronze samples compiled → Plot galactic coordinates → SN distance error + Angular resolution added

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Parameter Space Figures

Luminosities vs. TEff values of stars contained entire complied sample, colored by their intrinsic Ks magnitude. Stellar tracks from models at solar metallicity and including rotation are from Ekstr̃om et al. (2012); from the bottom to the top: the blue curve marks a stellar track of a 7 M⊙ star; the pink curve marks a 9 M⊙ track; the orange curve marks a 12 M⊙ track; the green curve shows a 15 M⊙ track; the yellow curve marks a 20 M⊙ track; and the top maroon line shows a 25 M⊙ track
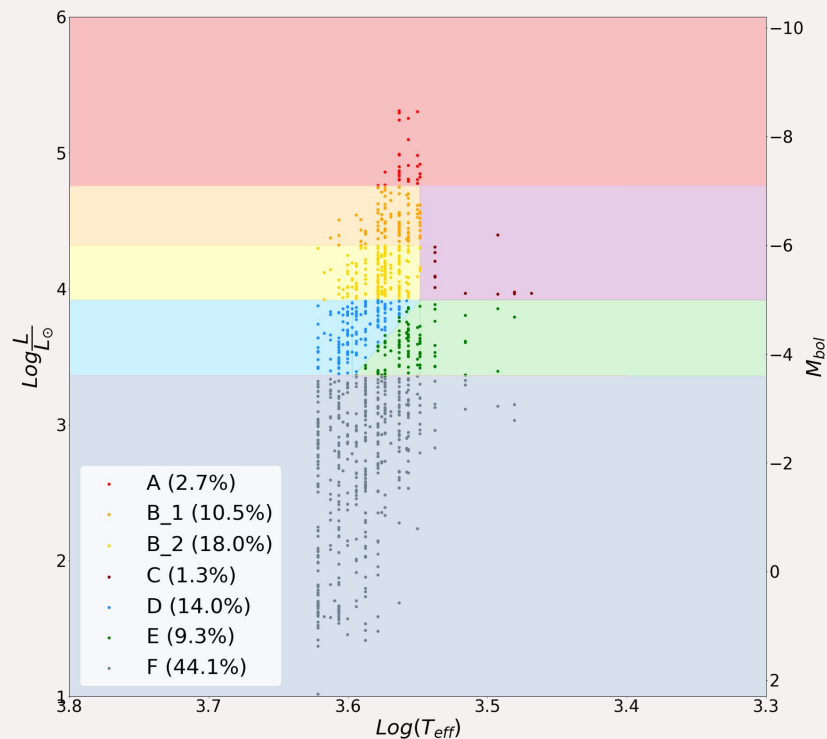
Luminosities vs. Teff values of stars from compiled sample set with relative error > 4 and RUWE < 2.7. Stars within the red region (Area A) are the most probable RSGs with Mbol < 7.1 mag. The orange region (Area B1) sources with Mbol < 6.0 mag and types < M4 contains possible RSGs but is contaminated by AGBs. The Yellow region (Area B2) sources with Mbol < 5.0 mag and types < M4 contains possible RSGs but is contaminated by AGBs even more so then Area B1.

Method 1: Compilation of K and M stars of luminosity class I

Background:

This attempt is based on <u>**Messineo and Brown 2019**</u>, which assembled a RSG list using known RSGs to define a region in Teff vs Luminosity and then compares to K and M stars of luminosity class I.

Results:

Had fewer possible RSGs even though started with a larger sample

Starting Sample	2616
Matches to Gaia DR2	2184
After Distance Cuts	1036
Gold	28
Silver	109
Bronze	187
Total Candidates	324

Method 2: Gaia DR2 + Henry Draper

Starting Sample	1303
Matches to Gaia DR2	1301
After Distance Cuts	1266
Gold	7
Silver	21
Bronze	52
Total Candidates	80

Idea: since not really able to improve, how about using spectral type to assign Teff as before but without require luminosity class I.

Start with rough cut on Gaia DR2 based on supergiant branch should be for G mag vs gr_rp, then match to Henry Draper's K and M stars
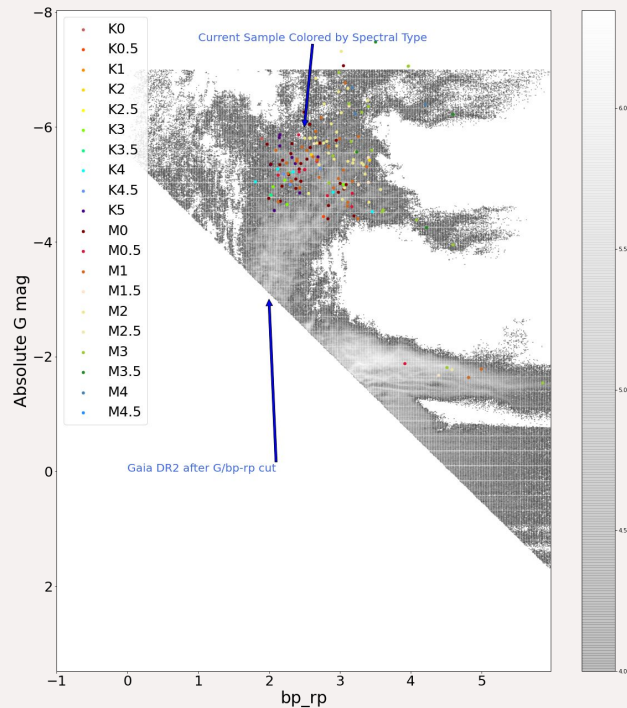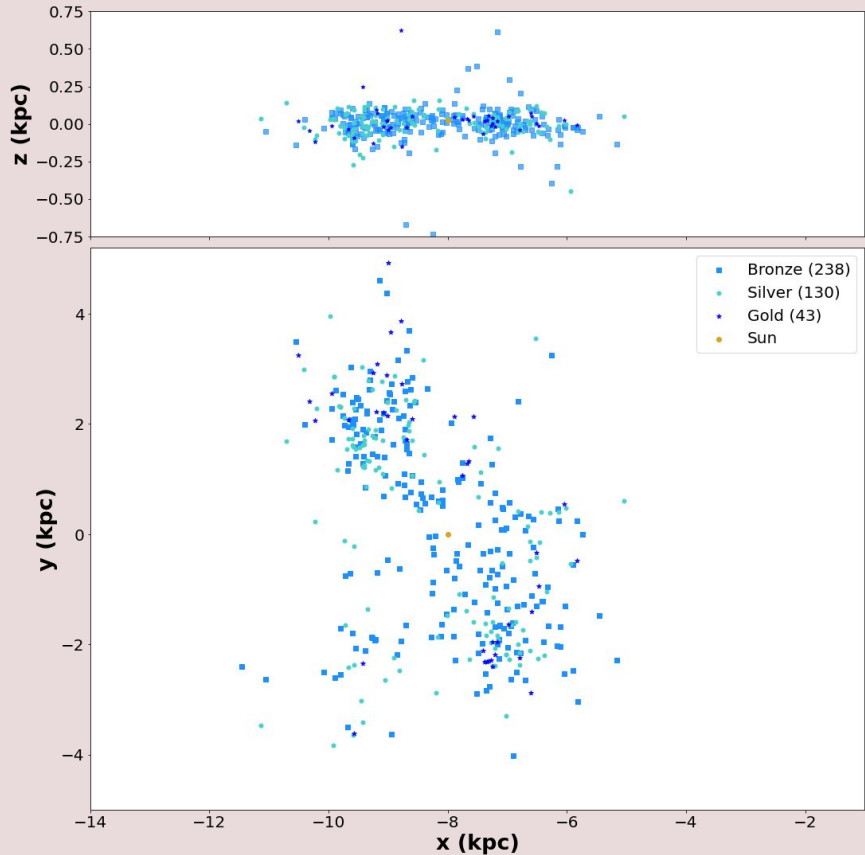
Results

411 RSGs candidates
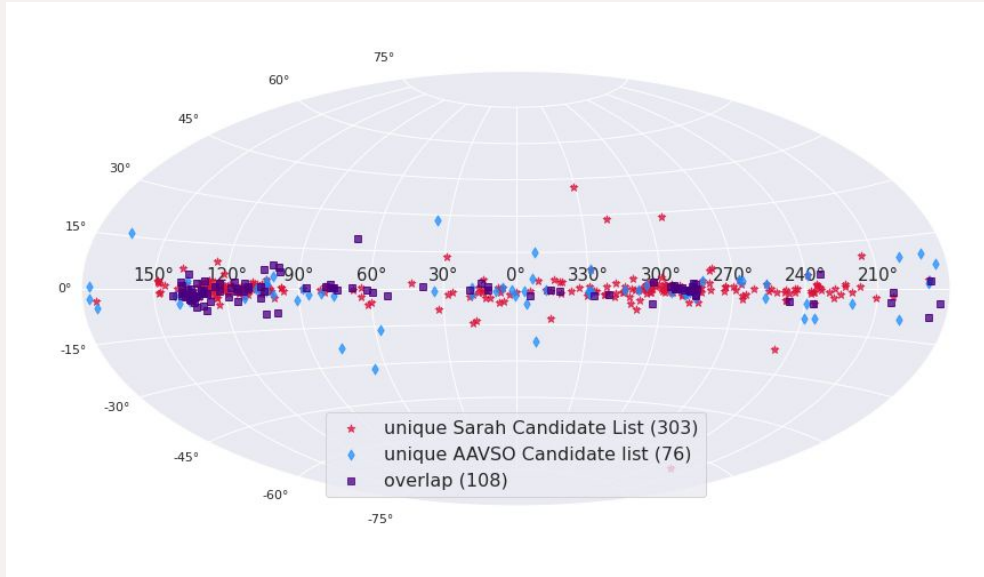
Range of distance: .2 to 4.2 kpc

Range of Gaia G mag: 2.4 to 12 mag

Range of bolometric mag: -5 to - 8.5

Figure: Gold sample plotted as teal circles along the Galactocentric coordinates of the Milky Way. Silver is plotted in dark blue diamonds and Bronze in light blue squares. The Sun location (8, 0, 0) is marked in orange.

Overlap with AAVSO Current Candidate list

Most AAVSO candidates are in our starting set as well as have Gaia matches

Most make our distance error cuts (~80%), and all have JHK magnitudes form 2MASS.

The rest are filtered out based on not making our brightness cuts. (*did not filter out non- RSGs stars from the list)

In future, we want to more closely at the stars which do not make the new list and define a confidence level that they are also RSGs.

Future Directions

Danny and Danielle will take the list plotting a localization map as well as estimate exposure times

Working more with the cuts to possible redefine as flags based on multiple factors

Checking the list ability to be resolved by neutrino pointing

Publishing the list!

Have AAVSO implement the list for observations

Possible follow up spectroscopy or other methods of extending the list further