

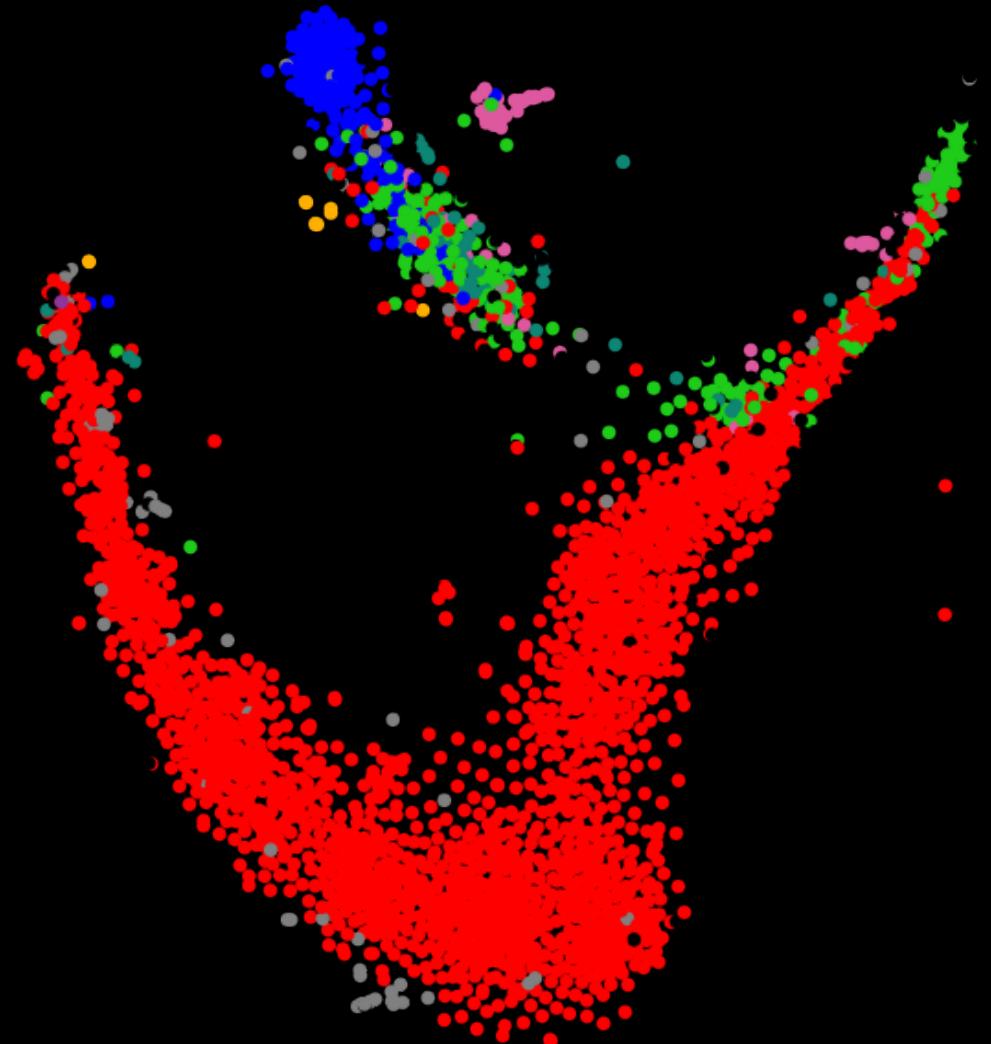


# Spectral Classification of White Dwarfs by Dimensionality Reduction

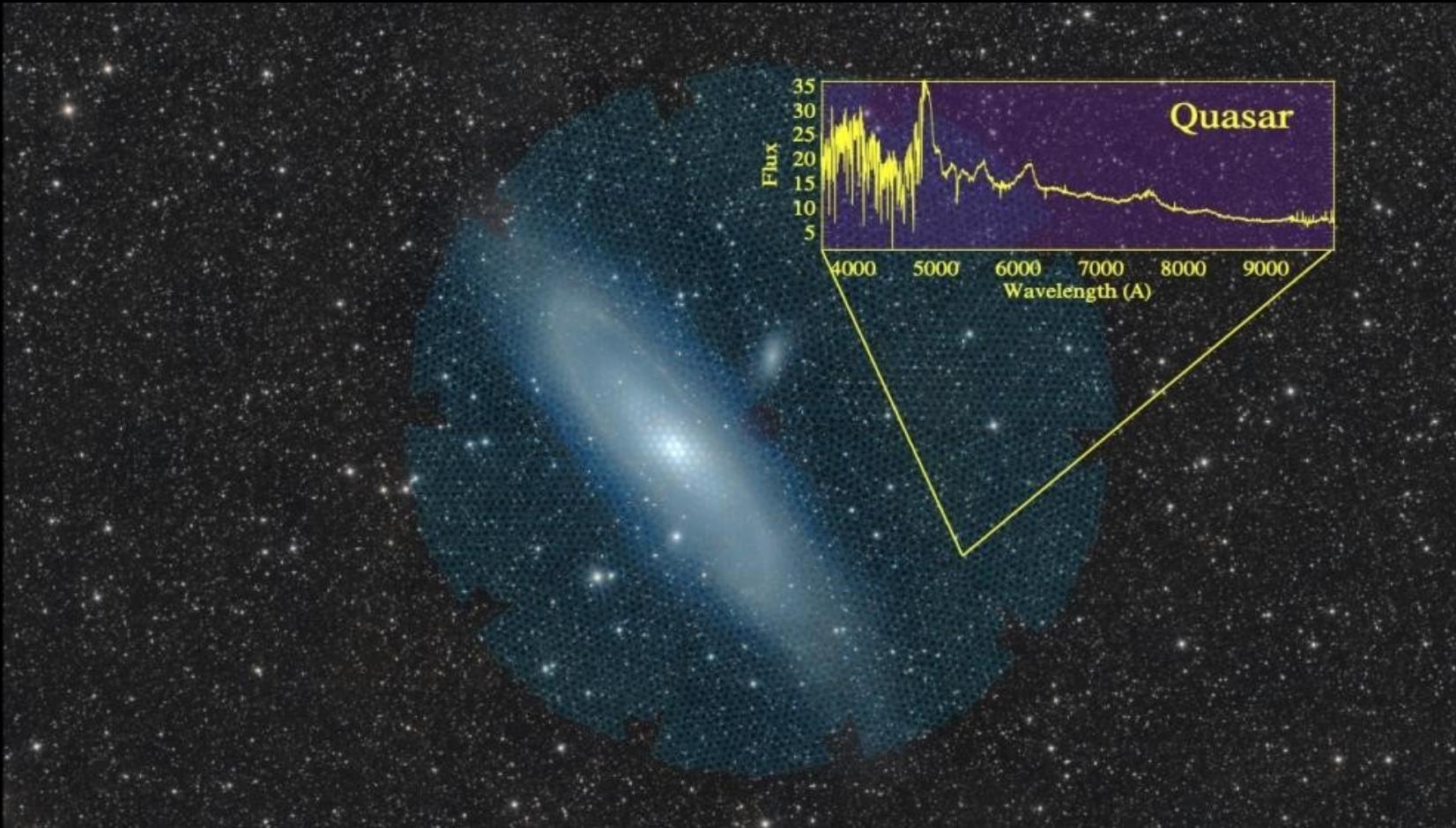
Xander Byrne  
Amy Bonsor – Laura Rogers – Christopher Manser

# Outline

- Spectroscopic surveys
- White dwarfs
- Dimensionality reduction (DR)
- Variation: focus on spectral lines

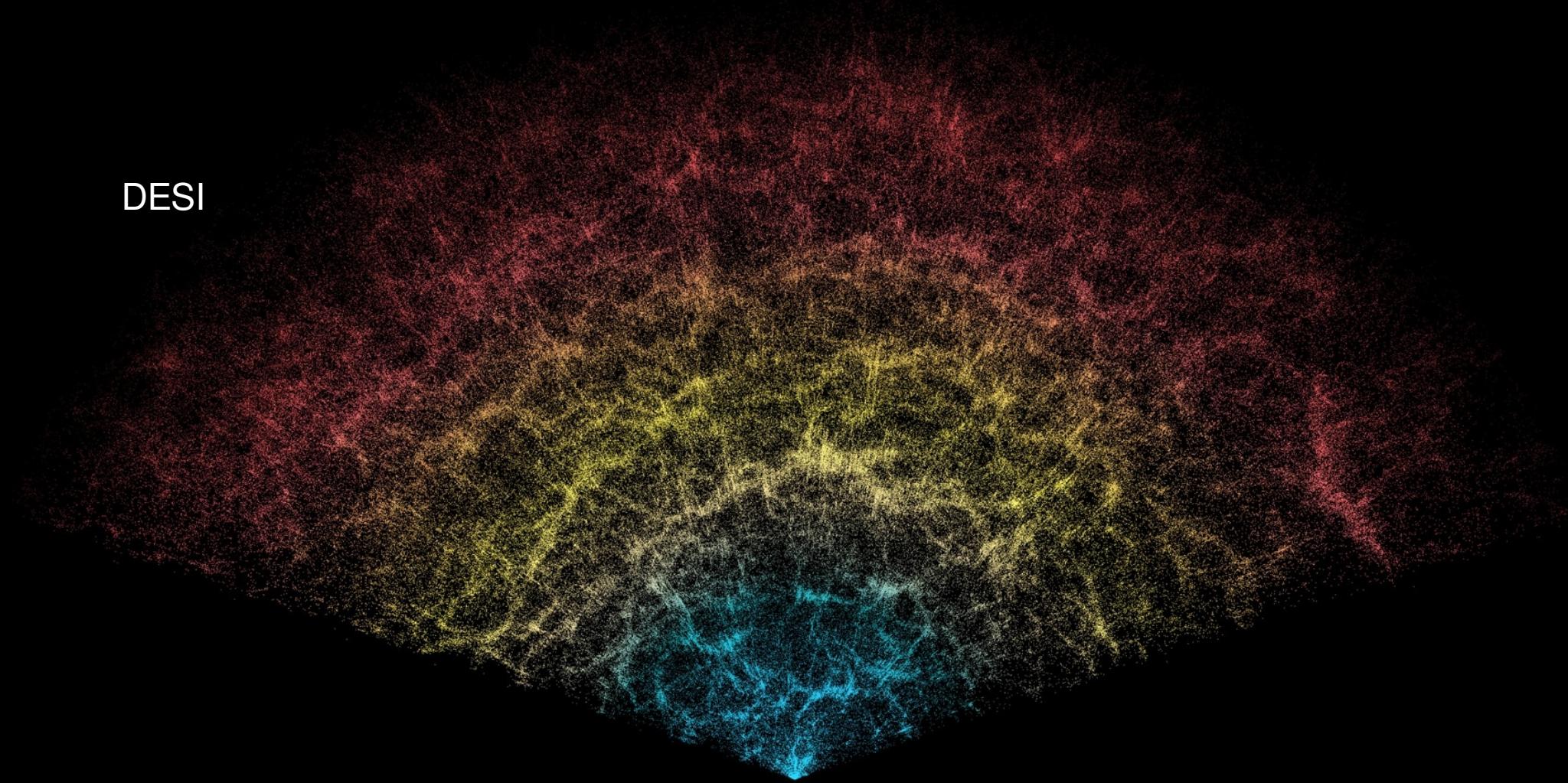


# Spectroscopic Surveys



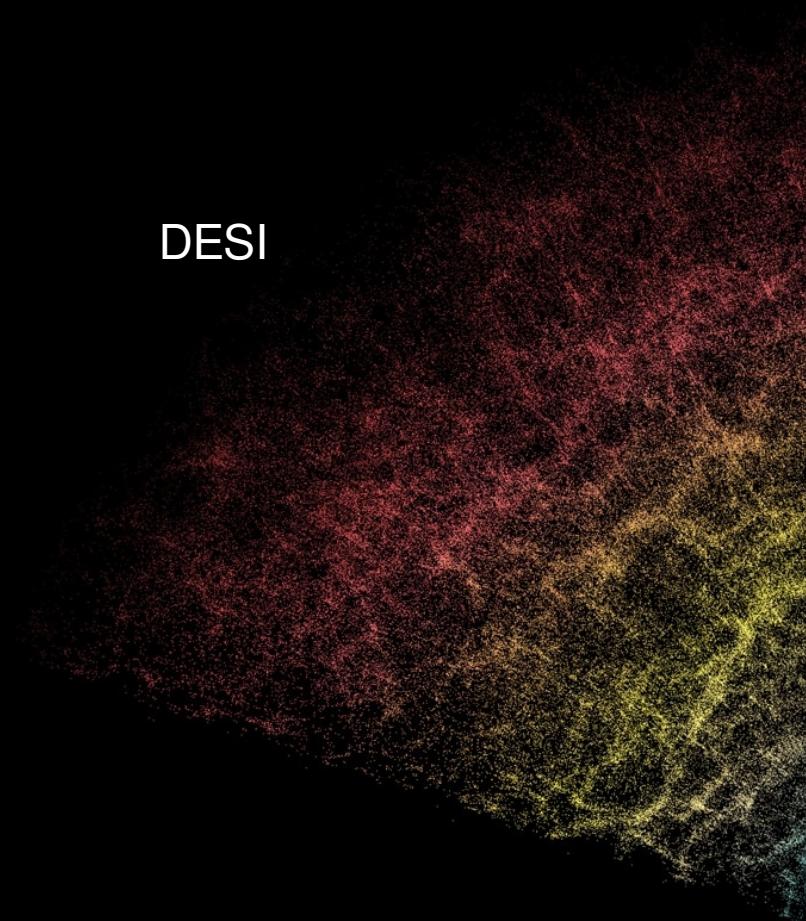
# Spectroscopic Surveys

DESI

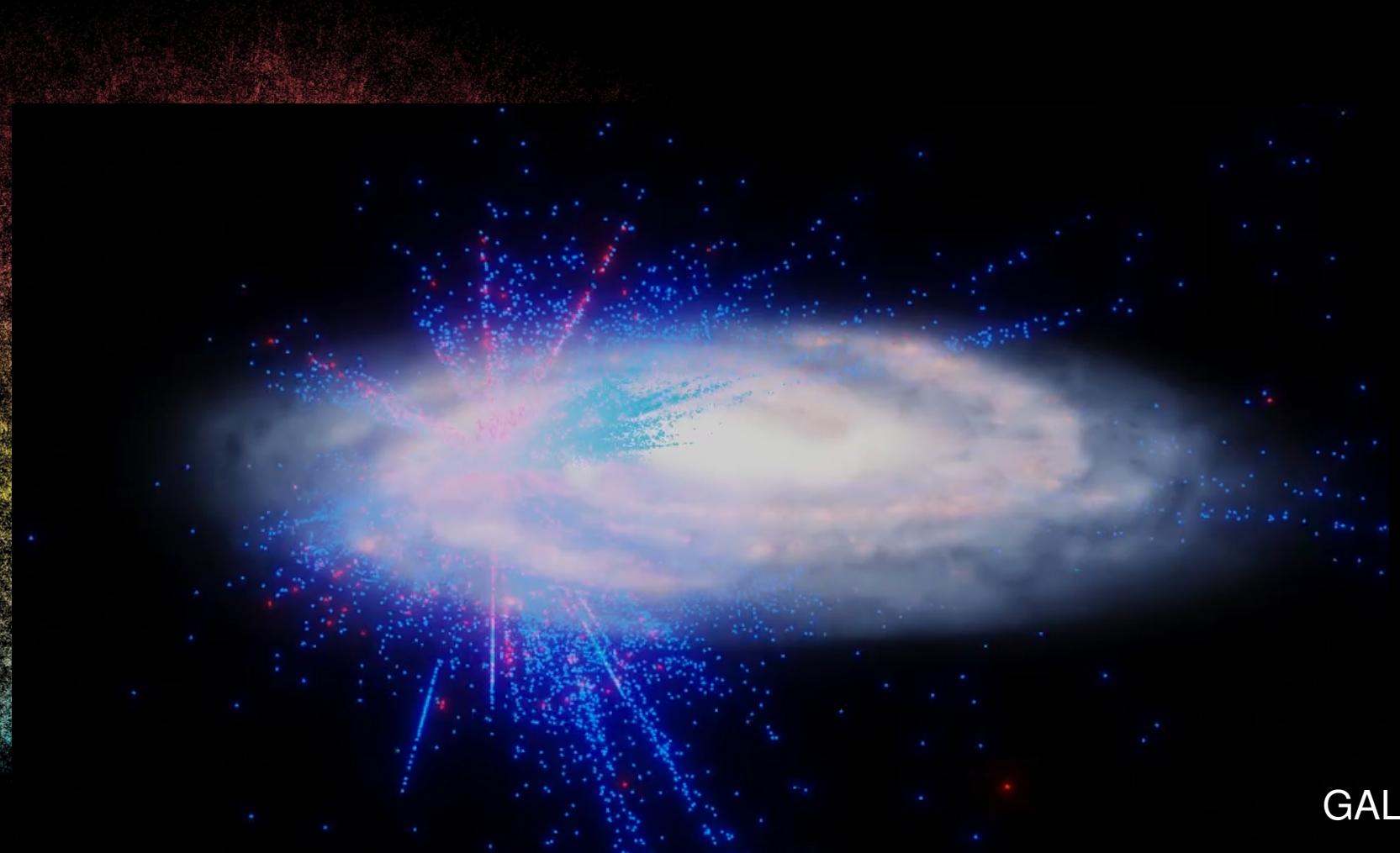


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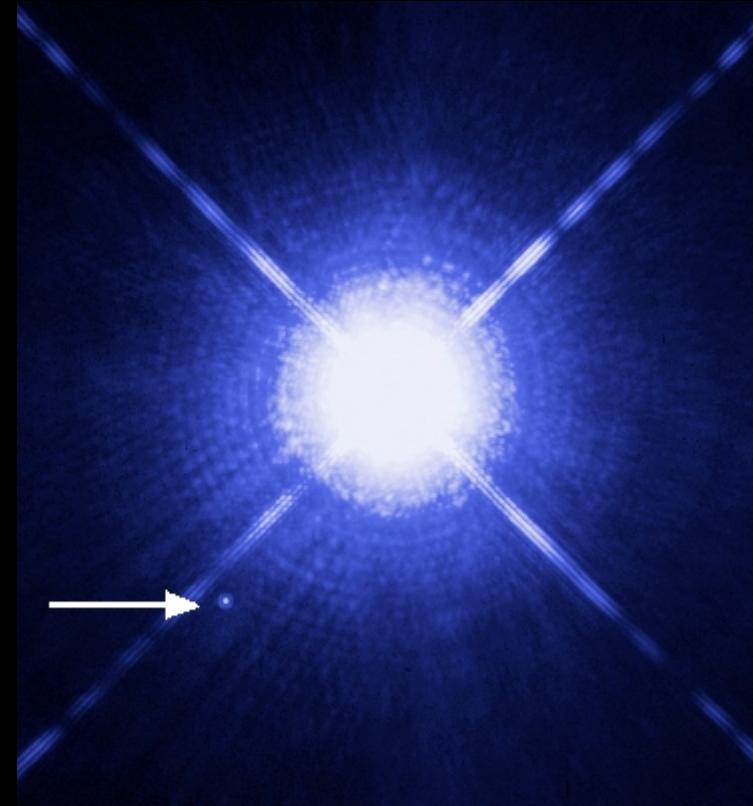
DESI



GALAH

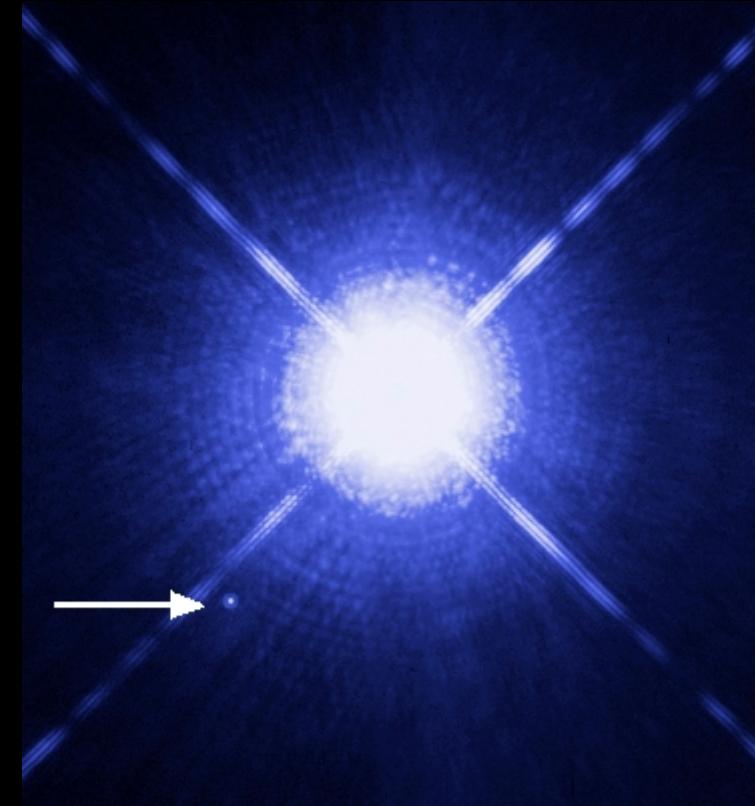


# White Dwarfs 101



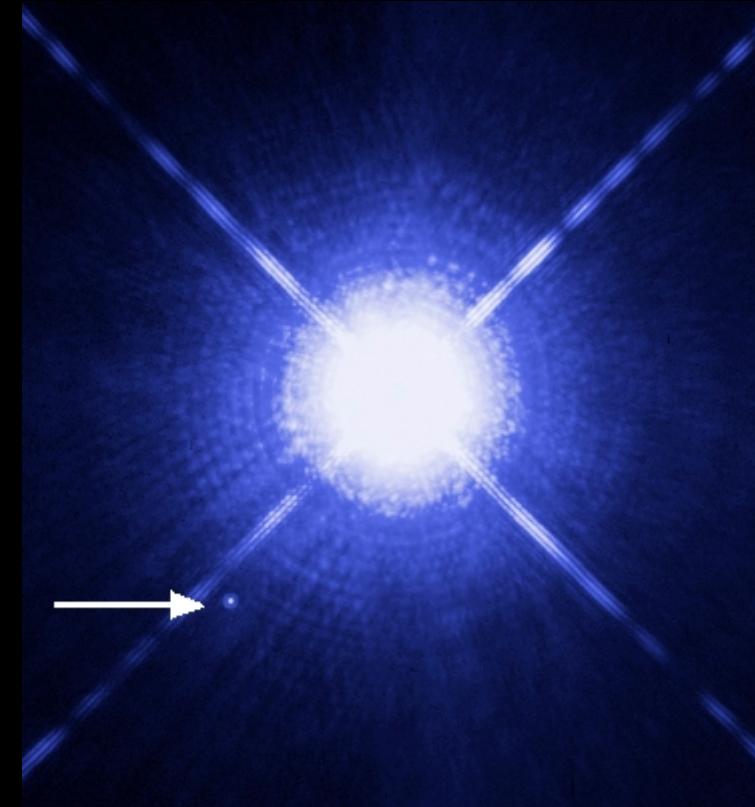
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- 97% of stars will be WDs ( $M \sim M_{\odot}$ ,  $R \sim R_E$ )



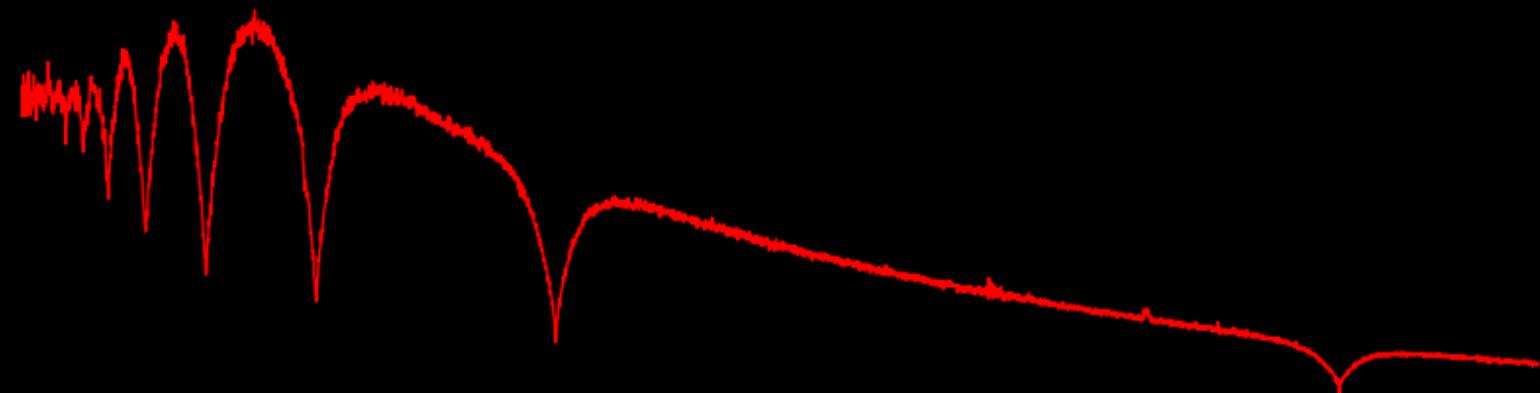
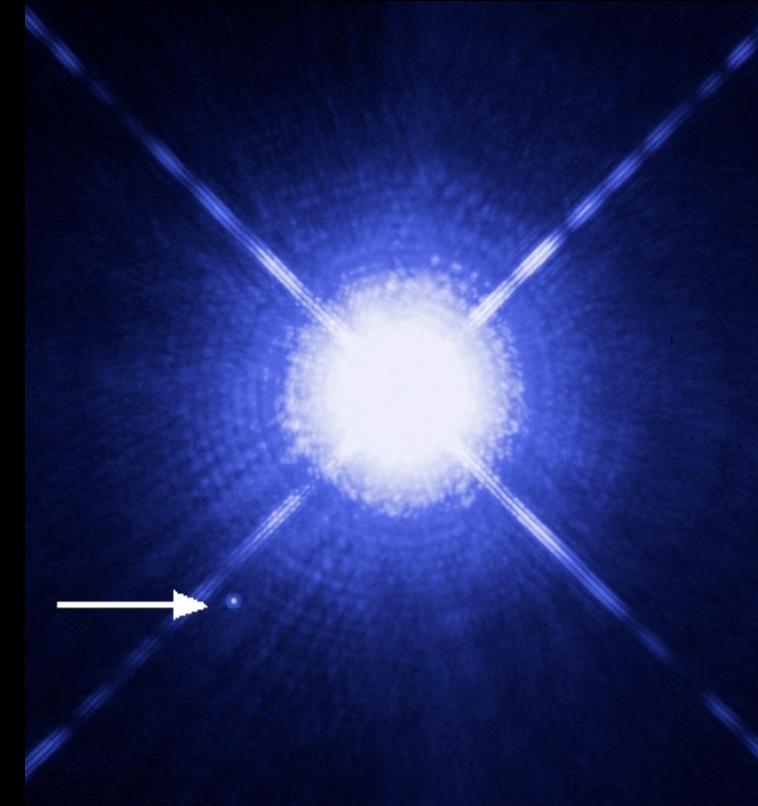
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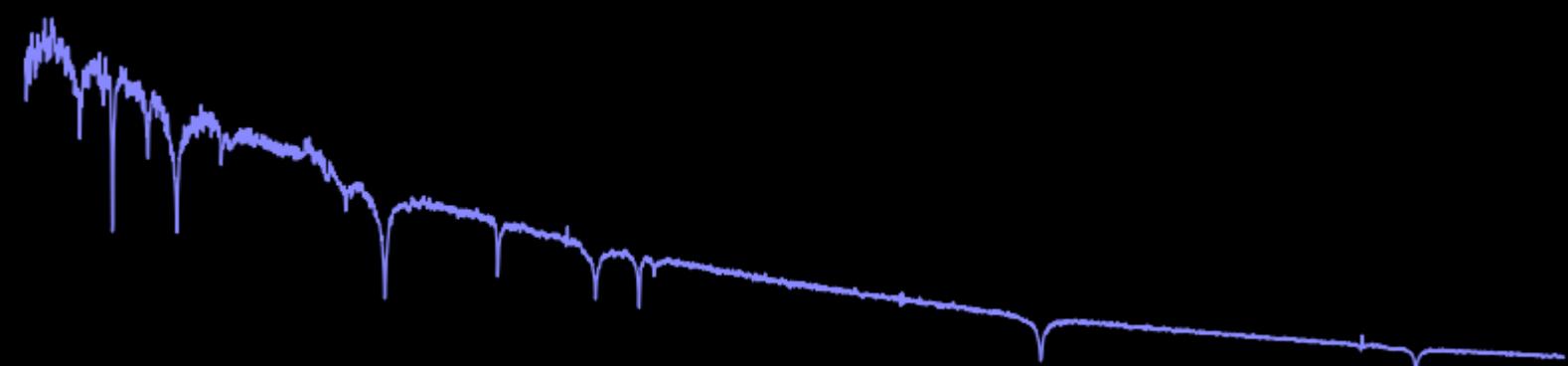
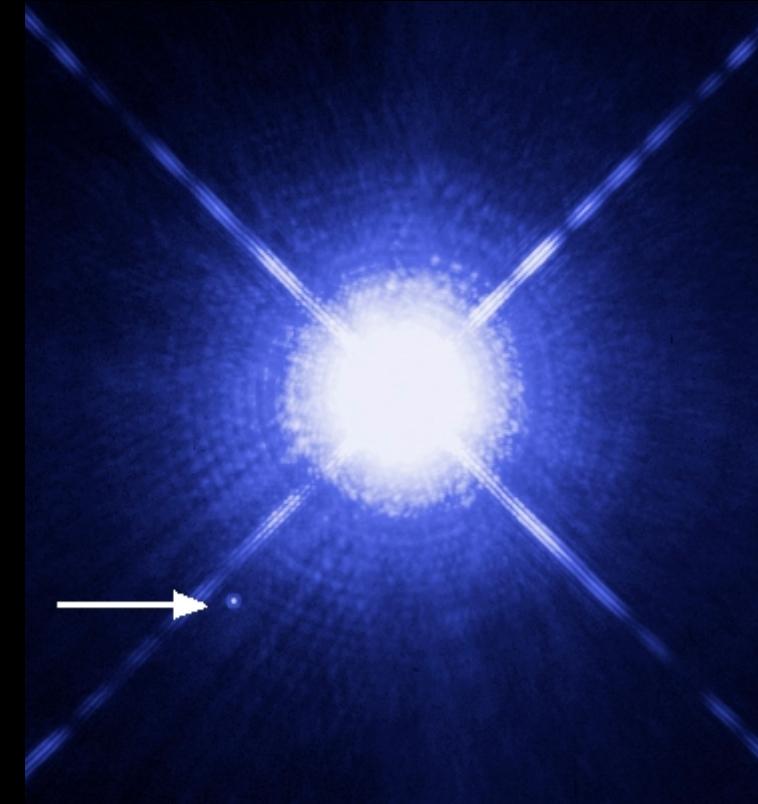
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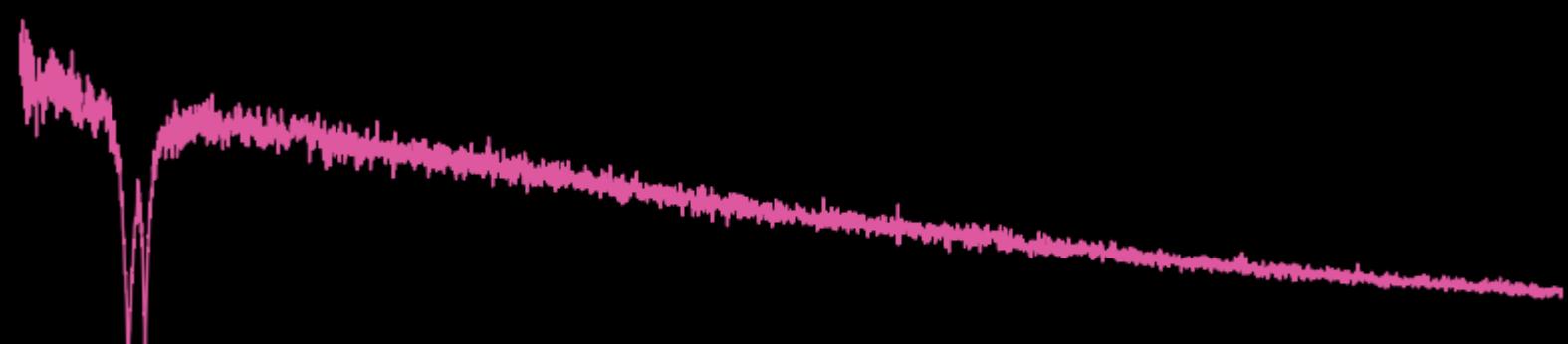
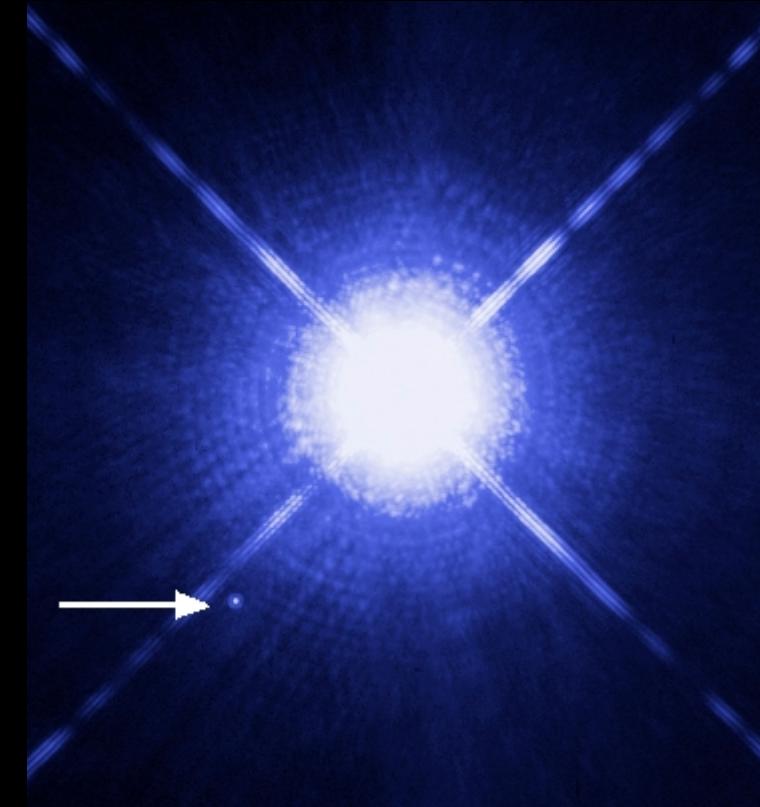
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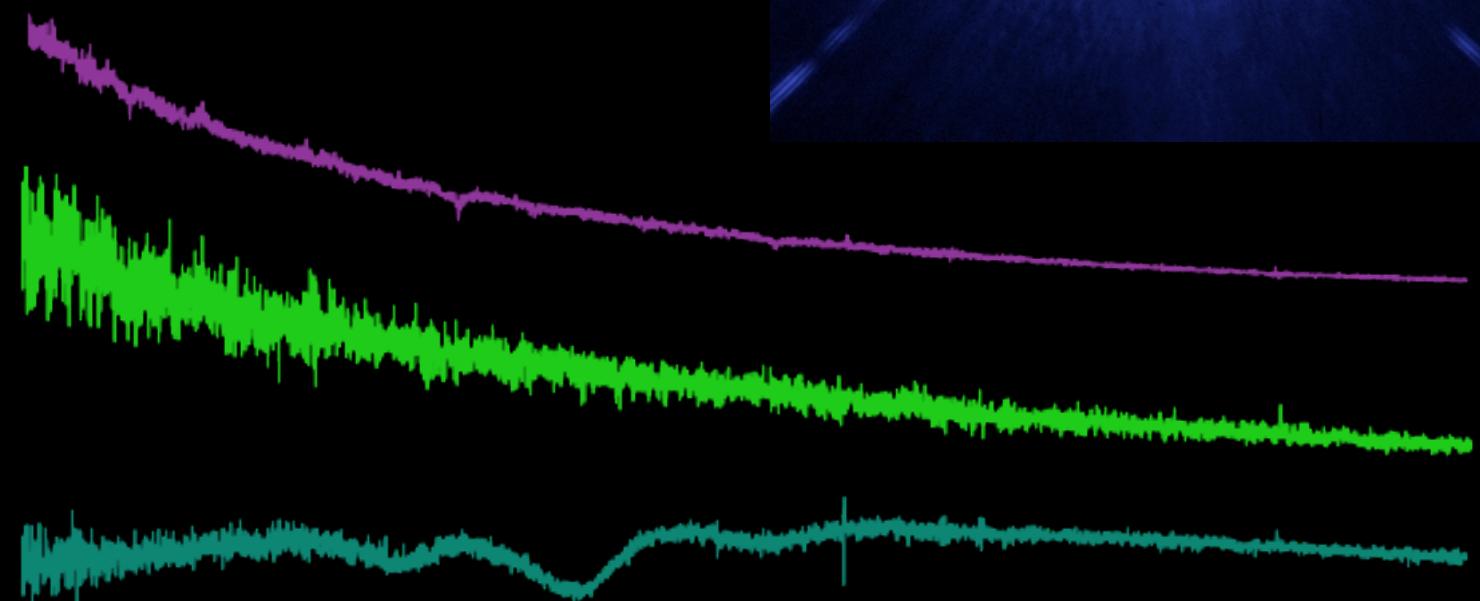
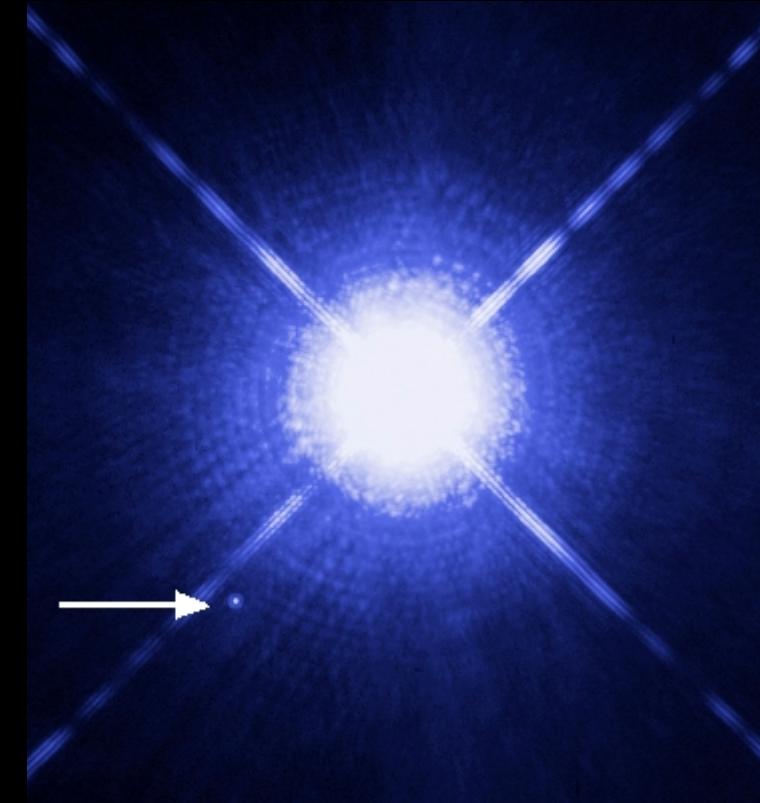
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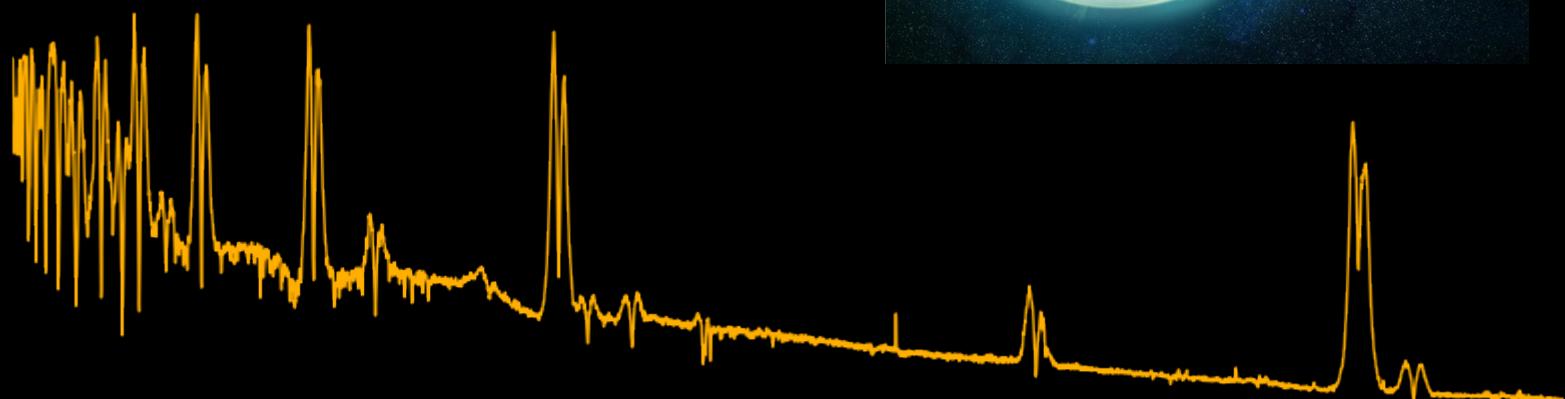
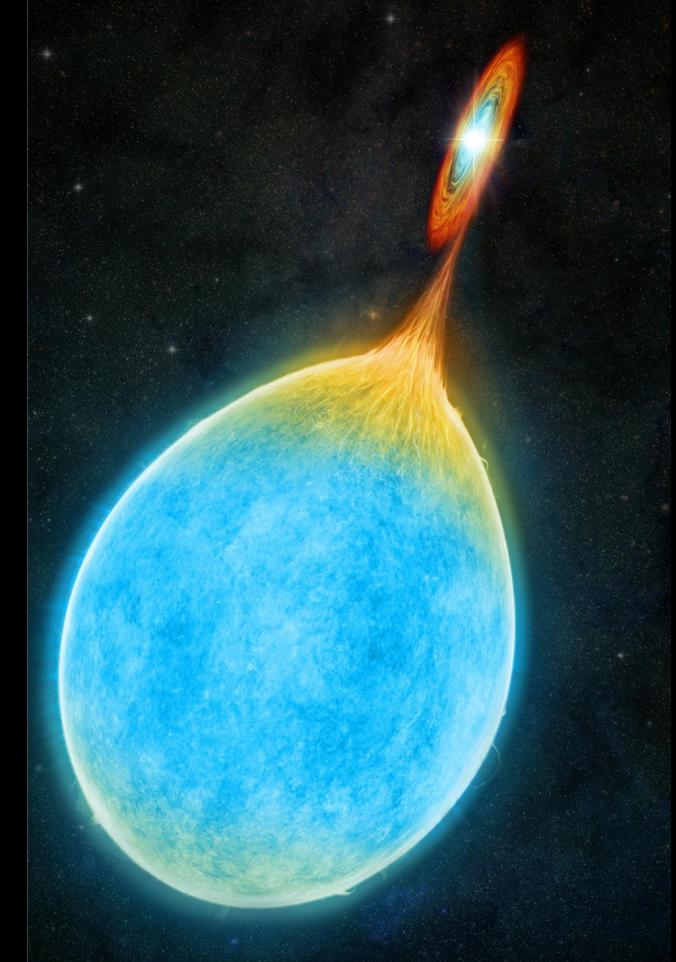
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  - **DZ** (Ca, Mg, ...)
  - ...
  - **CV** (double-peaked)



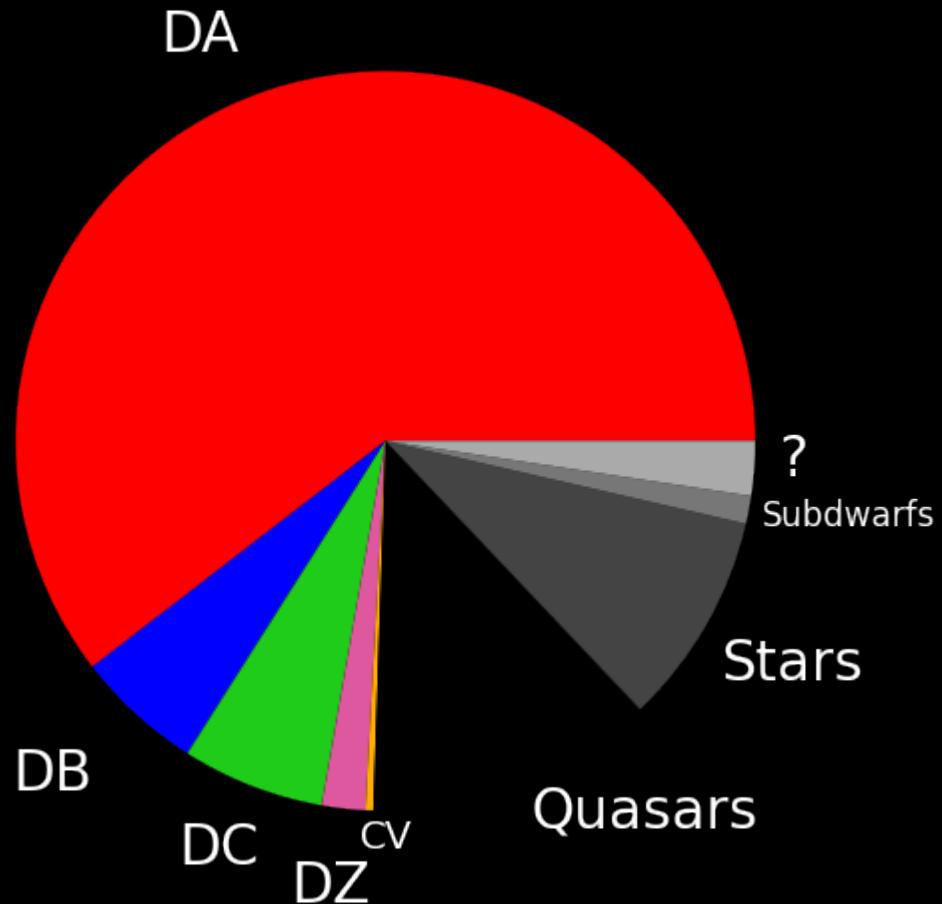
# ~{ Interlude: Astrocolonialism }~

- DESI is on the Mayall 4m telescope at  
**Iolkam Du'ag / Kitt Peak**
- This site is leased (dubiously?) from  
the **Tohono O'odham Nation**
- astrobites:  
'A tale of two observatories'

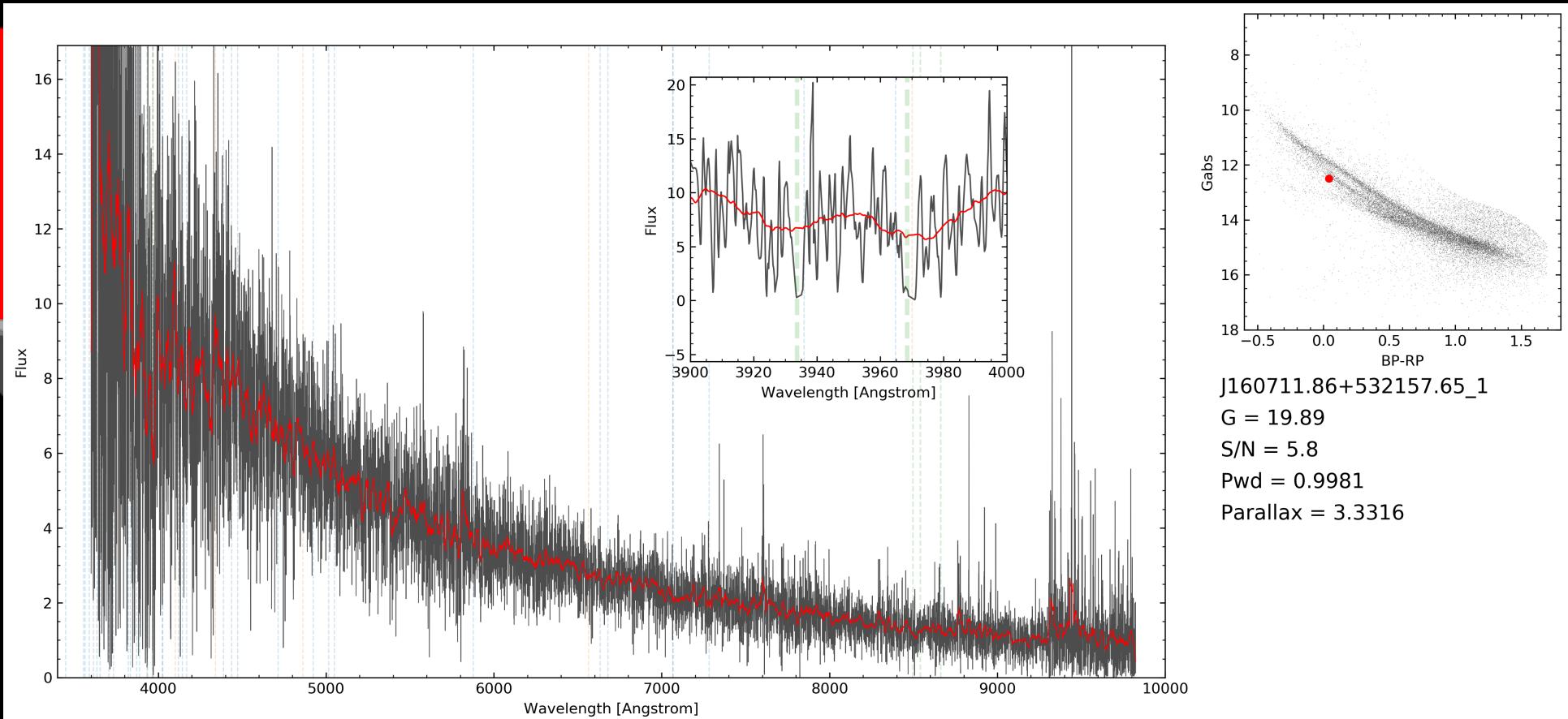
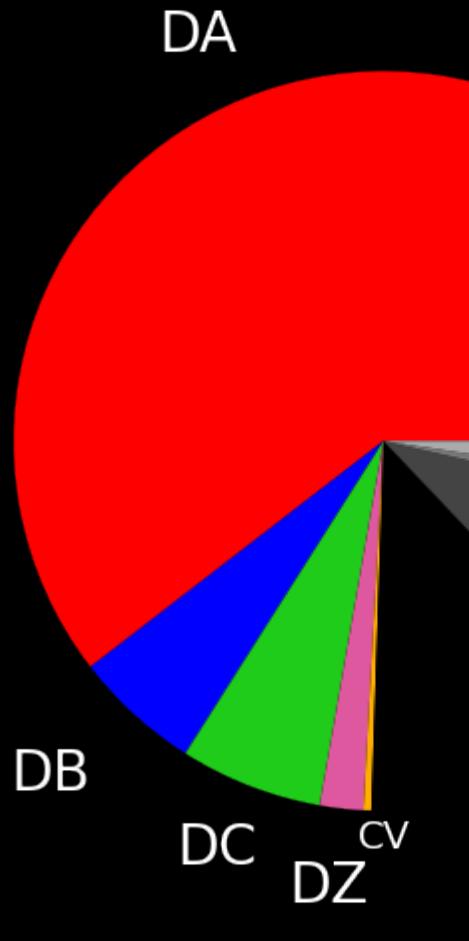


**DESI EDR – 4000 WD candidates**

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# Dimensionality Reduction (DR)

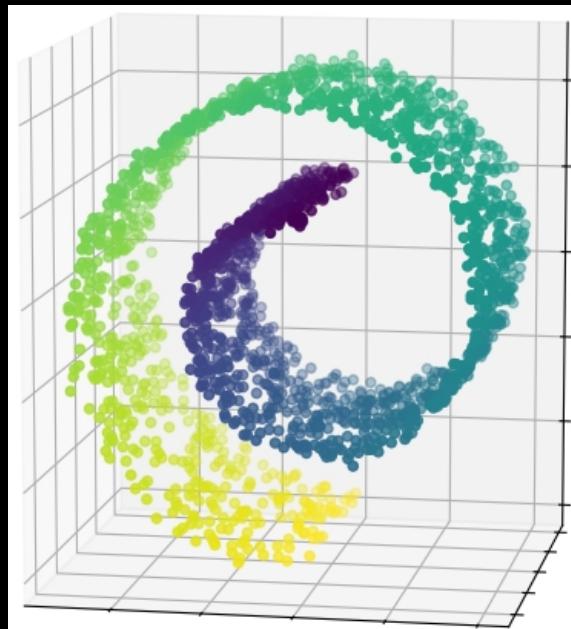
- An unsupervised method of **simplifying a high-D dataset**

# Dimensionality Reduction (DR)

- An unsupervised method of **simplifying a high-D dataset**
- Deprojects dataset into **2D map**, preserving distances

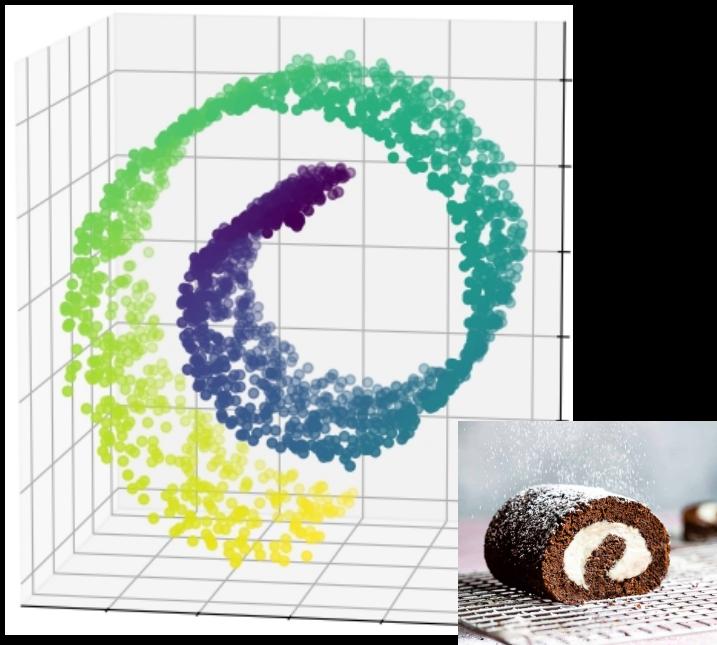
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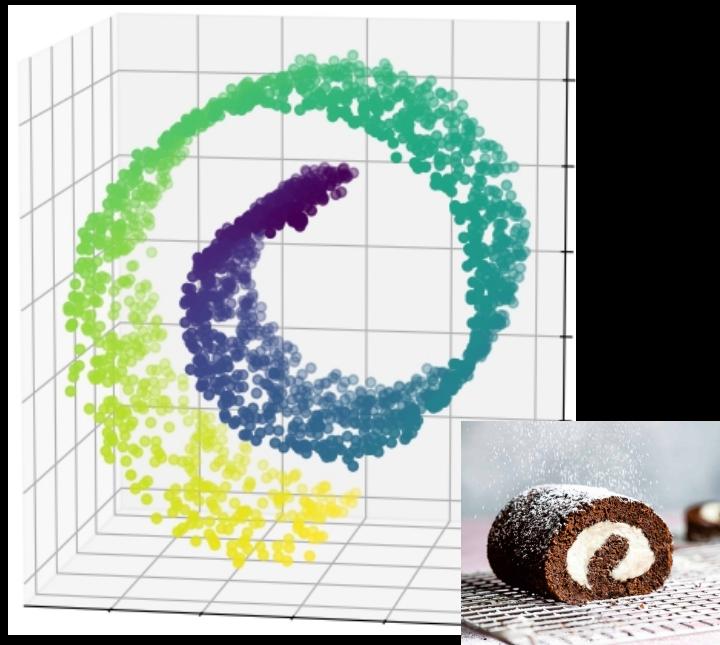
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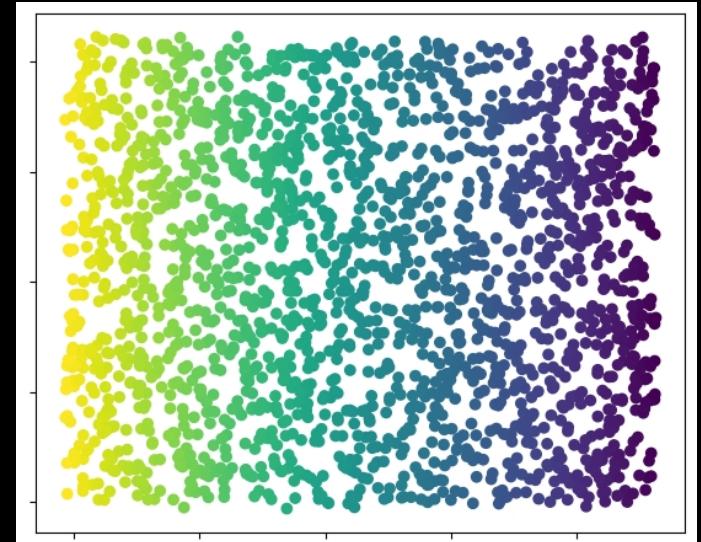


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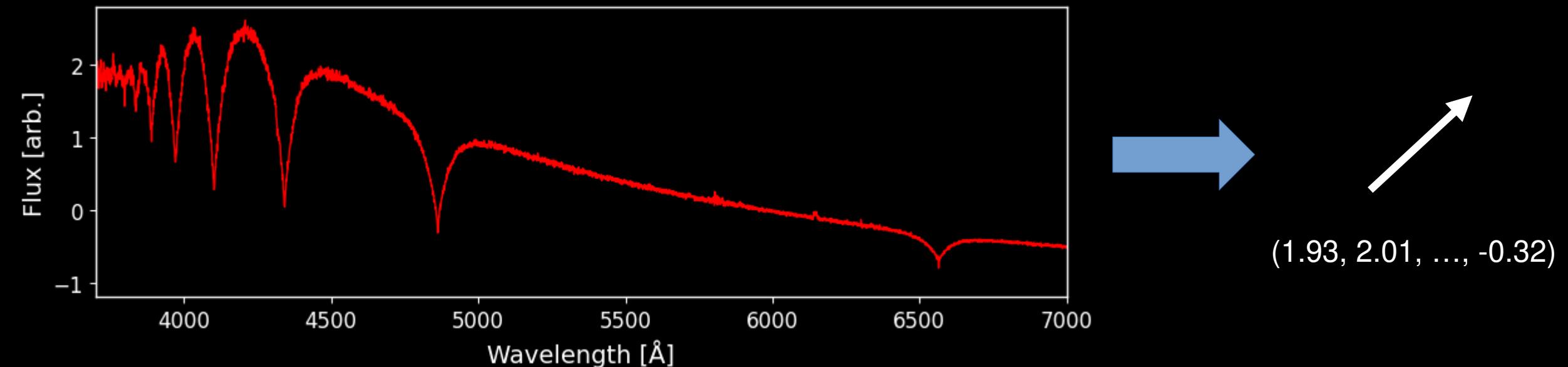


DR



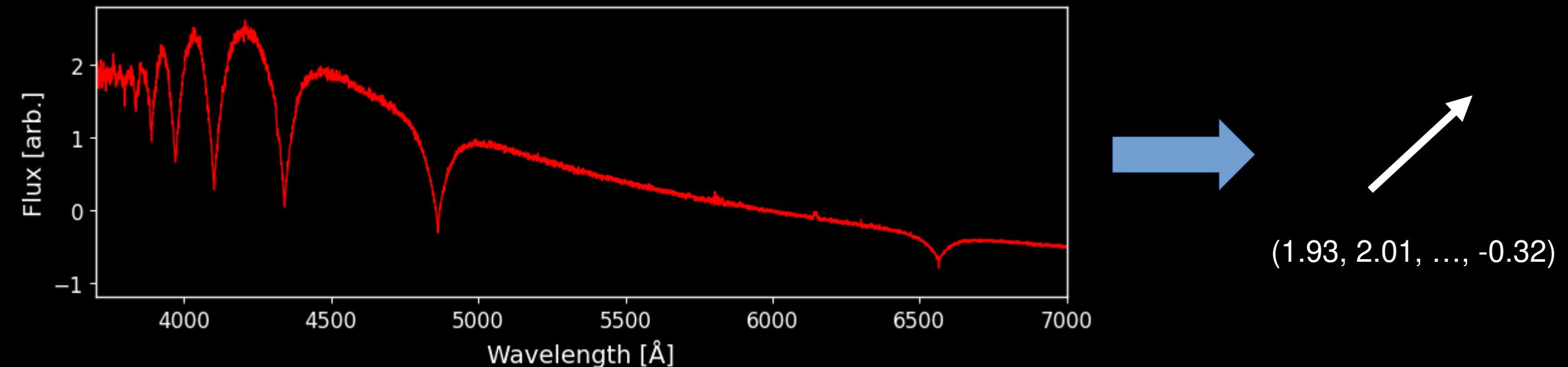
# DR on a spectroscopic survey

- Each data point (e.g. spectrum) **converted to a vector**:



# DR on a spectroscopic survey

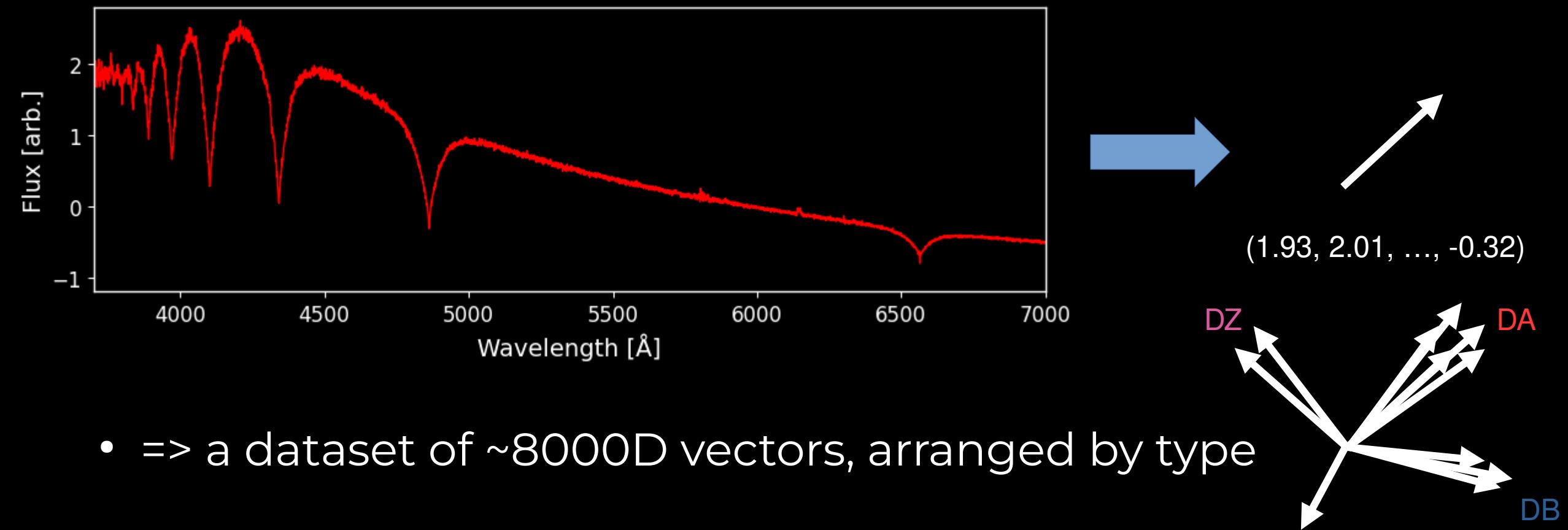
- Each data point (e.g. spectrum) **converted to a vector**:

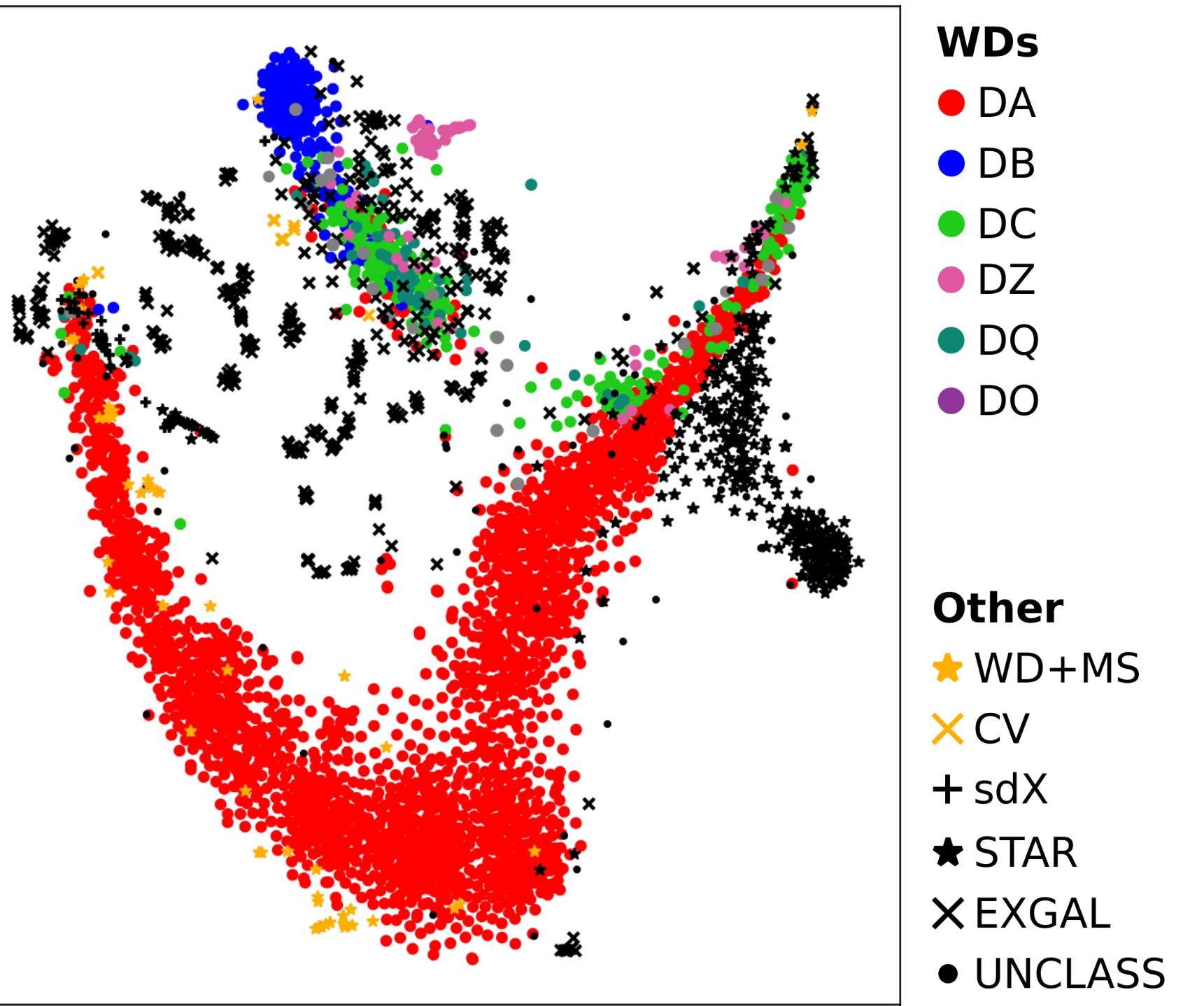


- => a dataset of ~8000D vectors

# DR on a spectroscopic survey

- Each data point (e.g. spectrum) **converted to a vector**:





# Advantages over visual classif'n

- **V. fast** (5.5s for  $N \approx 4000$ ) and scales as  $O(N \log N)$

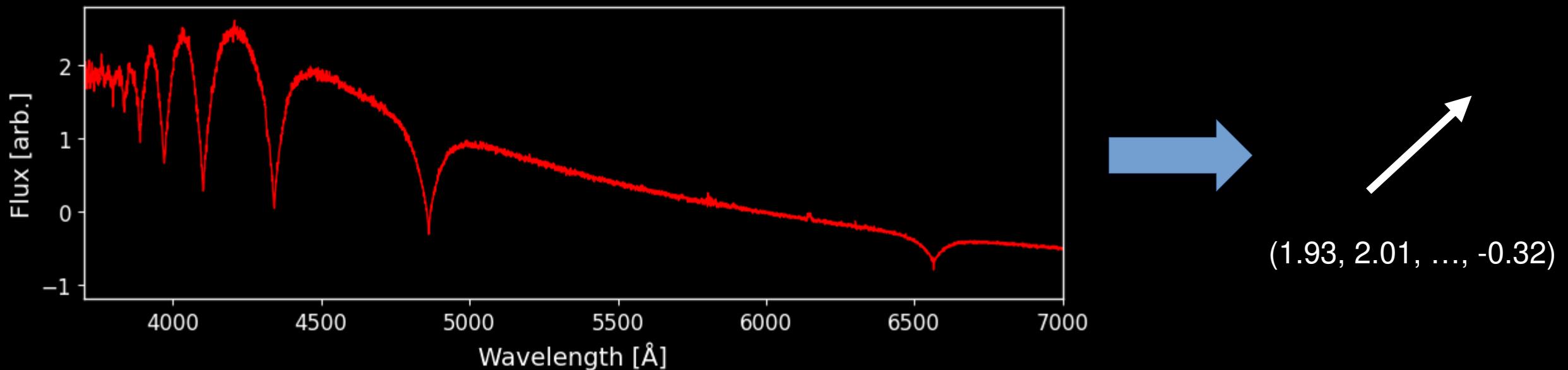
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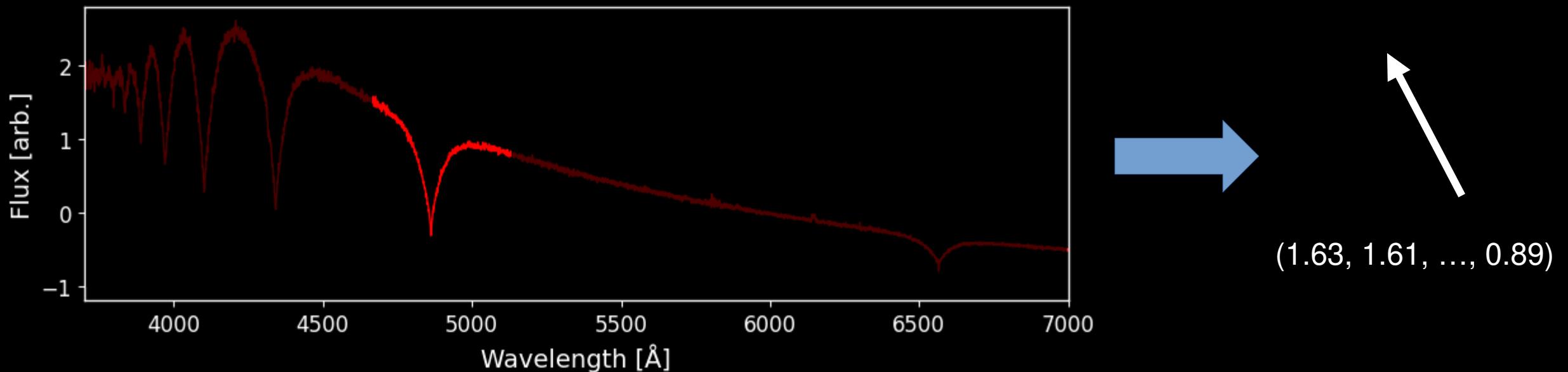
# Advantages over visual classif'n

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- => Much more **reproducible / modifiable**
- **Objective** – doesn't rely on human interpretation

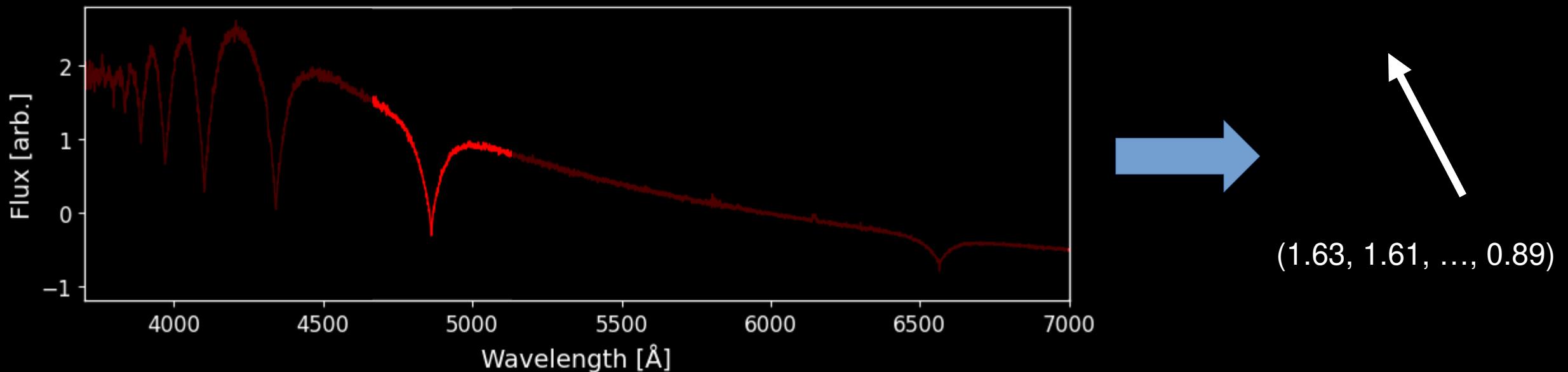
# Focusing on spectral lines



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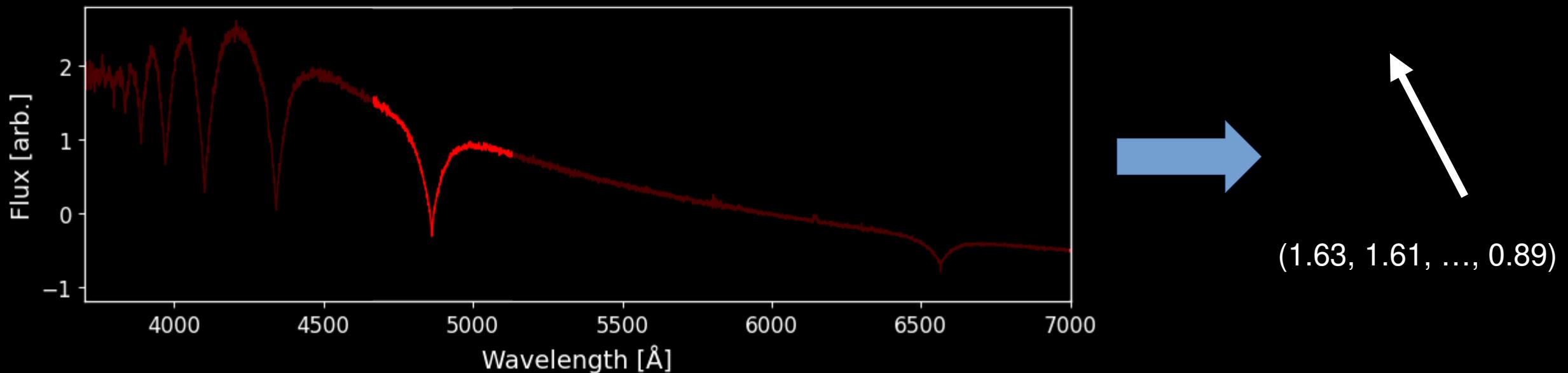


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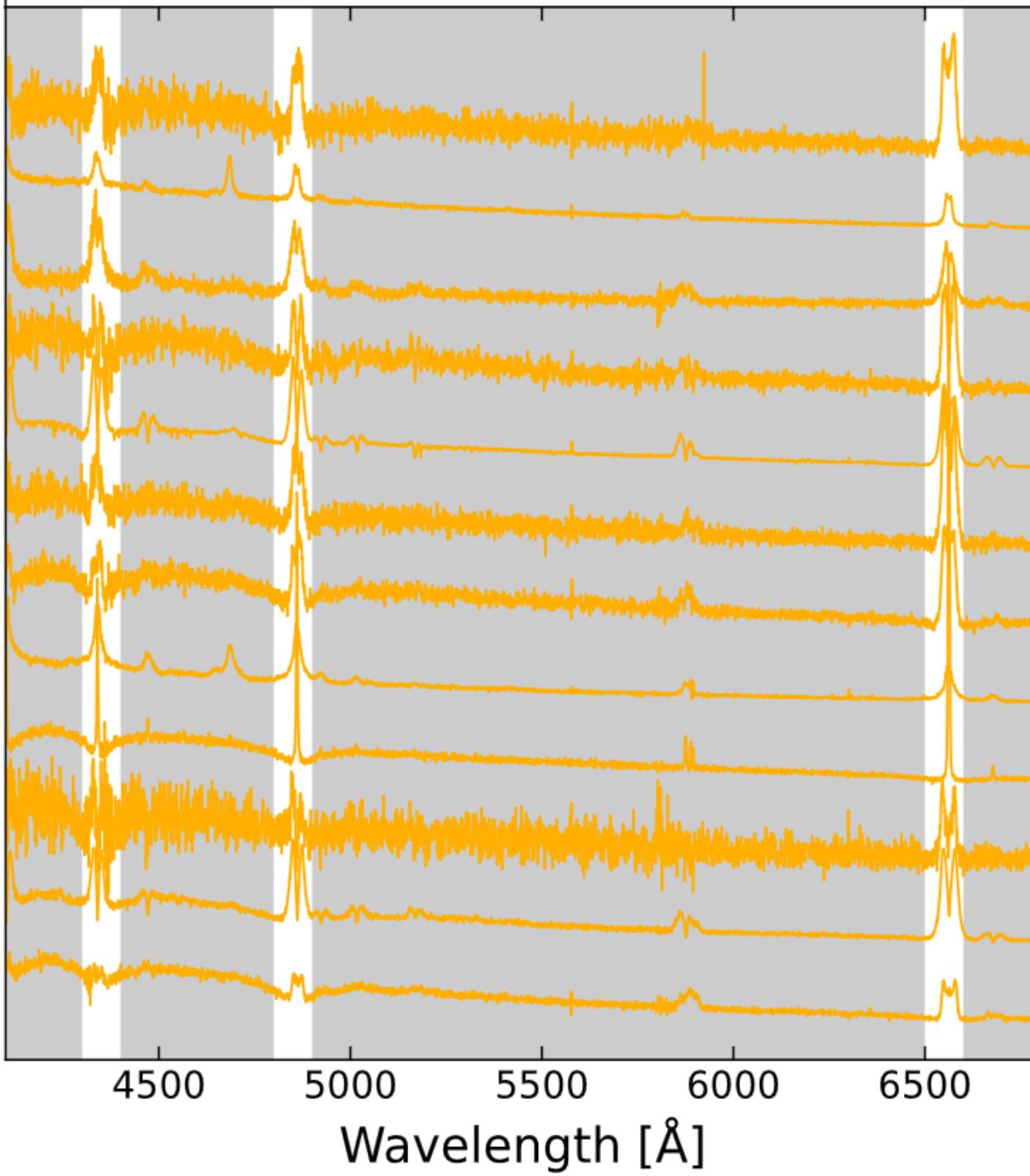


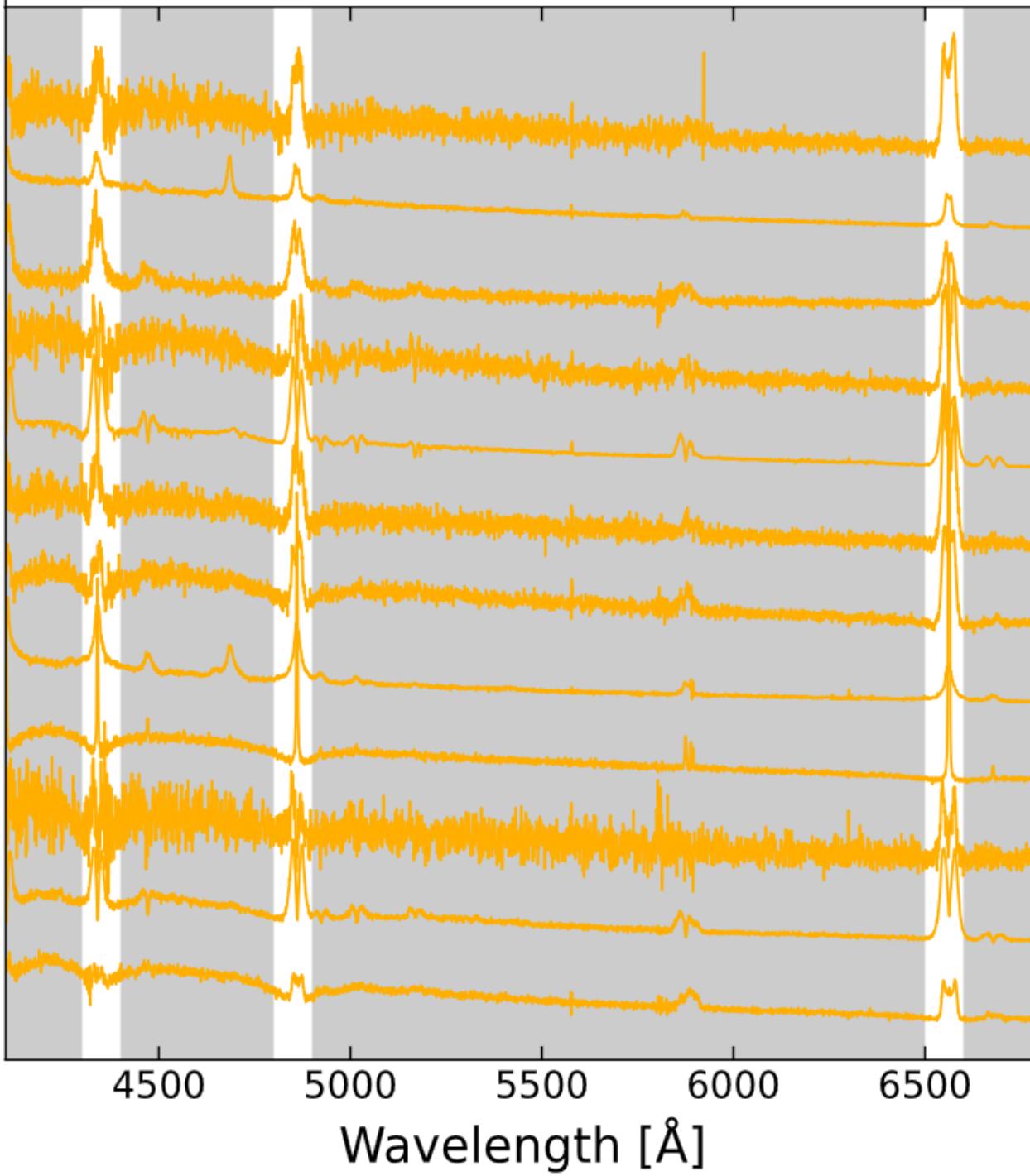
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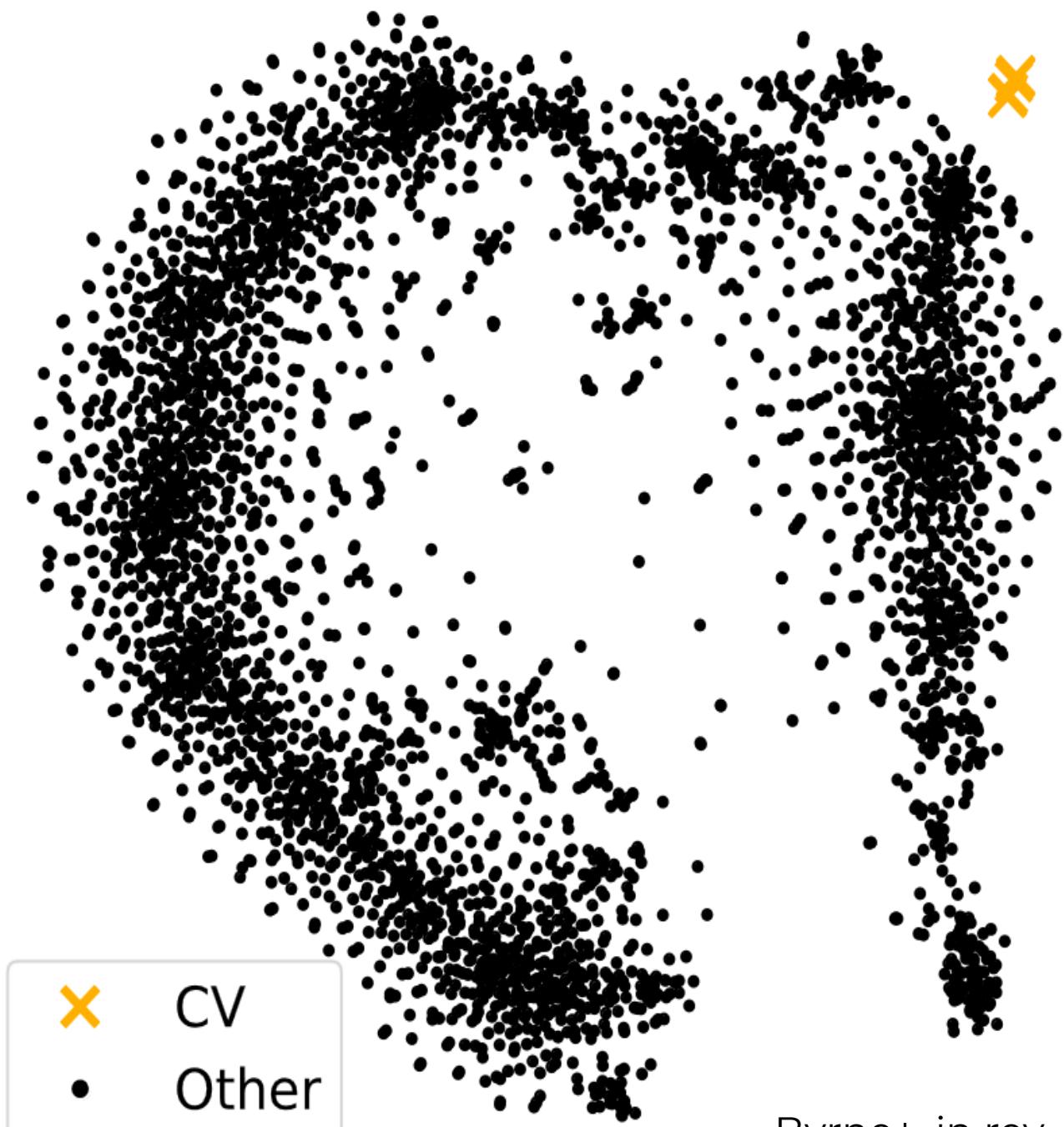


- Vectors now clustered based on a spectral feature
- Removes ‘distraction’ of rest of the spectrum





CV  
• Other



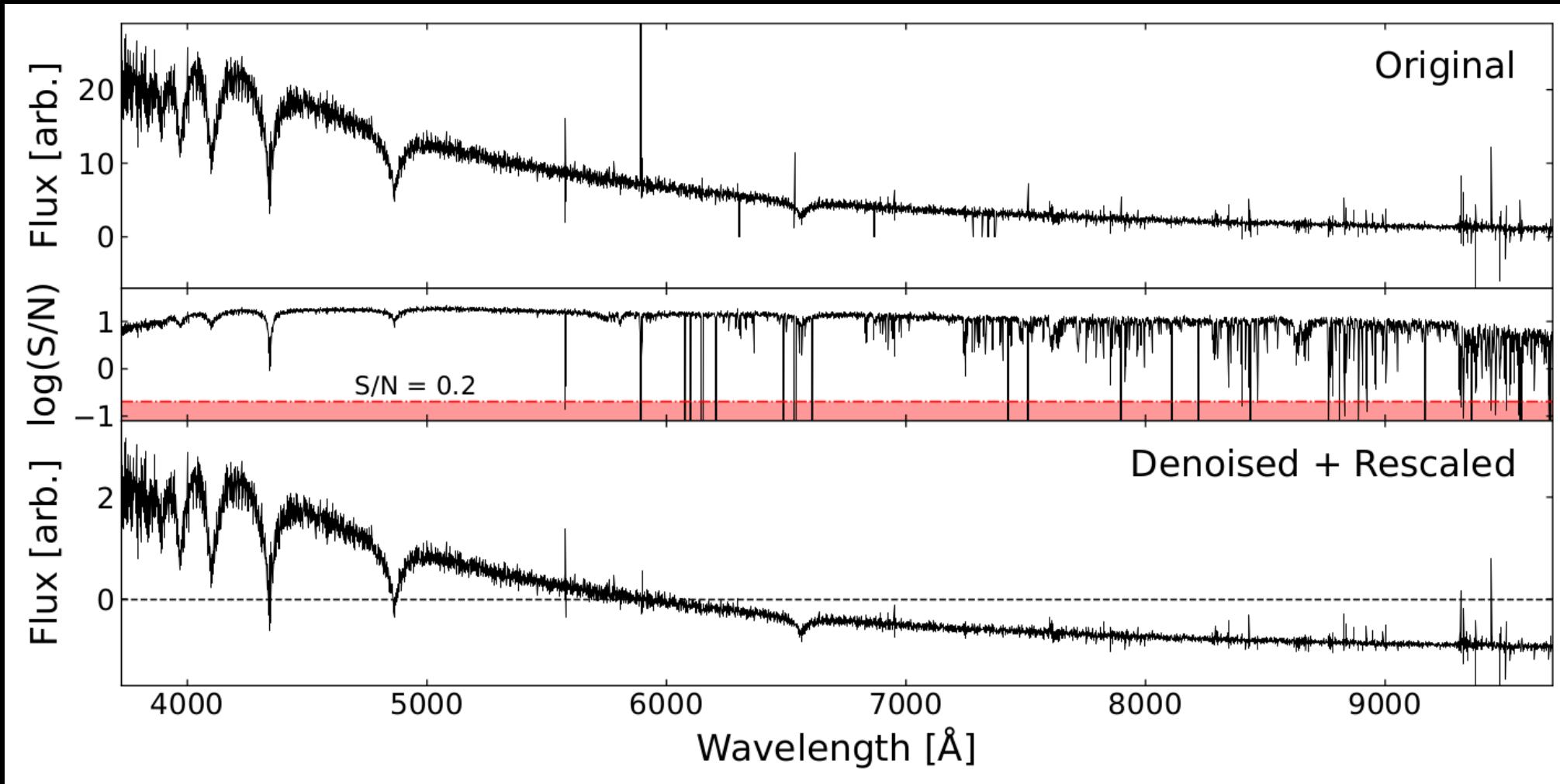
# Conclusions

- Spectroscopic surveys return valuable data for WD science
- Dimensionality reduction is a useful classification tool for spectroscopic surveys
- Focusing on spectral lines can improve classification power

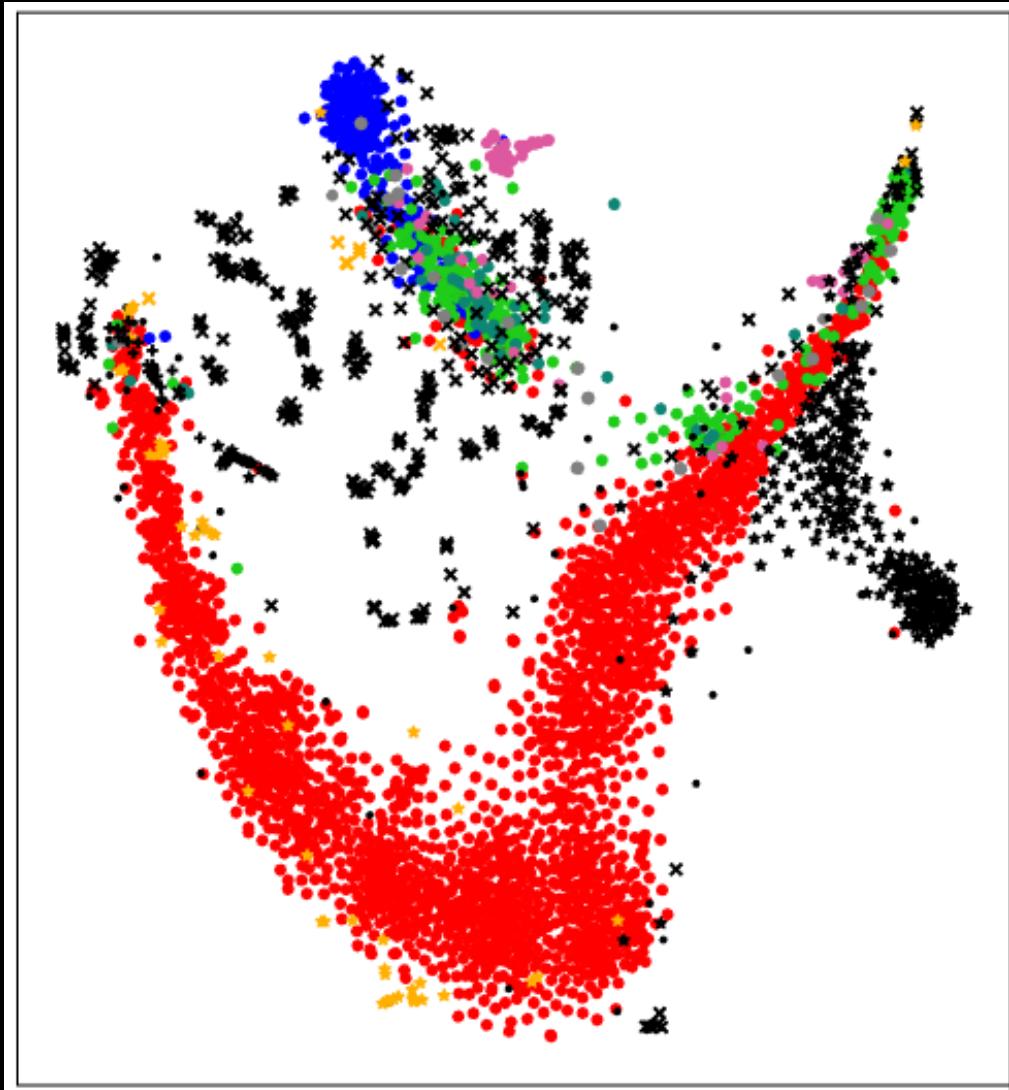


# Extra slides

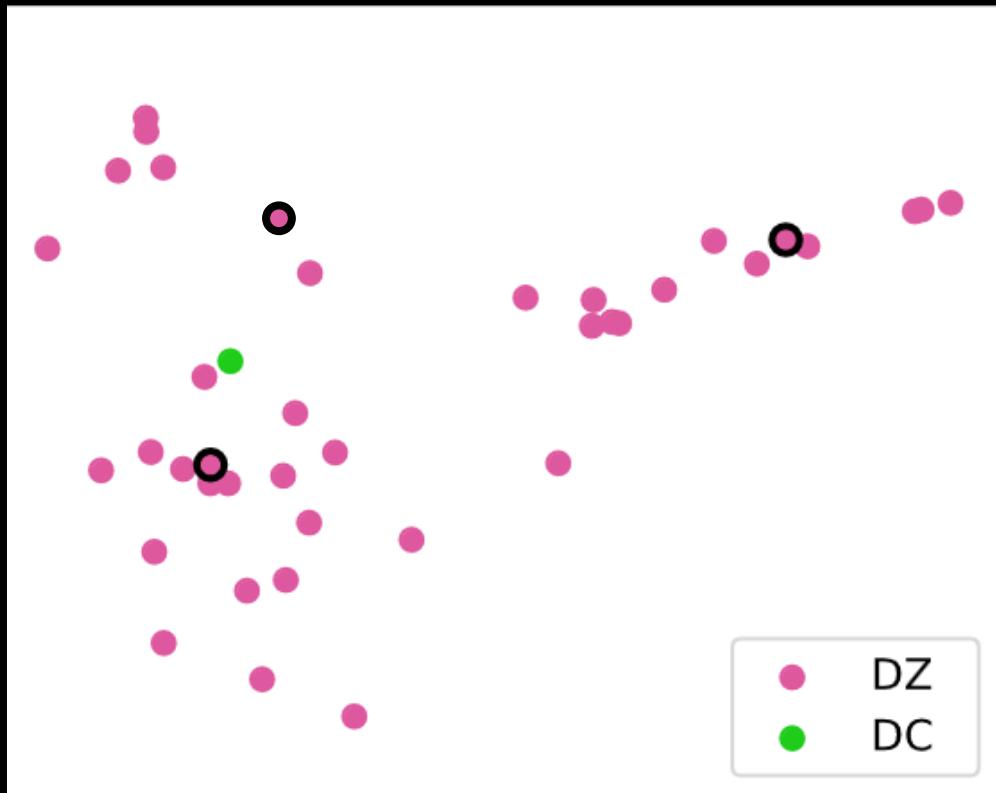
# Preprocessing



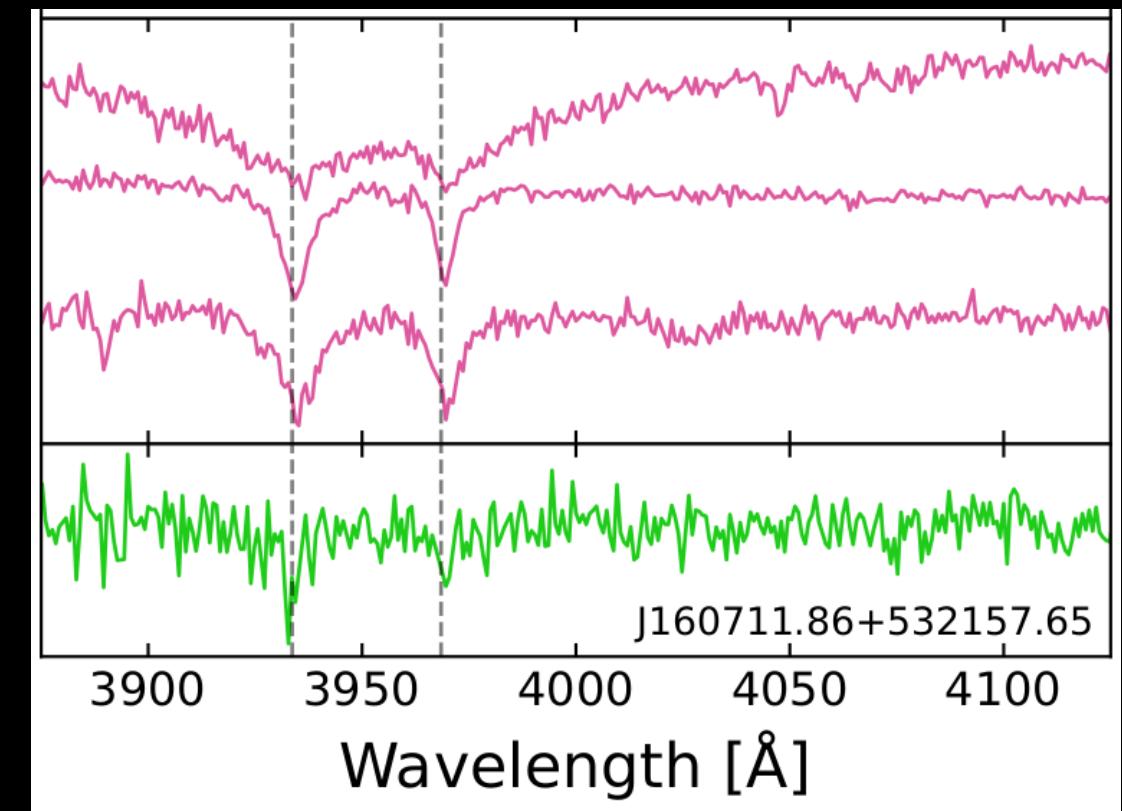
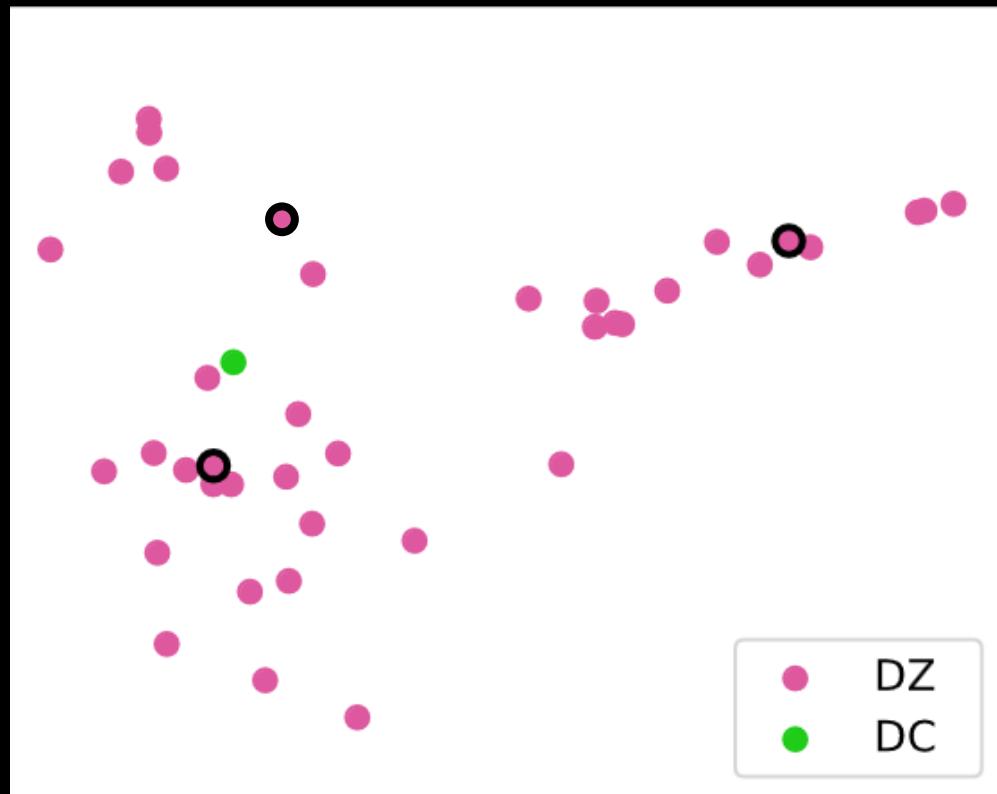
- Can **spot mistakes**



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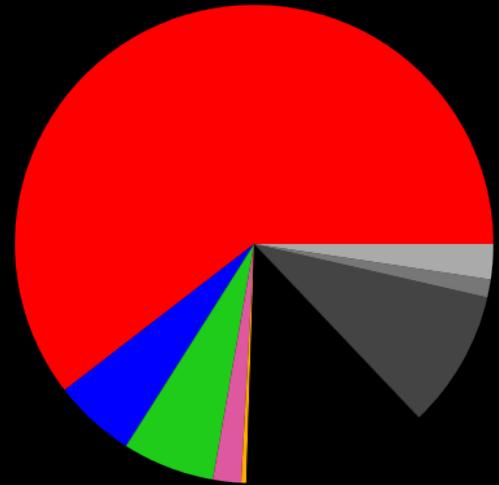
# Automated WD Classification

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- **Supervised** methods rely on a training set
  - Have shown promise in WD classification (Vincent+23, 24)

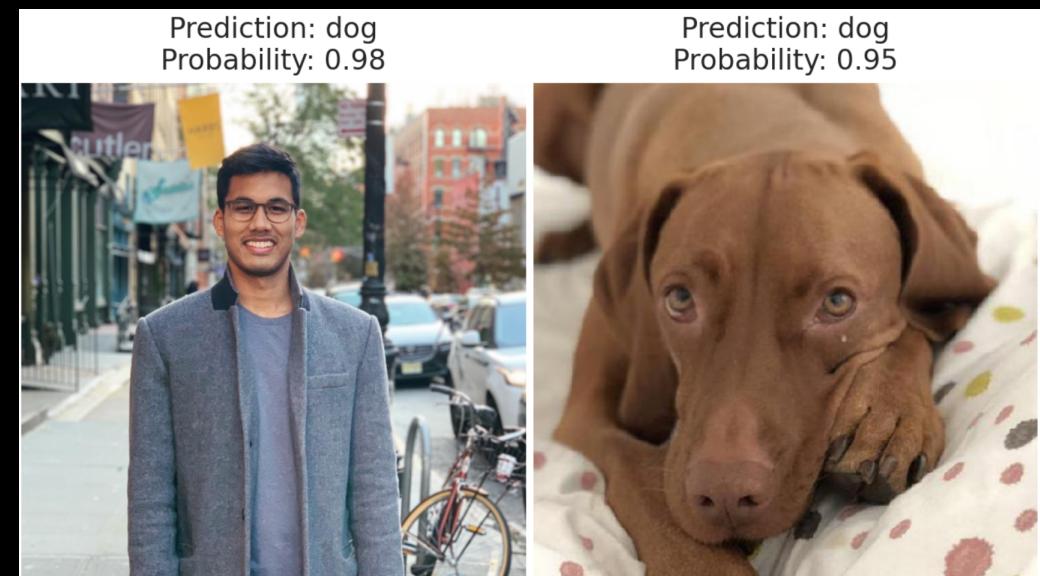
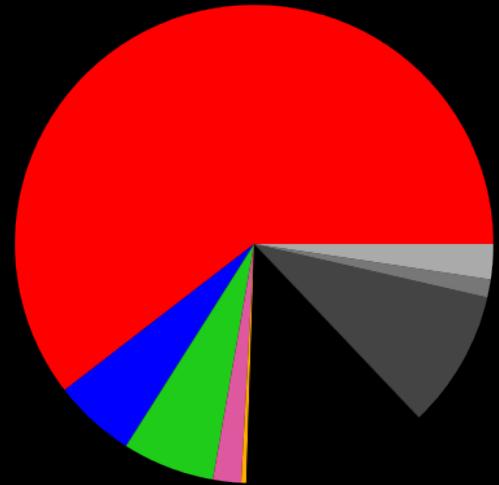
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- But can suffer from **class imbalance**
  - ...which always exists for WDs



# Automated WD Classification

- **Supervised** methods rely on a training set
  - Have shown promise in WD classification (Vincent+23, 24)
- But can suffer from **class imbalance**
  - ...which always exists for WDs
- Also, sometimes **weirdly confident**



Jonathan Ramkissoon

# Unsupervised Methods

- **Don't rely on a training set!**



van der Maaten + Hinton 08

# Unsupervised Methods

- **Don't rely on a training set!**
- Looks for **inherent structure** in a dataset (trends, clusters, ...)



van der Maaten + Hinton 08

# Unsupervised Methods

- **Don't rely on a training set!**
- Looks for **inherent structure** in a dataset (trends, clusters, ...)
- Usually involves **comparing data points to each other**

