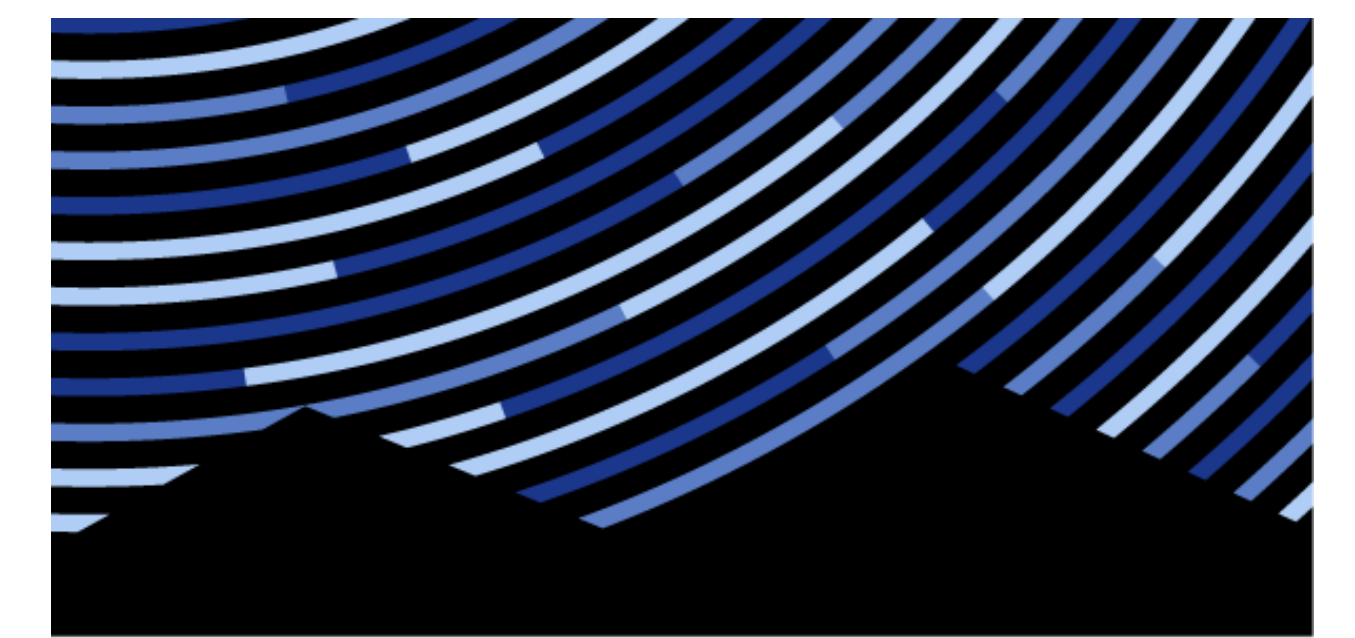


# Authentic Astronomical Research as Science Teacher Professional Development

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**McDonald Observatory**  
The University of Texas at Austin

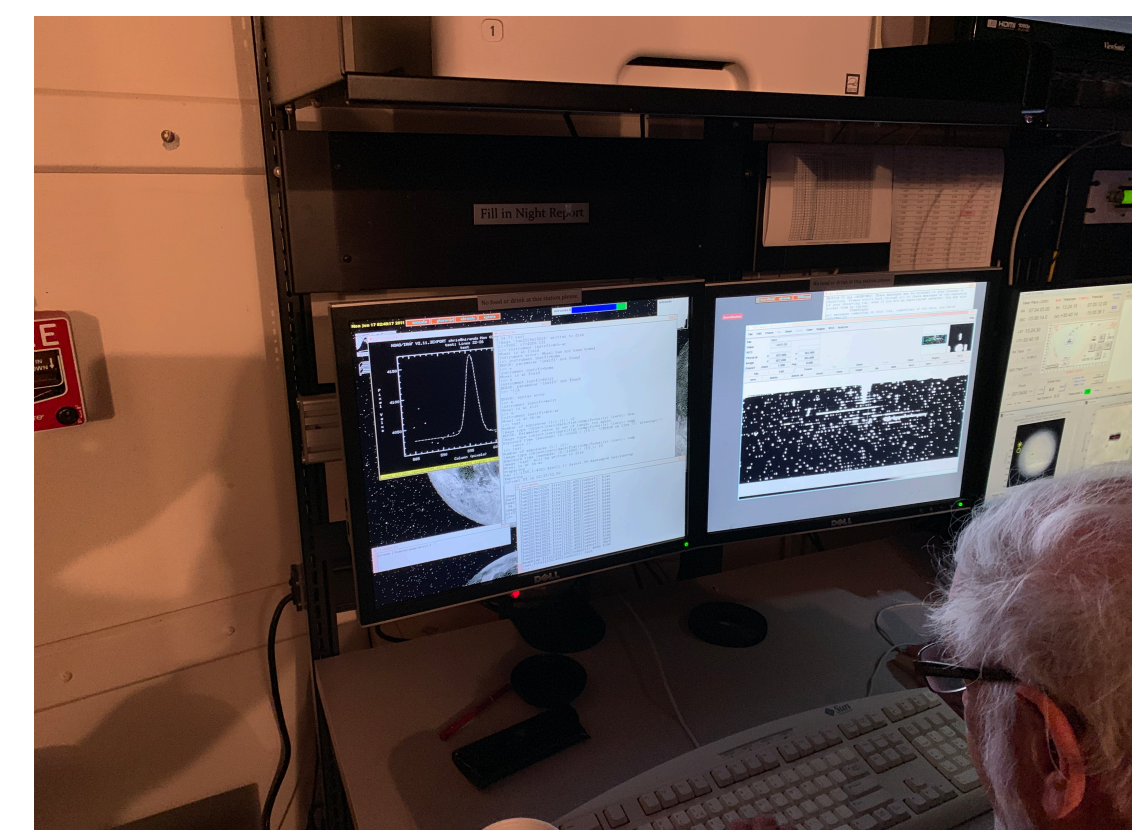
## Low Metallicity Stars Observing Run

In the summer of 2019, four members of the UT Austin EXES Teacher Associate program collected data using the Otto Struve 2.1-meter telescope & the Sandiford Echelle Spectrograph at McDonald Observatory. The purpose was to give teachers experience in observational astronomy and to create new classroom materials to share with other teachers.

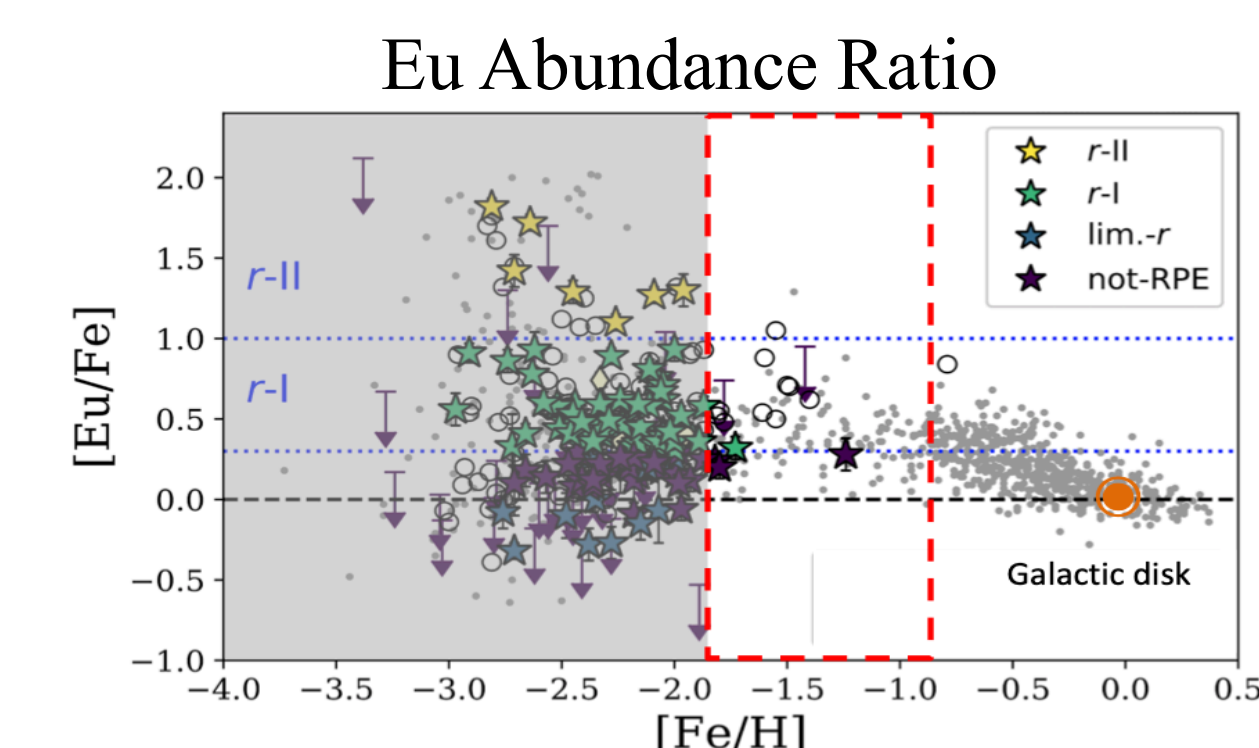


## Science as a Set of Skills

- Selecting targets
- Learning the telescope
- Learning the instrument
- Using software/computing
- Collecting data
- Real-time troubleshooting
- Reducing data



## Science as a Body of Knowledge



Stellar abundances of Eu vs metallicity showing the region of interest for this survey<sup>1</sup>

- Stellar evolution
- Milky Way structure
- Stellar nucleosynthesis
- Spectral analysis
- Night sky coordinates

## Science as a Way of Knowing

- Persistence
- Comfort with ambiguity
- Using failure to learn
- Collaboration
- Many small steps before large discoveries happen

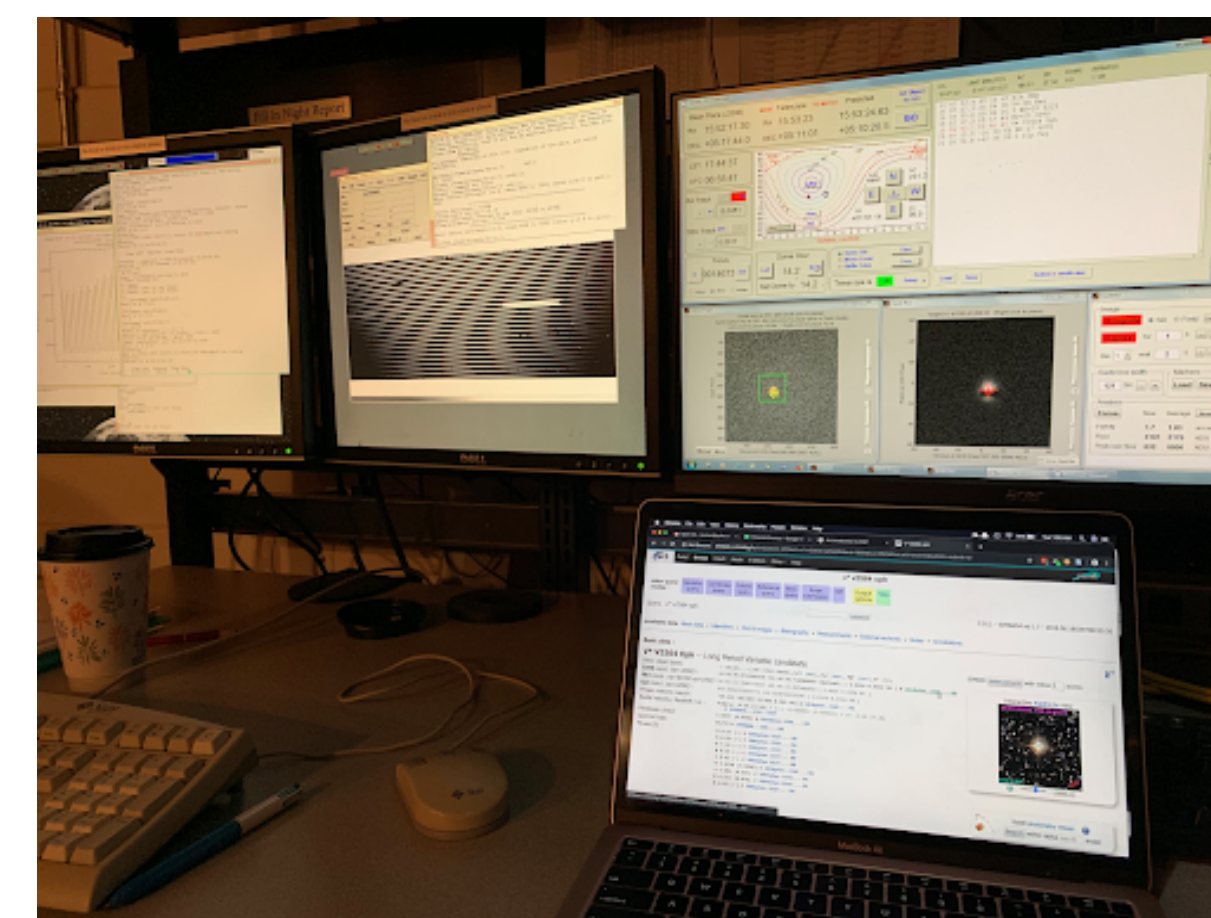


## Learning Science by Doing Science

- Open the dome to equilibrate the instruments
- Take flat and bias frames
- Take thorium argon frames



- Instrument checks
- Fill CCD coolant
- Check the dome slit alignment
- Watch for weather changes



- Running the workstation
- Target selections
- Taking images
- Calculate exposure time
- Monitor telescope
- Detailed note keeping
- Stay awake!



- Transfer FITS files
- Subtract flats and bias
- Find wavelength ranges
- Mark spectral orders
- Normalize spectra
- Python visualization



## Improved Classroom Inquiry

*“Applying a longer and appropriate wait time... I wait for more complicated and creative answers.”*

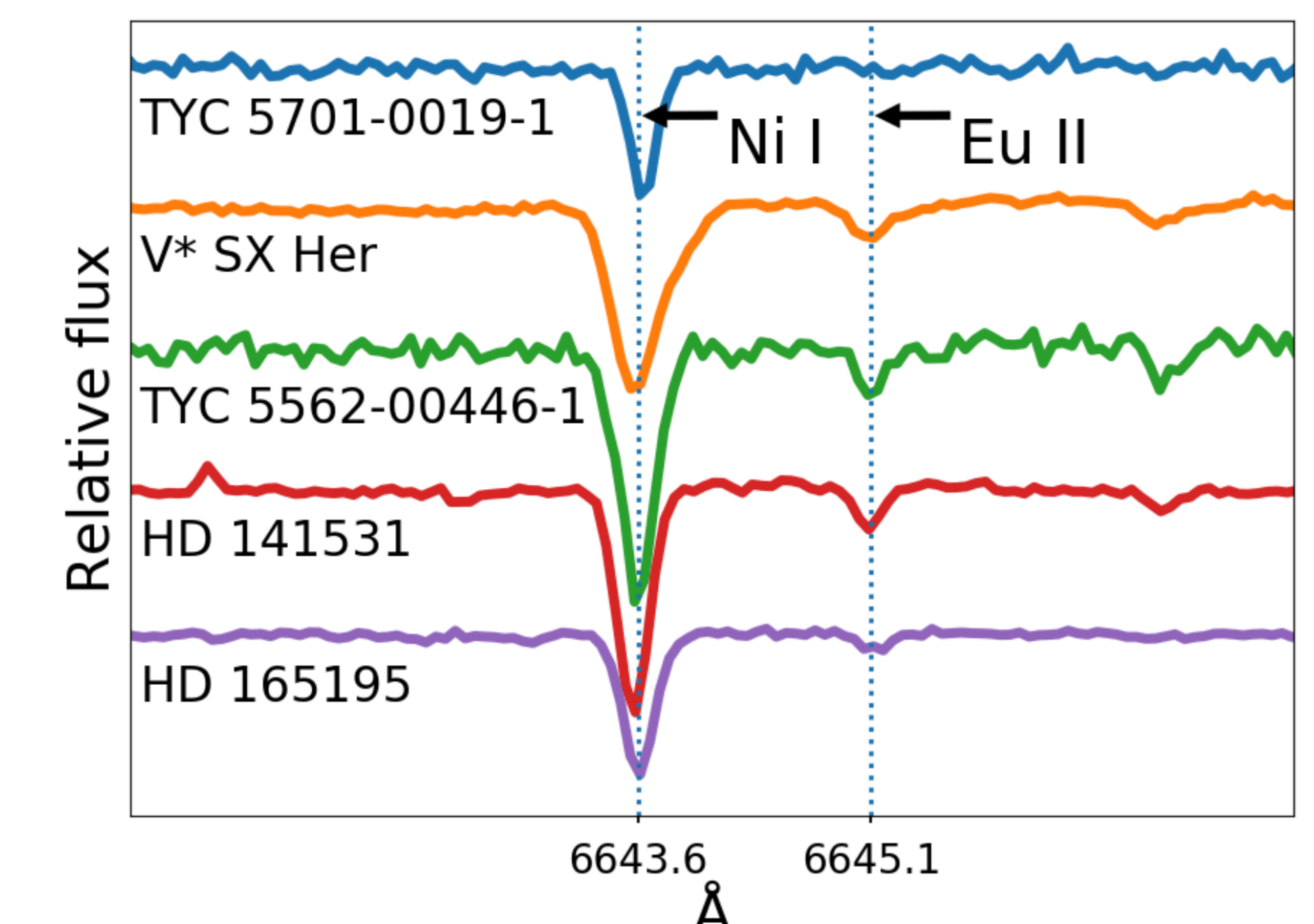
*“...not having an answer is not just ok, but how most science is accomplished. It is normal and expected to struggle through a problem and attempt a solution without knowing if it is correct.”*

*“Integrating how science is constructed builds an understanding ... [and] encourages their inquisitiveness and innate curiosity.”*

## Results

Detection of Eu II among our targets confirms need for further study of the presence of the lanthanides in low metallicity halo stars.

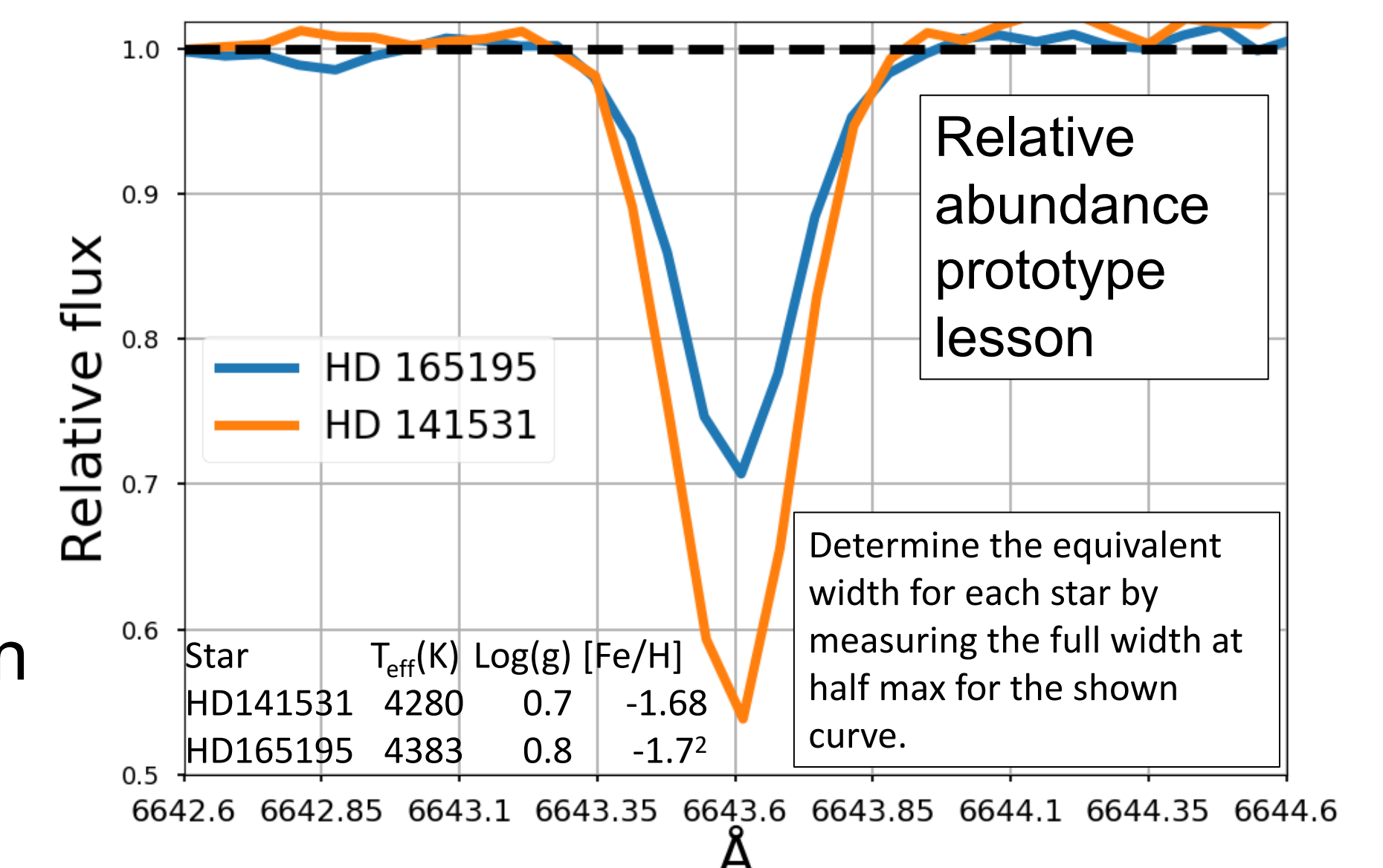
### Eu II Absorption Detection



## Future Works

- Create lessons for science classes
- Publish science results
- Expand participation in research

### Ni I Relative Abundance



## Find Out More

Visit the project website for a lot more information including data, source code, and references.

<https://wp.me/P3rYuP-6SAswl>



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Thanks to Dr. John Kuehne for his generous training and observing support. Additionally thanks to the other members of the UT EXES Teacher Associate program for their help and support. This program was originated by Dr. Mary Kay Hemenway, retired senior lecturer at University of Texas at Austin as the SOFIA EXES Teacher Associate Program. This project was funded by NSF Grant No. AST-1616040.

The University of Texas at Austin  
Department of Astronomy  
College of Natural Sciences



## References

- <sup>1</sup>Sakari, et al. (2019). The R-Process Alliance: Discovery of a Low- $\alpha$ , r-process-enhanced Metal-poor Star in the Galactic Halo. The Astrophysical Journal, 874(2)
- <sup>2</sup>Soubiran, et al. (2010). The PASTEL catalogue of stellar parameters. Astronomy and Astrophysics, 515(11)