The First homogeneous set of stellar parameters of the reference O stars

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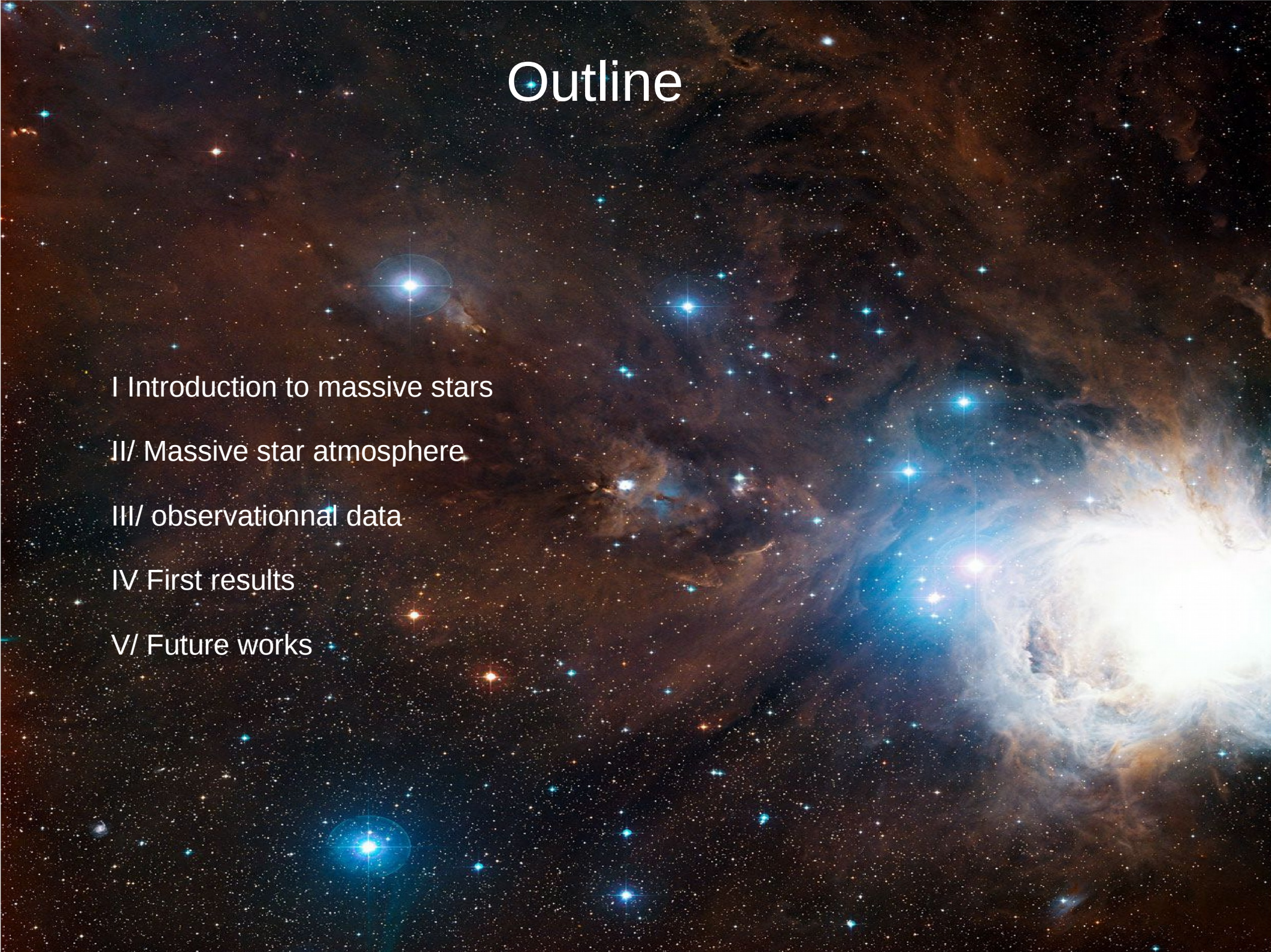


Outline

I Introduction to massive stars

II/ Massive star atmosphere

III/ observationnal data

IV First results

V/ Future works

Introduction to massive stars

Main characteristics:

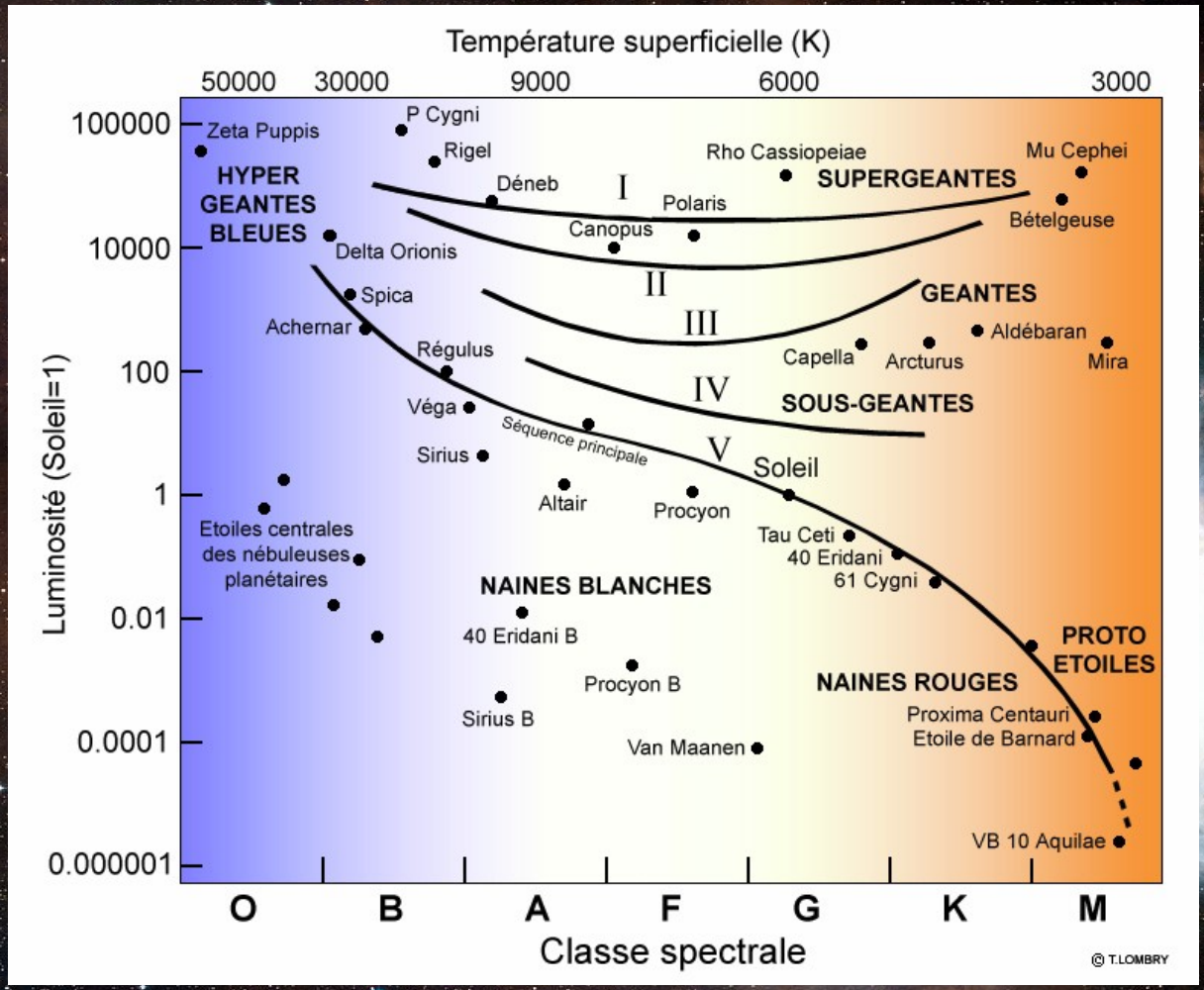
- Mass > 8 M⊙ (lower limit to obtain fusion of Carbon in the core of the star)

- Life time ~ 1-10 million years

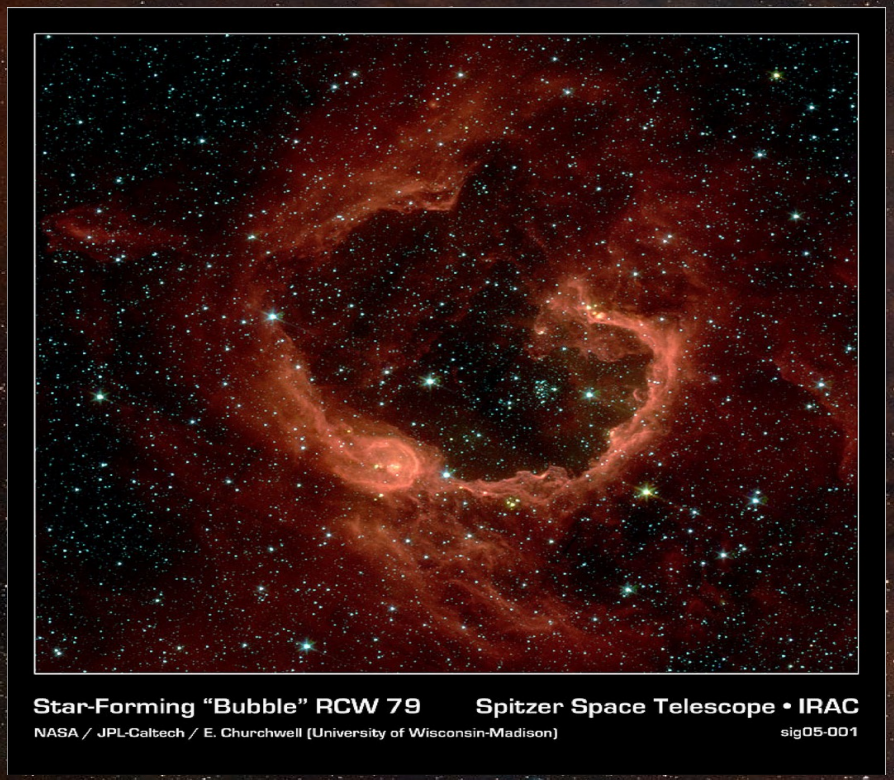
-High effective temperature
15kK < Temperature < 100kK
T⊙= 5800K

-High luminosity
10^5 L⊙ < Luminosity < 10^6 L⊙

- Strong mass loss rate
10^{-8} M⊙/yr < Mdot <10^{-4} M⊙/yr



Introduction to massive stars



Stellar winds:

-Trigger low-mass star formation

-Chemically enrich the Interstellar Medium (ISM)

Supernovae explosions:

Chemically enrich the ISM on larger scales

Introduction to massive stars

For stars initially more massive than ~ 75M⊙
O → WN(H − rich) → LBV → WN(H − poor) → WC → SNIc,

whereas for stars of initial mass from ~ 40 − 75M⊙,
O → LBV → WN(H − poor) → WC → SNIc,

for stars of initial mass in the range 25–40M⊙,
O → LBV/RSG → WN(H − poor) → SNIb.

for stars of initial mass in the range 20–25M⊙,
O → RSG → WN → SNII/ Ib
And for stars of initial mass in the range 10-20M⊙
OB → RSG → BSG → SN II

Massive star atmosphere

- High luminosity radiative processes dominate over collisional → processes
⇒ Non LTE treatment mandatory

- Strong stellar winds → typical scale of the atmosphere >> stellar radius
⇒ Spherical geometry mandatory
→ velocity gradients
⇒ Doppler shifts and non local photon / matter interaction

- Presence of metals: UV spectrum dominated by metallic lines
⇒ Line-blanketing effects

Codes:
- CMFGEN (Hillier & Miller 1998)

Spectral type and luminosity class determination

In 70's Walbon identified key lines which varying across the population of O stars :

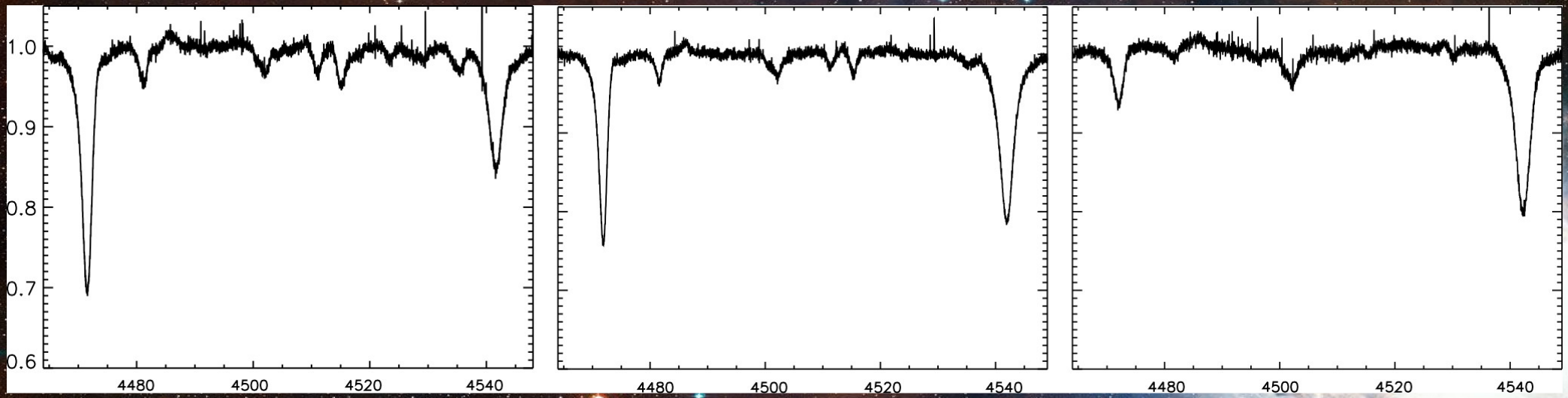
He develops a 2 dimension classification :

- spectral type from O9.7 to O4
- luminosity class from dwarf (V) to brigth supergiant supergiant (Ia)

This classification is still relevant today

Spectral type and luminosity class determination

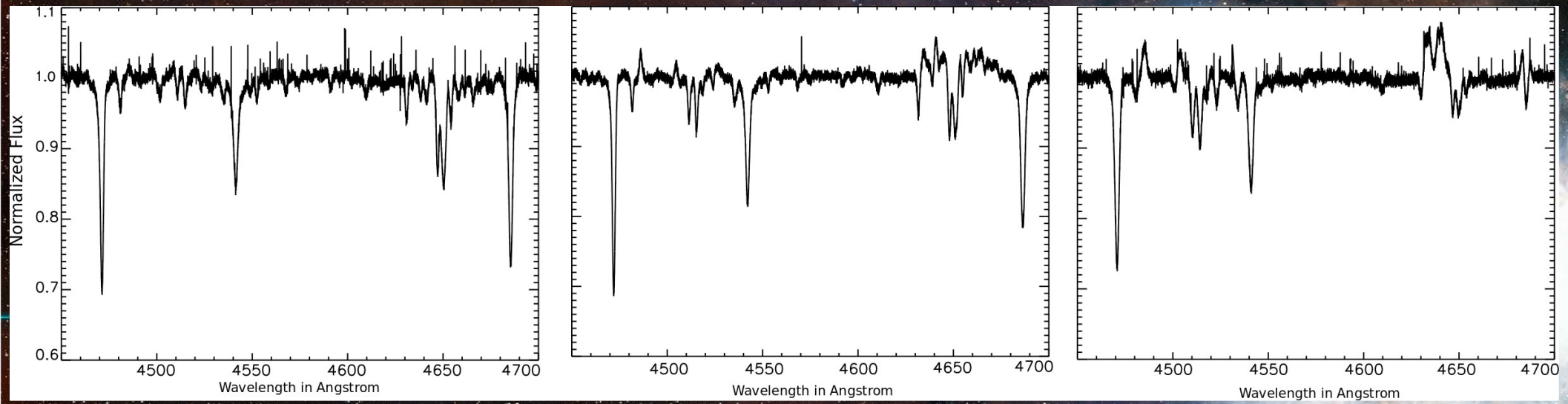
The relative strength of the HeI and HeII lines is used to define the spectral type.



HD191978 HD42088 HD46223

Spectral type and luminosity class determination

the ratio of HeI and Si IV lines are used to determine the luminosity class



HD191978

Lambda Ori

HD225160

Spectral Classification Standards

	V	IV	III	II	Ib	Iab/I	Ia
O2						*HD 93 129 AaAb*	
O3	*HD 64 568*		...			Cyg OB2-7	
O3.5	*HD 93 128*		*Pismis 24-17*			*Pismis 24-1 AB*	
O4	**HD 46 223** *HD 96 715*		**HD 168 076 AB** *HD 93 250*			HD 15 570 HD 16 691 HD 190 429 A	
O4.5	HD 15 629 *HDE 303 308*		Cyg OB2-8 C			HD 14 947 Cyg OB2-9	
O5	**HD 46 150** *HDE 319 699*		**HD 168 112** *HD 93 403* *HD 93 843*			*CPD -47 2963*	
O5.5	*HD 93 204*		...			Cyg OB2-11	
O6	HD 42 088 *HDE 303 311*	*HD 101 190*	...	HDE 229 196	...	...	**HD 169 582**
O6.5	*HD 91 572* HD 12 993	*HDE 322 417*	HD 190 864 *HD 96 946* *HD 152 723* *HD 156 738*	**HD 157 857**	...	...	*HD 163 758*
O7	*HD 93 146* HDE 242 926 *HD 91 824* *HD 93 222* **15 Mon AaAb**	...	Cyg OB2-4	*HD 94 963* *HD 151 515*	*HD 69 464* HD 193 514	...	...
O7.5	*HDE 319 703 A* *HD 152 590*	...	*HD 163 800*	HD 34 656 **HD 171 589**	HD 17 603 *HD 156 154*	HD 192 639 **9 Sge**	...
O8	HD 191 978 *HD 97 848*	*HD 97 166*	*HDE 319 702* **λ Ori A**	*HD 162 978*	**BD −11 4586**	HD 225 160	*HD 151 804*
O8.5	**HD 46 149** *HD 57 236* HD 14 633	**HD 46 966**	*HD 114 737* HD 218 195 A	*HD 75 211*	*HD 125 241*	...	*HDE 303 492*
O9	10 Lac HD 216 898	*CPD -41 7733* *HD 93 028*	HD 24 431 *HD 93 249* HD 193 443 AB	*τ CMa* HD 207 198 *HD 71 304*	19 Cep	HD 202 124 *HD 148 546* *HD 152 249*	*α* Cam
O9.5	AE Aur **HD 46 202** HD 12 323	HD 192 001 *HD 93 027* *HD 155 889* *HD 96 622*	*HD 96 264*	*δ* **Ori AaAb**	*HD 76 968*	HD 188 209 *HD 154 368* *HD 123 008*	...
O9.7	*υ* **Ori**	HD 207 538	HD 189 957 *HD 154 643*	*HD 68 450* *HD 152 405* HD 10 125	**V689 Mon**	HD 225 146 *HD 75 222* *μ Nor*	HD 195 592 **HD 173 010** *HD 105 056* *HD 152 424*

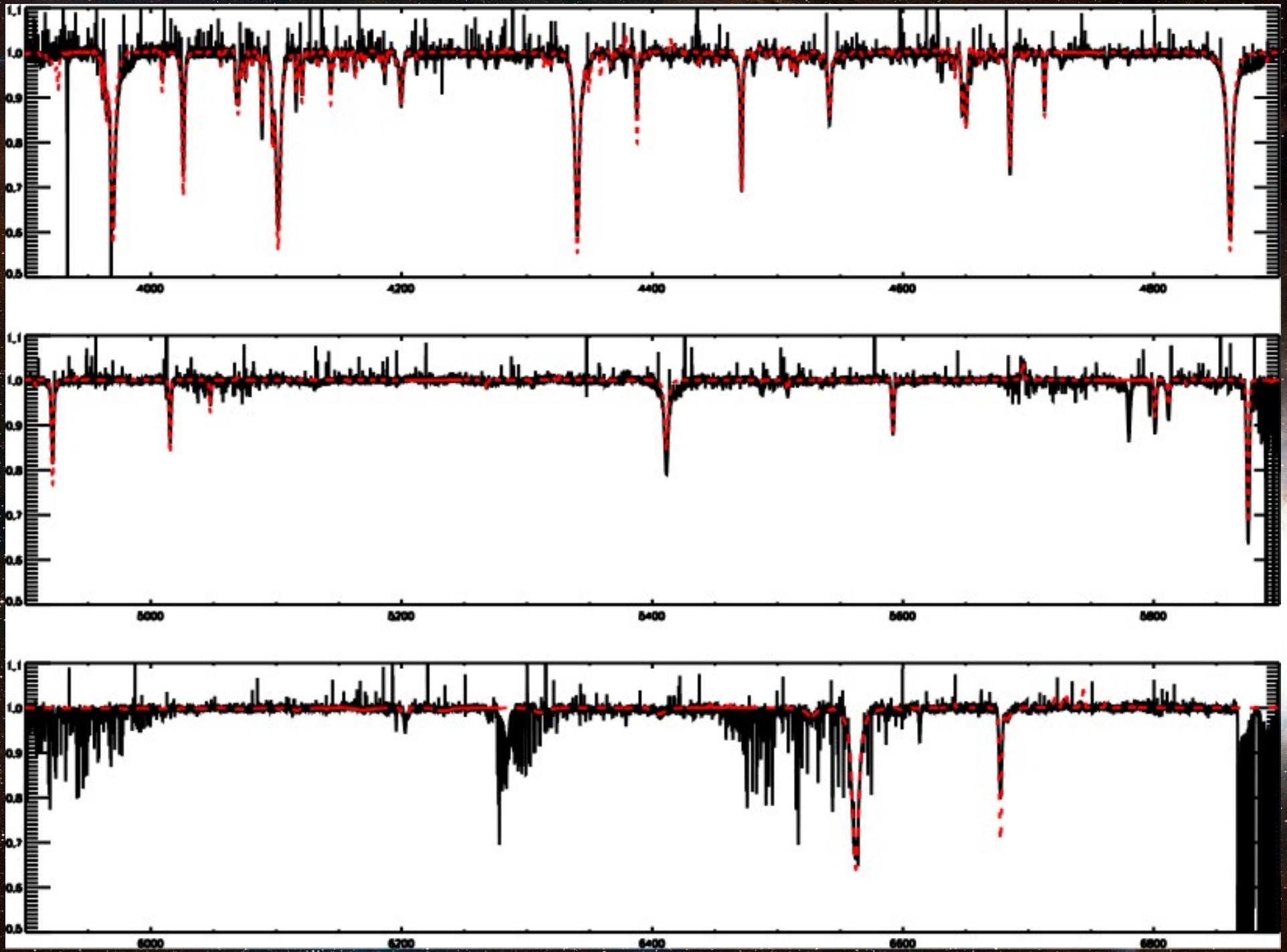
Observation

- Observations with SOPHIE (R=40000) on the 193 cm at OHP for the north hemisphere stars
  - 5 nights in August 2014
  - 1 night in december 2014
  - SNR ~ 300

- FEROS (R=48000) archive for the star in the south hemisphere

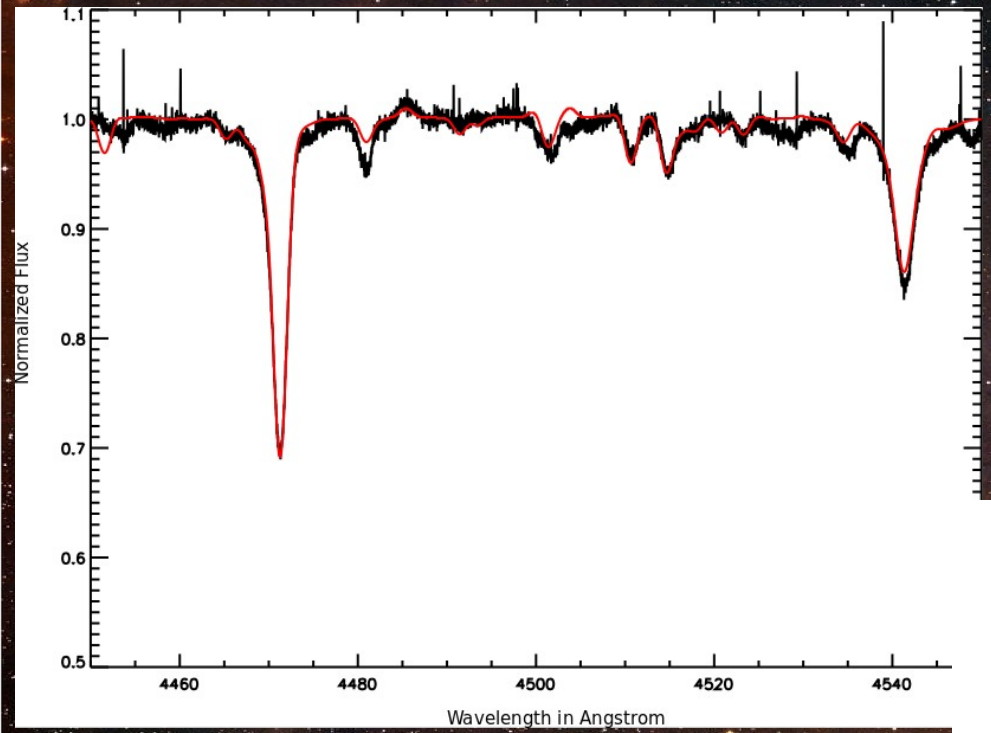
- IUE and HST archive for the UV spectra

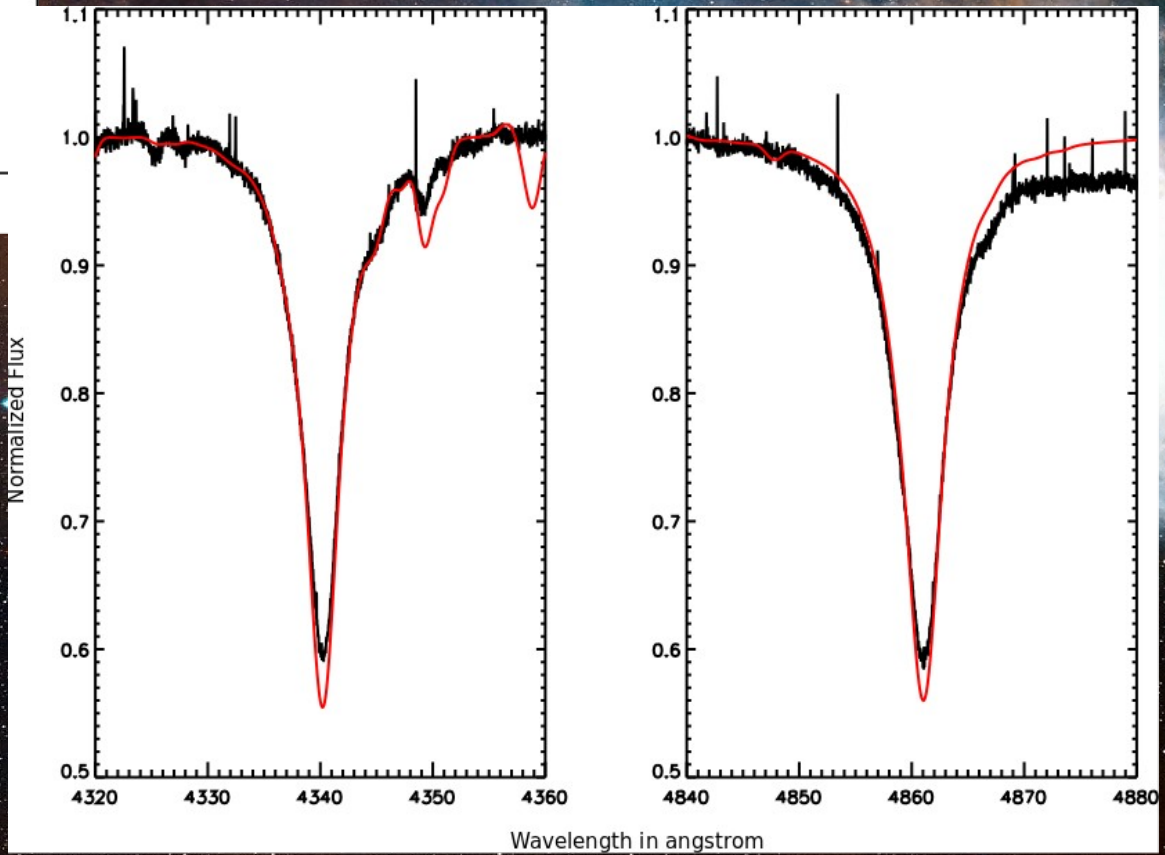
First results



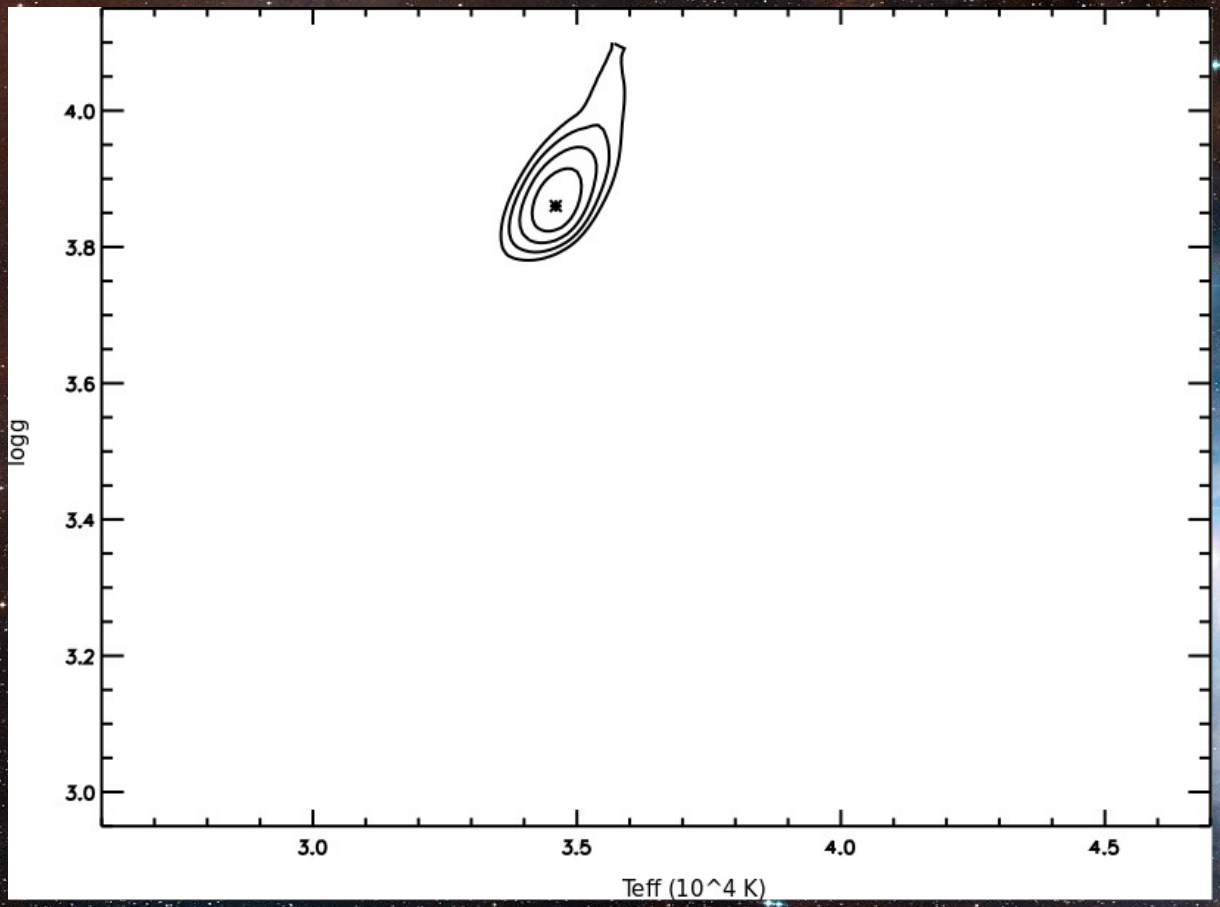
HD191978

First results

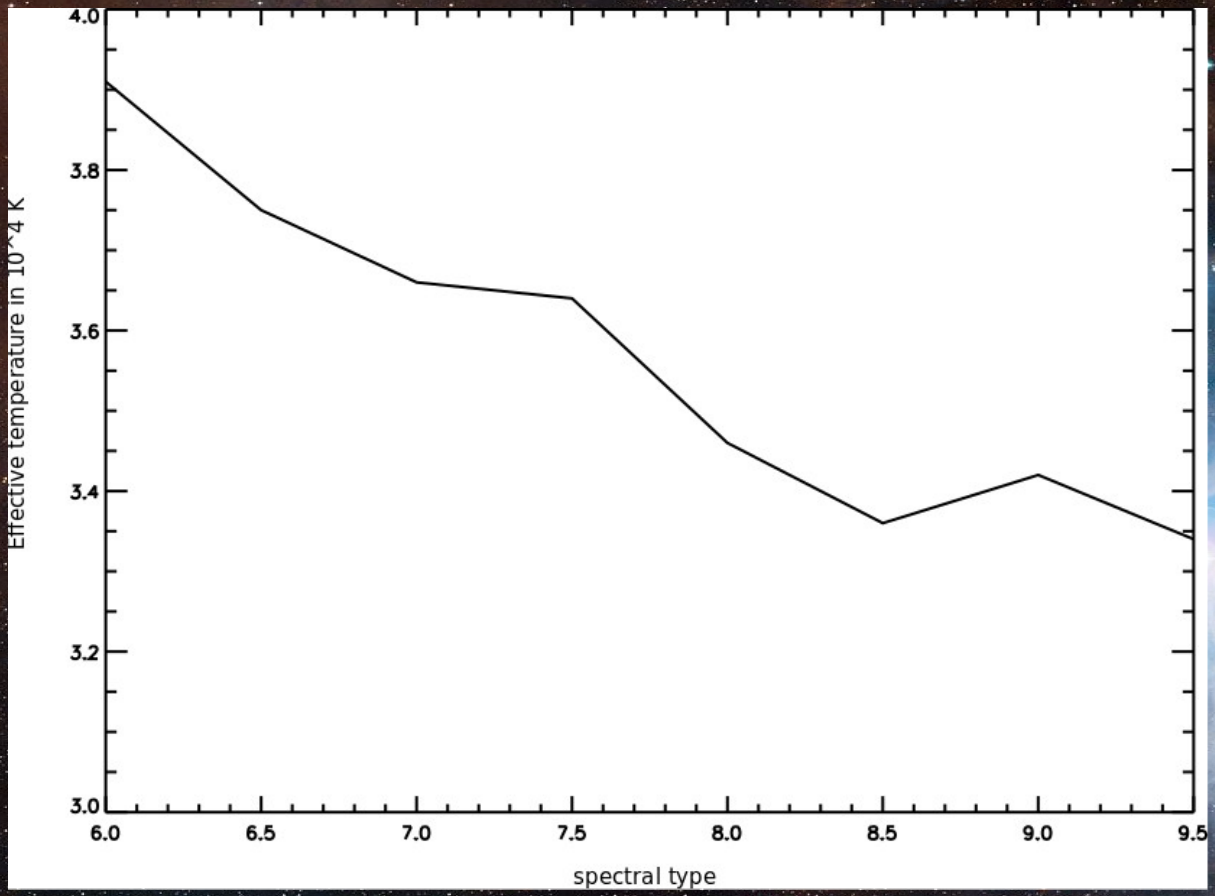




First results



First results



Future works

Determination of the stellar and wind parameters for all the standard O-type stars :

- Effective temperature
- surface gravity
- mass loss rate and clumping
- CNO abundances