

Oxygen and other α -elements vs Fe in massive stars at the Galactic Center: Clues on a top-heavy star formation?

Paco Najarro

Centro de Astrobiología (CAB)

Don Figer, Rochester

Rolf Kudritzki, Hawaii

Tom Geballe, Hawaii

John Hillier, Pittsburgh

Tenerife, 15-May-2012



- **Introduction**

- Why metallicity?
- Why the Infrared?
- Are there any diagnostic O lines in the IR?

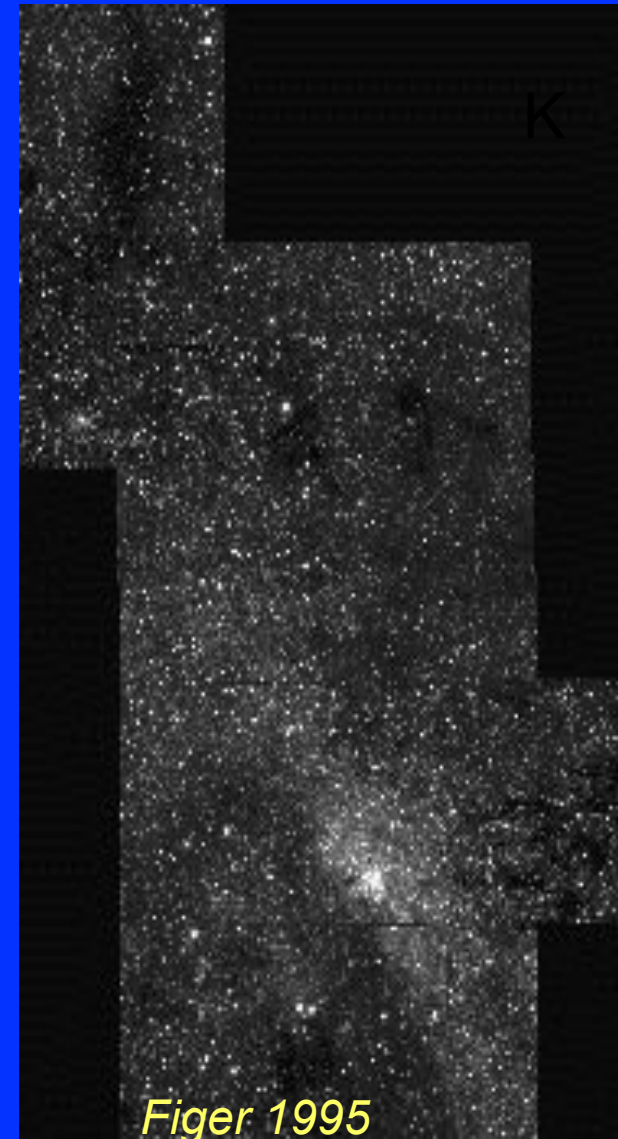
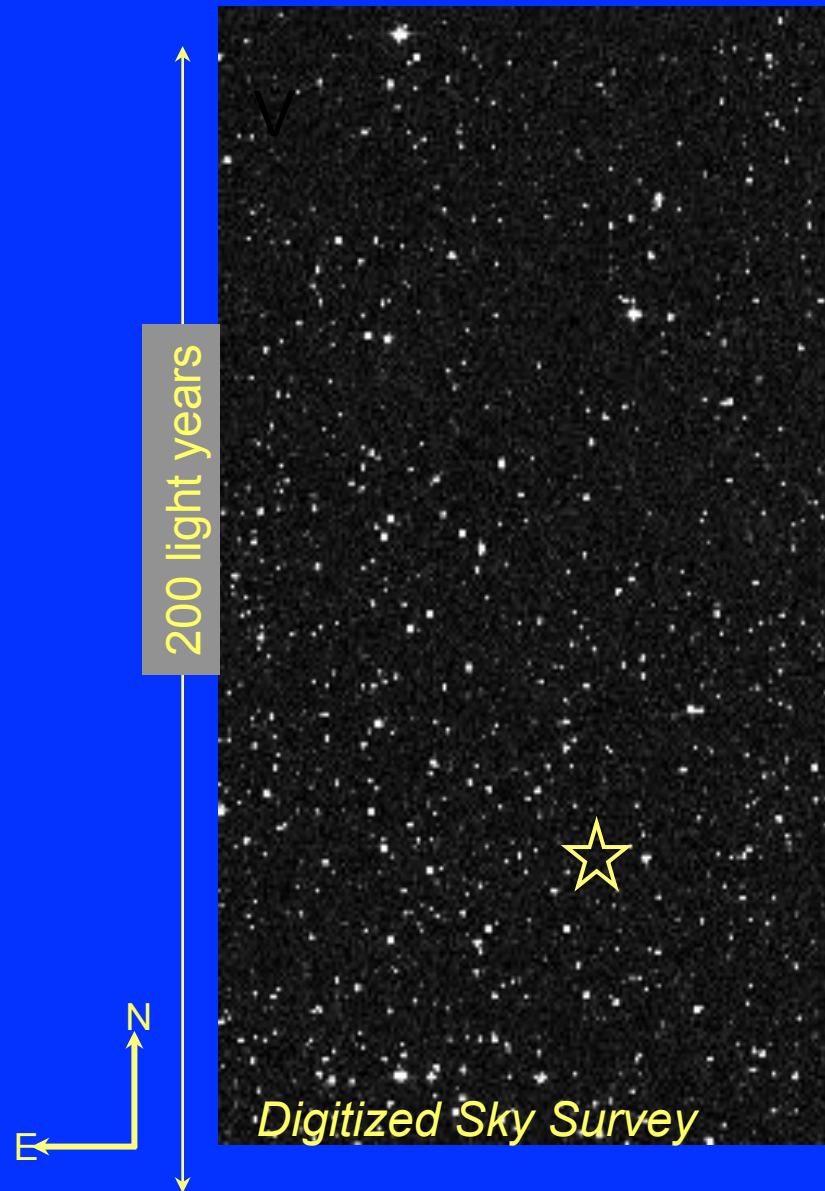
- **Metallicity Determinations in the IR**

- Direct estimates → Olf phase
- Direct estimates → LBV phase (Fe vs α)
- Indirect estimates → WNL phase

Metallicity Studies

- **Why metallicity?**
 - **α -elements vs Fe ratio. Top heavy IMFs**
 - **Constraints to evolutionary models**
 - **2-D metallicity map of the inner Milky Way to provide constraints to galactic chemical evolution models**

Why in the Infrared?



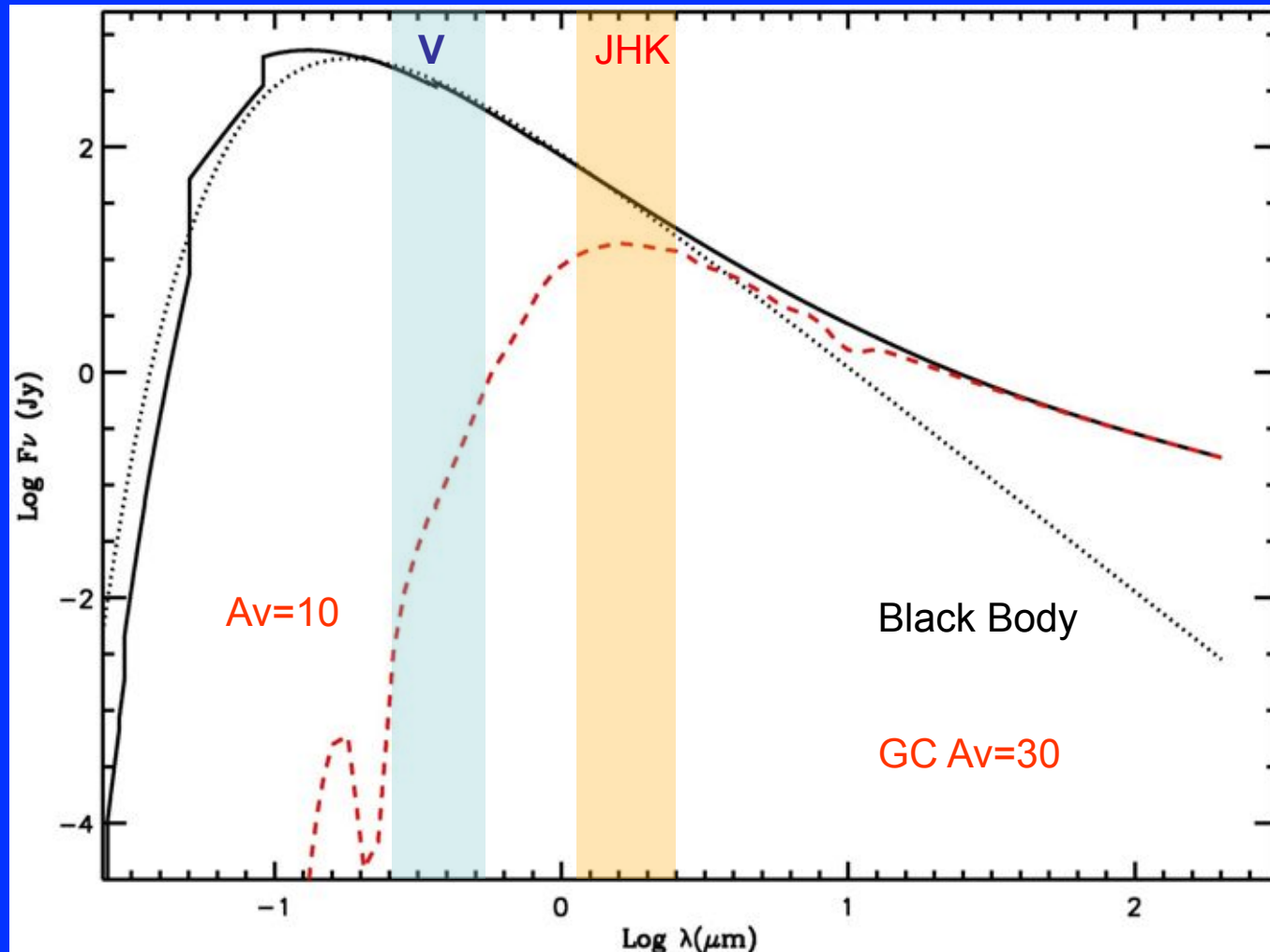
Clusters at the Galactic Center



Massive Stars at the GC and inner Galactic Regions

Extinction !

O8If



Are there any diagnostic Oxygen lines in the IR?

- OI

- J (1.129, 1.316) ; H (1.802, 1.824) ; K -- ; L (2.764, 2.893, 3.098) μm

- OII

- OIII ???

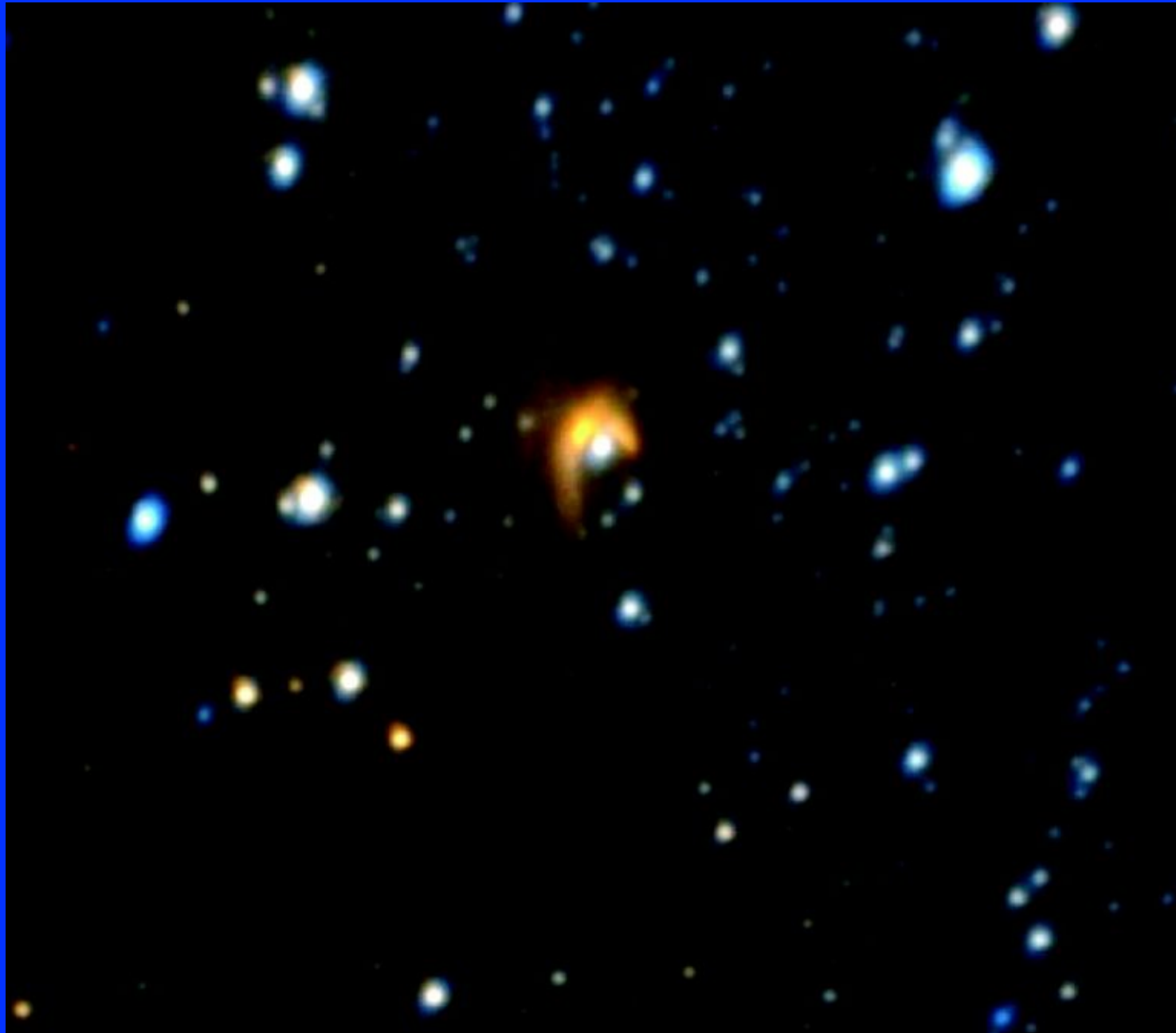
- Metallicity Determinations in the IR

- Direct estimates \rightarrow Olf phase
 - Direct estimates \rightarrow LBV phase (Fe vs α)
 - Indirect estimates \rightarrow WNL phase

Estimates of metallicity in the IR

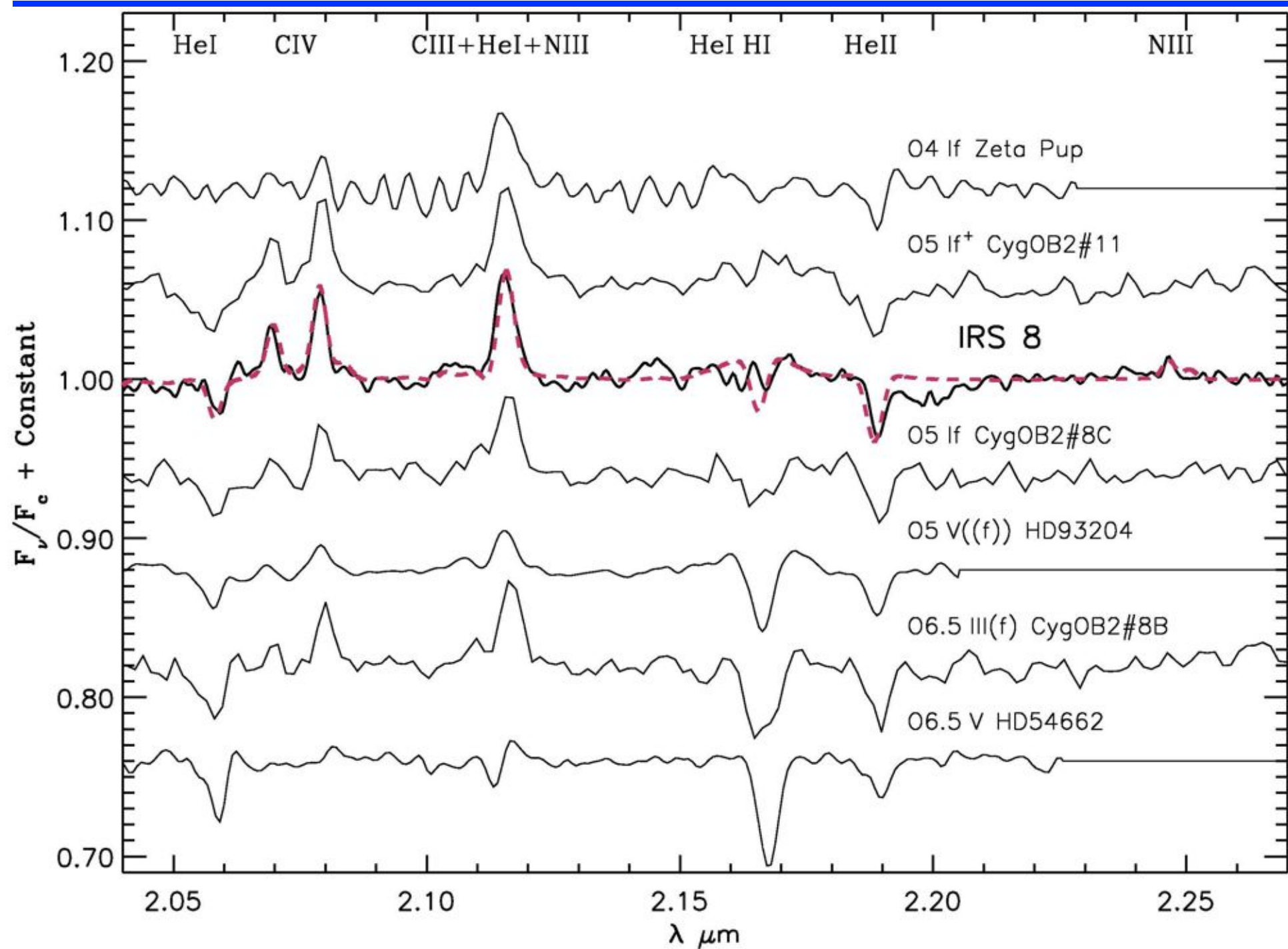
- Metallicity from Olf phase
 - Weak features
 - Clue to derive metallicity?

BOW SHOCK STARS IN THE GC: IRS8



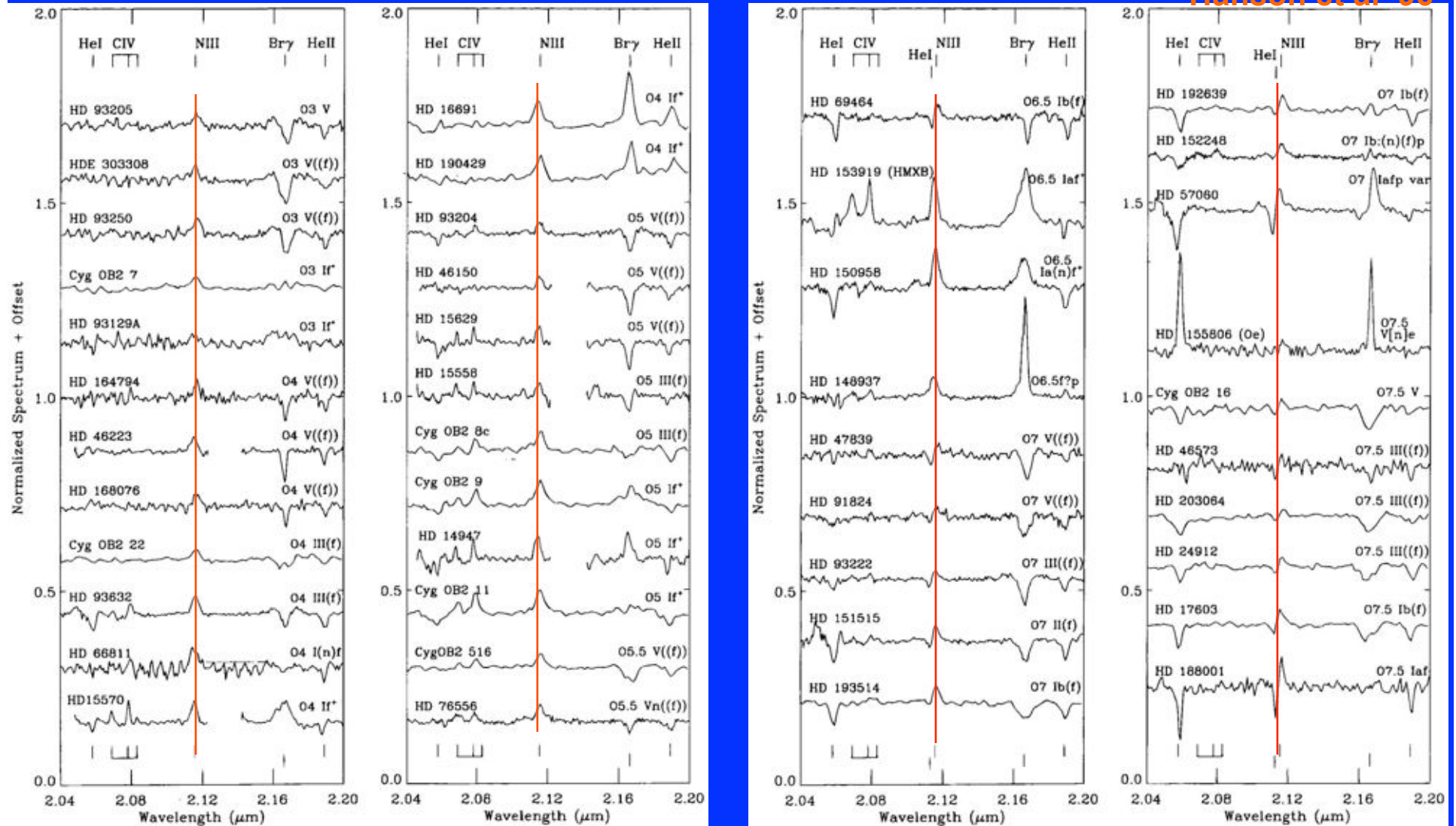
Geballe et al 04

15-May-2012

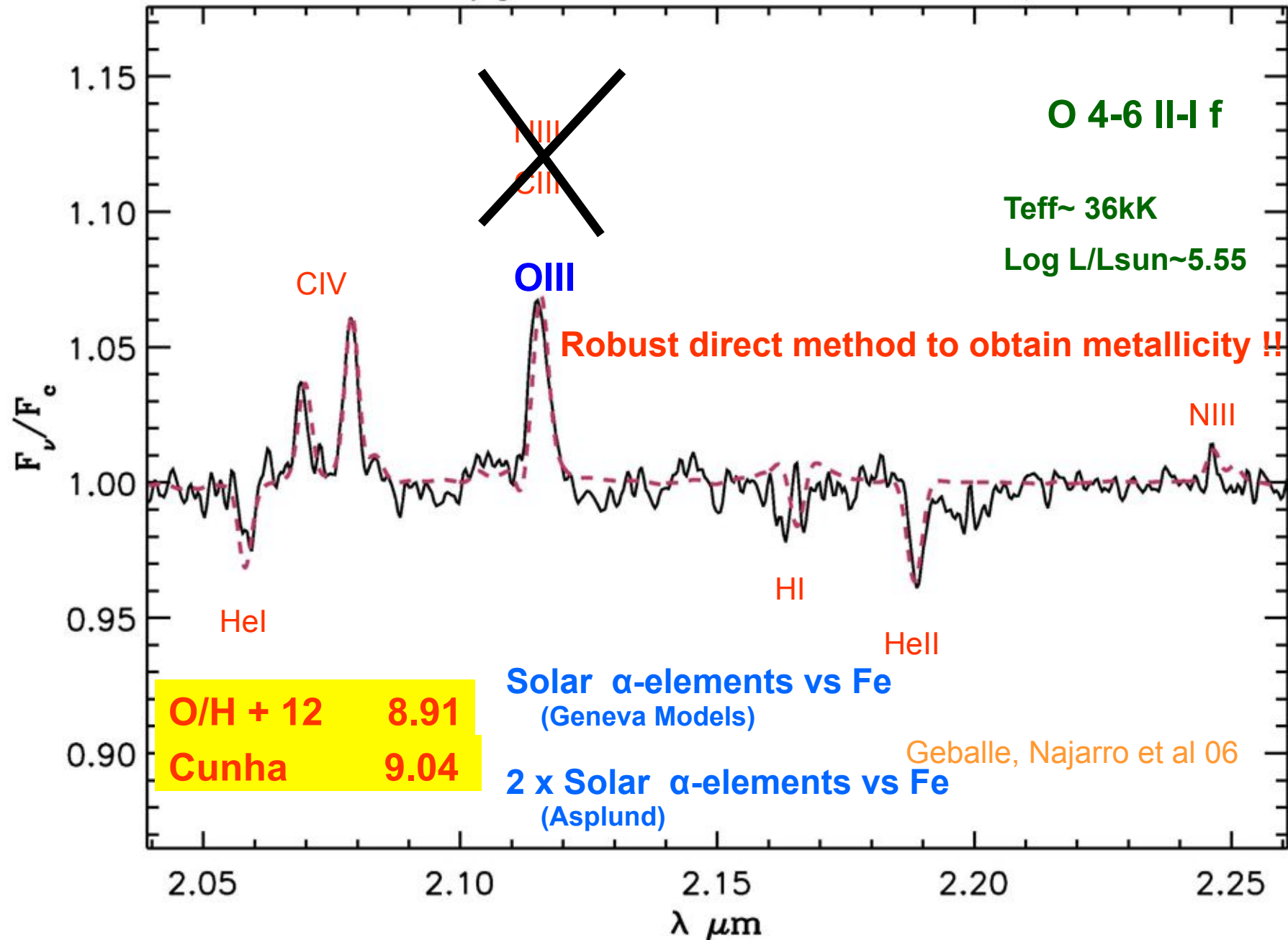


The 2.115 feature in Ostars: new clue for Metallicity estimates?

Hanson et al 96



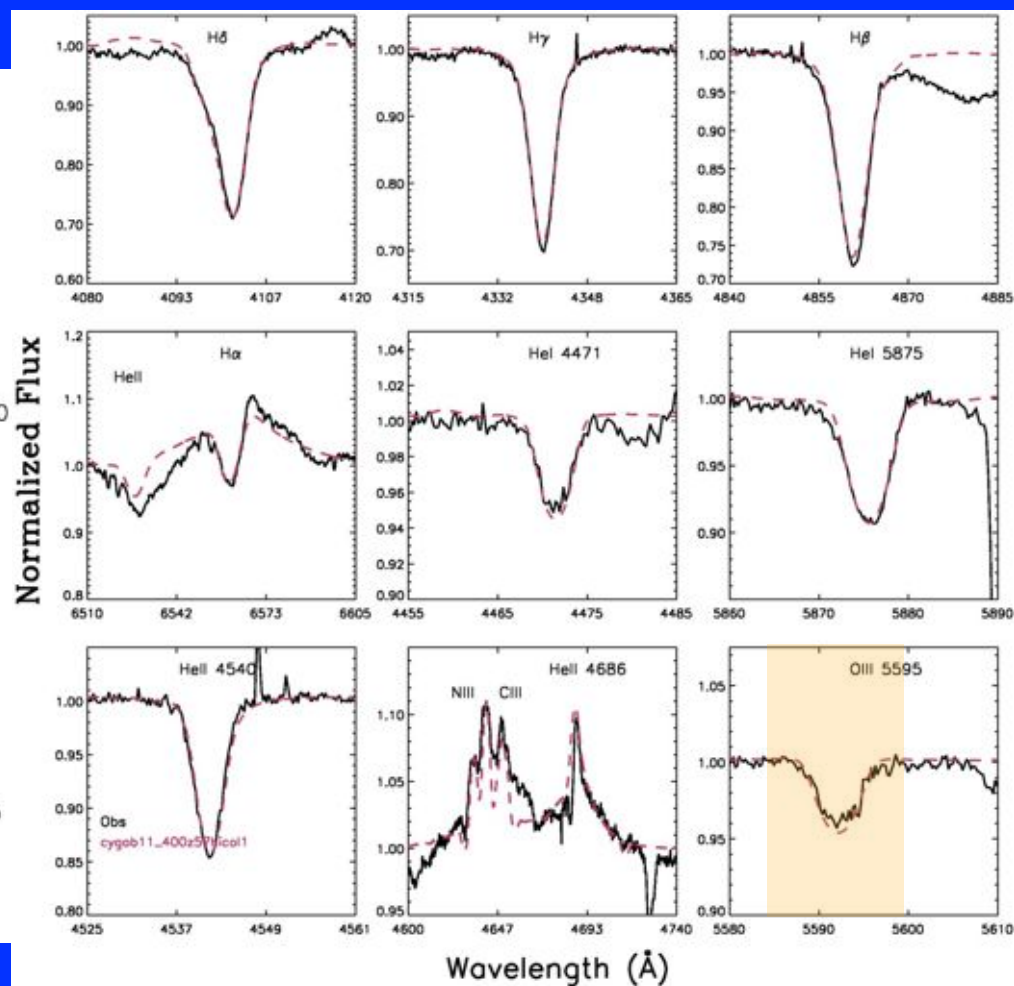
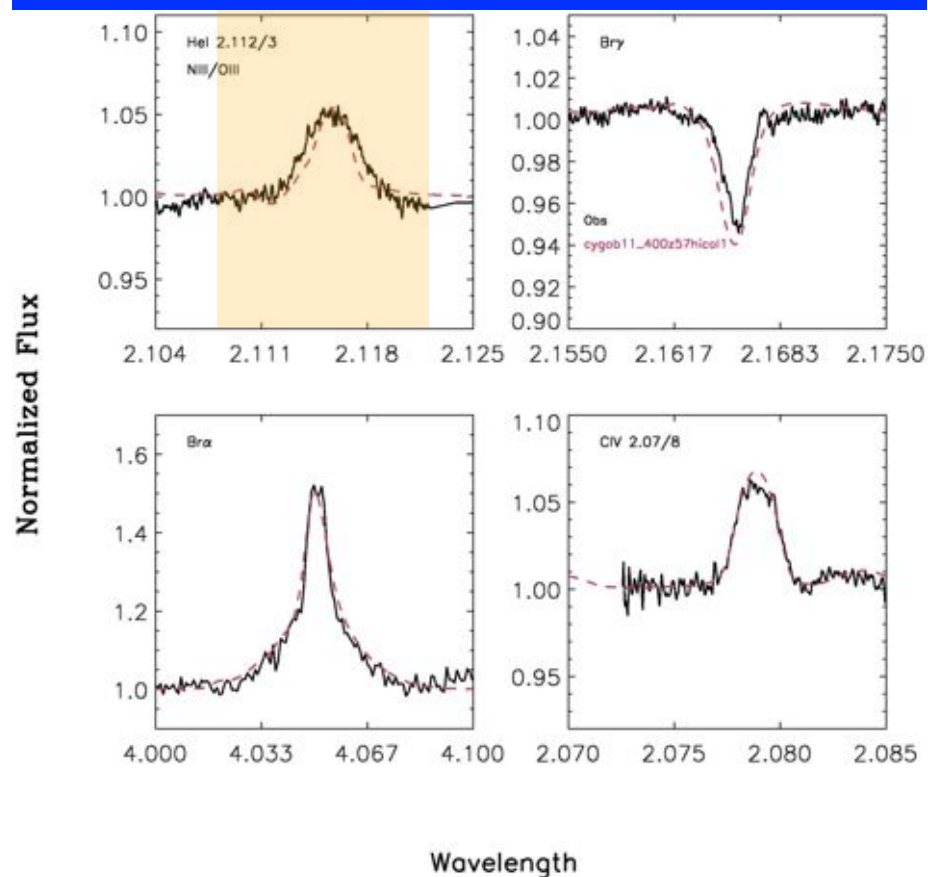
K IRS8 vs MODELS: cygob11_400v FWHM:365.km/s vsini:150.km/s



Calibrating the OIII 2.115 feature

Consistency between optical and IR studies !!!

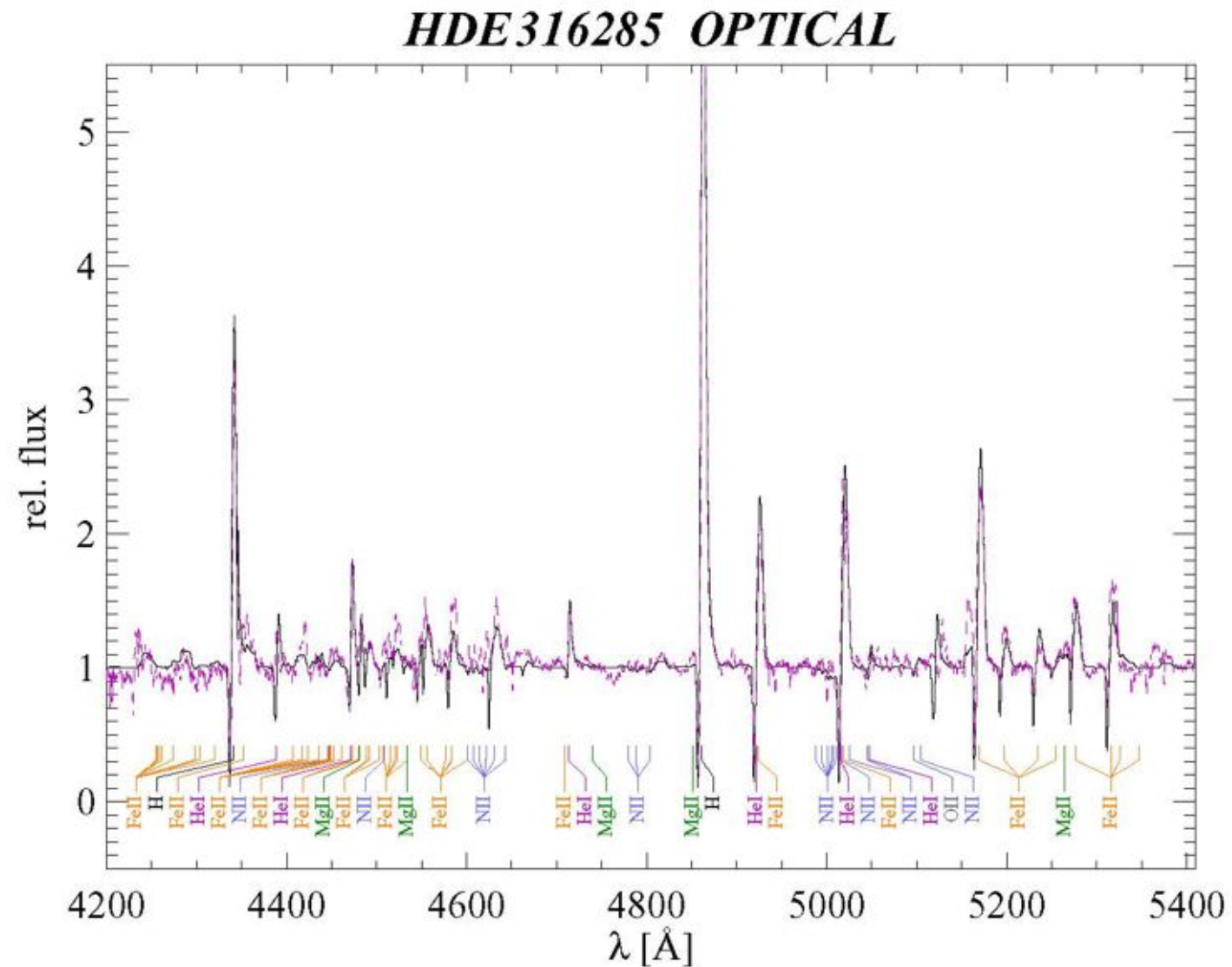
CygOB2 8C O5.5If



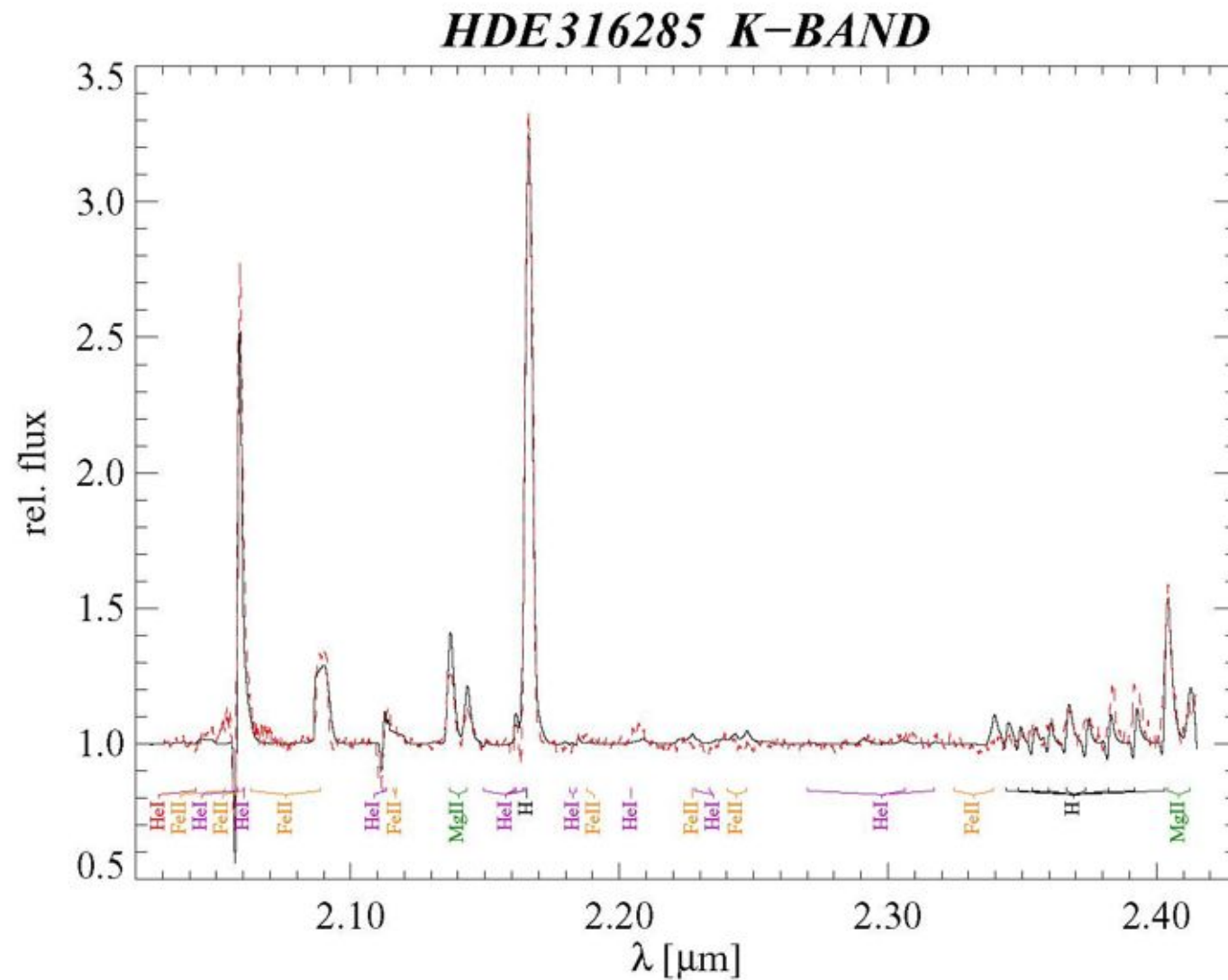
Estimates of metallicity in the IR

- Metallicity from LBV phase (Fe vs α)
 - **Calibrators from Optical-IR studies** (HDE316285)
 - **LBVs in the Quintuplet Cluster** (Pistol Star & #362)

Consistency Test in Optical and IR



Consistency Test in Optical and IR

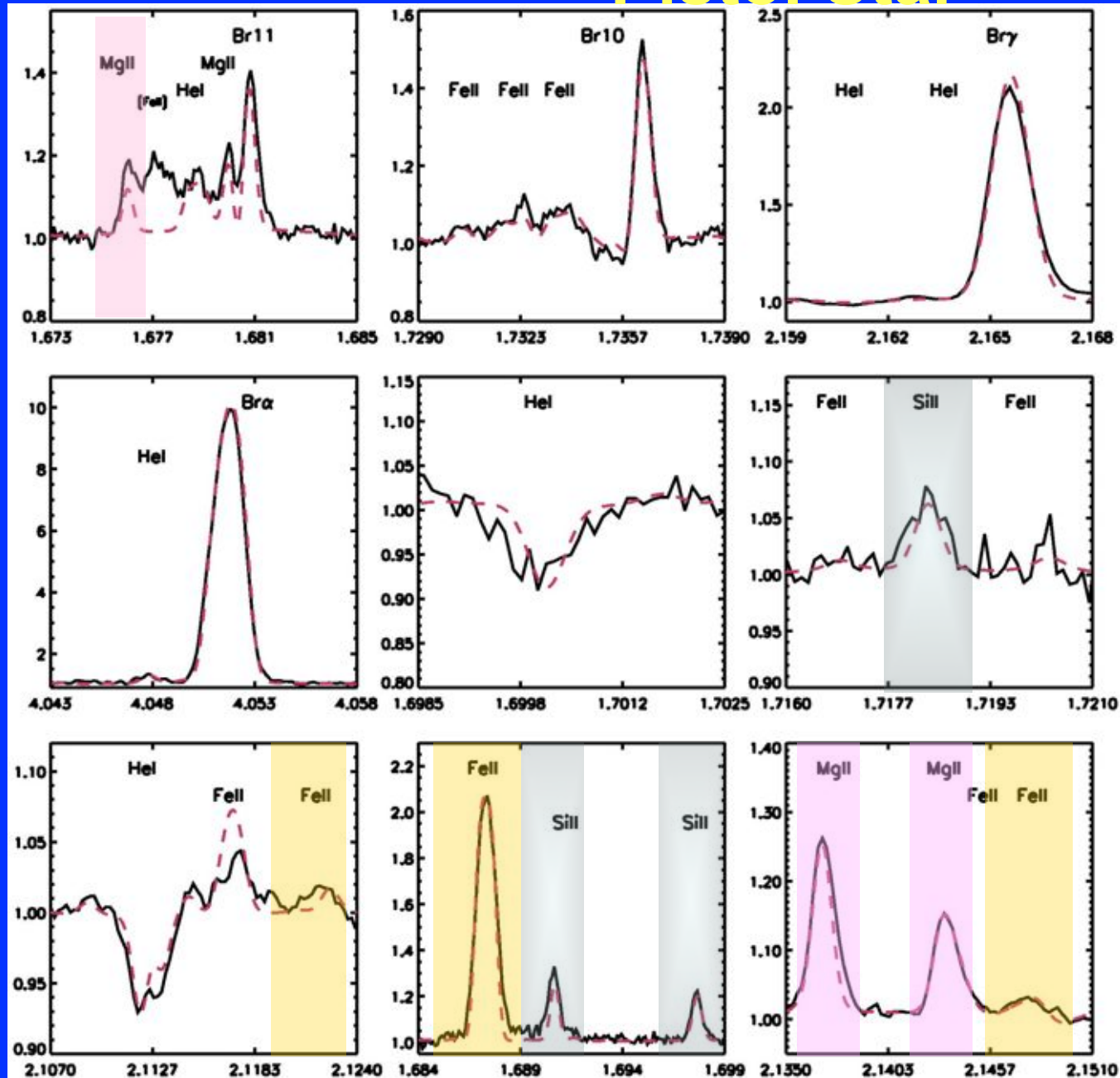


LBVs in the Quintuplet Cluster



Tenerife 15-May-2012

Pistol Star



Fe Solar

Mg 2xSolar

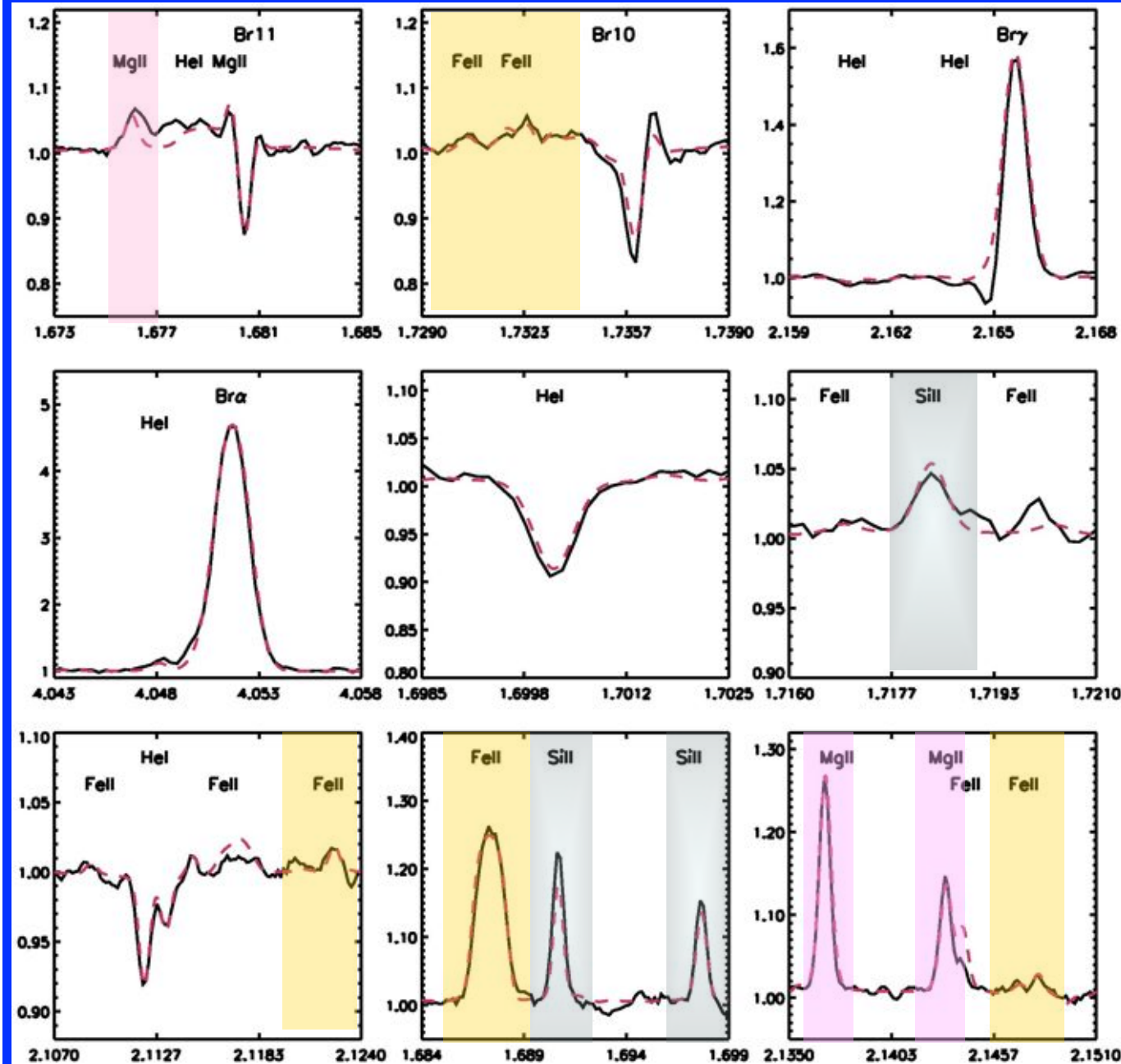
Si 2xSolar

$\alpha/\text{Fe} = 2 !!$

Najarro et al. 2009

Tenerife 15-May-2012

LBV #362



Fe Solar
Mg 2xSolar
Si 2xSolar

$\alpha/\text{Fe} = 2 !!$

Najarro et al. 2009

Tenerife 15-May-2012

Estimates of metallicity in the IR

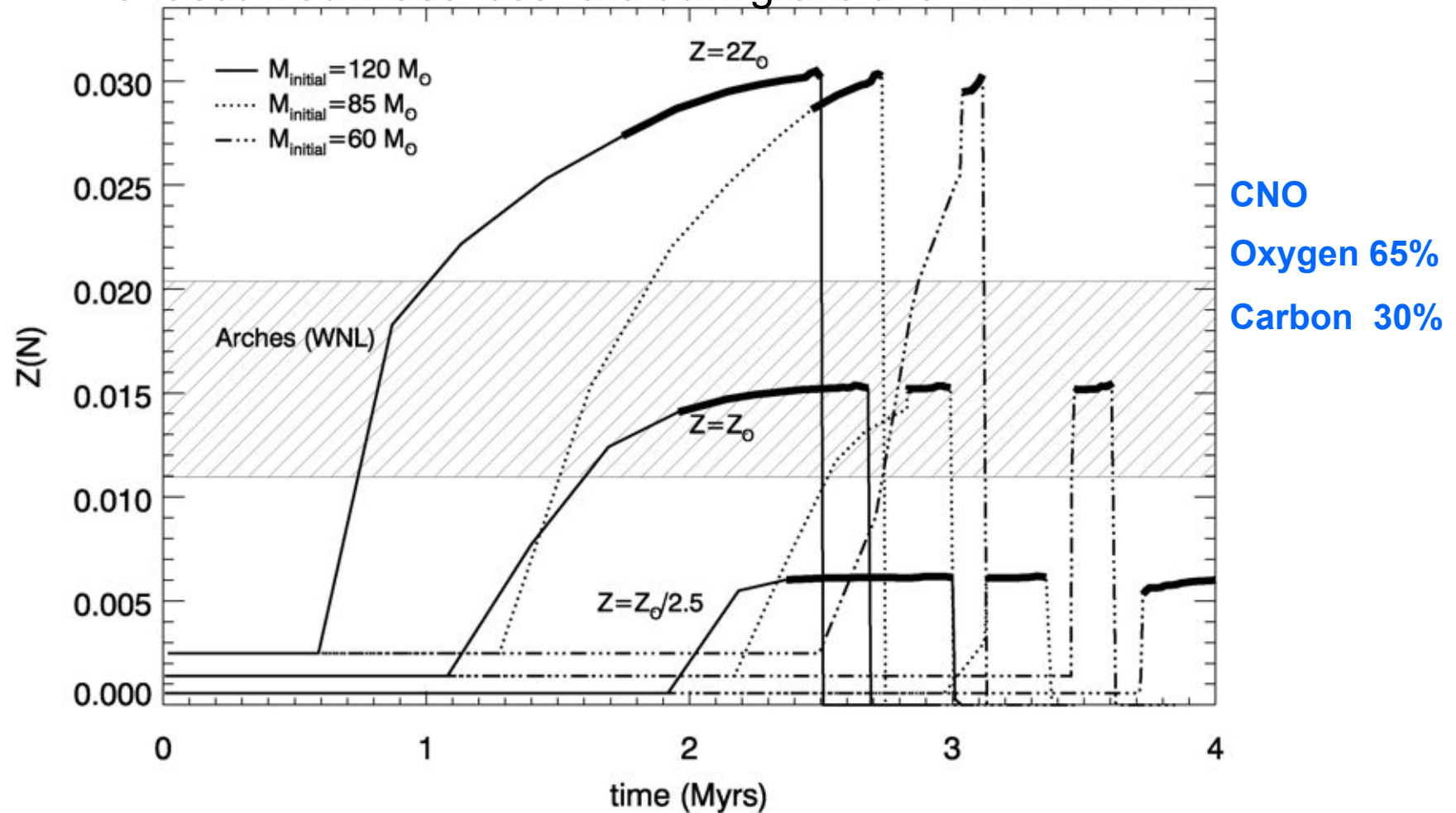
• Indirect methods: WNLs

- Arches Cluster: very young cluster
 - High number of WNLs
 - Significant presence of Olf+ stars

Is it possible to derive metallicity?

Evolutionary models:

- **Maximum N** surface fraction during **WNL** phase
- Nitrogen fraction depends **only on initial CNO** and **NOT** on rotation or assumed mass loss rate during evolution.

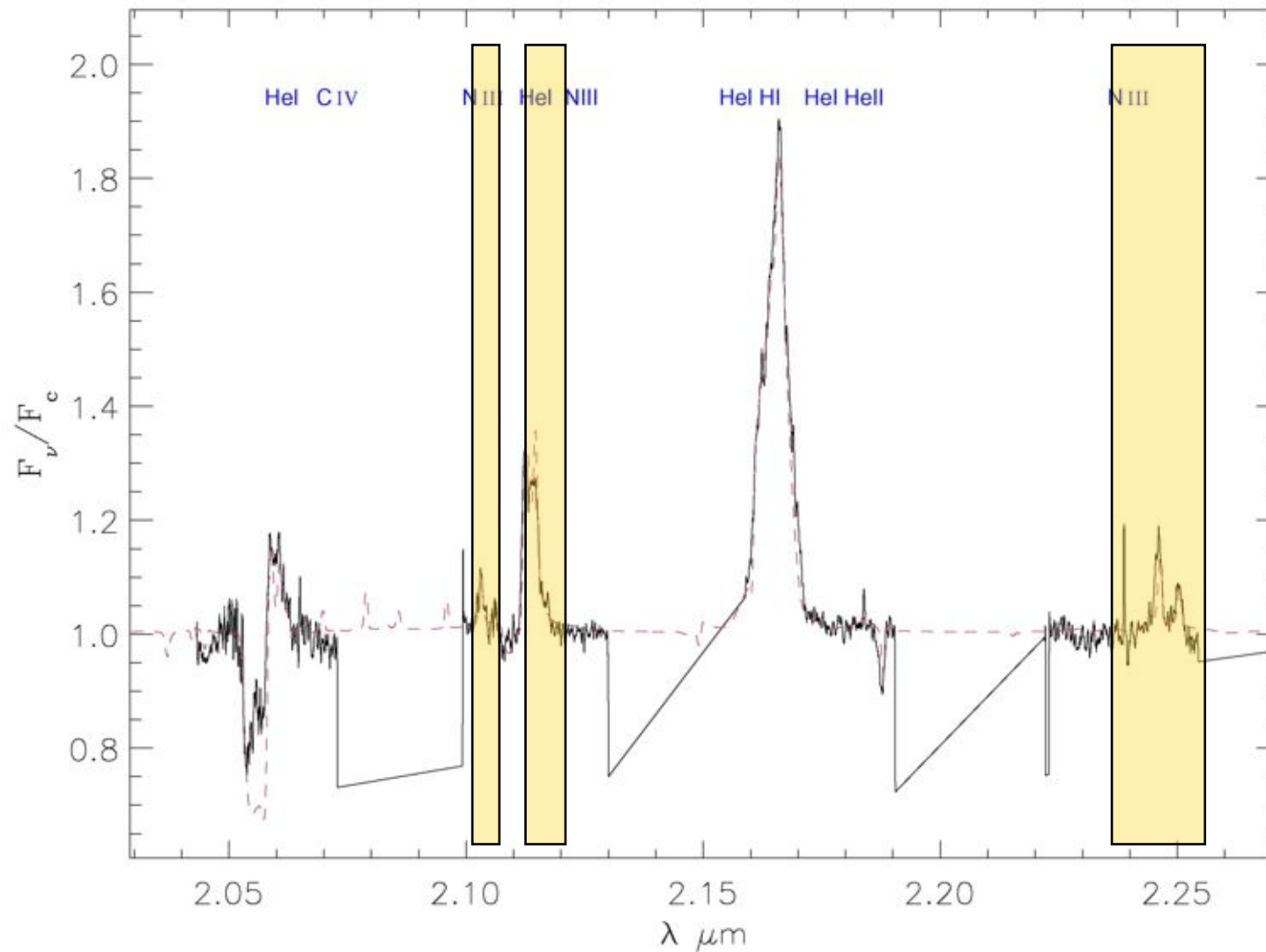


Mainly measure Oxygen (alpha)

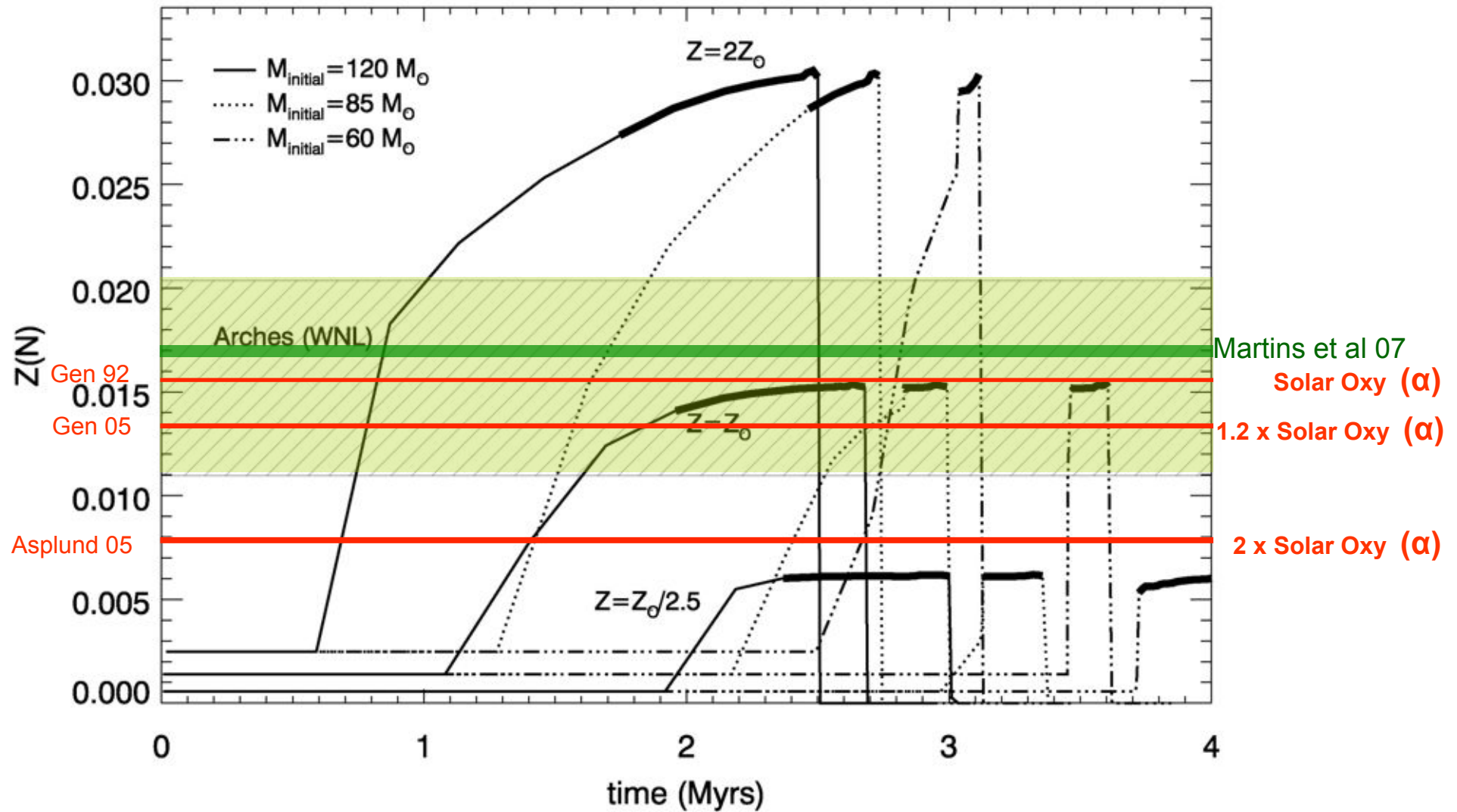
NIRSPEC Observations of the Arches Cluster

#1 ID5 WNL

Najarro et al 2004



Nitrogen as tracer of Metallicity in WNL stars



Najarro et al 2004

Conclusions

- **IR provides diagnostic lines to determine metallicity in young massive stellar clusters at different evolutionary stages.**
- **Galactic Center clusters:**
 - solar Fe abundance
 - Oxygen and α -elements enrichment (2x solar).
 - α -elements vs Fe \rightarrow Top heavy IMF.