

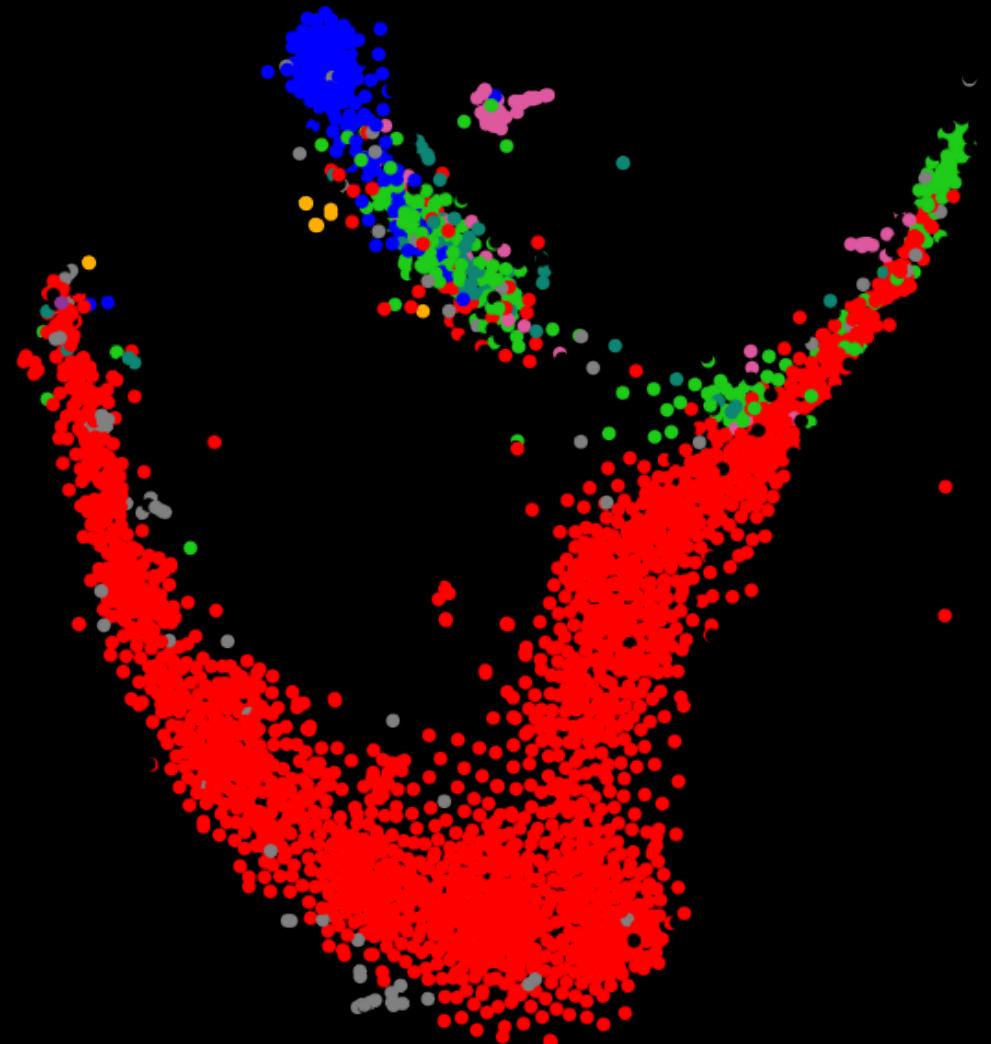


Spectral Classification of White Dwarfs by Dimensionality Reduction

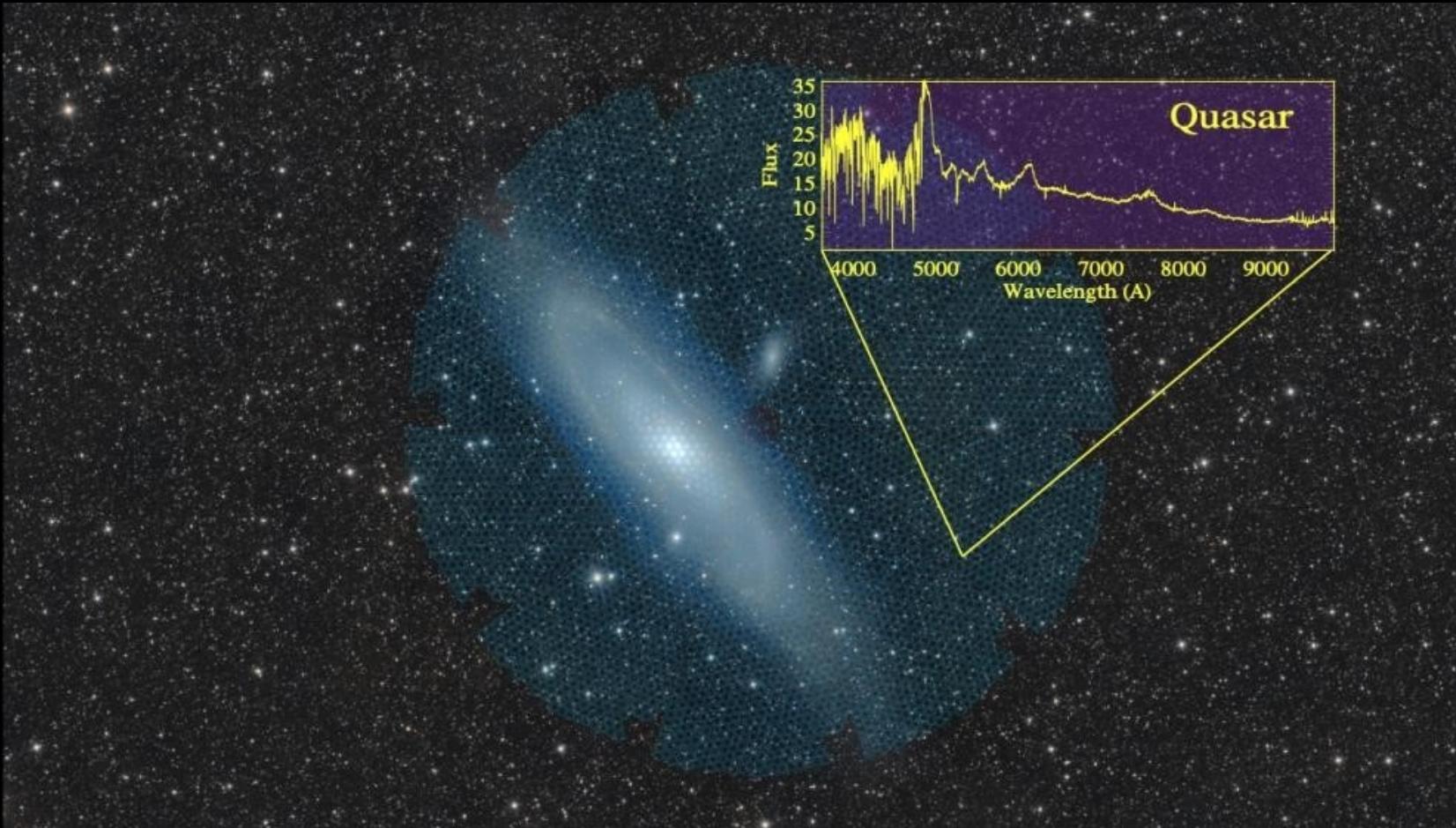
Xander Byrne
Amy Bonsor – Laura Rogers – Christopher Manser

Outline

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

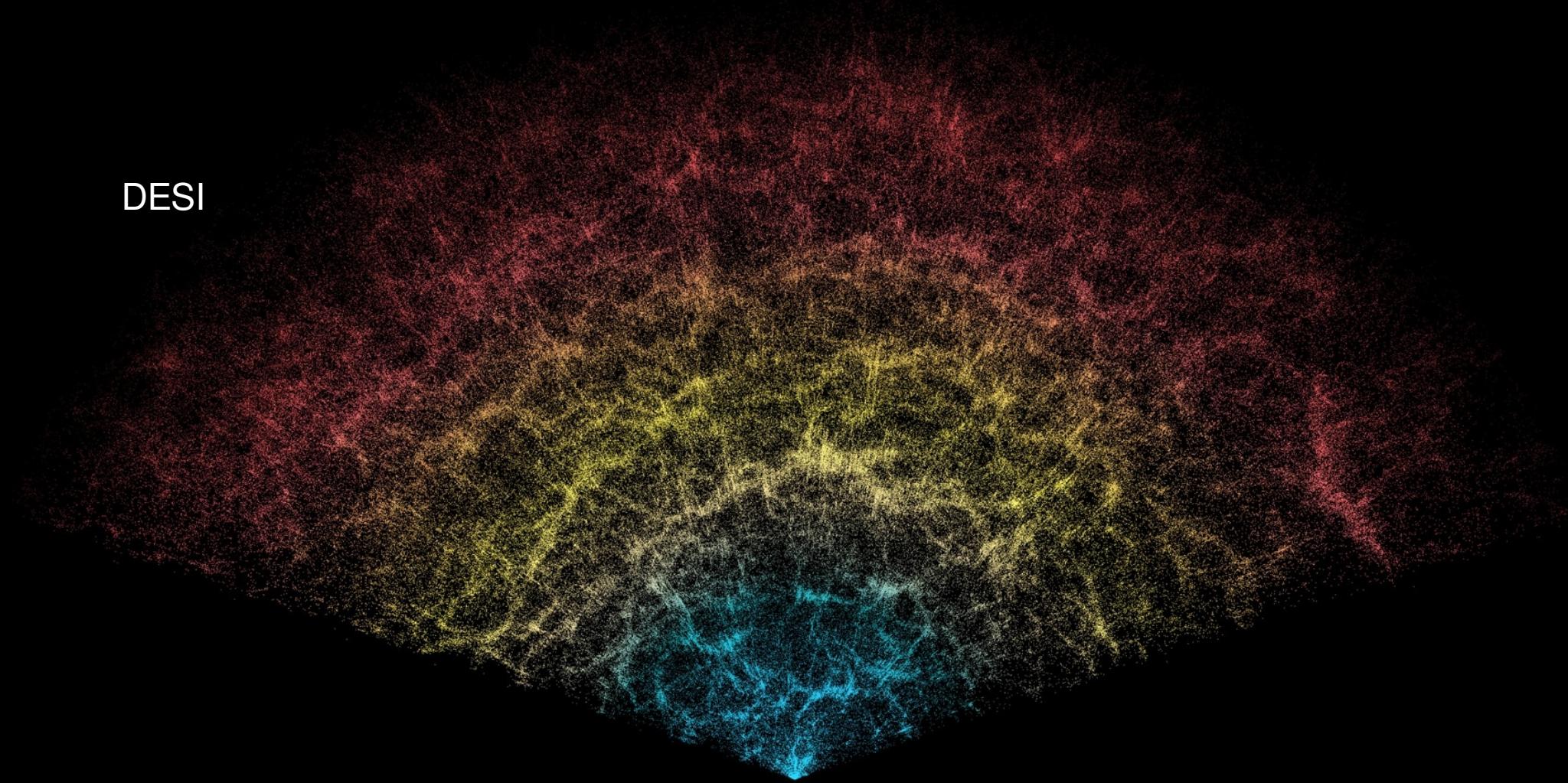


Spectroscopic Surveys



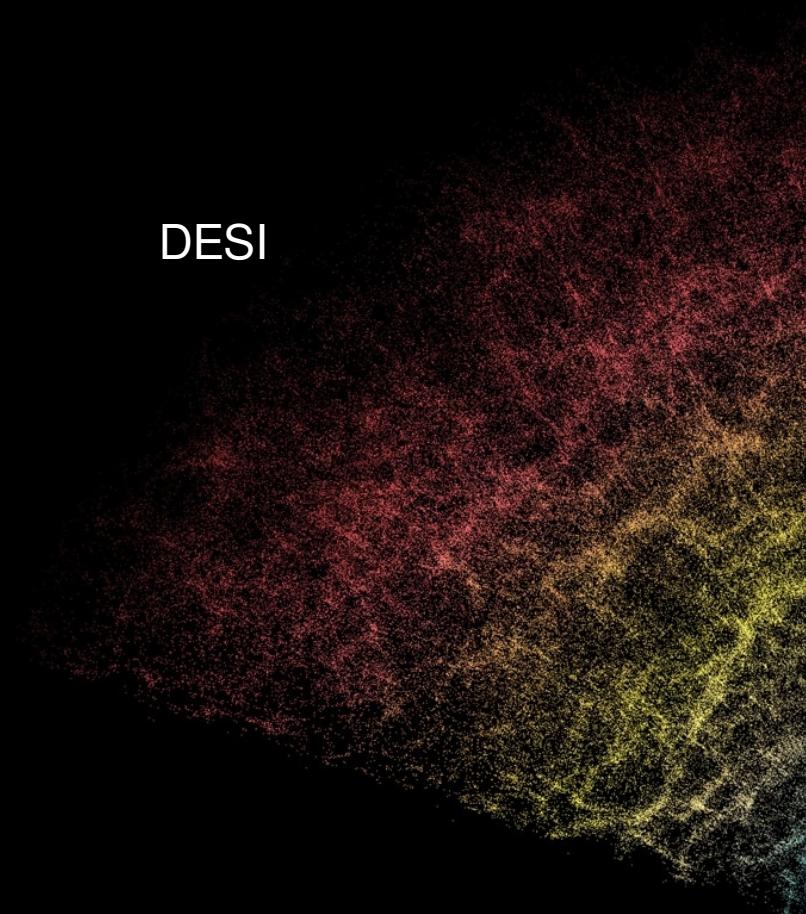
Spectroscopic Surveys

DESI

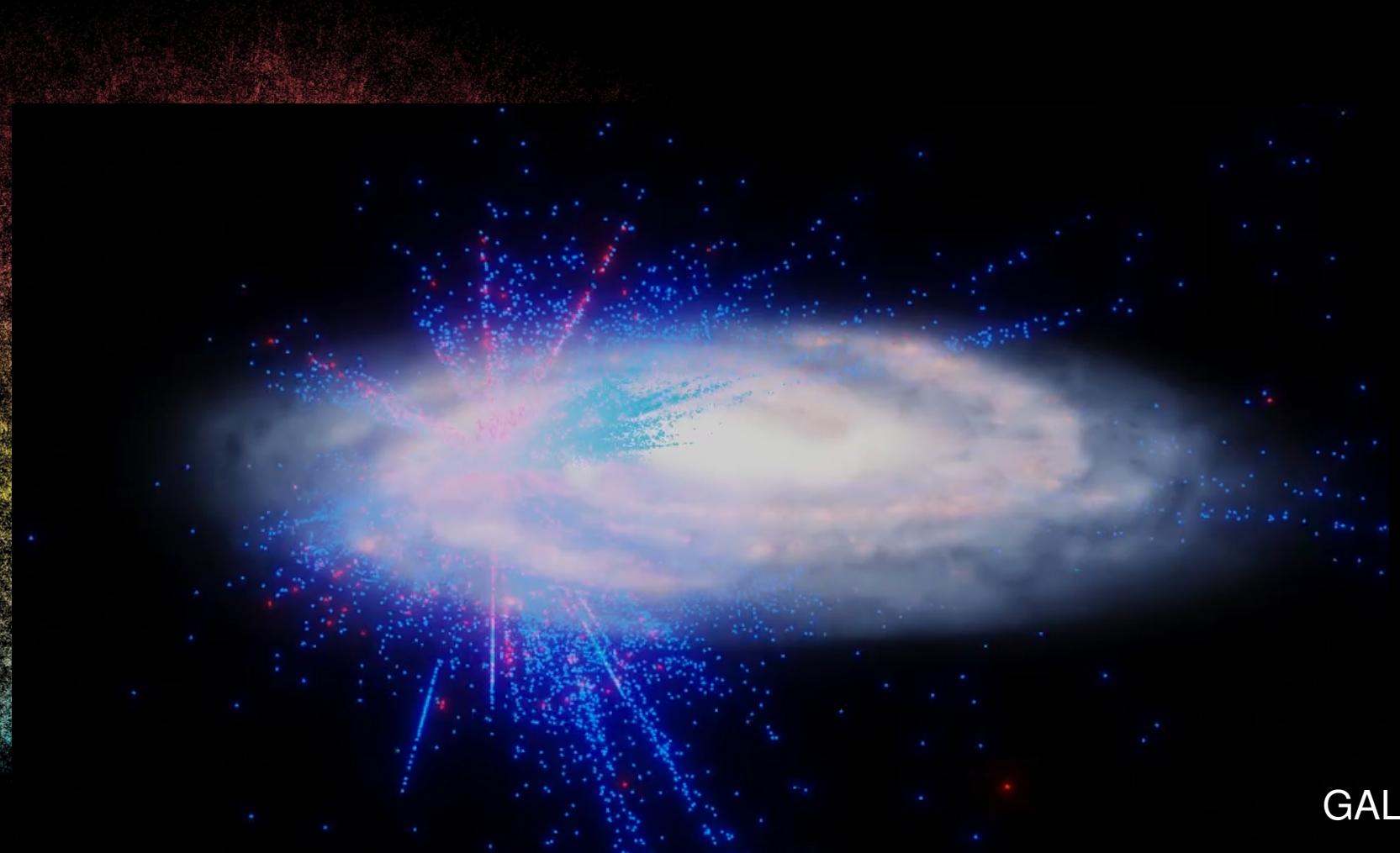


Spectroscopic Surveys

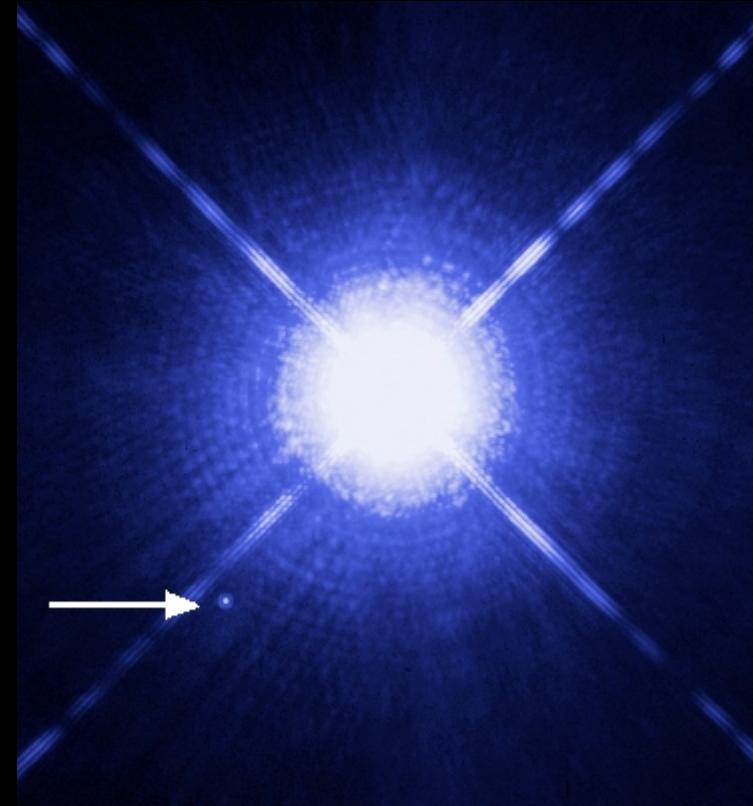
DESI



GALAH

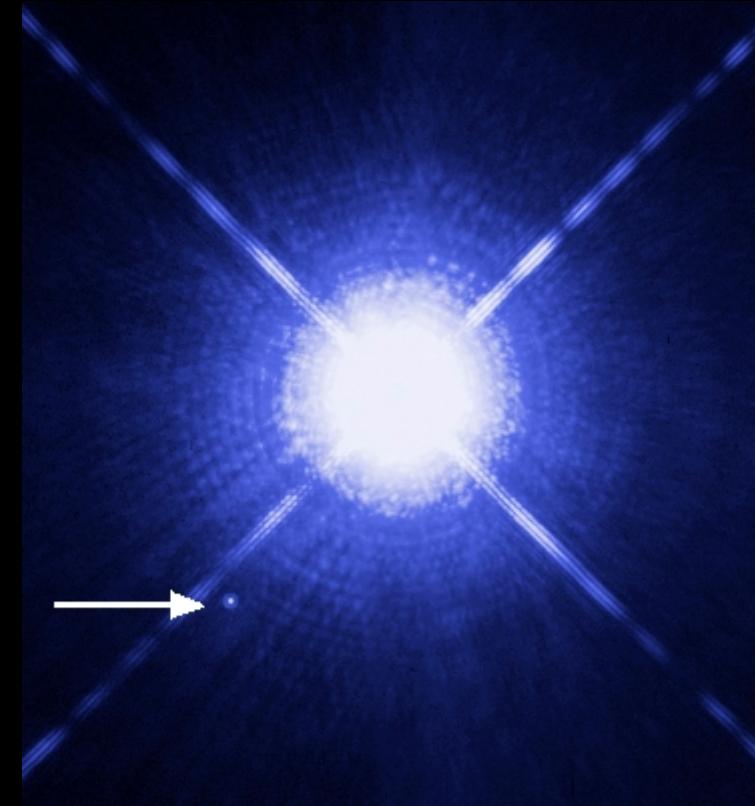


White Dwarfs 101



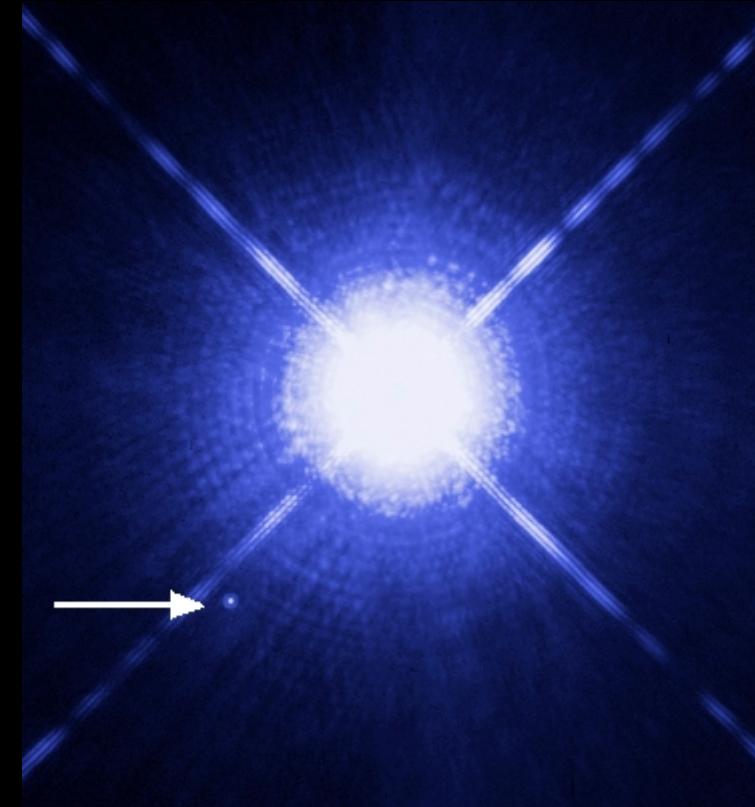
White Dwarfs 101

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



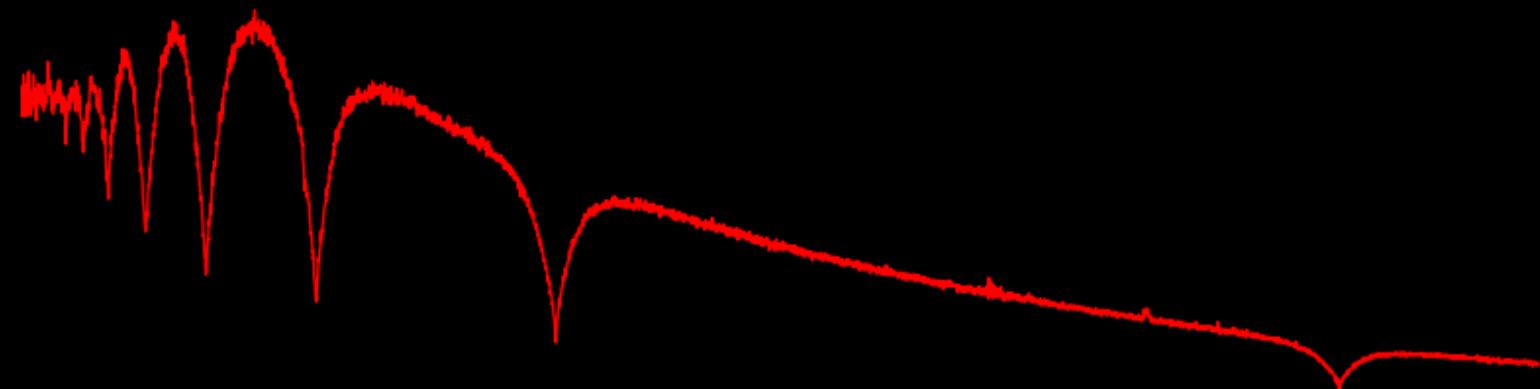
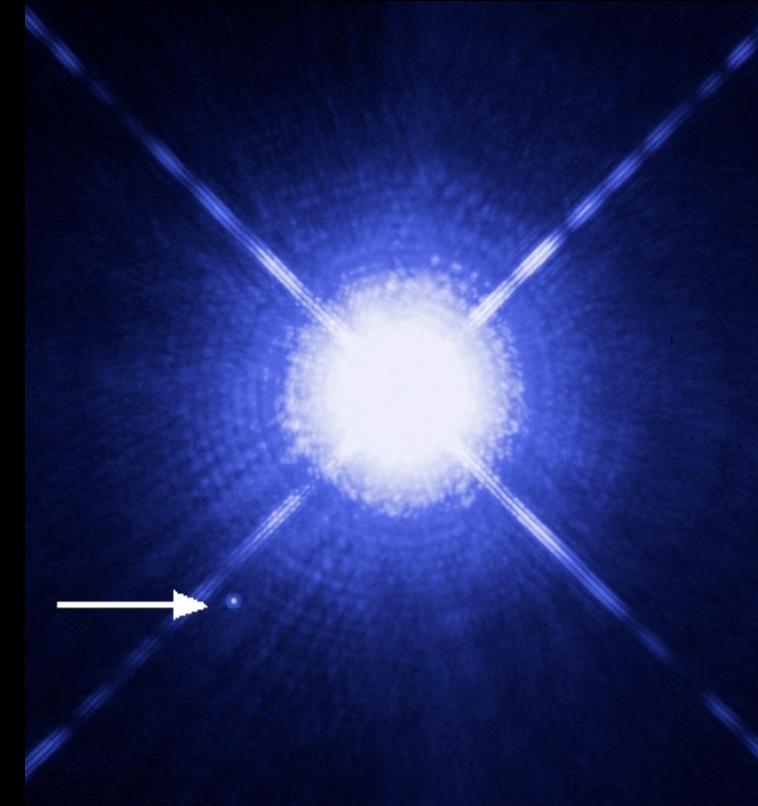
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- Spectral types:



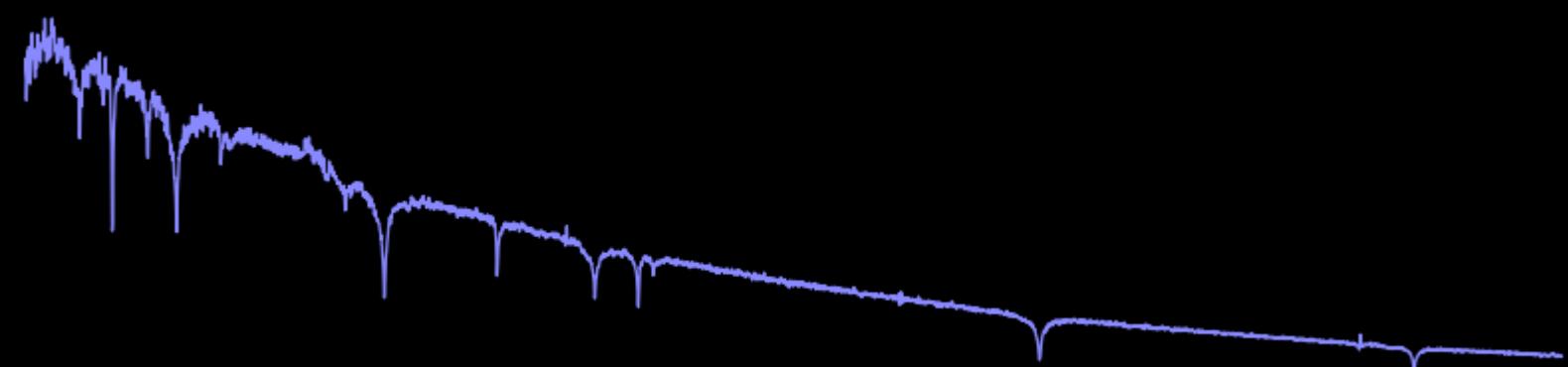
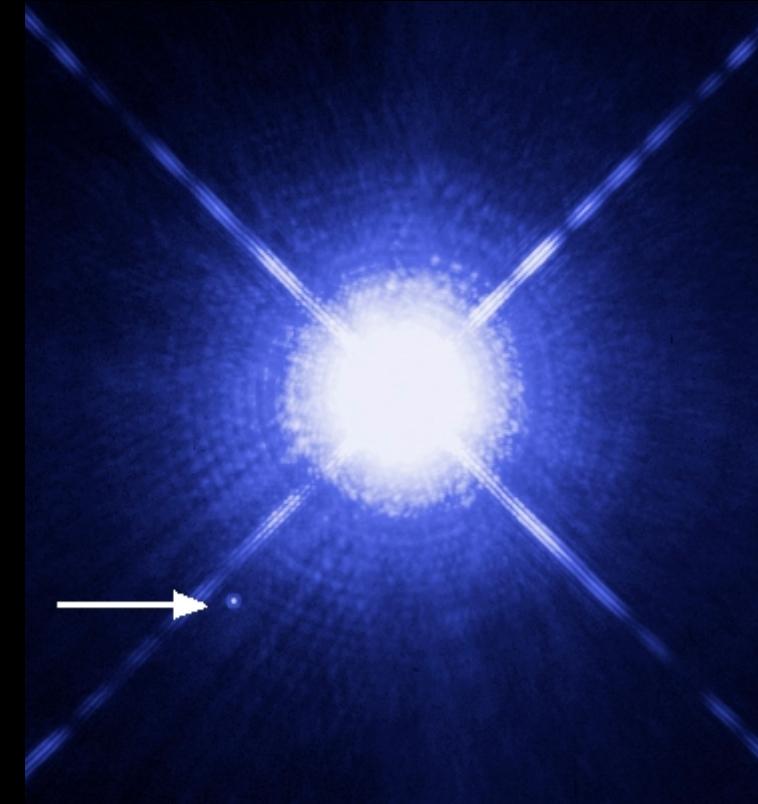
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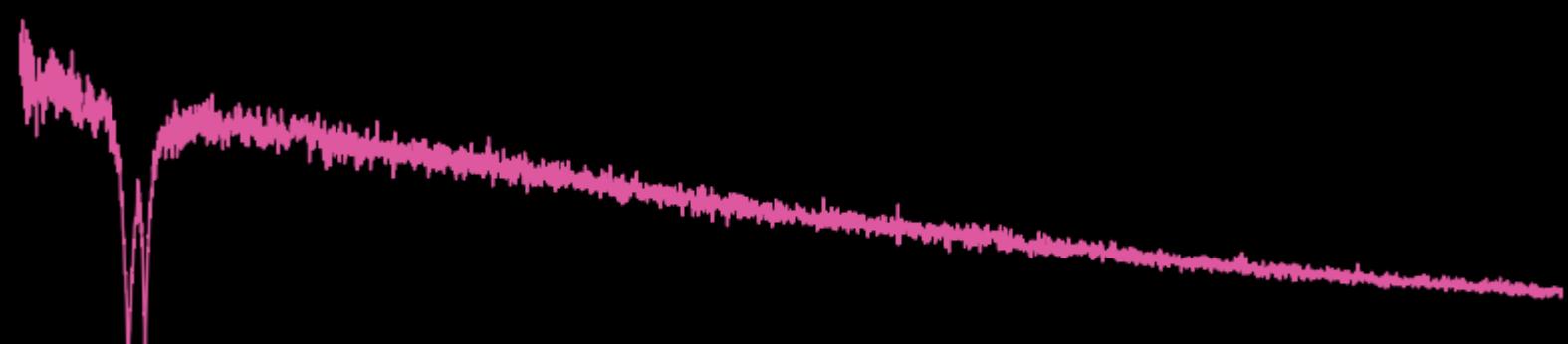
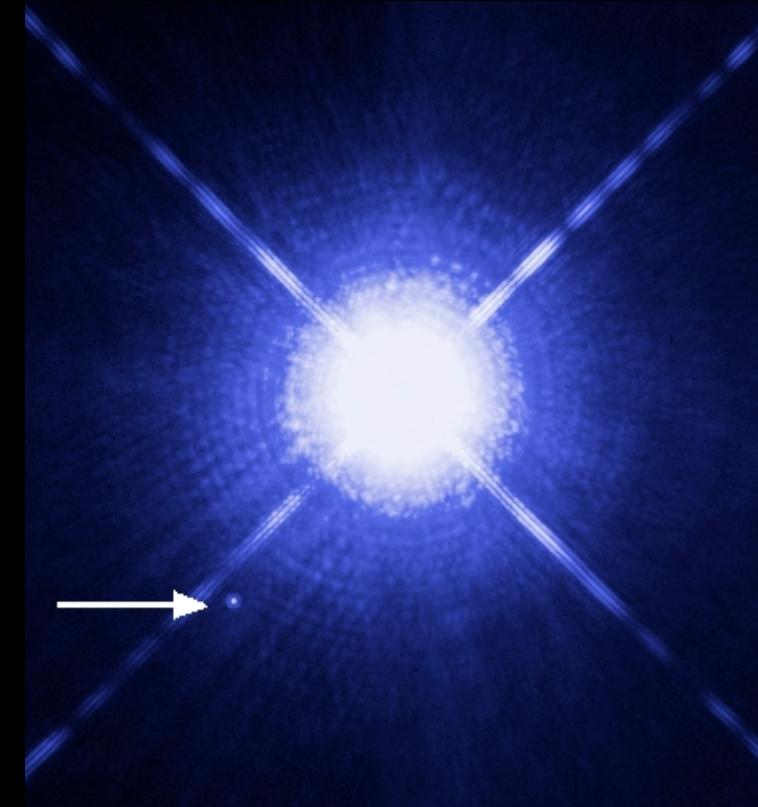
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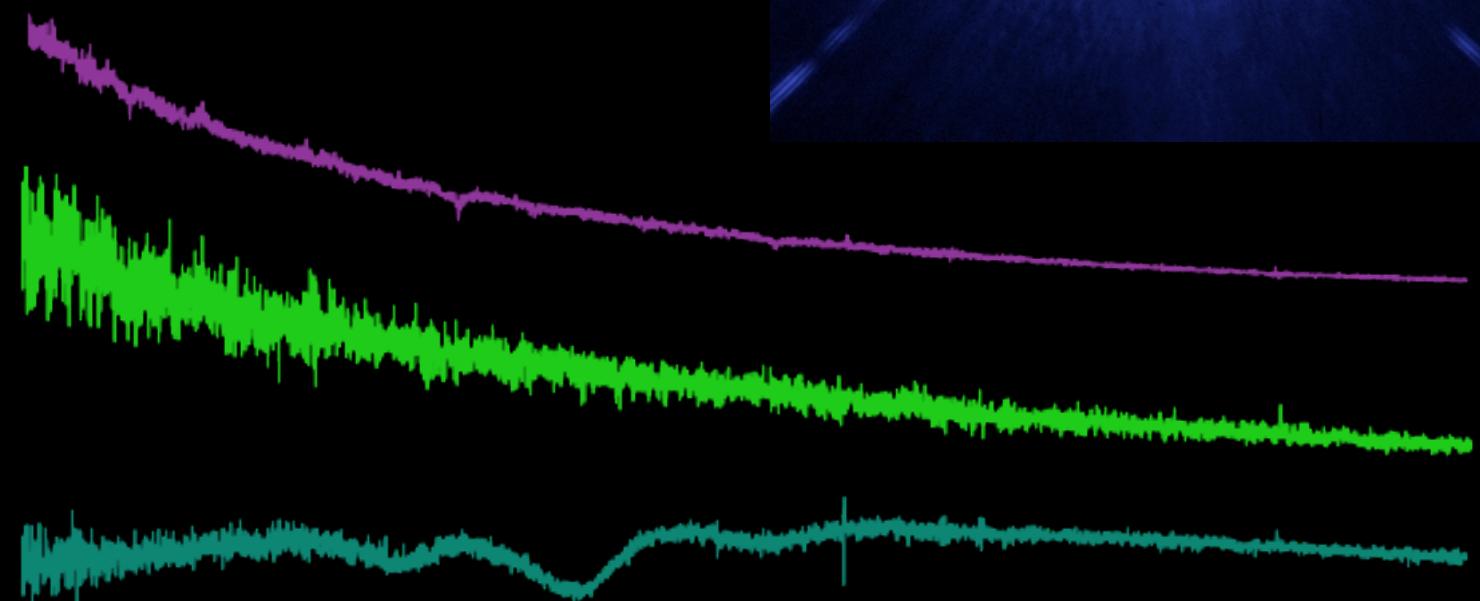
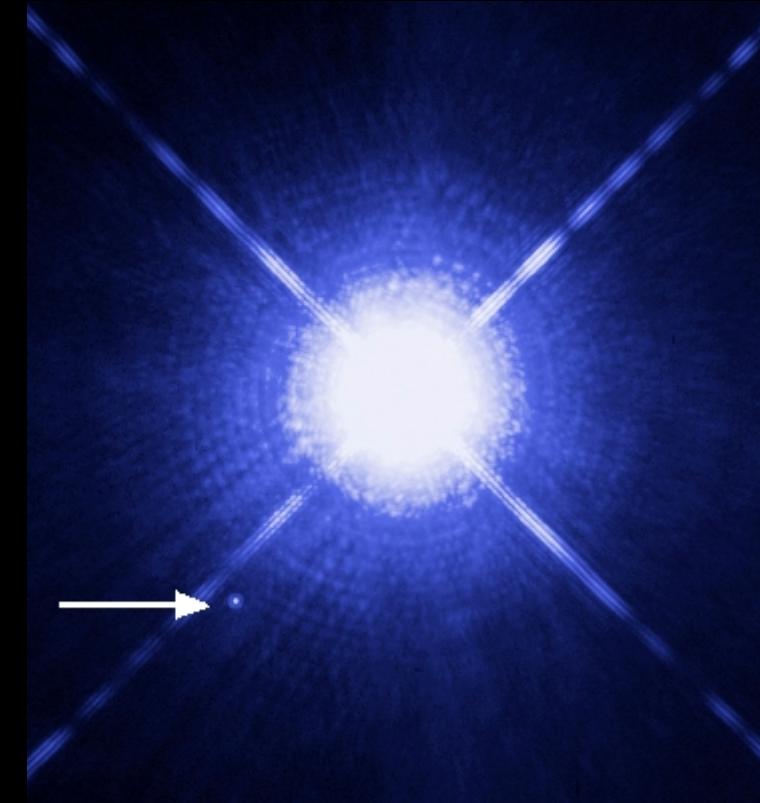
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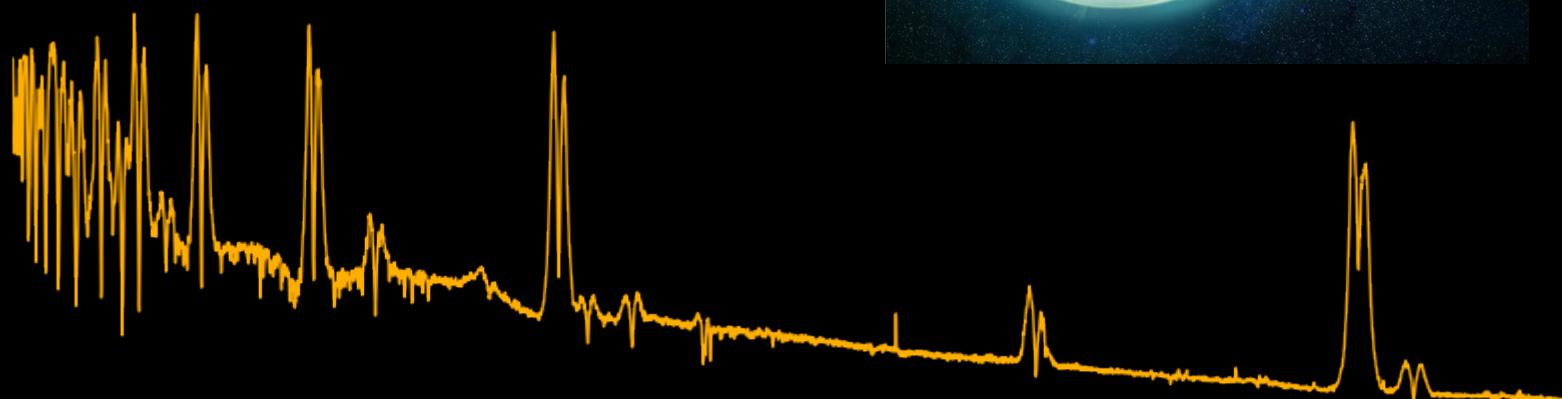
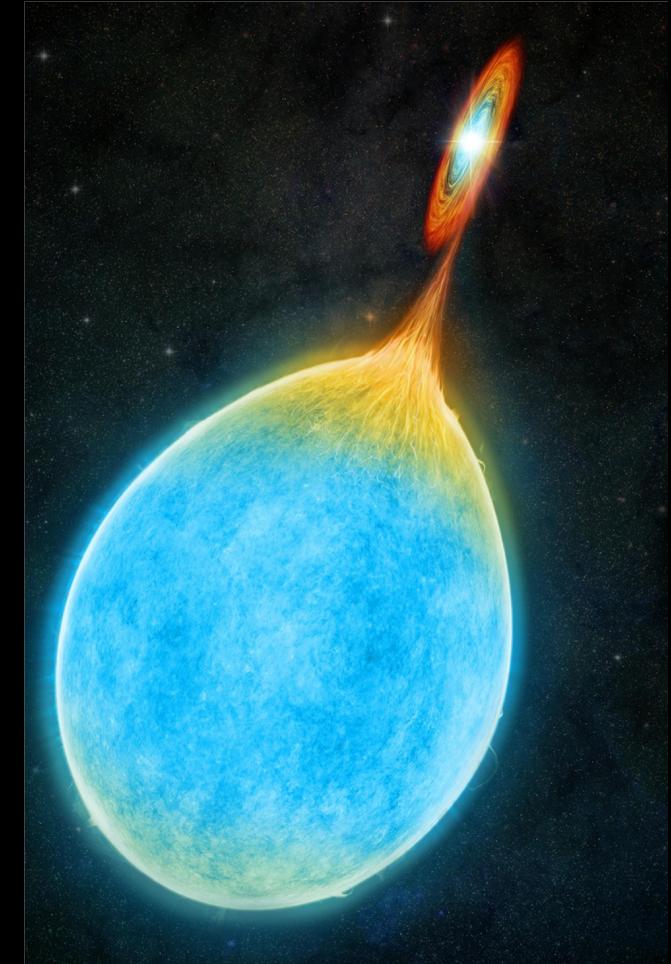
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White Dwarfs 101

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- Spectral types:
 - **DA** (hydrogen)
 - **DB** (helium)
 - **DZ** (Ca, Mg, ...)
 - ...
 - **CV** (double-peaked)



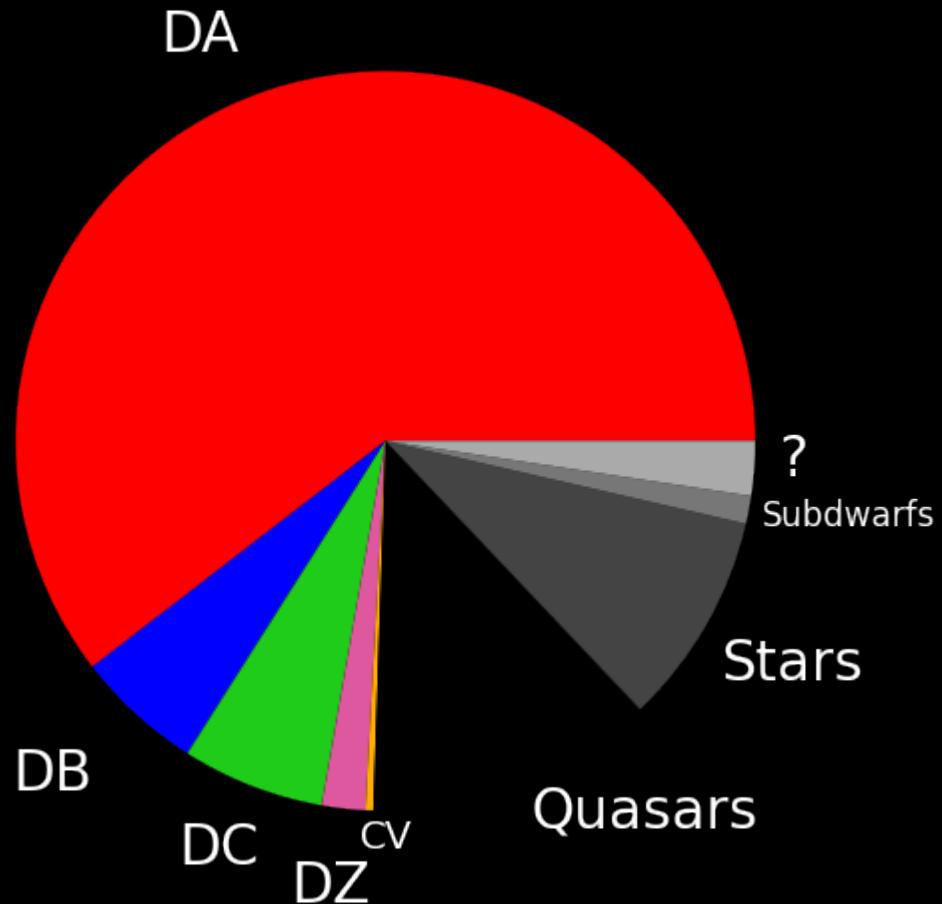
~{ Interlude: Astrocolonialism }~

- 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'

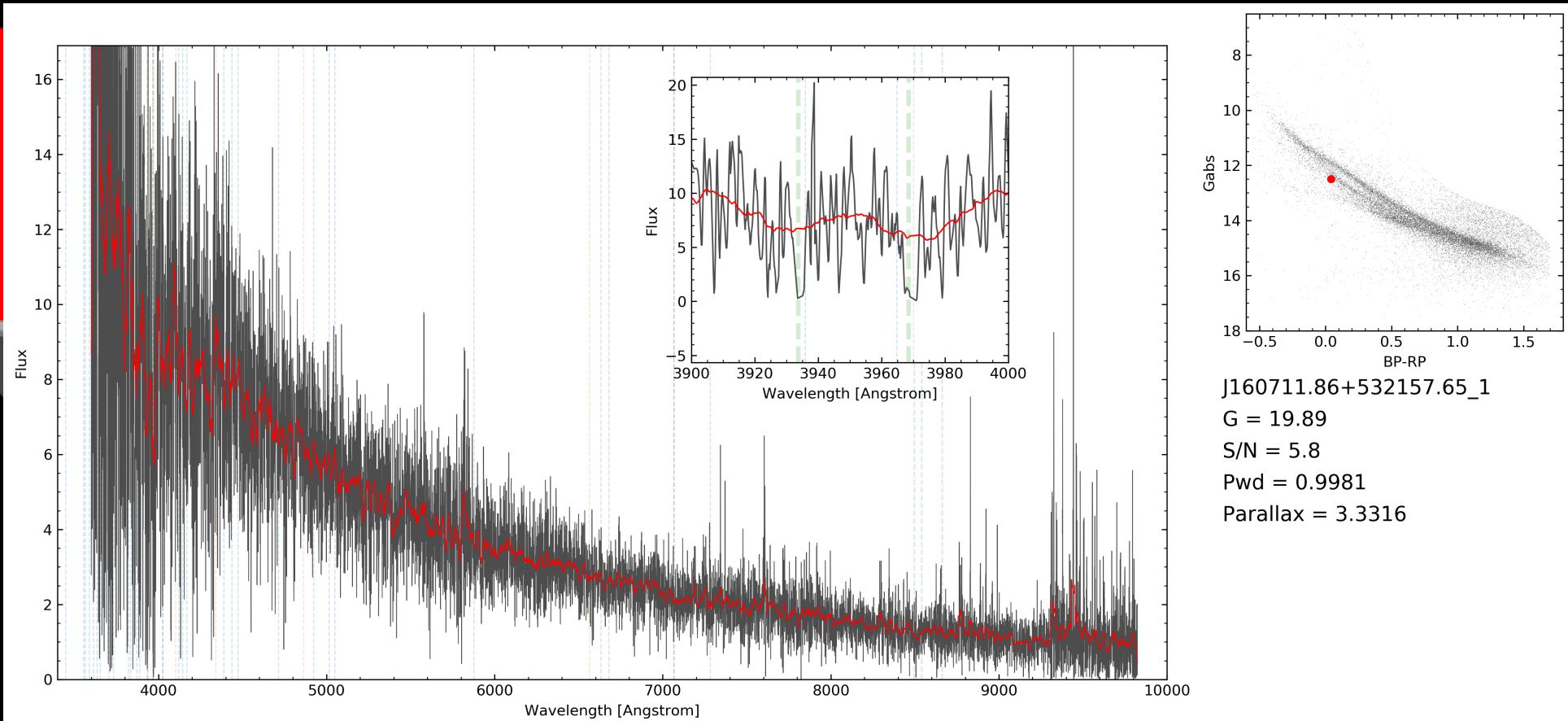
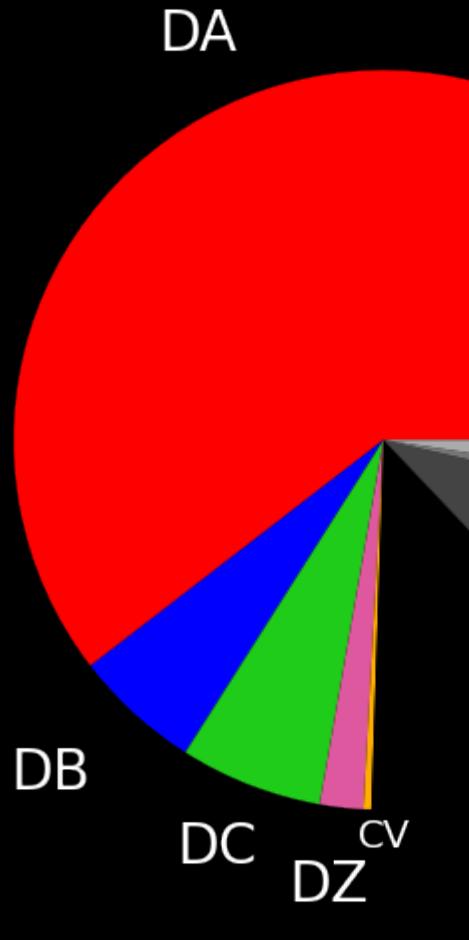


DESI EDR – 4000 WD candidates

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Dimensionality Reduction (DR)

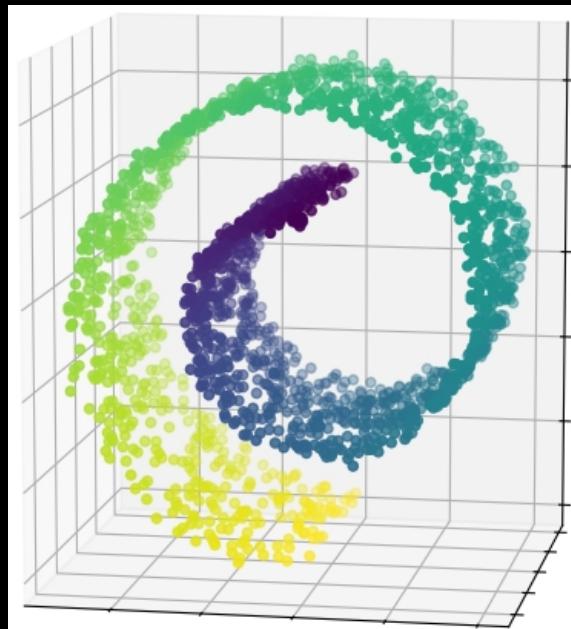
- An unsupervised method of **simplifying a high-D dataset**

Dimensionality Reduction (DR)

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- Deprojects dataset into **2D map**, preserving distances

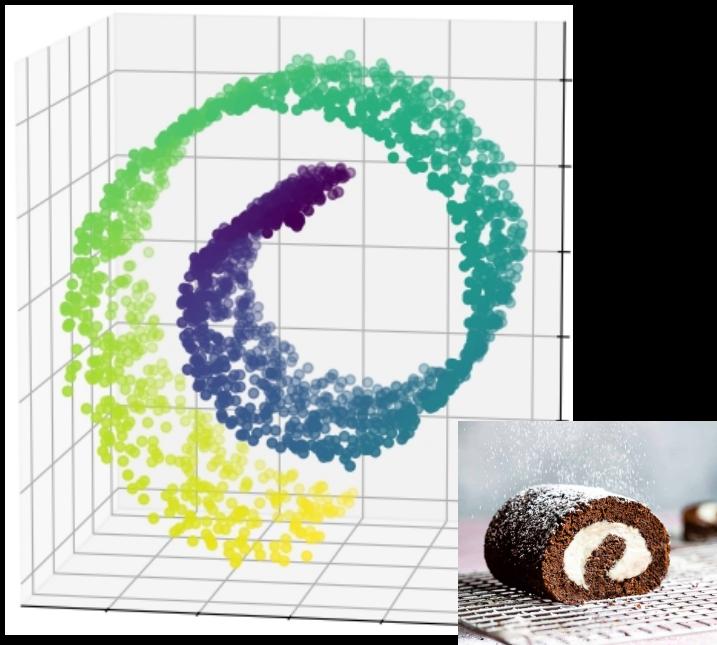
Dimensionality Reduction (DR)

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



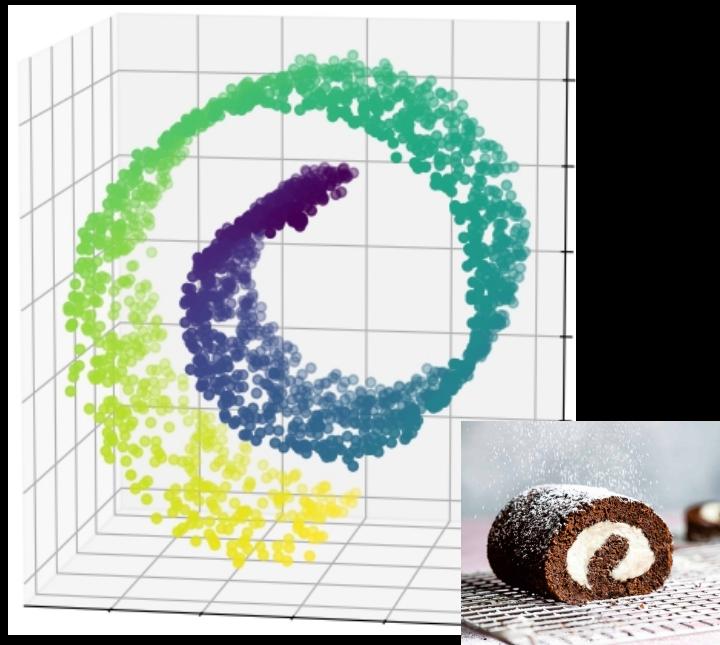
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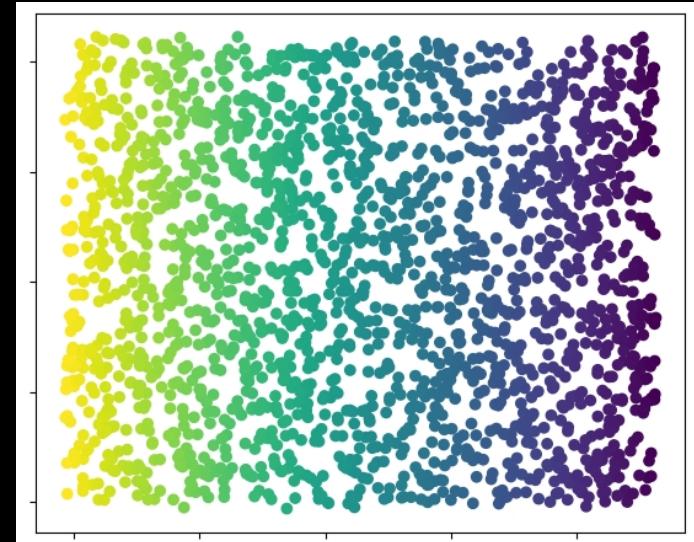


Dimensionality Reduction (DR)

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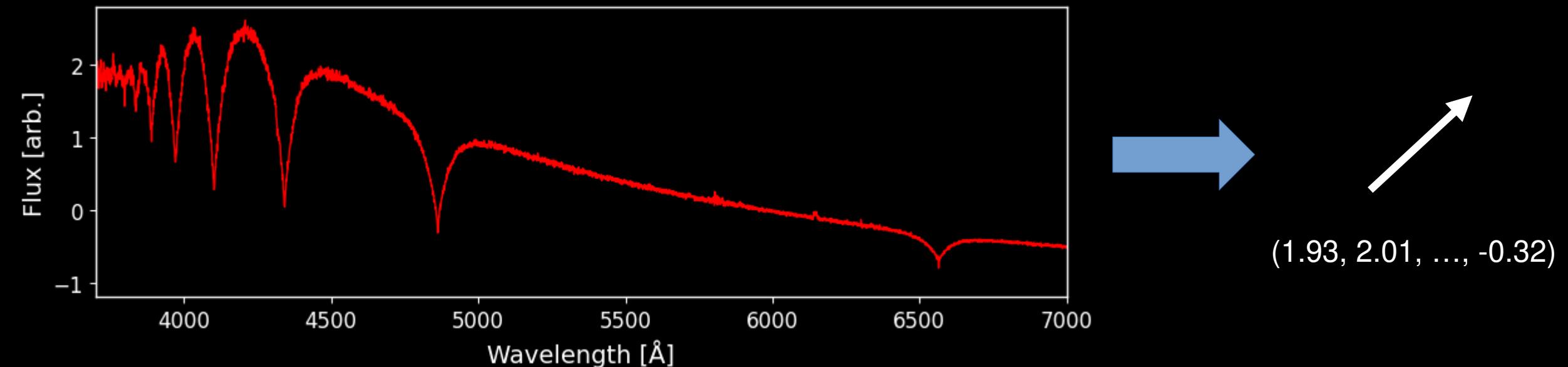


DR



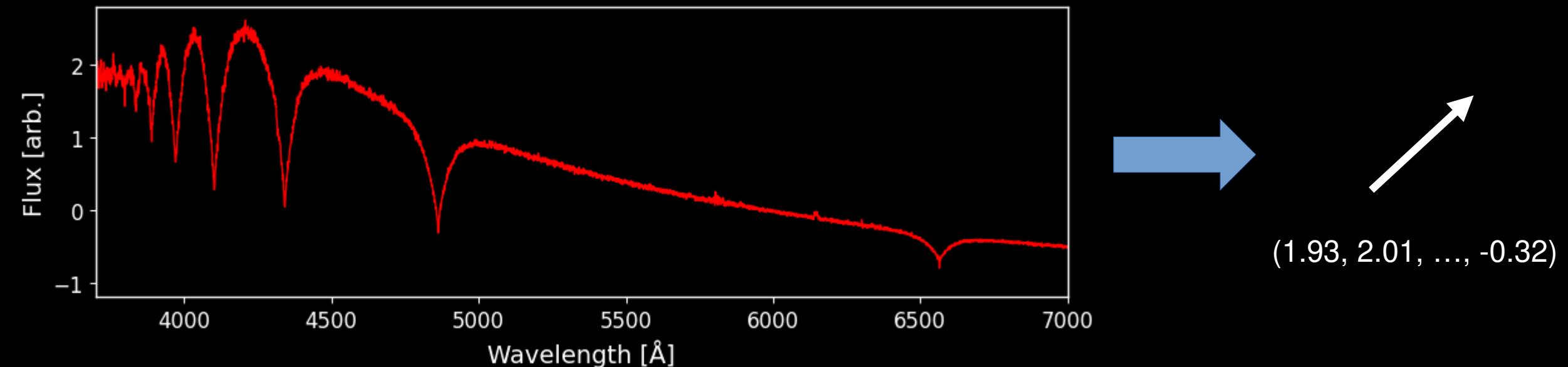
DR on a spectroscopic survey

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



DR on a spectroscopic survey

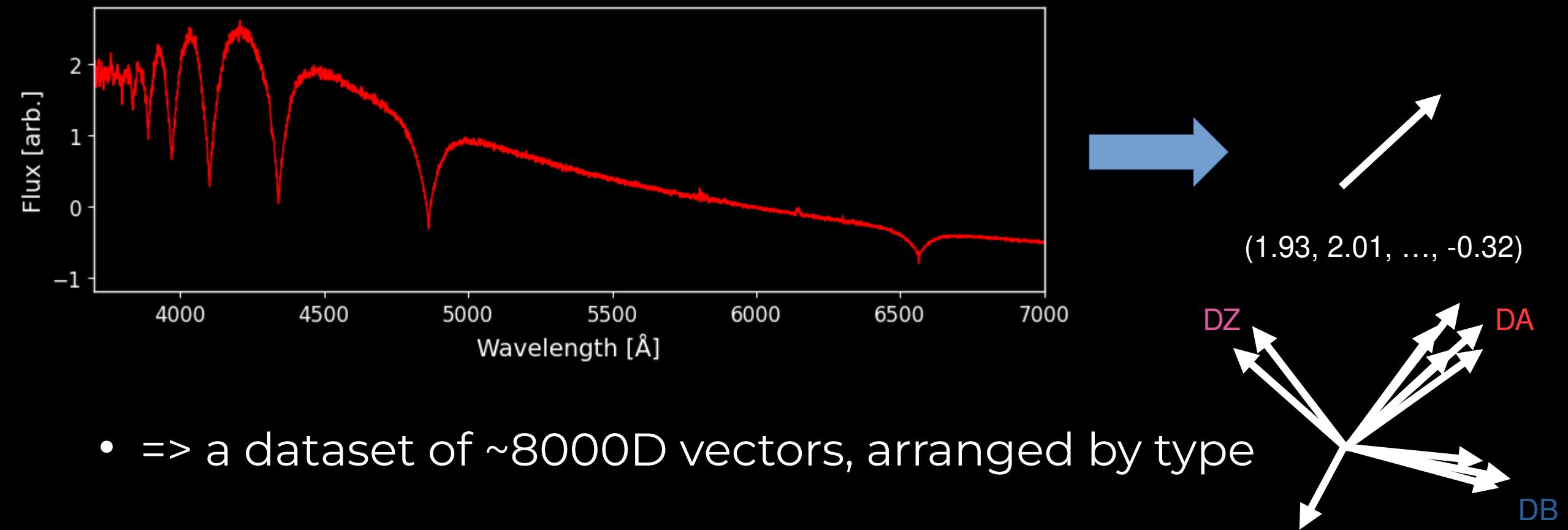
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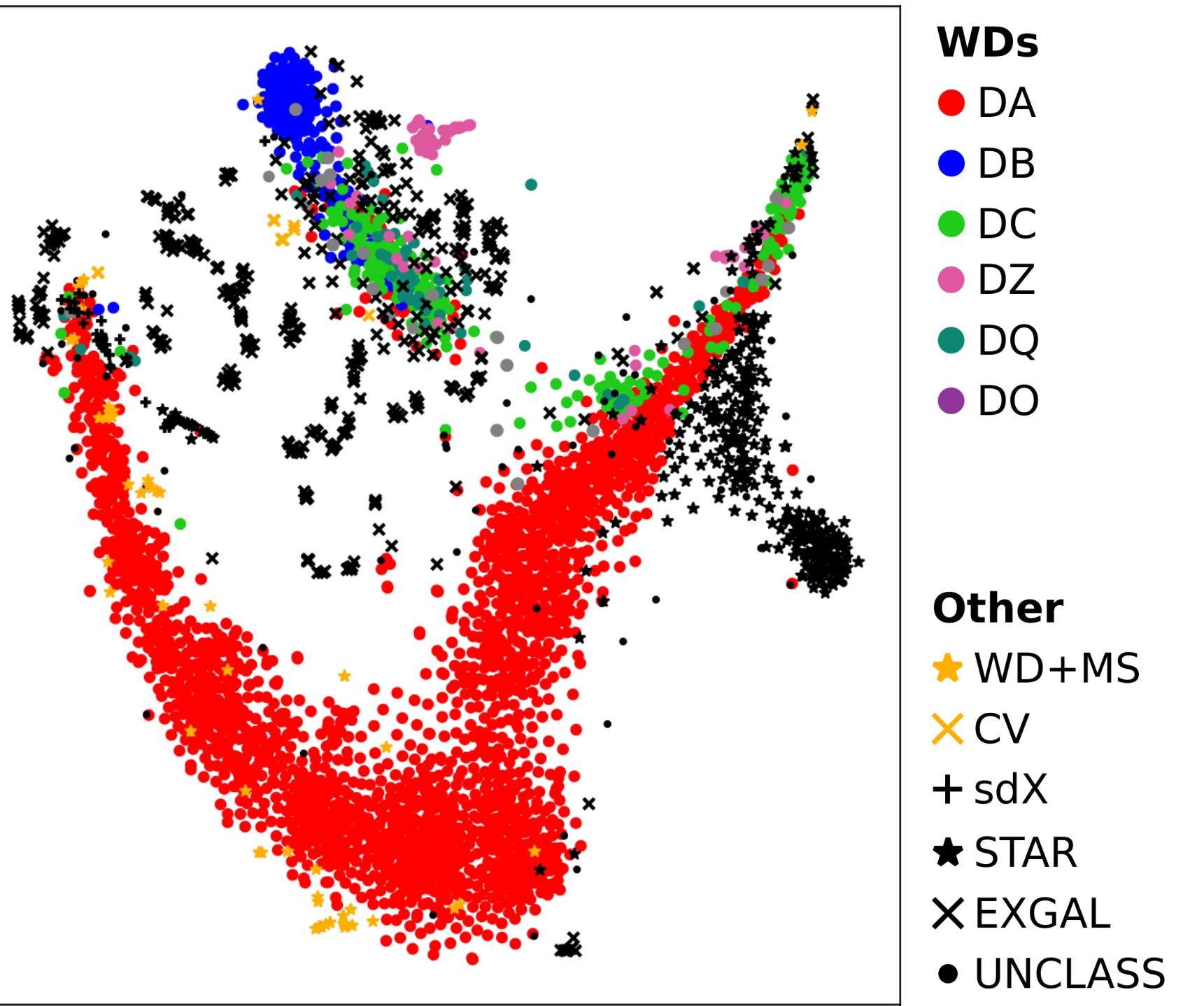


- => a dataset of ~8000D vectors

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 $O(N \log N)$

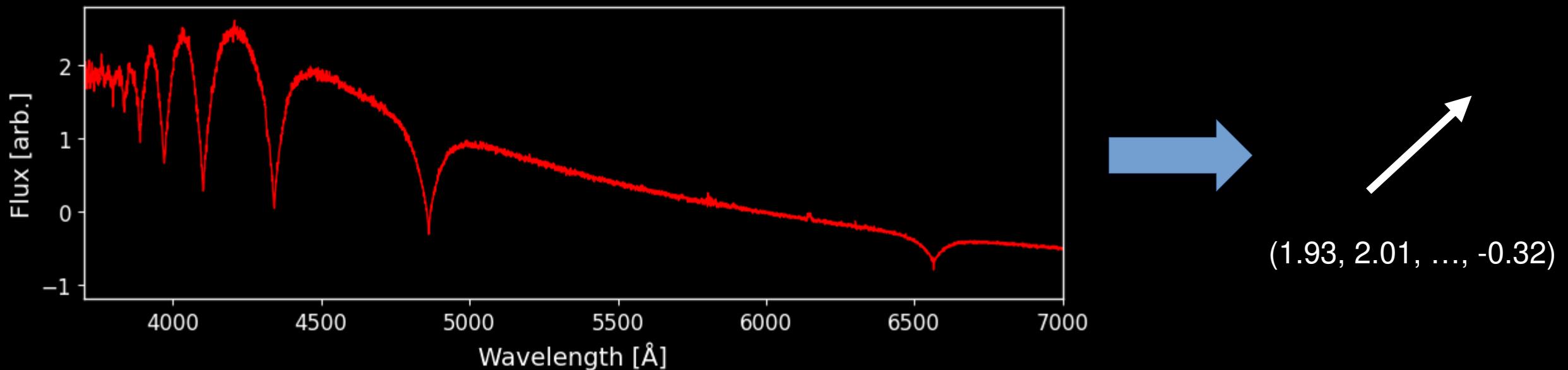
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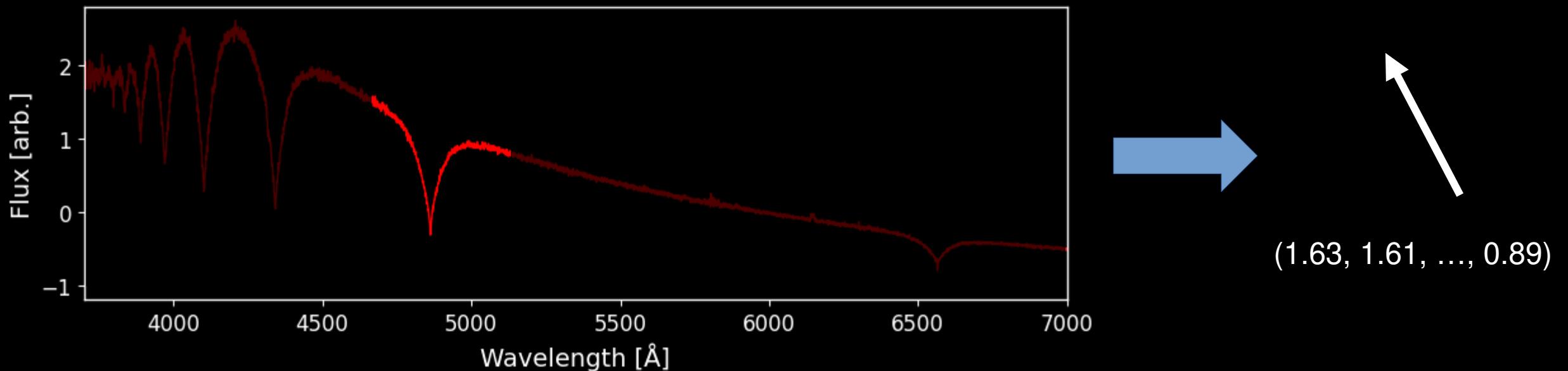
Advantages over visual classif'n

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

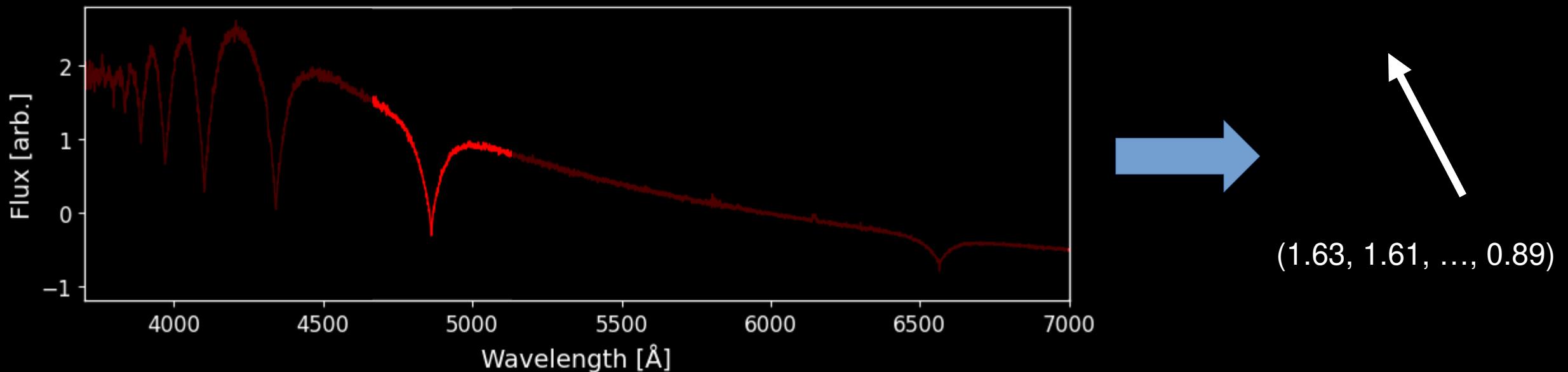
Focusing on spectral lines



Focusing on spectral lines

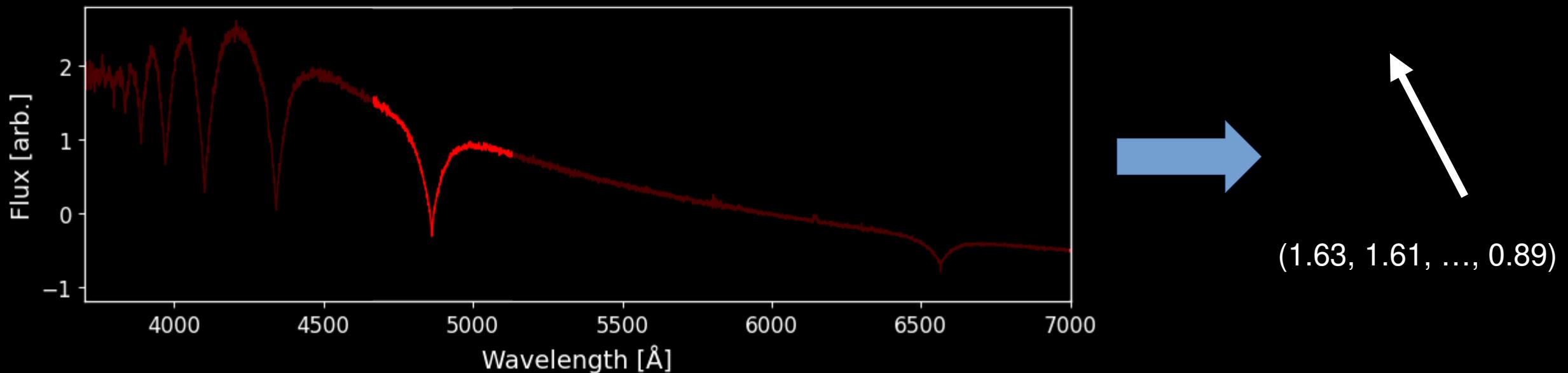


Focusing on spectral lines

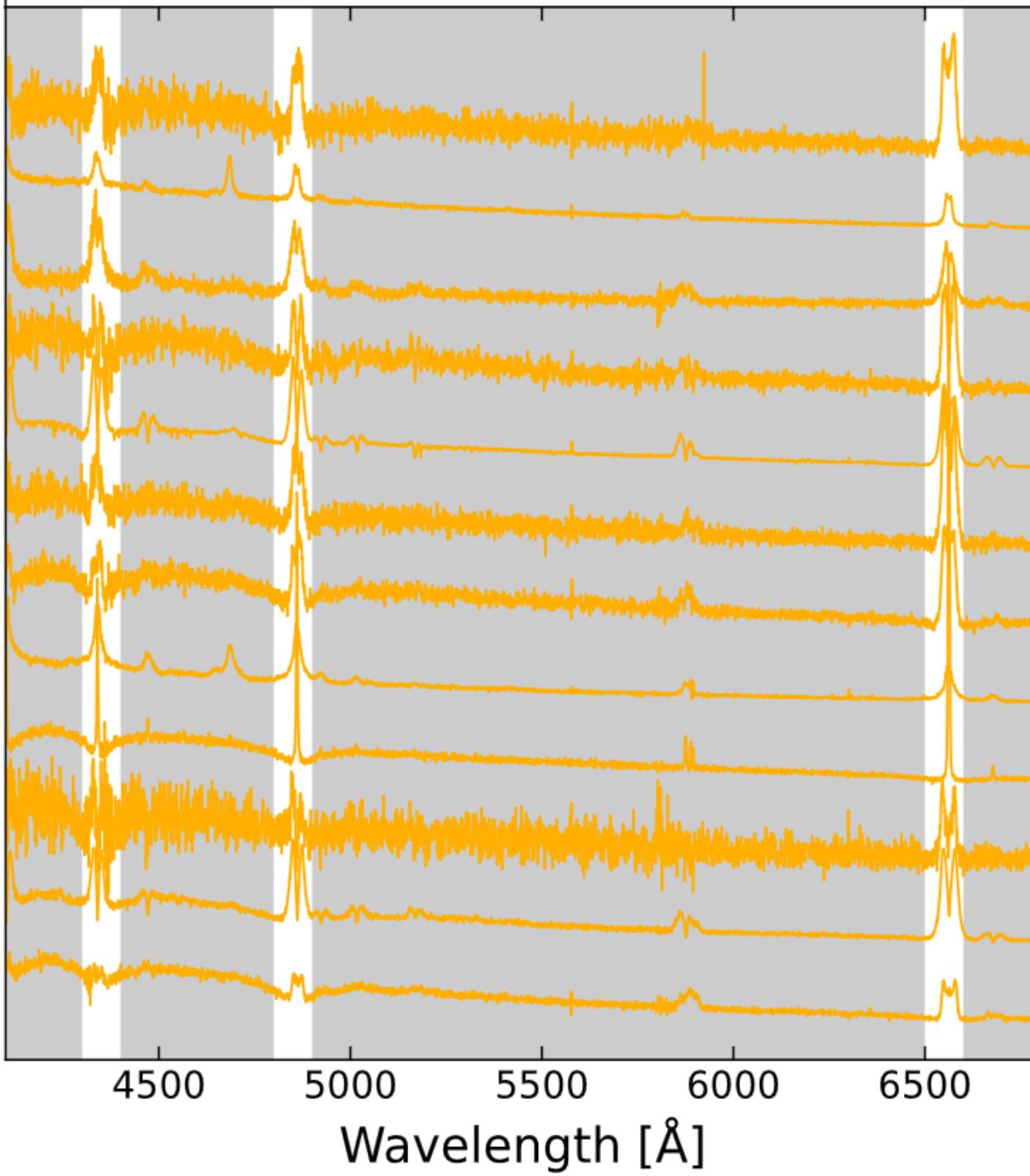


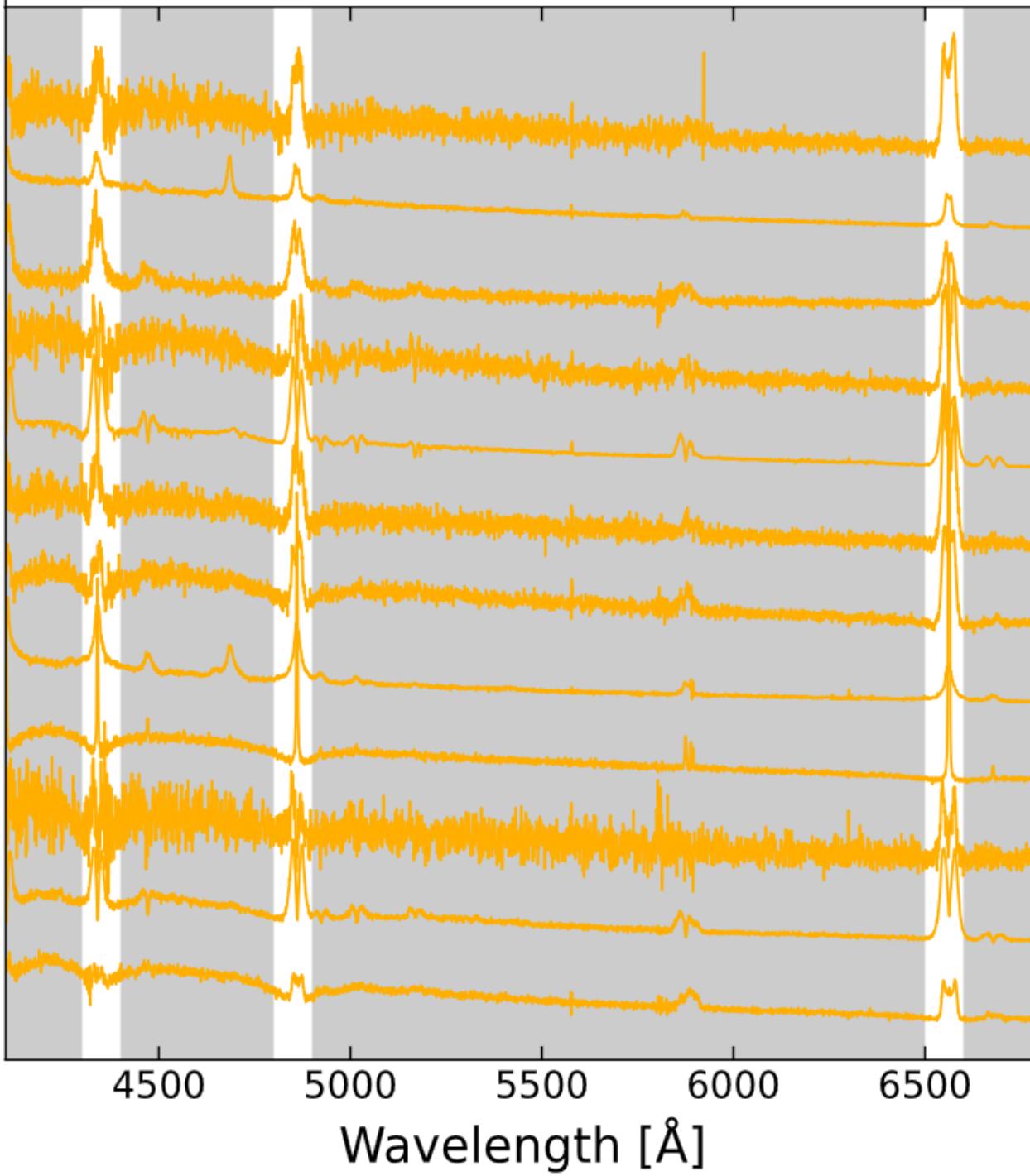
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Focusing on spectral lines

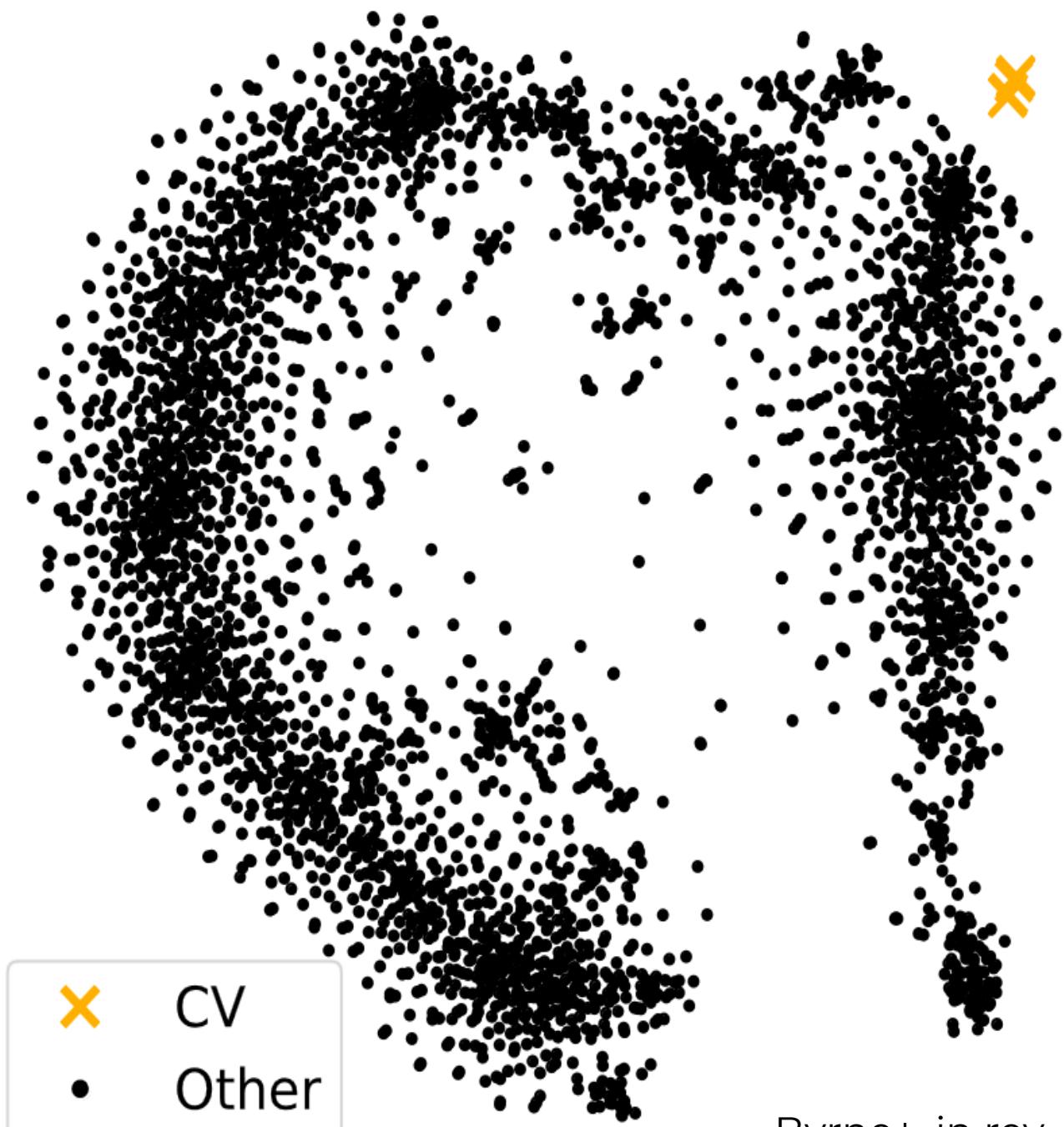


- Vectors now clustered based on a spectral feature
- Removes ‘distraction’ of rest of the spectrum





CV
• Other



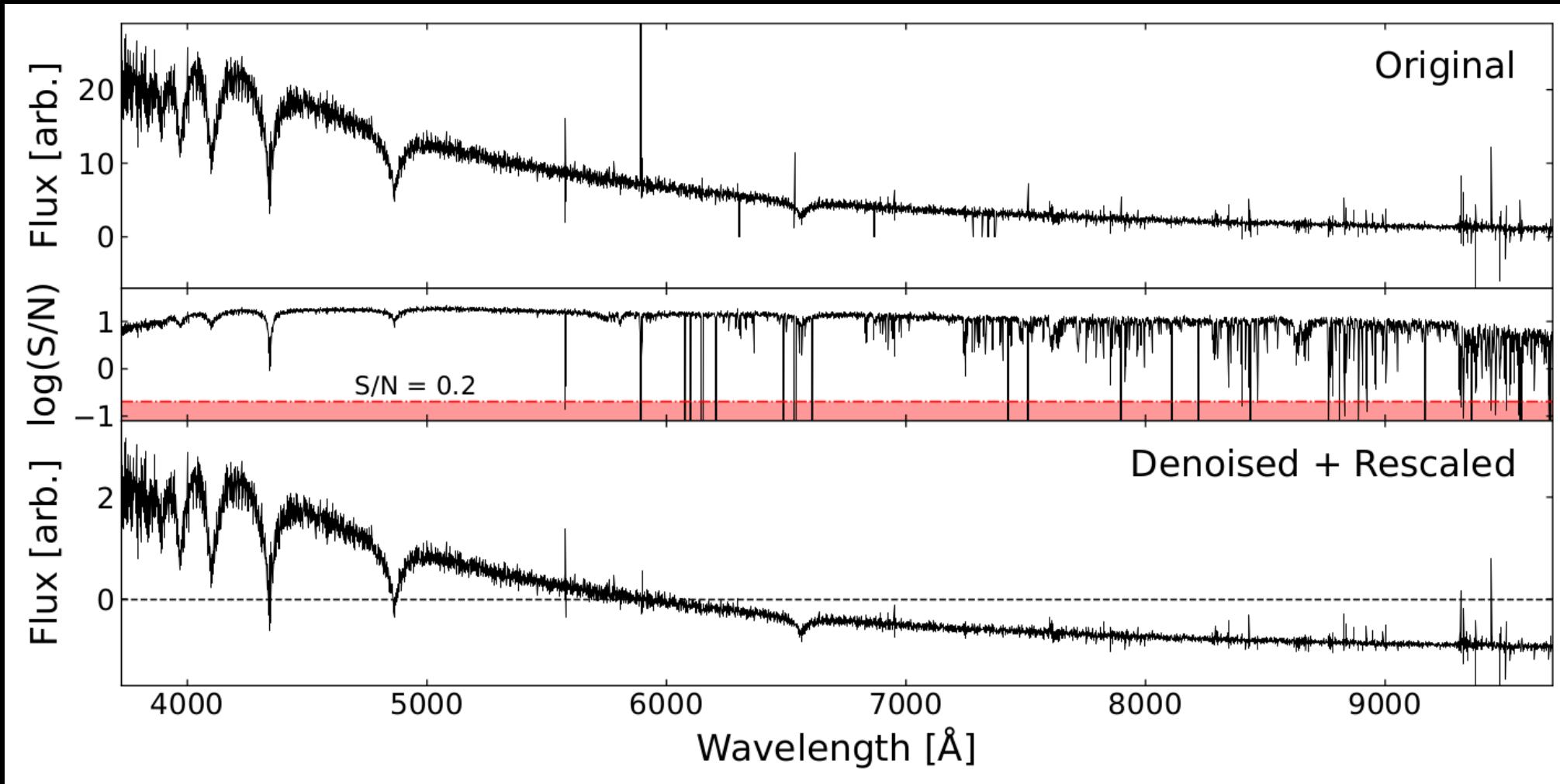
Conclusions

- 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

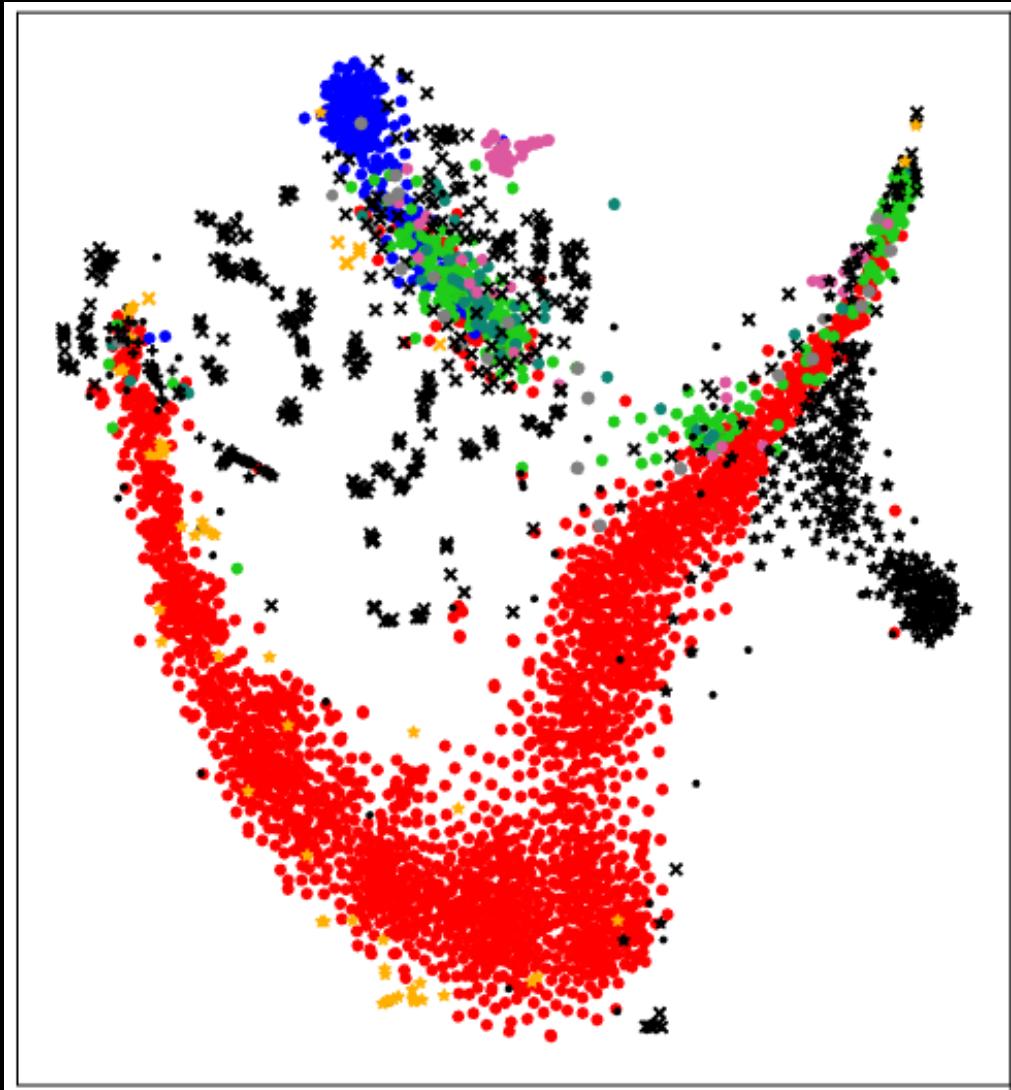


Extra slides

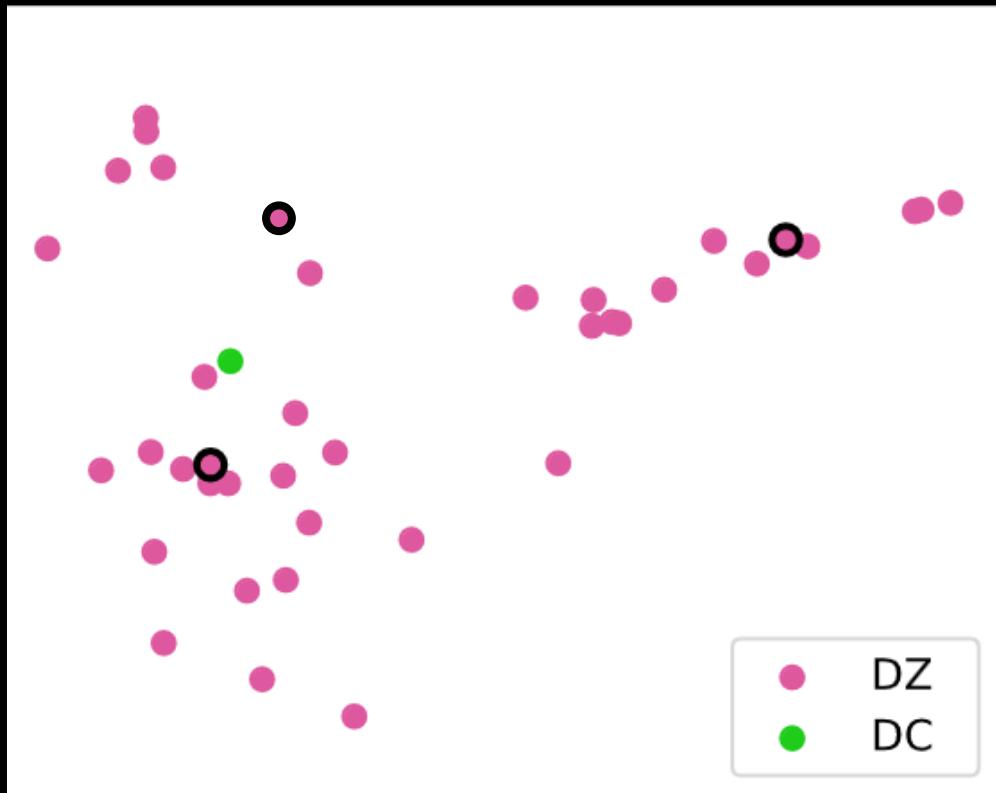
Preprocessing



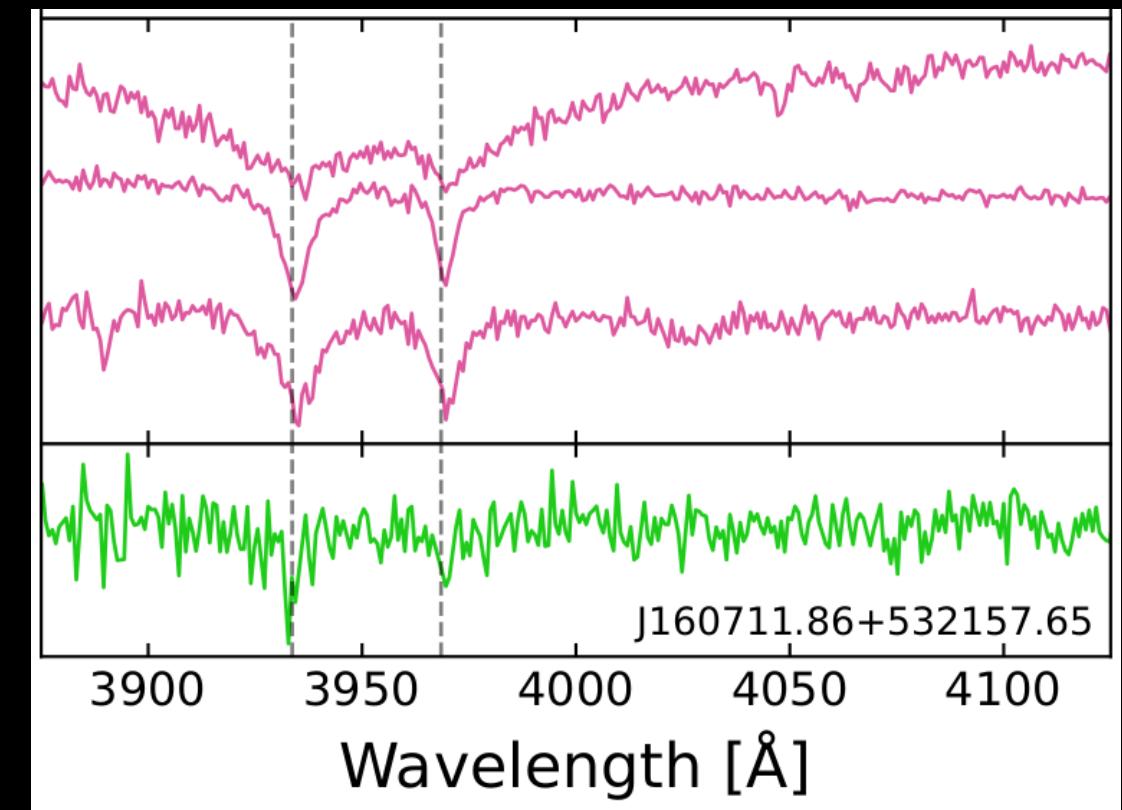
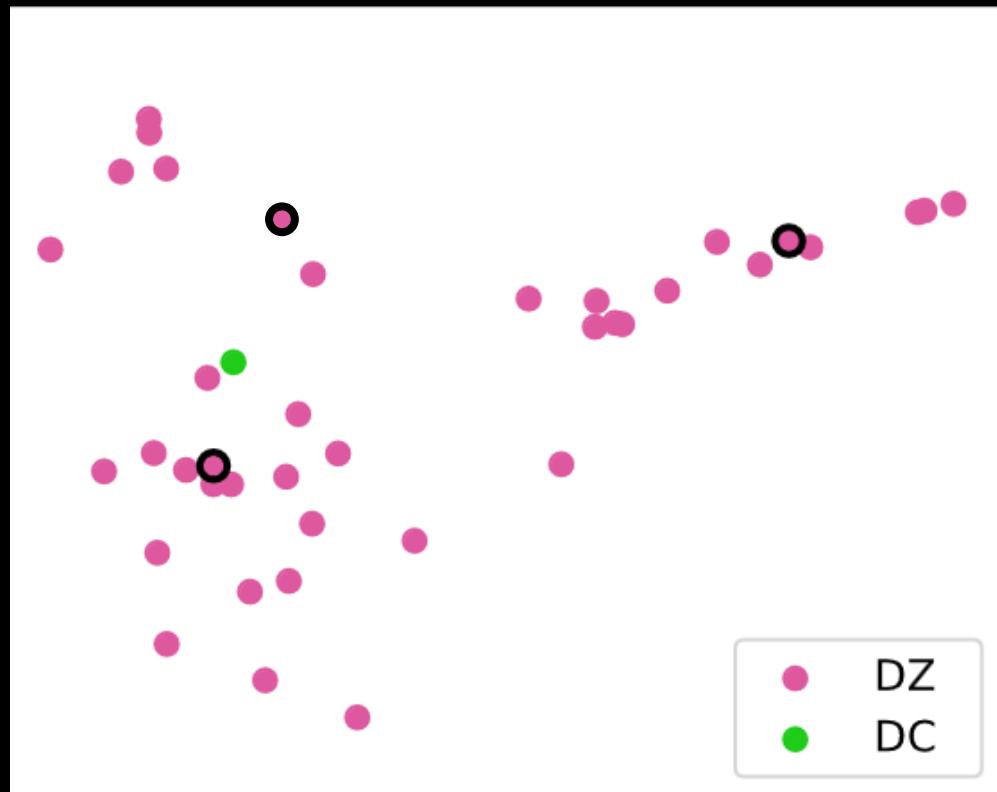
- Can **spot mistakes**



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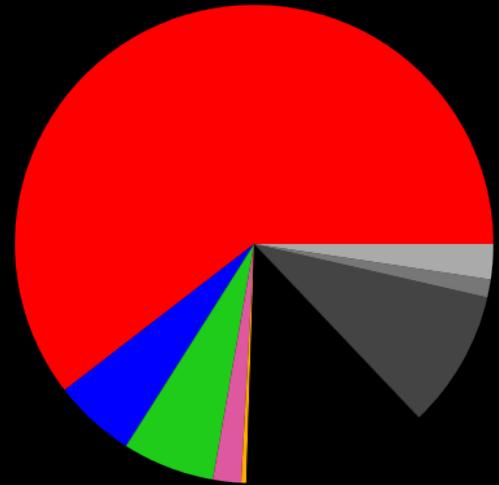
Automated WD Classification

Automated WD Classification

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

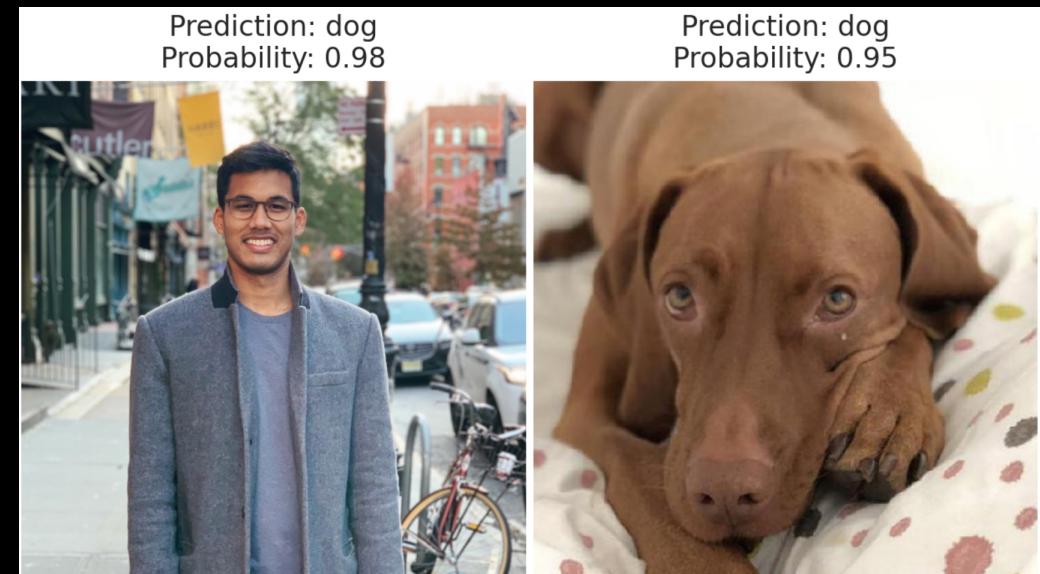
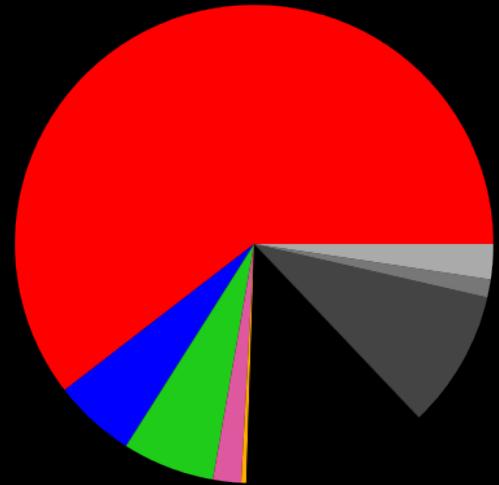
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 - ...which always exists for WDs



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!**



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**

