

Identifying White Dwarf Candidates

Courtney Crawford

Advisor: Dr. Mukremin Kilic

What is a White Dwarf?

- White Dwarves (WDs) are stars with masses comparable to the Sun and radius comparable to Earth. (force of gravity $\sim 10^8 \text{ m/s}^2$)
- Low- or intermediate-mass stars will expel their surface layers, leaving behind its core. This core serves as a WD progenitor.

Properties of WDs

- Dense (10^9 kg/m^3) and high gravity
- Composed of electron degenerate matter
- Not powered by fusion
 - Luminous because of releasing thermal energy
 - Faint objects
- Energy is transported by conduction
 - Interior is nearly isothermal
 - Surface cools at an essentially constant rate

Detection

- WDs are dim → easier to detect those closest to us
- Closer to us → move “faster” relative to background objects
 - Movement per year relative to background is called proper motion
- Using both proper motion and photometric colors, we can make a preliminary selection of WD candidates

Proper Motion Data

- HSOY (Hot Stuff for One Year) is a bridge between Gaia DR1 and Gaia DR2, published in Feb 2017.
- Until the release of Gaia DR2, HSOY contains the best set of proper motion data to date.
- 583 million objects with proper motion precise up to < 1 milliarcsecond/year

Proper Motion Data

- Using HSOY, objects with 5σ significant proper motion were chosen.
- Separate sets for proper motion in right ascension and declination
 - Right ascension, declination are the celestial coordinates of an object
- Only objects between 0 and 30 right ascension

Reduced Proper Motion Diagram

$$H = m_g + 5 \log \mu + 5$$

$$H = M + 5 \log V_{\text{tan}} - 3.379$$

μ = proper motion

m_g = g-band magnitude

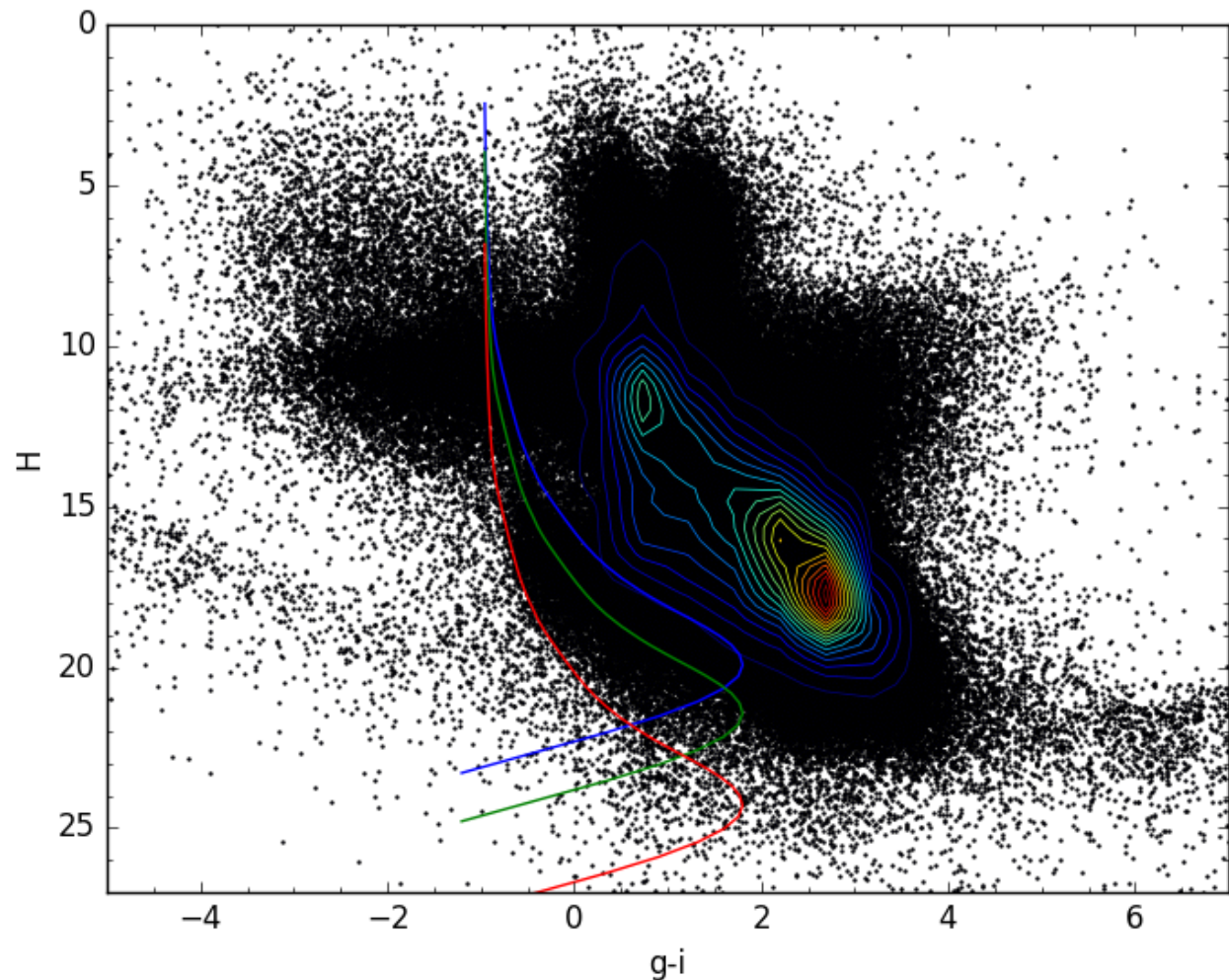
M = absolute magnitude

Blue = 20 km/s

Green = 40 km/s

Red = 150 km/s

1.5 million data points

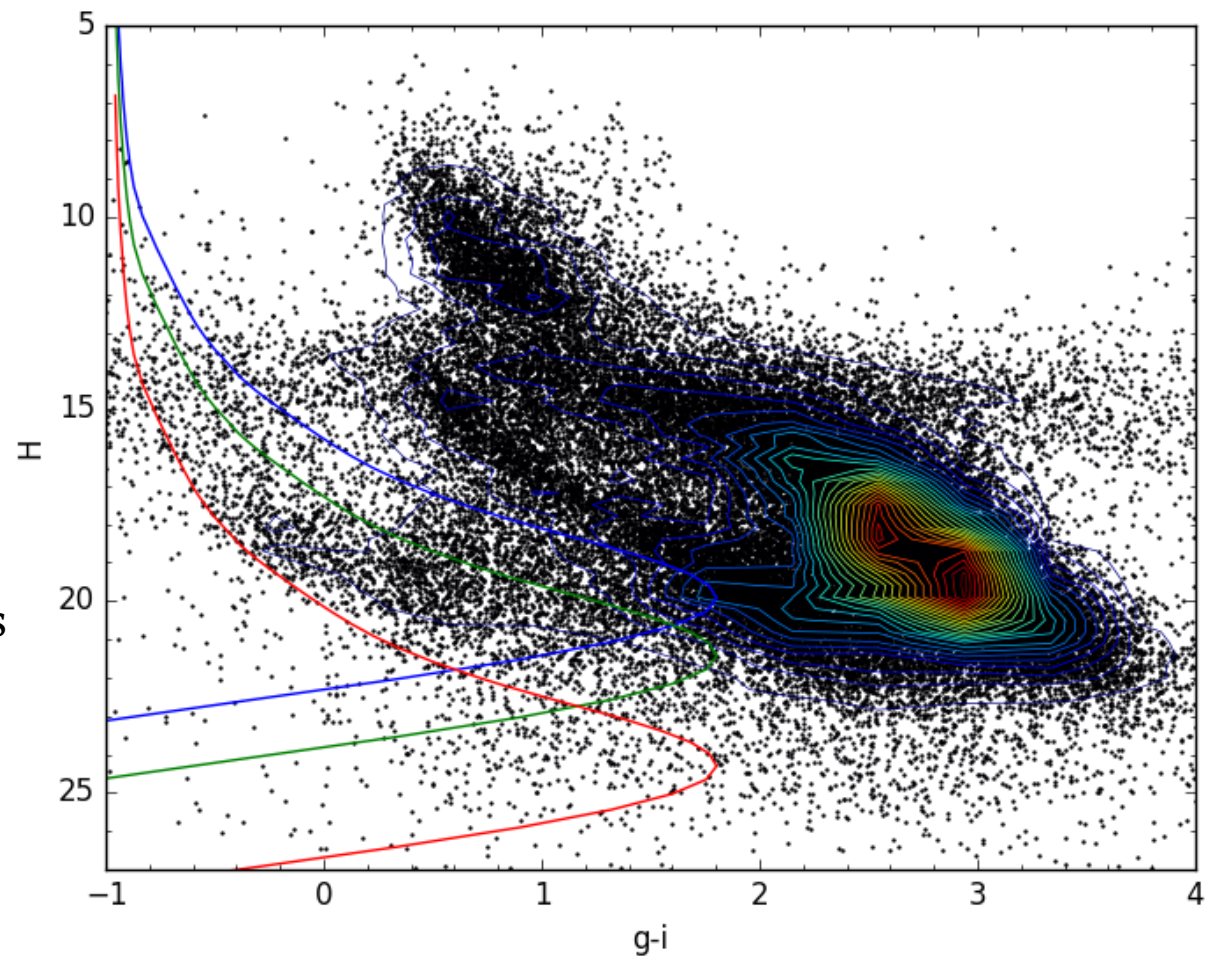


Reduced Proper Motion Diagram

3 kinematically similar
populations

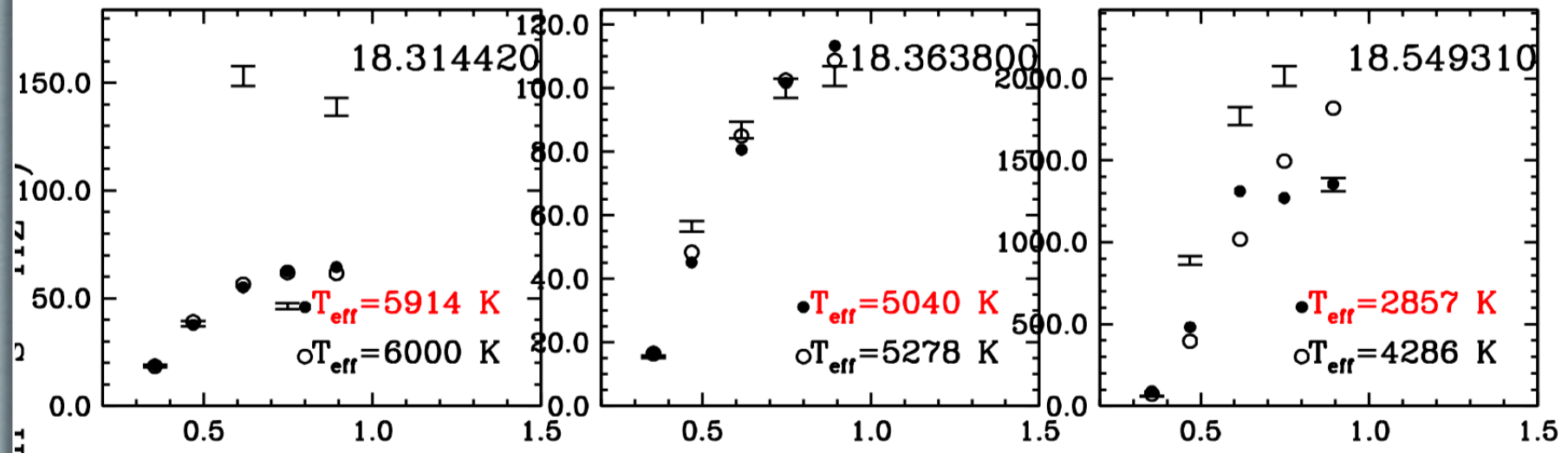
Select objects below the
 $V_{\text{tan}} = 20$ km/s line as
potential WD candidates

67,185 data points



Spectral Energy Distribution Modeling

Fit ~ 50,000 objects, still processing data from the fits



What's Next?

- Sorting through fit code output to cut further objects with no good fit
- Possibly following up with a cross match with infrared data for objects with good fits
- Spectra of the object is necessary to confirm whether the object is a WD or not
- Statistical analysis of the selection process itself to discern efficiency

In Conclusion

- The elusive nature of dim WDs makes it difficult to create a comprehensive, well defined sample of them
- Deep proper motion surveys such as Gaia and selection processes such as this one help to create one
- Finding a WD is the first step to being able to learn more about it