Supernovae Distributions and Their Relationships to Classes of Stars

Sydney Menne

Faculty Mentor Dr. Tim Young

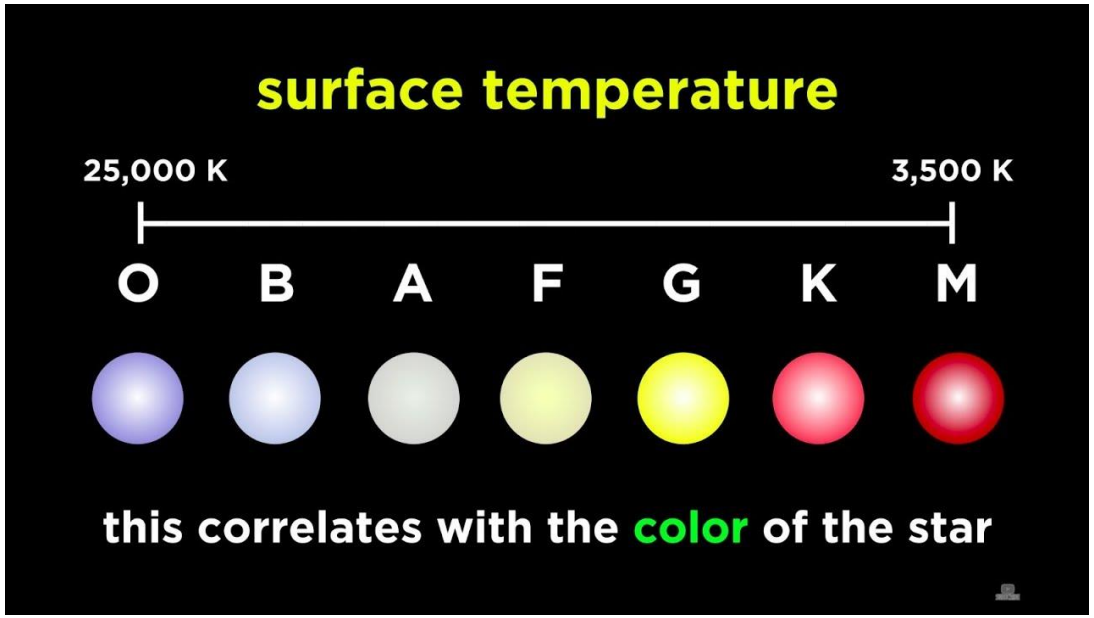
Summer 2020 NDSGC Student Research Fellowship

Outline

- Stellar Types and Classifications
- What is a Supernova?
- How does a Supernova Happen?
- Project Goals
- Research Methods
- Results
- Significance
- Academic and Career Goals

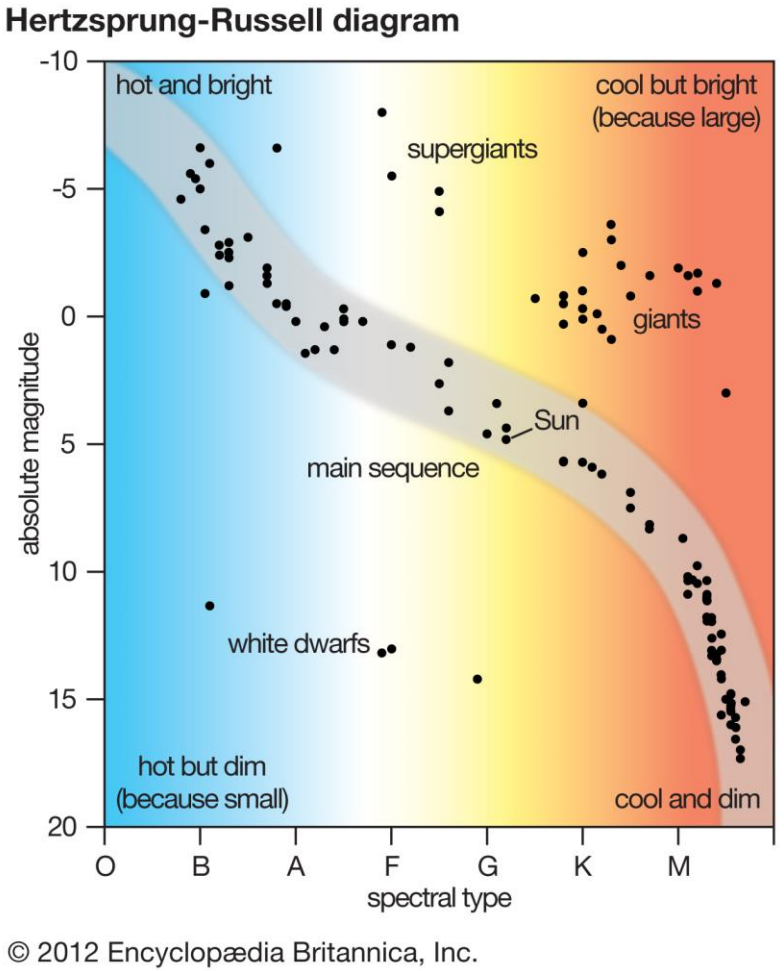
Stellar Types and Classifications

Spectral Types: (O, B, A, F, G, K, M)



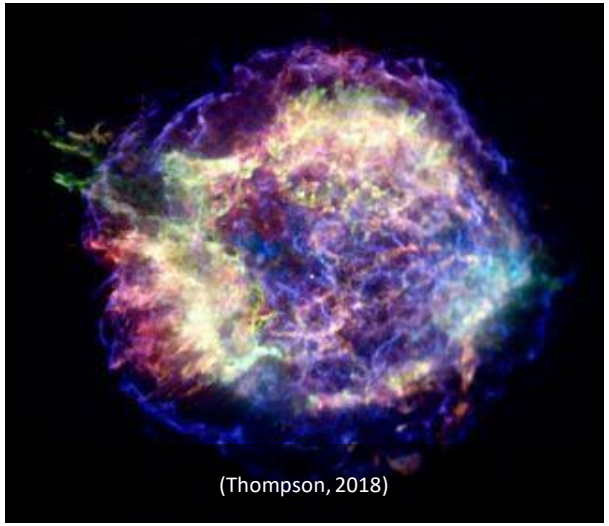
(*Classification of stars: Spectral analysis and the H-R diagram* 2018)

Luminosity Classes: Supergiants (I), Bright Giants (II), Giants (III), Subgiants (IV), and Main Sequence (V), White Dwarf (VII)

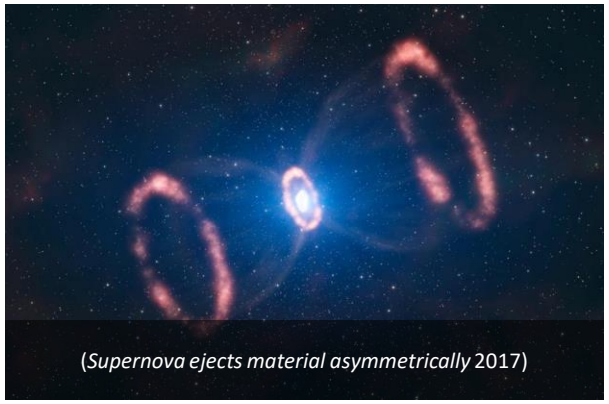


(*Stellar classification* 2012)

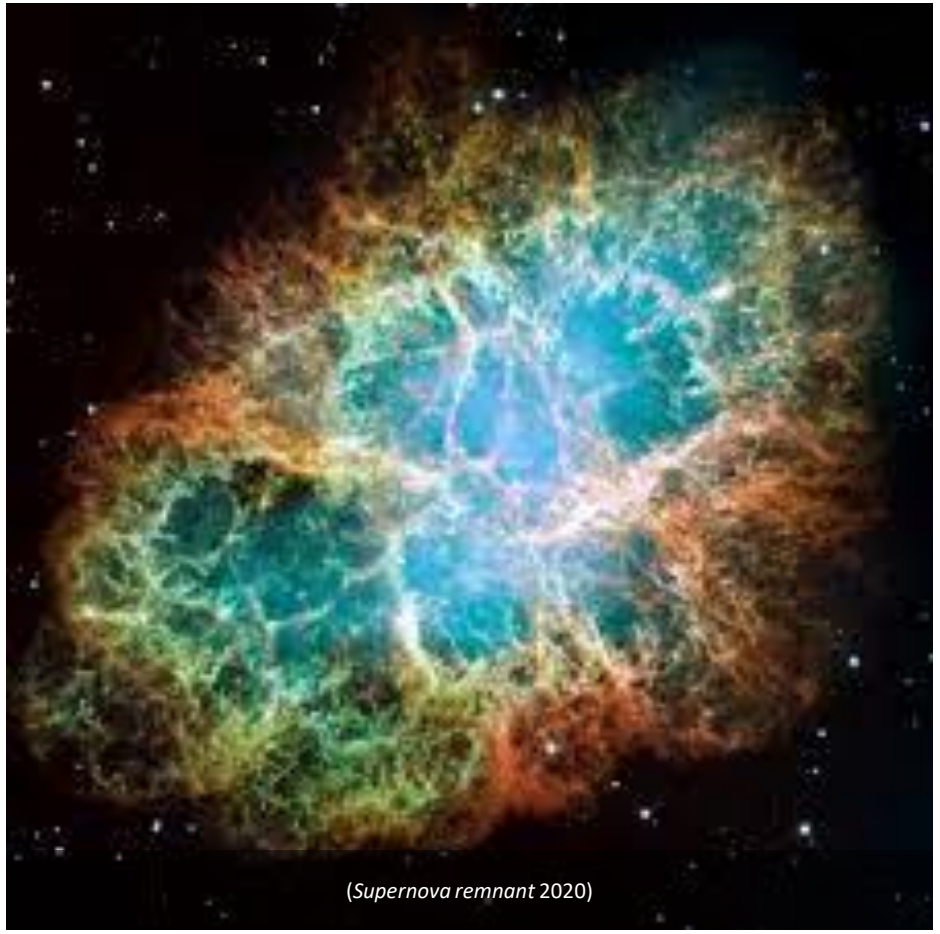
What is a supernova?



(Thompson, 2018)



(*Supernova ejects material asymmetrically* 2017)

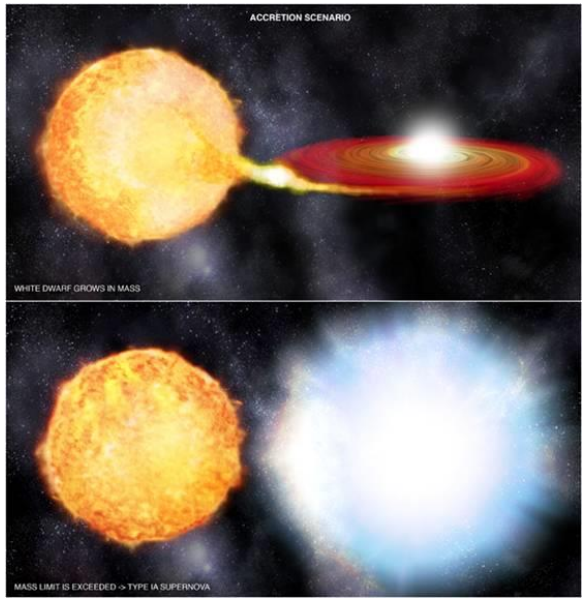


(*Supernova remnant* 2020)

How Do Supernovae Happen?

Type Ia Supernovae (Binary Systems)

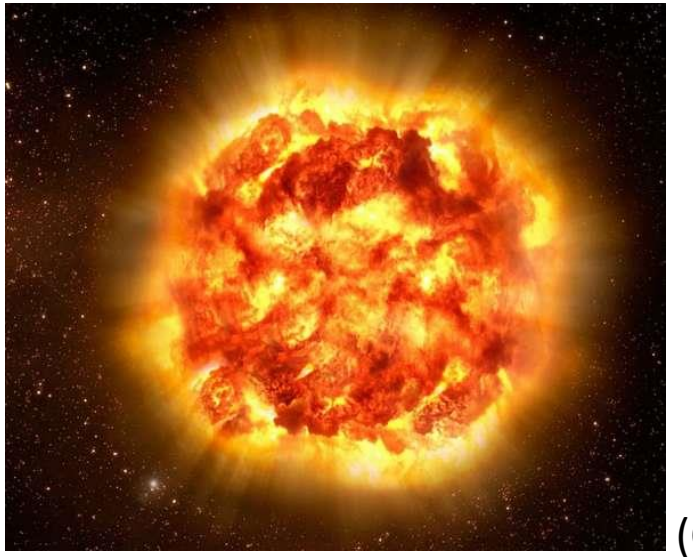
- White Dwarf (luminosity class VII)
  - < 8 SM
- Typically brighter than Type II
- Has to form white dwarf and nearby red supergiant, then supernova; takes longer to occur than Type II



(Institute of Astrophysics Andalusia, 2014)

Type II Supernovae (Single Stars)

- Supergiant or Bright Giant stars (luminosity class I and II)
  - 8 – 40 SM
- Formed when a giant star can no longer do nuclear fusion
- Can have different peak luminosities (depending on the star)



(Cain, 2016)

Project Goals

- Classify nearby stars and identify progenitor stars (pre-supernovae stars). How many progenitor stars are around us?

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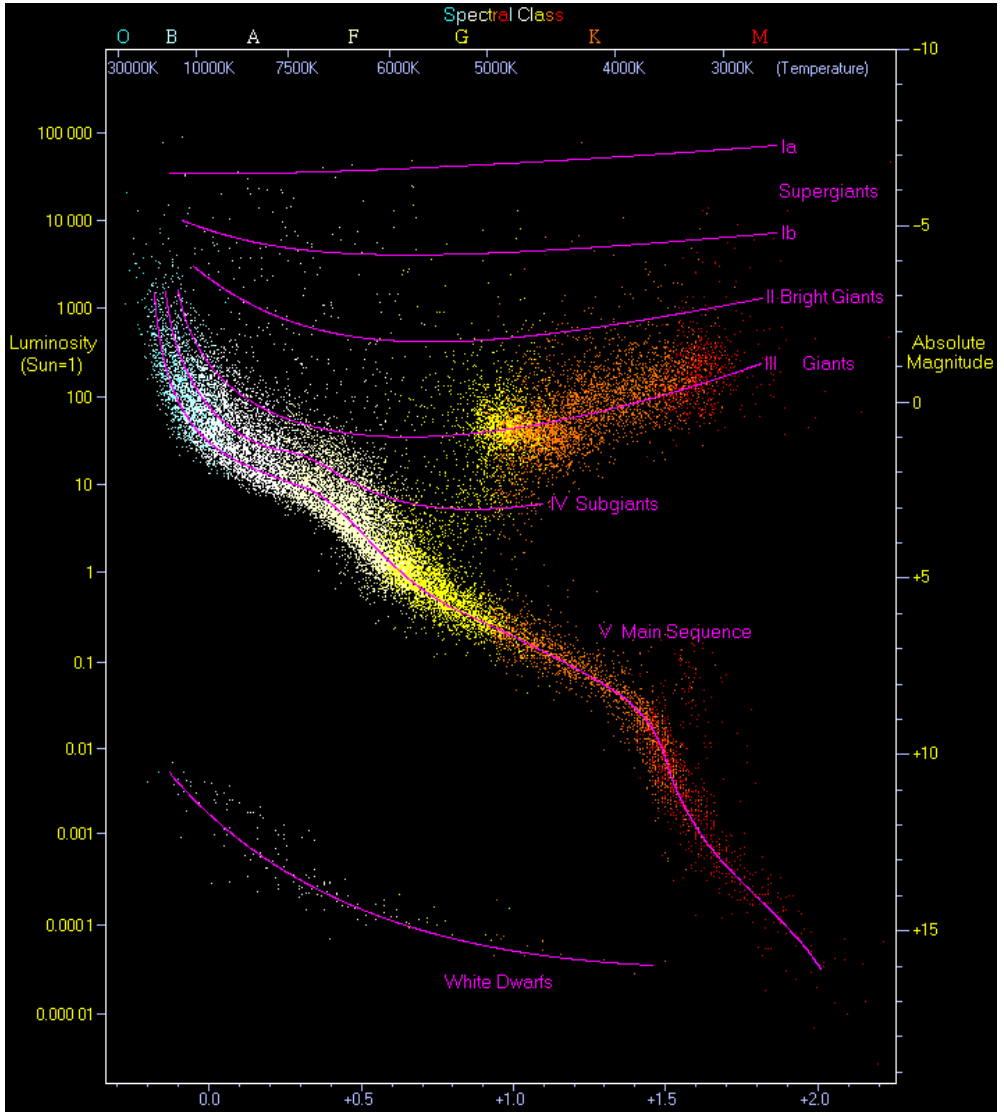
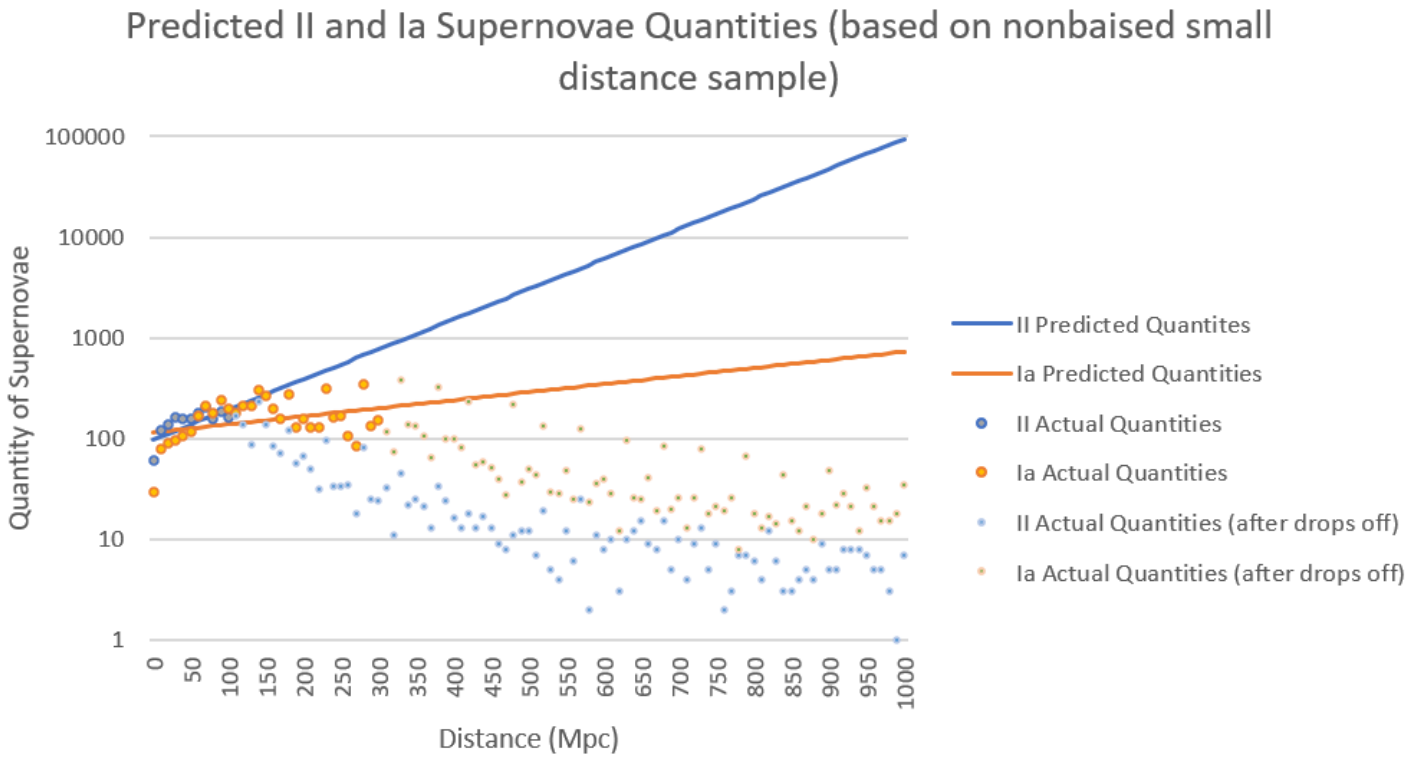


(Powell, 2007)

Project Goals

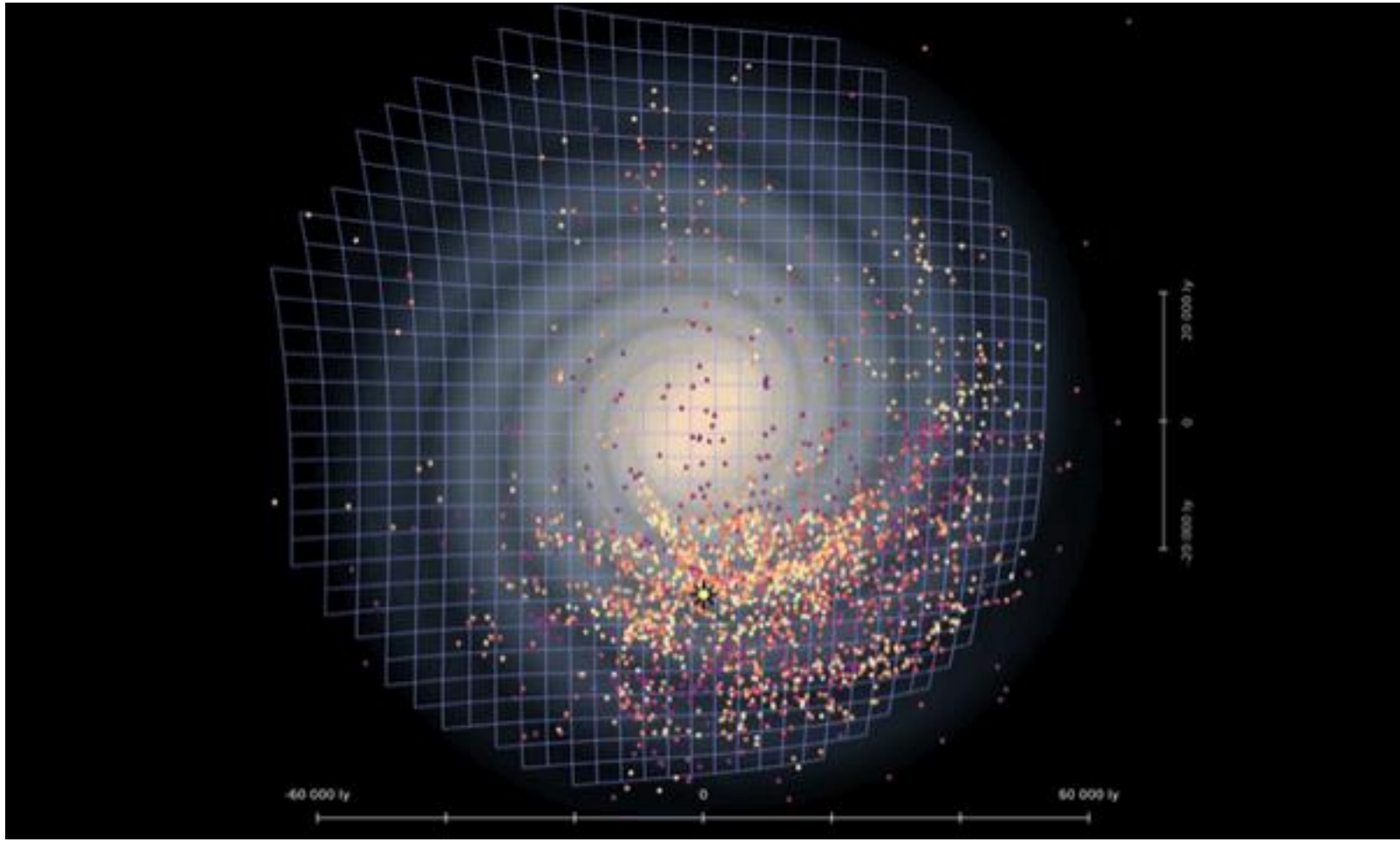
- Classify nearby stars and identify progenitor stars (pre-supernovae stars). How many progenitor stars are around us?
- Identify correlations between luminosity classes of stars and types of supernovae
- Identify selection effects observed in stellar and supernovae data



(Menne, 2020)

Project Goals

- Classify nearby stars and identify progenitor stars (pre-supernovae stars). How many progenitor stars are around us?
- Identify correlations between luminosity classes of stars and types of supernovae
- Identify selection effects observed in stellar and supernovae data
- Gain a better, more complete understanding of our stellar neighborhood



(Buczkowski, 2019)

Research Methods

- CNS3 - Gliese Catalog of Nearby Stars (NASA) (Gliese & Jahreiss, 1995)
  - 25 parsecs (81.5 LY)
  - 3,803 stars
- Tycho-2 Catalogue (Hipparcos satellite) (Høg et al., 2000)
  - 117,995 stars

Research Methods

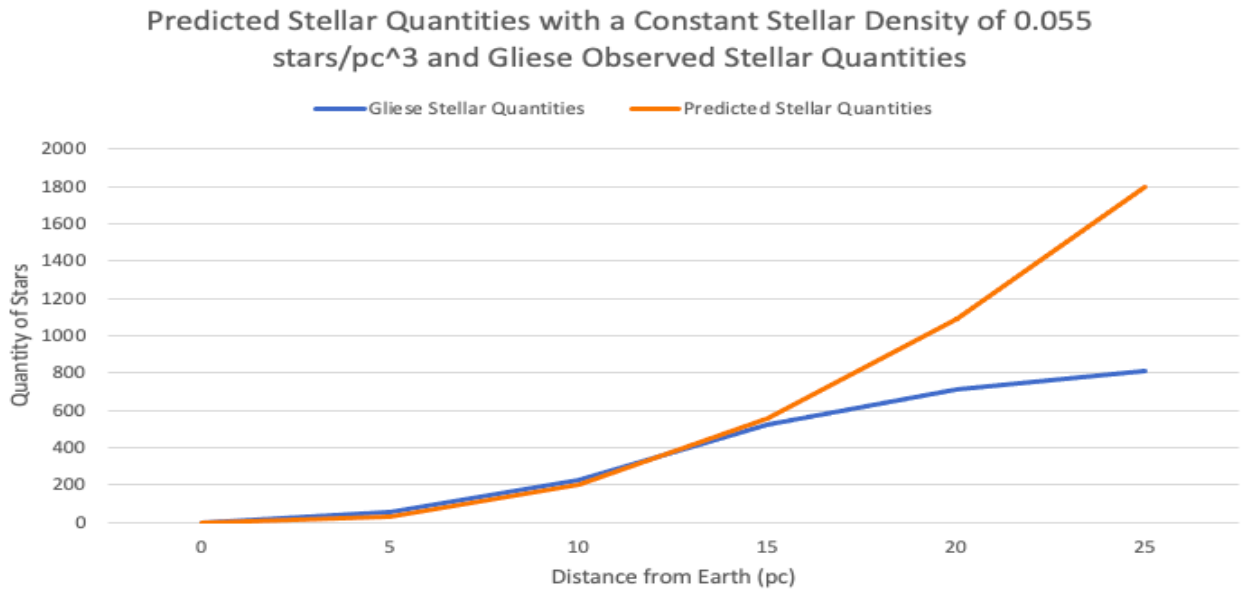
- The Open Supernova Catalog (Guillochon, Parrent, Kelley, & Margutti, 2017)
  - 66,682 supernovae
  - Beyond Milky Way Galaxy

  Went out in radial distances (spherical shells) from the Sun

Results

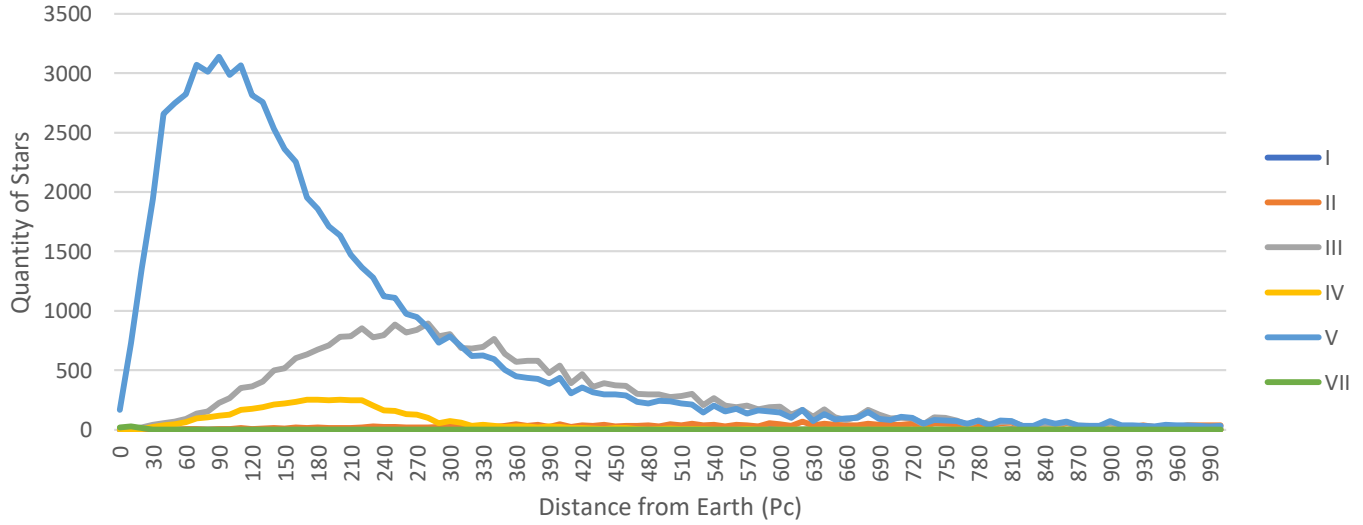
- Luminosity selection effects
  - CNS3 Catalog
  - Tycho-2 Catalog

Malmquist Bias



Quantity of Class of Stars as a Function of Distance (Hipparcos Catalog, 1000 Pc)

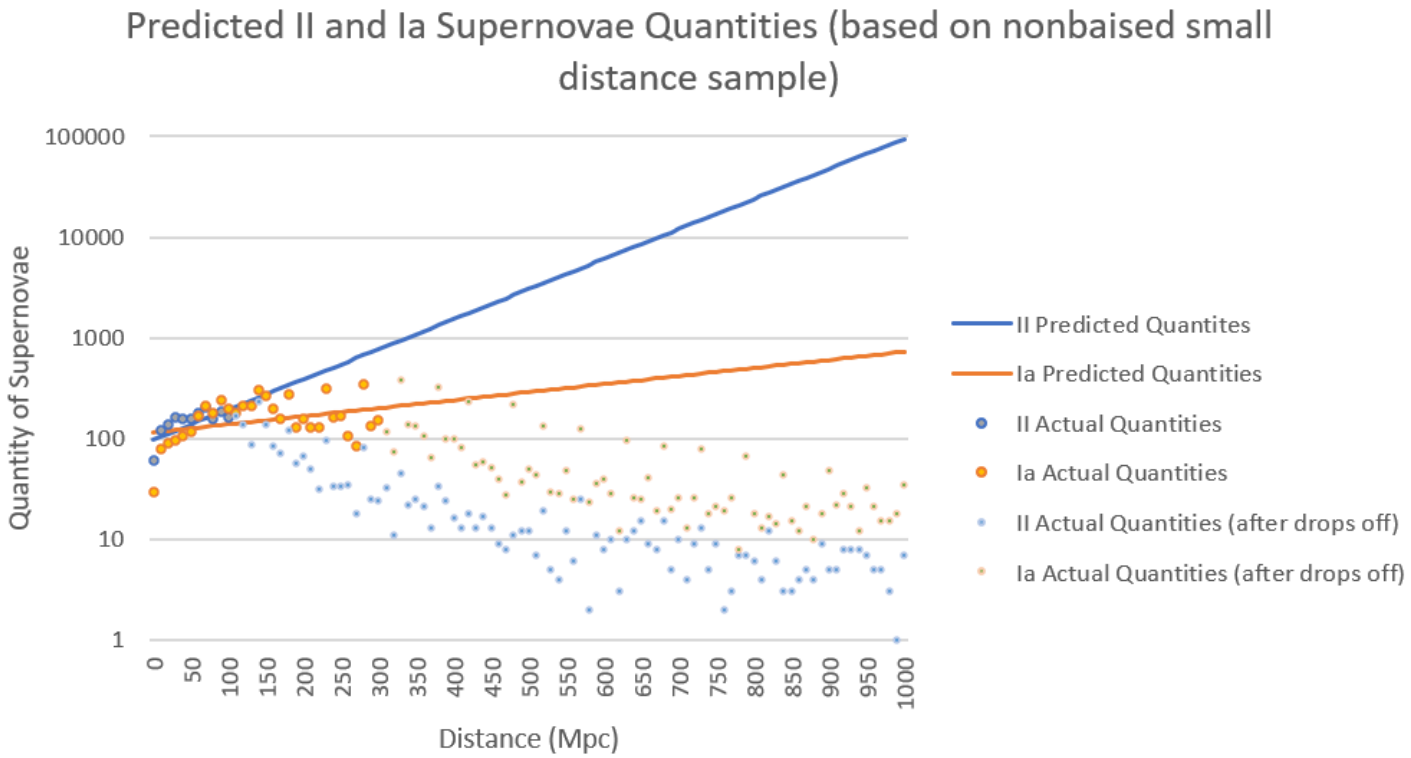
(Menne, 2020)



(Menne, 2020)

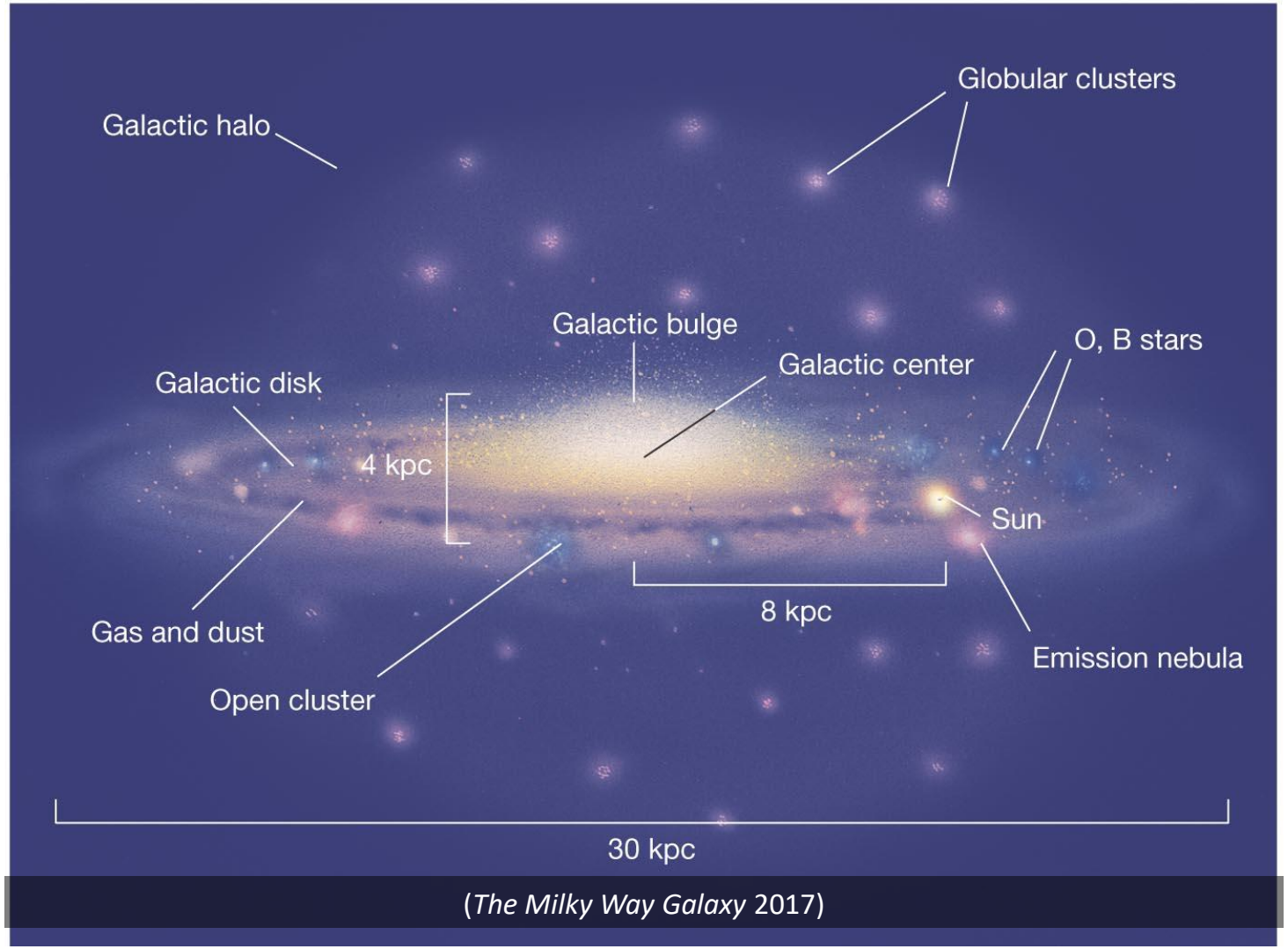
Results

- Luminosity selection effects
  - Supernova quantities (Open Supernova Catalog)



Results

- Progenitor stars
  - 7,050 within 24 kpc
  - 6,849 within 10 kpc
- Neutrino detection



(*The Milky Way Galaxy* 2017)

Academic and Career Goals

- PhD in Astrophysics or Astroparticle Physics
- Conduct research in a national or international lab

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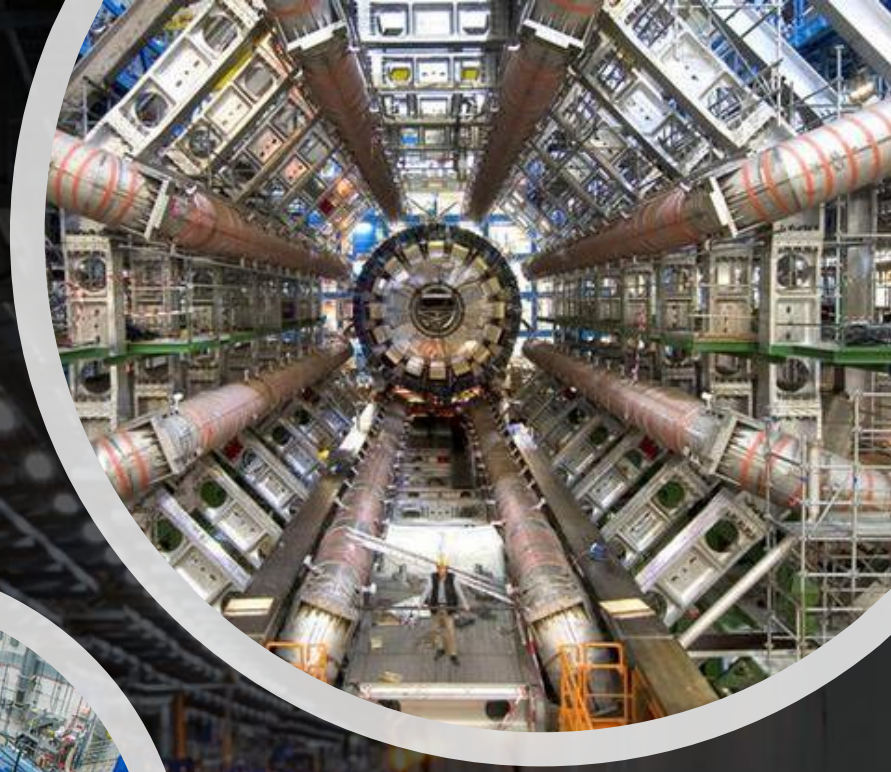

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