



# The Chemical Composition of an Extrasolar Kuiper-Belt-Object

**Siyi Xu (许偲艺)**

ESO Fellow

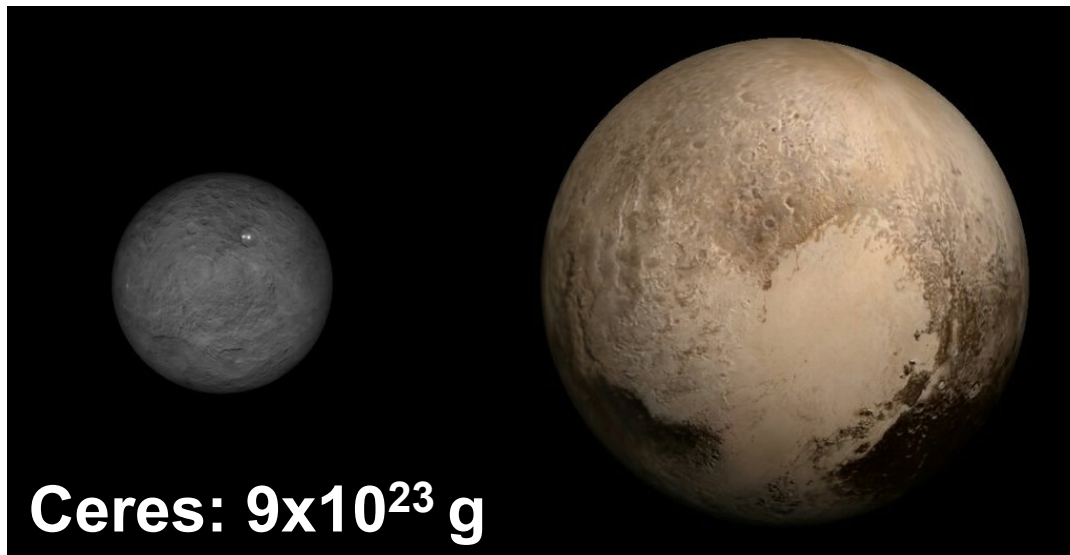
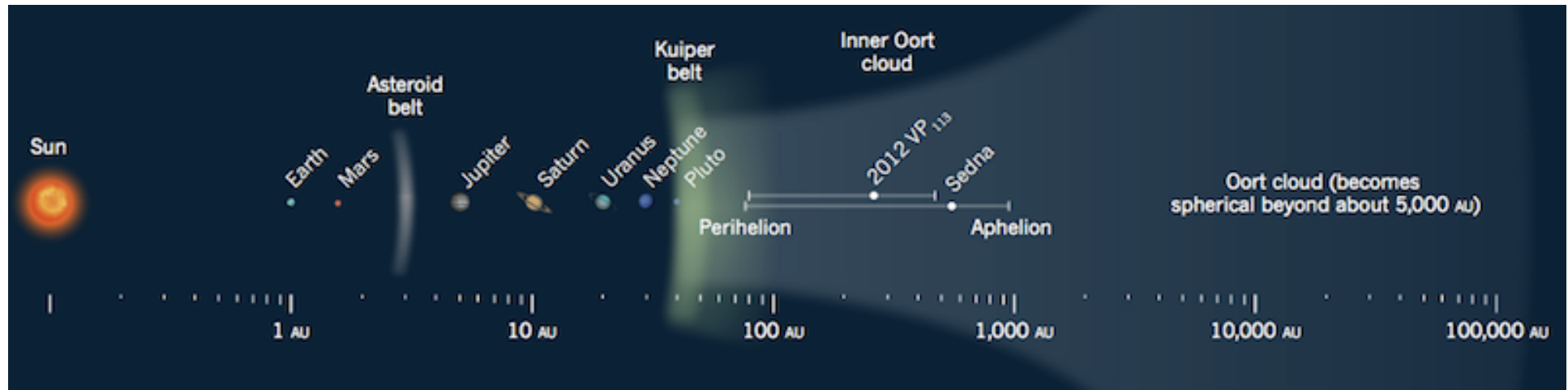
*In collaboration with...*

B. Zuckerman, P. Dufour,  
E. D. Young, B. Klein &  
M. Jura

2017, ApJL, 836, L7



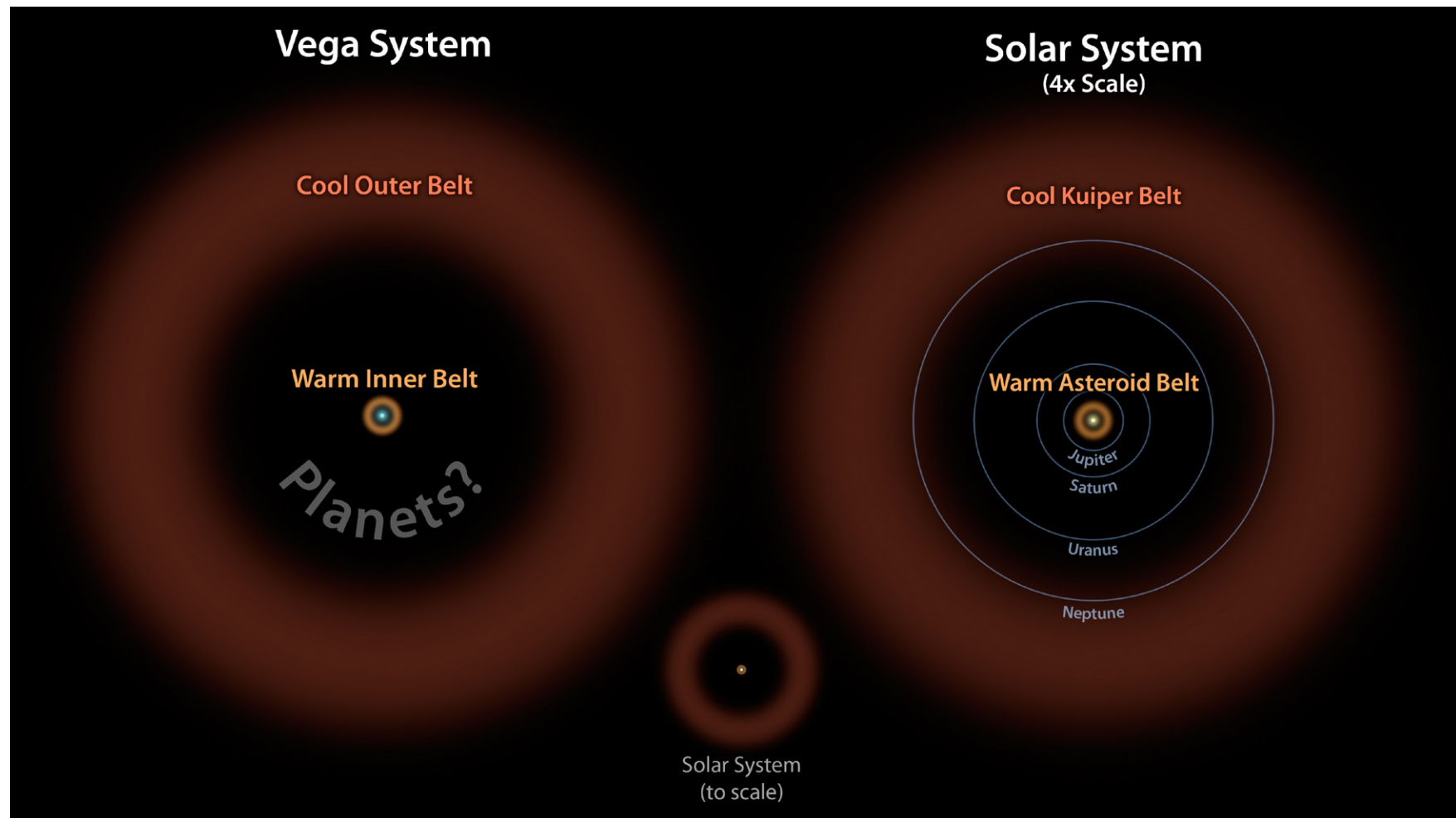
# Minor Planets in the Solar System



**Ceres:  $9 \times 10^{23}$  g**

**Pluto:  $10^{25}$  g**

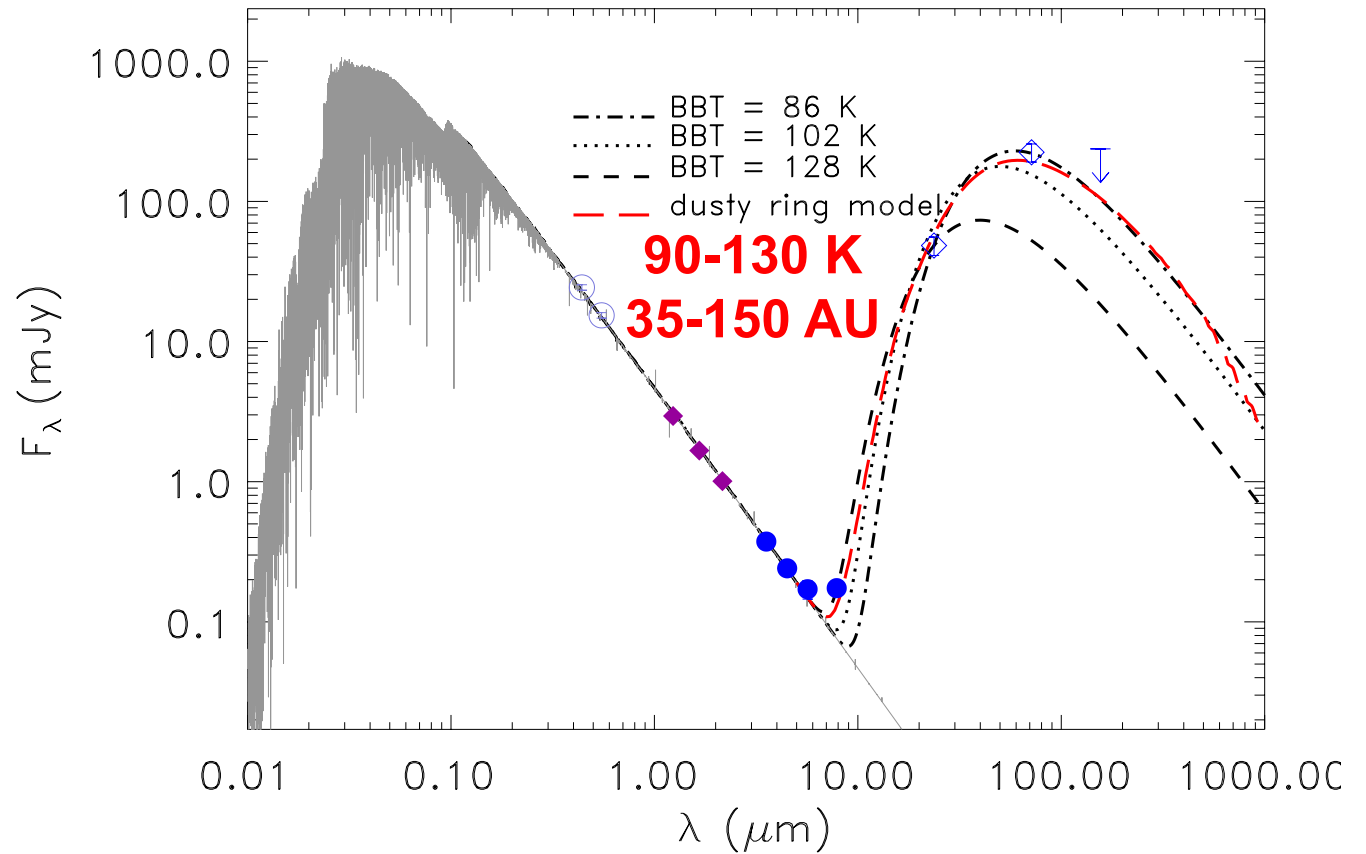
# KBO Analogs around Other Stars

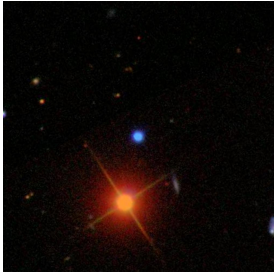


# Helix Nebula: Collisions between KBOs?



View From Hubble





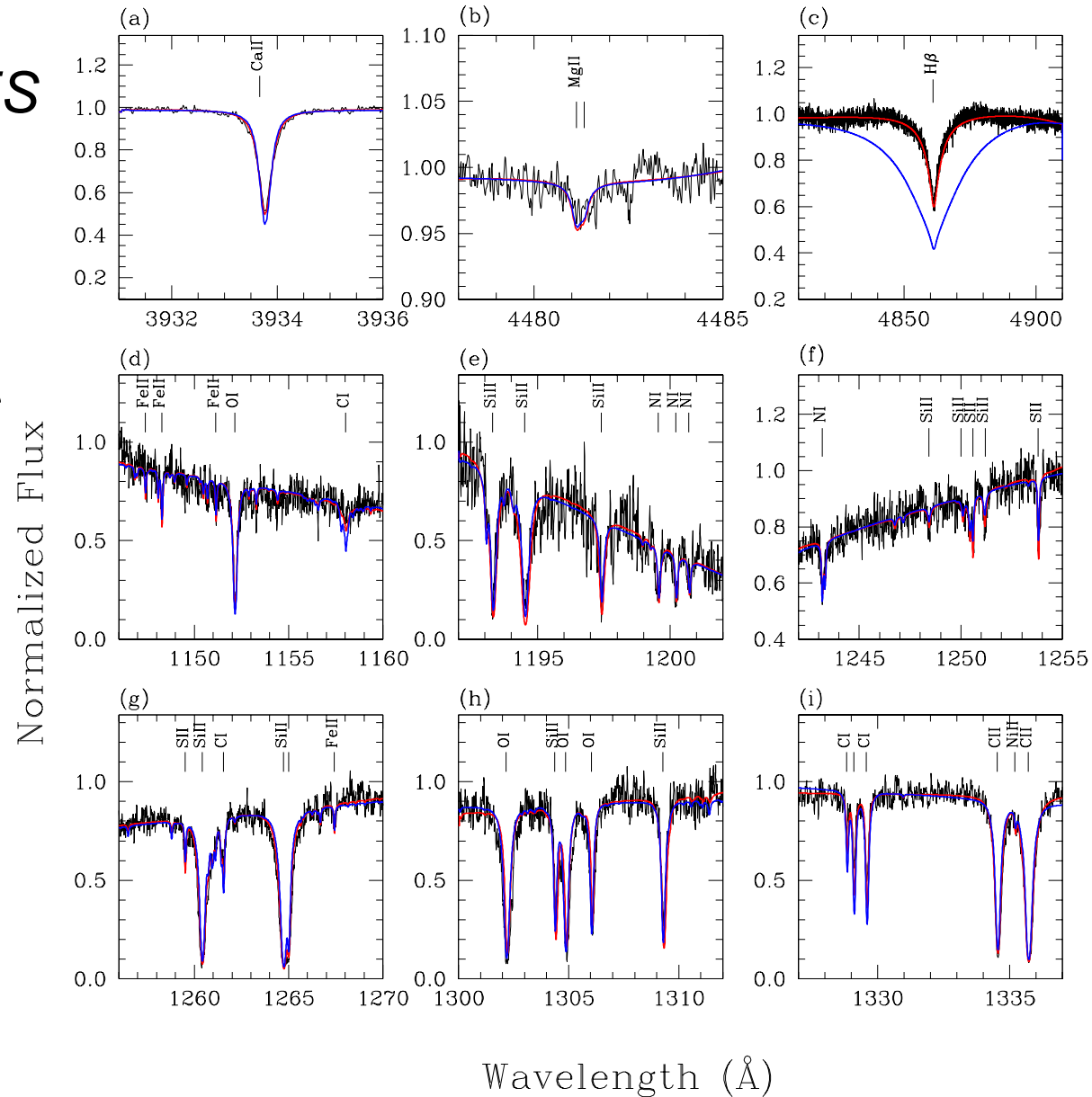
# WD 1425+540: Spectroscopic Observations

Keck/HIRES

Ca, Mg

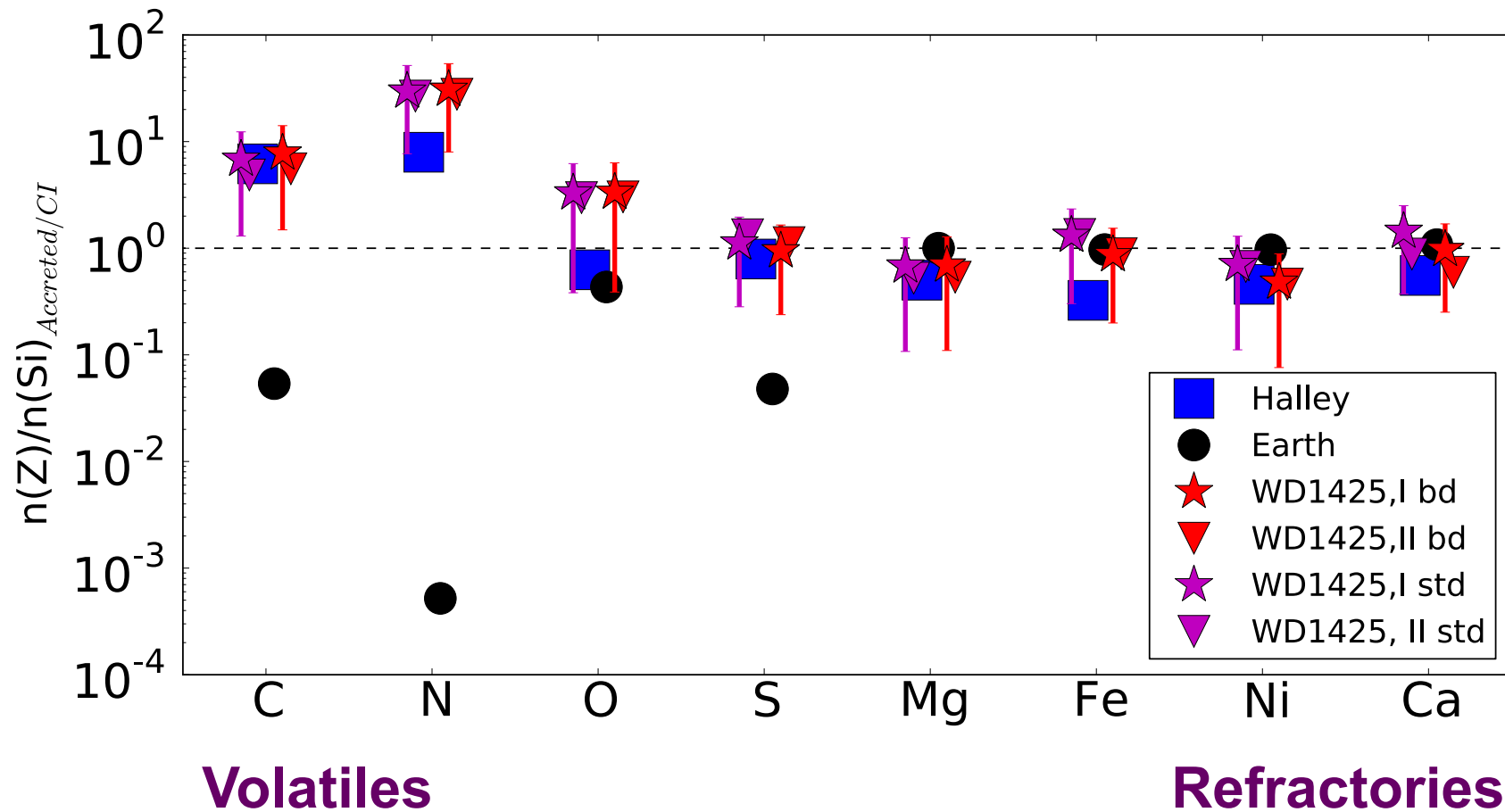
HST/COS

C, N, O,  
Si, S, Fe  
Ni

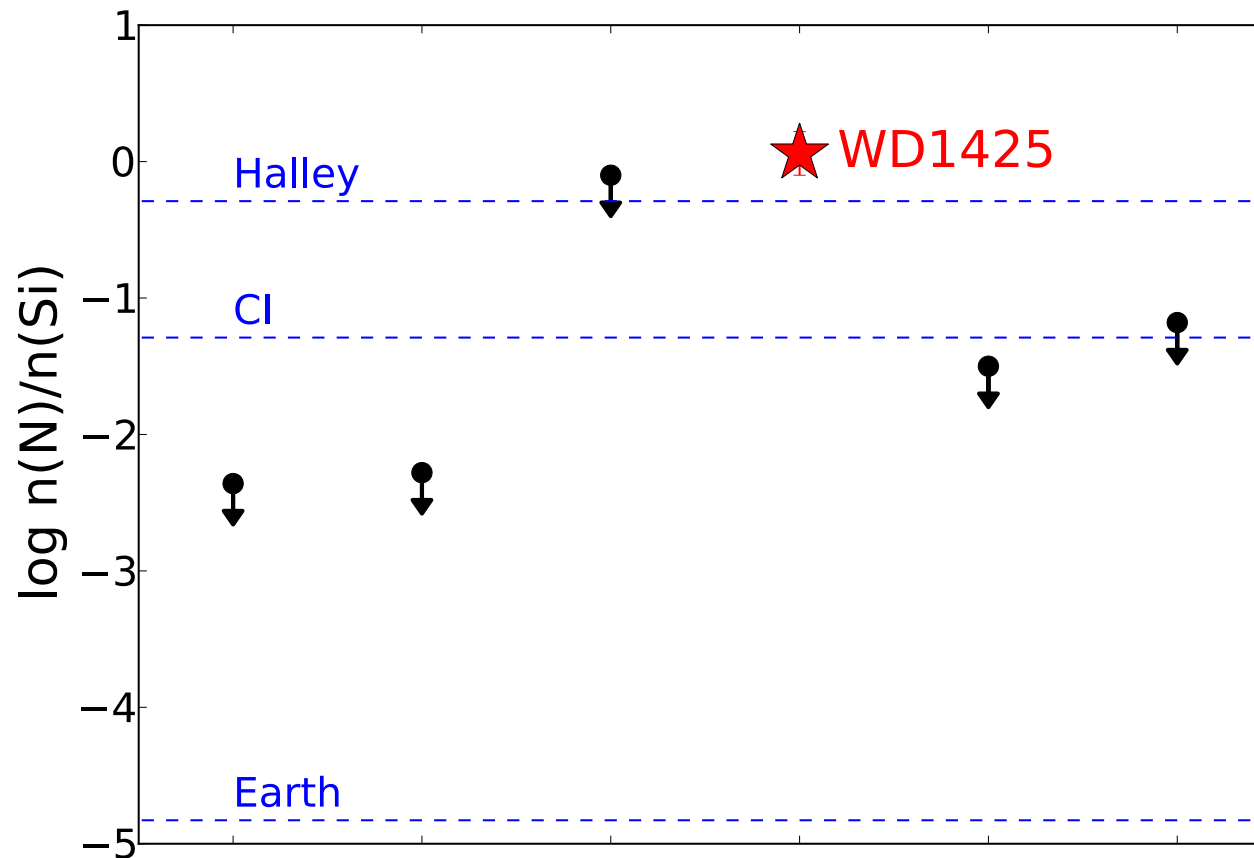


# Accretion from Comet Halley Analog

but at least ~100,000 more massive

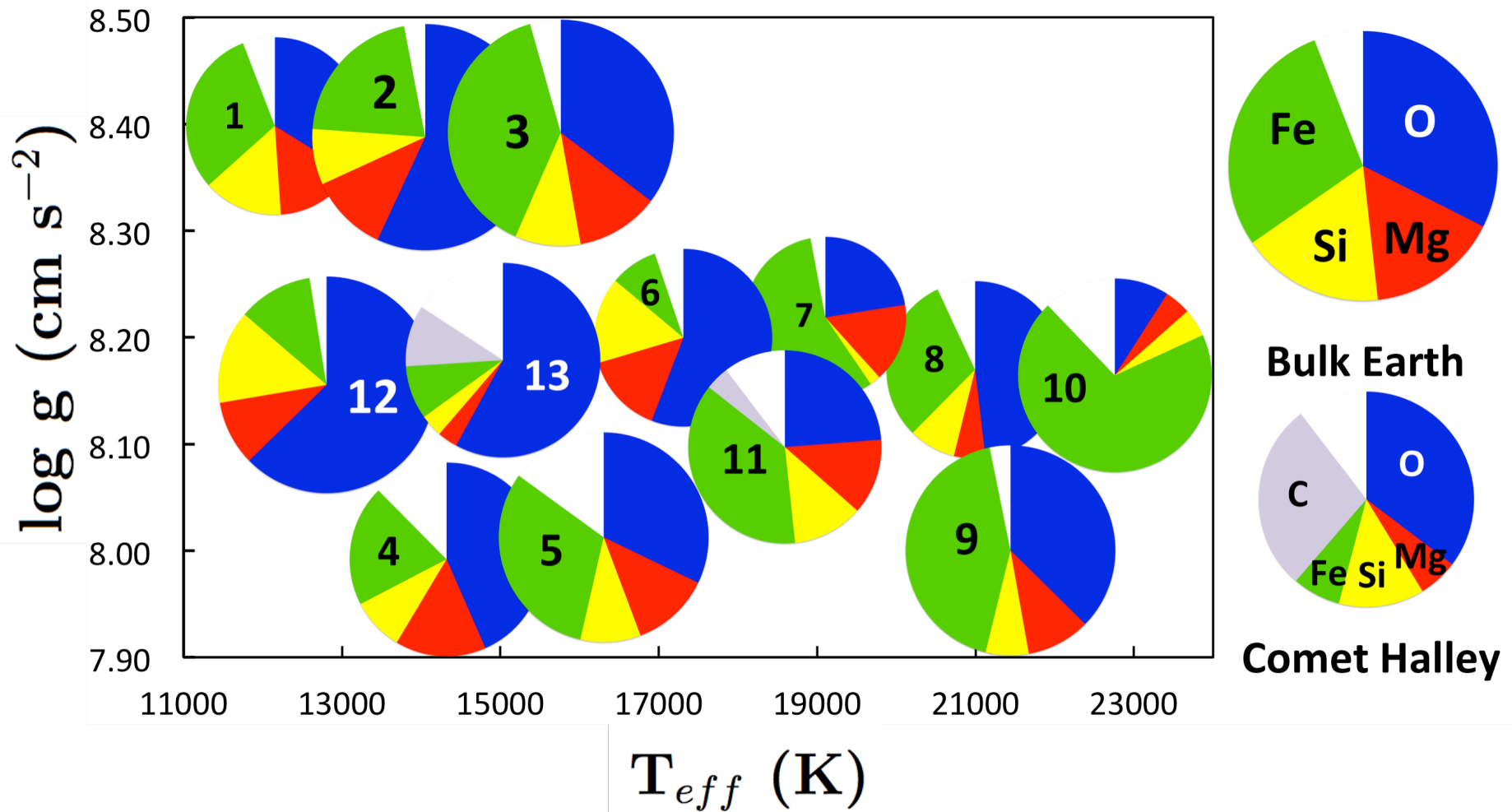


# The Mass Fraction of Nitrogen is ~2%



- Other polluted WDs

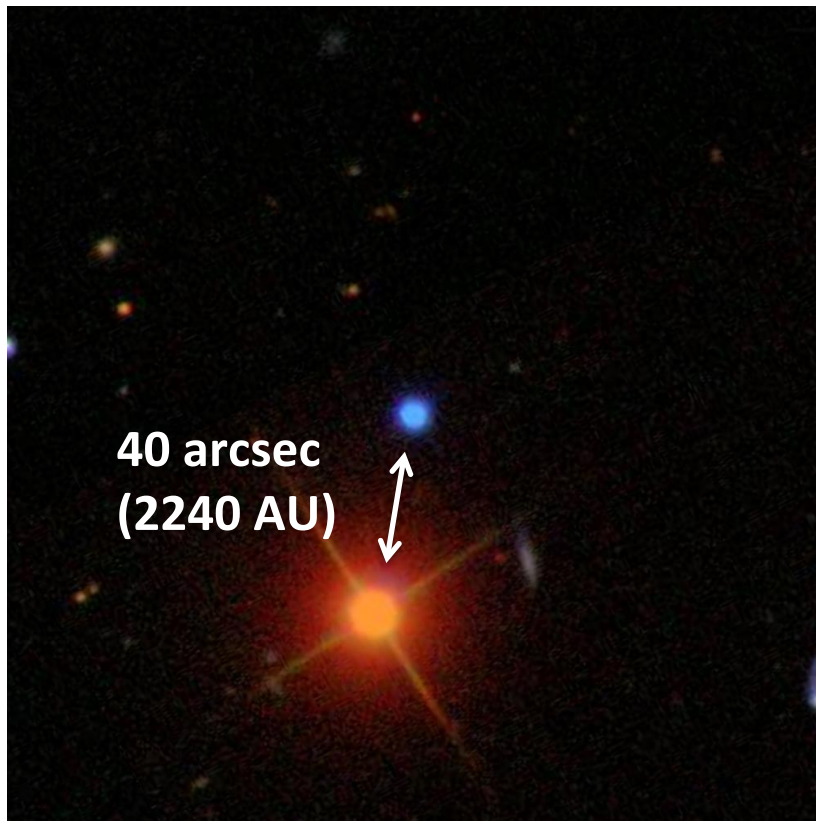
# #13 The Most Carbon-rich Extrasolar Planetary Material



Updated from Xu+ 2014



# Binary Companion

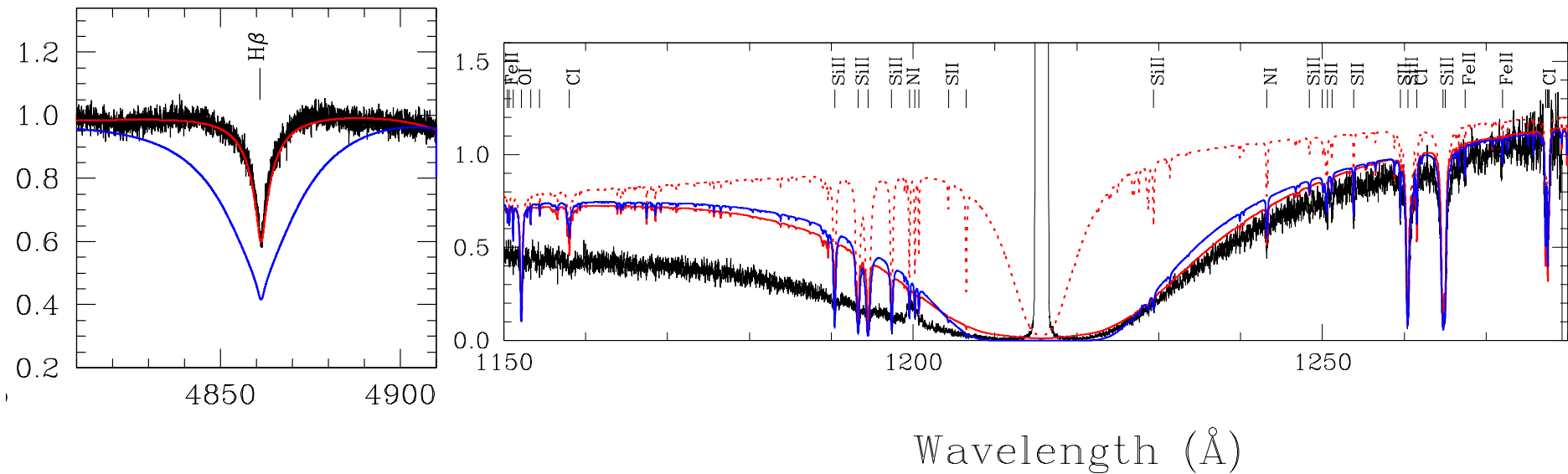


From SDSS

- WD 1425+540 has a K dwarf companion
- KBO analog originally located  $\sim 120$  AU
- Galactic Tides (Bonsor & Veras 2015)? Kozai-Lidov Mechanism?

# Future Work #1: Hydrogen Abundance

- Optical ( $H\alpha$  &  $H\beta$ ):  $\log n(H)/n(He) = -4.2$
- UV ( $Ly\alpha$ ):  $\log n(H)/n(He) = -3.0$  (asymmetric)



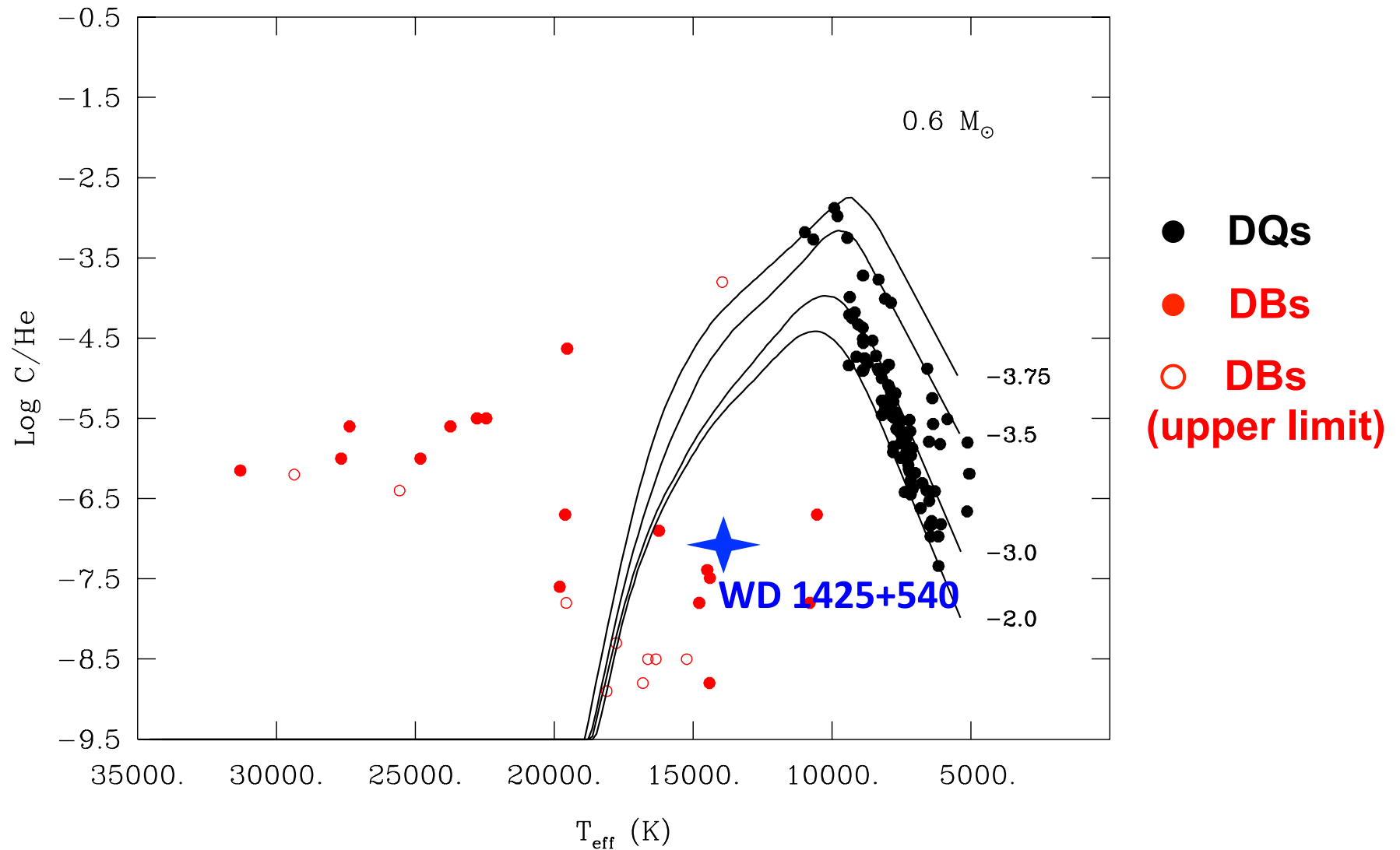
—  $\log n(H)/n(He) = -3.0$

—  $\log n(H)/n(He) = -4.2$

-----  $\log n(H)/n(He) = -4.2$

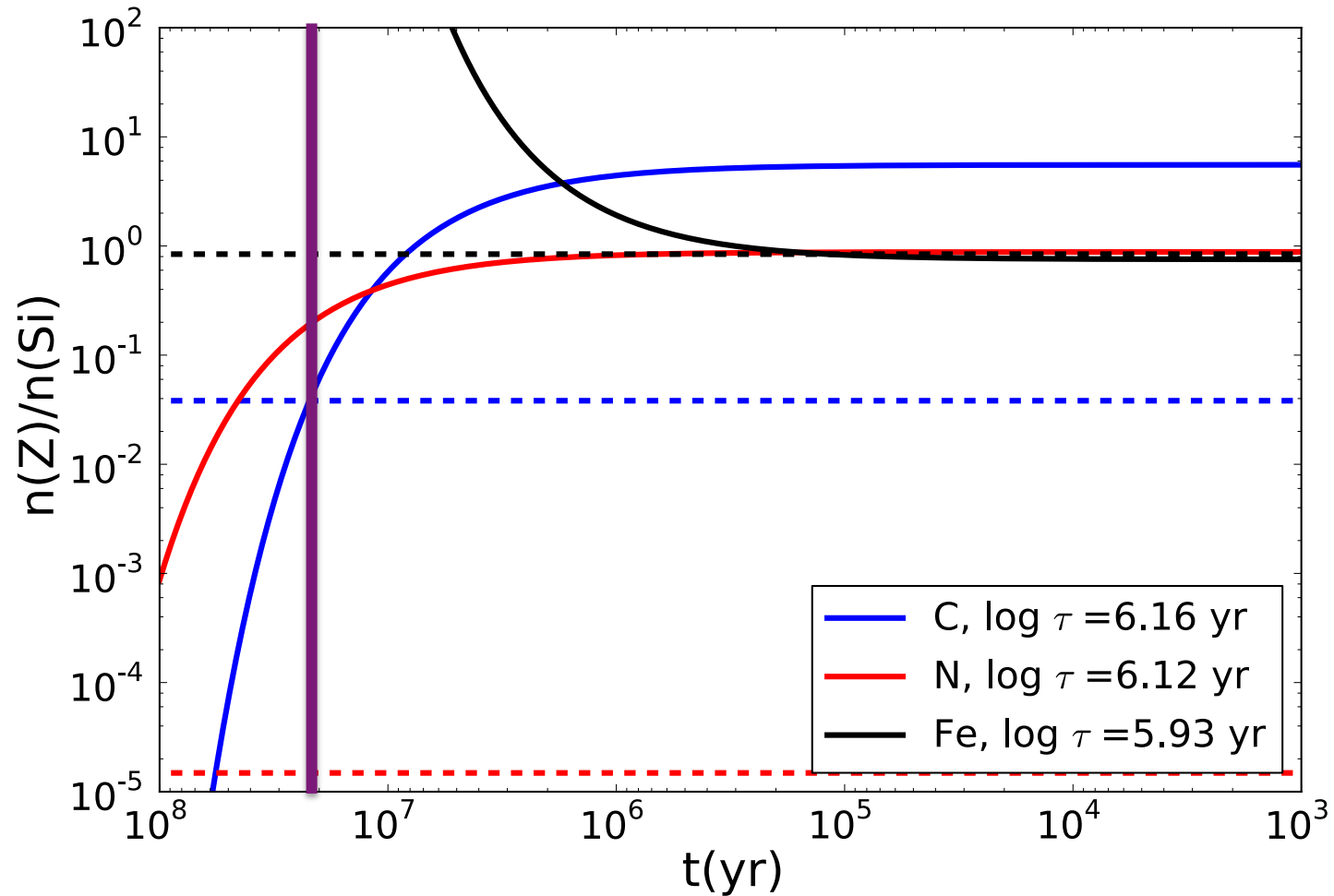
—  $\log n(H)/n(He) = -4.2$   
 $+10^{22} \text{ cm}^{-2}$  interstellar H

# Future Work #2: Carbon Dredge-Up



From G. Fontaine

## Future Work #3: Accretion Stage



For Si,  $\log \tau = 6.11$  yr

# Summary

- WD 1425+540 provides direct evidence for KBO analog around other stars
- Its chemical composition is very similar to that of comet Halley
- N is detected for the first time and it is enhanced
- A lot of future work...

***Thank you!***

