



RECENT RESULTS FROM VEGA

Denis Mourard, OCA-FIZEAU

With contributions from

Philippe Bériro, Omar Delaa, Roxanne Ligi, Nicolas Nardetto, Karine Perraut, Frédéric Thévenin,

And support from

Daniel Bonneau, Jean-Michel Clausse, Olivier Chesneau, Florentin Millour, Philippe Stee, Alain Spang, Isabelle Tallon-Bosc

FIZEAU-Nice, LAOG-Grenoble, CRAL-Lyon





Summary

- Rapid summary of 2010 papers
- General presentations of programs that have been engaged
- Example of works on
 - Circumstellar environment: ϵ Aur
 - Stellar atmospheres : Chromospheres of K giant stars
 - Fundamental parameters:
 - Diameter and effective temperature of HD 49933
 - Rotation of α Cep
- Conclusion on new large programs: Limb Darkening et Surface Brightness



2010/2011 results

Papers published in 2010/2011

- The H α line forming region of AB Aur spatially resolved at sub-AU
- Time, spatial and spectral resolution of the H α line-formation region of Deneb and Rigel
- An investigation of the close environment of β Cep
- The fundamental parameters of the roAp star γ Equ
- Kinematics and geometrical study of the Be stars 48 Per and psi Per

Papers submitted

- A large H α line forming region for the massive interacting binaries β Lyrae and υ Sagittarii
- The binary Be star δ Sco at high spectral and spatial resolution: I. Orbital elements, disk geometry and kinematics before the 2011 periastron



Works in progress

Papers in preparation:

- ✓ Chromospheres of K giant stars: Spatial structure determination
- ✓ VEGA/CHARA diameter to constrain T_{eff} of HD 49933
- ✓ High angular and spectral resolution views on the complex system of ϵ Aurigae
- ✓ Determination of the position angle of the fast rotator α Cephei

Programs needing more processing, analysis or data

θ Cyg

P Cyg

48 And and sub-giants study

β Cas

γ Cas

θ_1 OriC

YSO: AB Aur and MWC 361

ρ Cas

λ Tau

Sirius

Orion supergiants

Bn stars



Summary

- Rapid summary of 2010 papers
- General presentations of programs that have been engaged
- **Example of works on**
 - **Circumstellar environment: ϵ Aur**
 - **Stellar atmospheres : Chromospheres of K giant stars**
 - **Fundamental parameters:**
 - **Diameter and effective temperature of HD 49933**
 - **Rotation of α Cep**
- Conclusion on new large programs: Limb Darkening et Surface Brightness



Summary of existing VEGA data on ϵ Aur

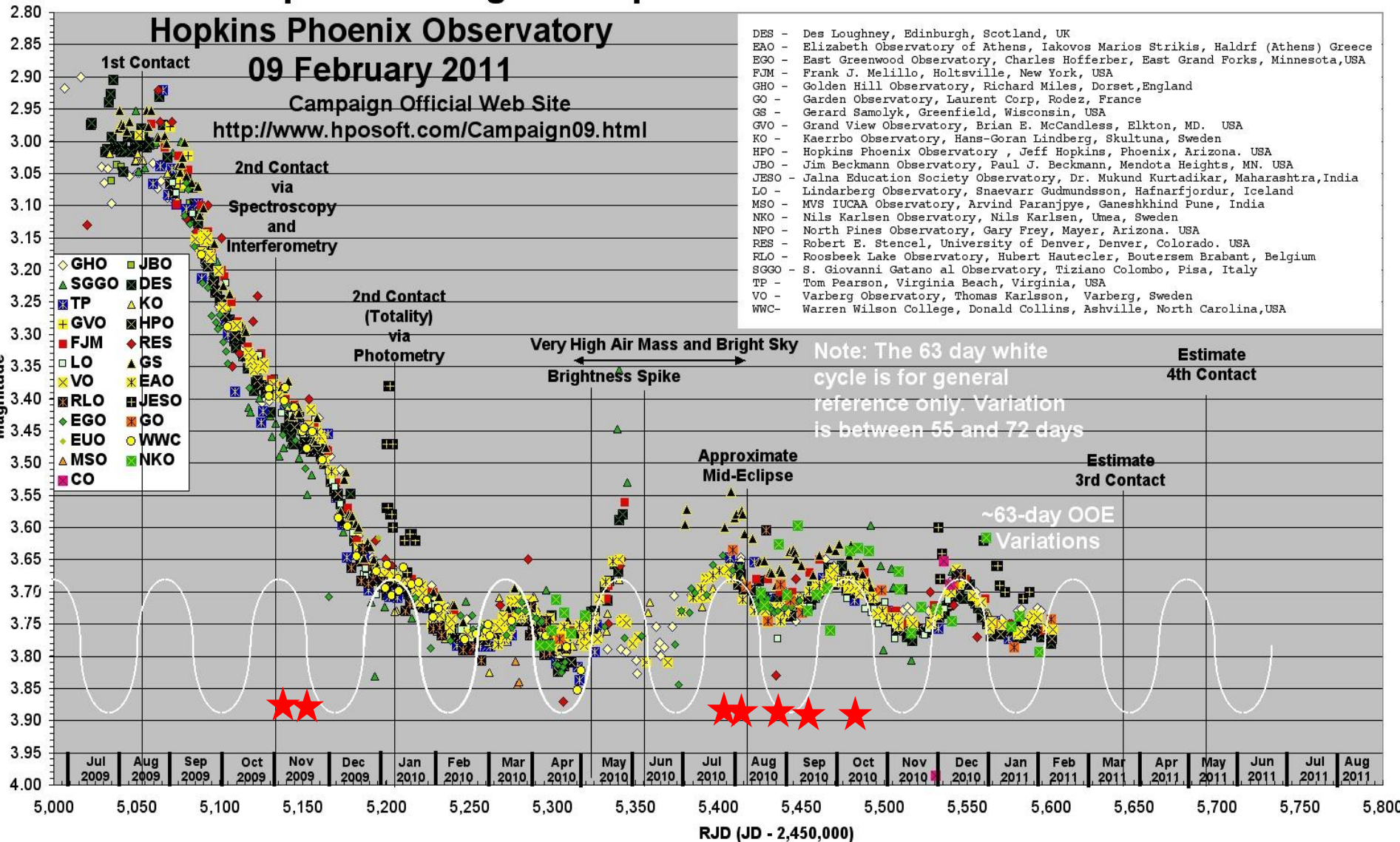
S1S2 baseline only. High Spectral Resolution, no calibrators.
For november 2009 and october 2010. A few points in MR with cal.

Date	Phase	H α	KI	NaD
2009.11.05	Start of second contact	2		
2009.11.17	“	3		
2010.07.31	Mid-eclipse	1	1	
2010.08.01	“	1		1
2010.08.26	“	1		
2010.08.27	“	2	1	1
2010.09.17	“	2	1	
2010.09.18	“	2		1
2010.10.11	“	2	2	1



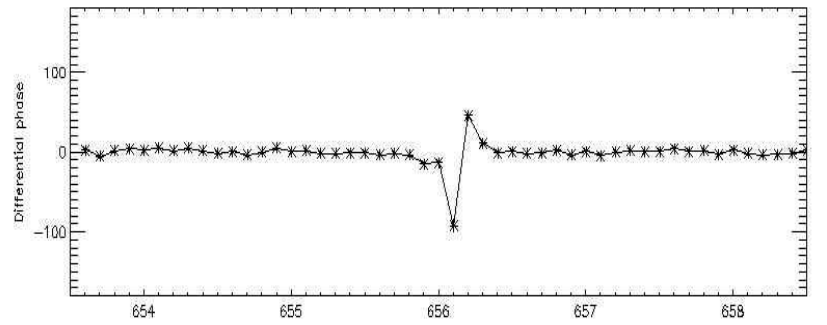
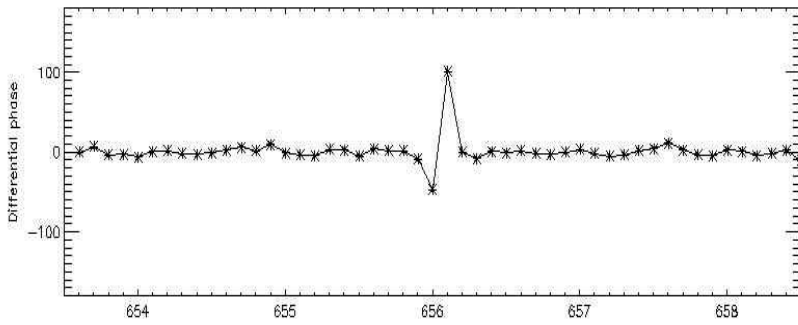
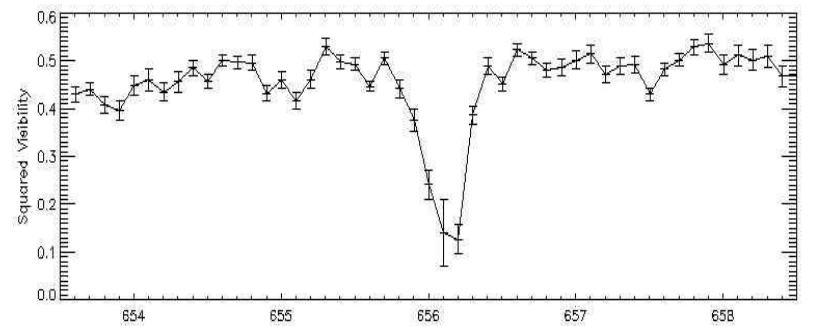
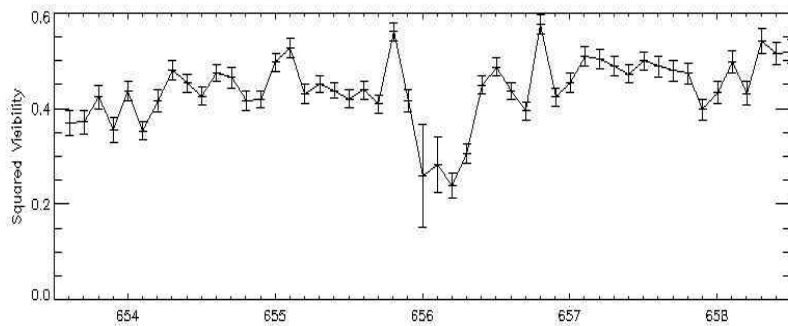
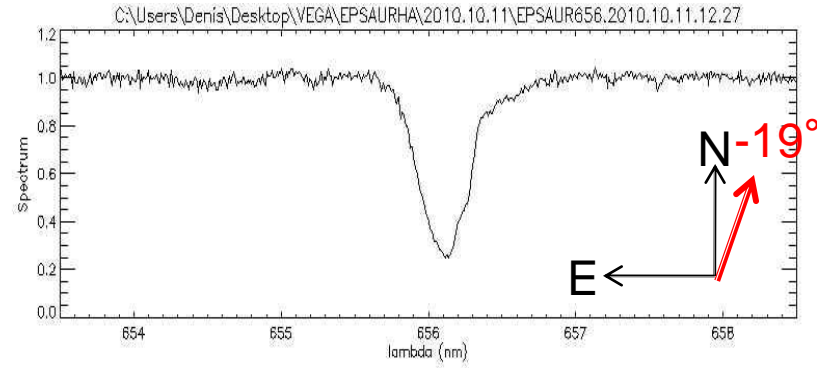
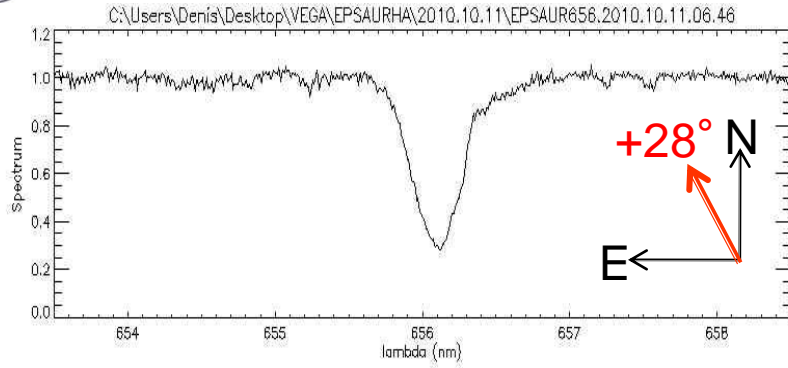
Photometry of ϵ Aur

Epsilon Aurigae Eclipse 2009/2011 V Band Data





One example of H α differential measurements



LESIA



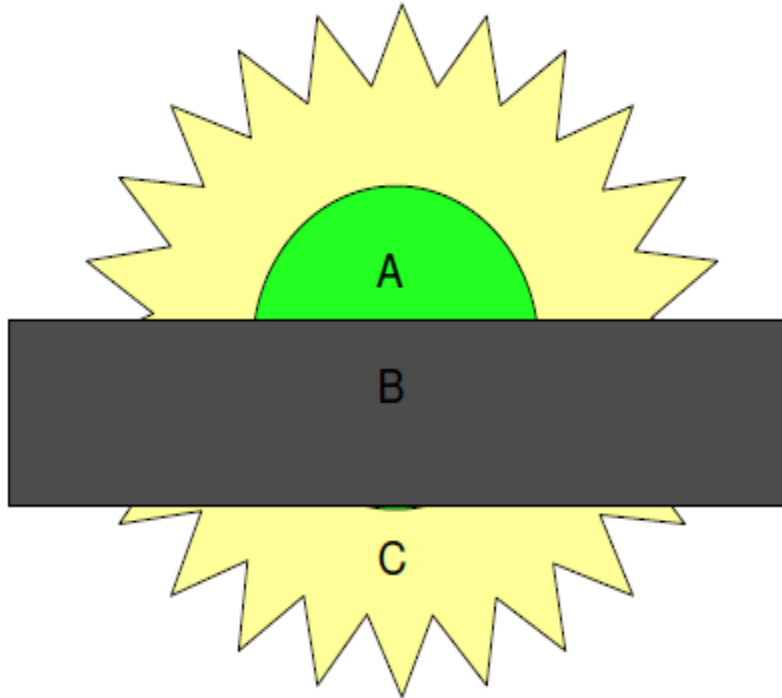
Observatoire de la CÔTE d'AZUR



Modeling for interpretation

Collaboration with Dr. Stencel group

The eclipse's hunter!



Zones for VEGA eps Aur model 2011A:

A: F star photosphere (always brightest)

B: dark disk & its atmosphere, including central jets (above and below plane) or in-plane/near-plane 'brightening' ($H\alpha$)

C: F star "chromosphere" which may include equatorial ring, prominence-like structures

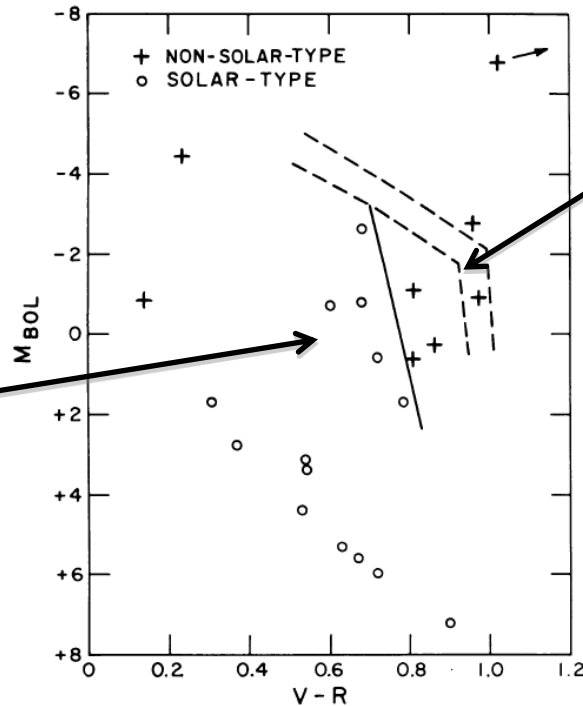


K giant stars program

Goals:

- Study the structure of the chromosphere of red giant stars (K-type)
- Investigation on the Linsky-Haisch dividing line in the H-R diagram

Linsky&Haisch, ApJ, 1979



Solar-type giant stars:

- Chromosphere
- Transition region
- Coroneae

Non-solar-type giant stars:

- Extended Chromosphere only



Method:

- Observation in chromospheric lines (CaII triplet and H α) and in the continuum
 - Estimation of the limb-darkened diameter in the continuum
 - Estimation of the extension of the forming region of the different chromospheric lines => global extension and structure
- High Spectral Resolution mode for observations in the chromospheric lines
- Medium Spectral Resolution mode for observations in the continuum (790nm and 620nm)
- Short baseline S1S2

HD	Name	Spectral Type	m_V	$V - R$
4128	β Ceti	K0III	2.02	0.72
6805	η Ceti	K2III	3.45	0.83
98430	δ Crateris	K0III	3.56	0.83
127665	ρ Bootis	K3III	3.59	0.92
161096	β Ophiucus	K2III	2.77	0.82
169414	109 Herculis	K2III	3.84	0.85
216228	ι Cephei	K0III	3.53	0.83



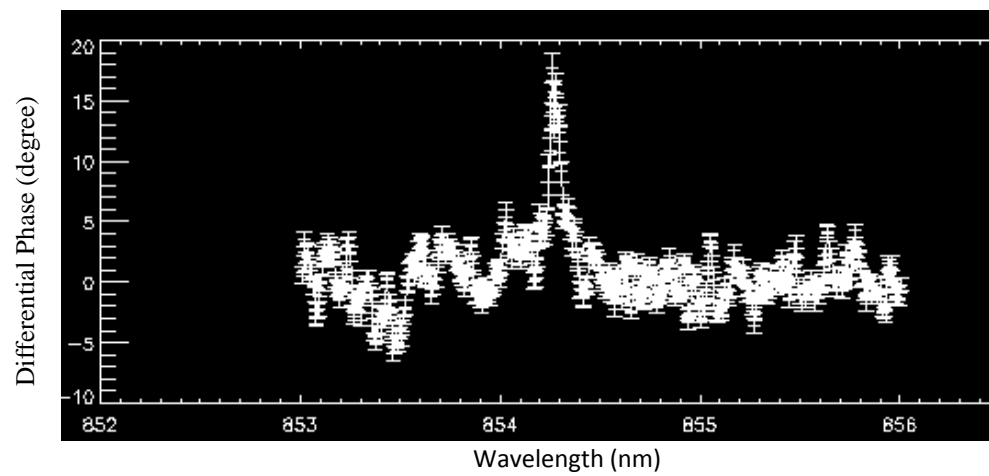
Chromosphere extension

STAR	Chromosphere Ratio			
	R849/790	R854/790	R866/790	R656/790
delta Crt		1,2		1,24
beta Ceti	1,01	1,10	1,14	
rho Boo		1,16	1,13	
eta Ceti	1,09	1,24	1,32	
beta Oph				
iota Cep	1,7	1,93	2,04	
109 Her				

STAR	Chromosphere Ratio Error			
	R849/790	R854/790	R866/790	R656/790
delta Crt		0,002		0,06
beta Ceti	0,013	0,05	0,05	
rho Boo		0,08	0,12	
eta Ceti	0,06	0,07	0,09	
beta Oph				
iota Cep	0,15	0,17	0,83	
109 Her				

Signature in the differential phase

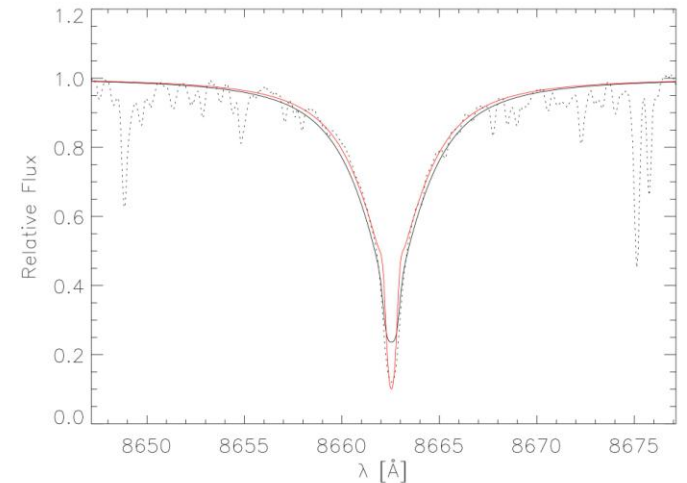
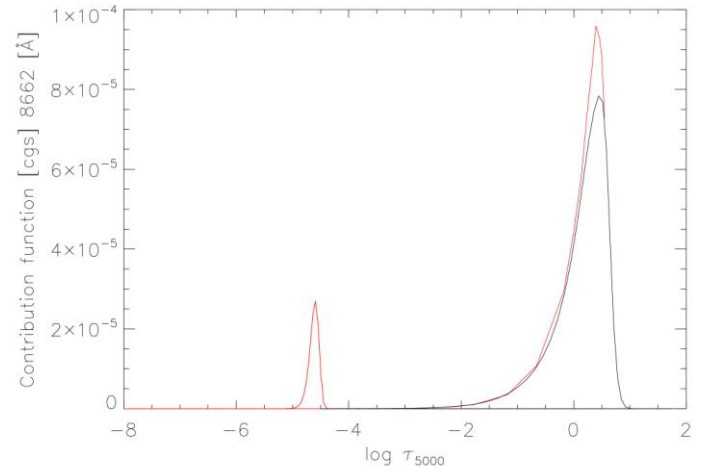
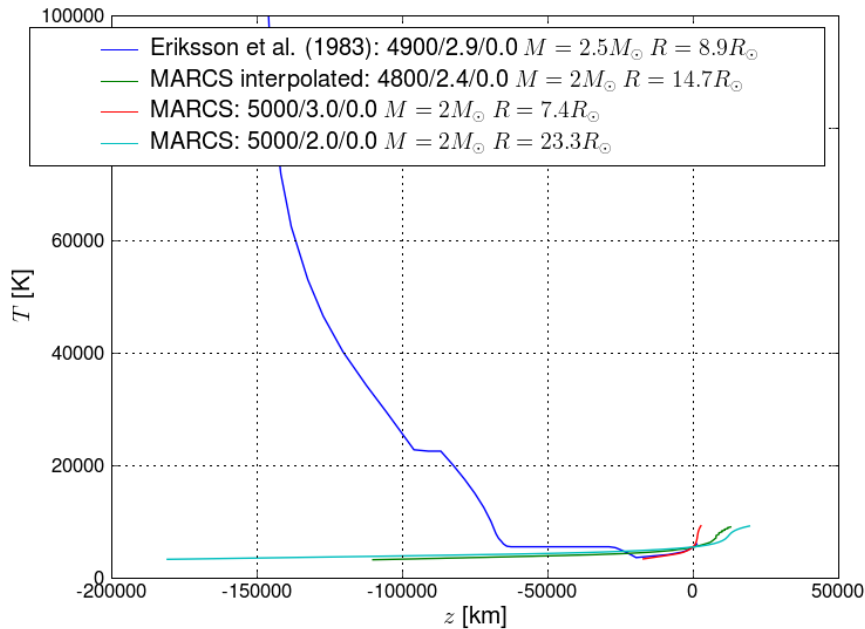
=> nonsymmetric chromosphere, structures at the stellar surface ?





Modelization of β Ceti

Model MARCS + Eriksson Chromosphere Model
Code MULTI: non-LTE spectral line computations



=> Starting from the Eriksson model, we attempt to determine the temperature and density profile in order to reproduce spectrometric and interferometric features in the Call IR triplet and the MgII UV doublet.



LESIA

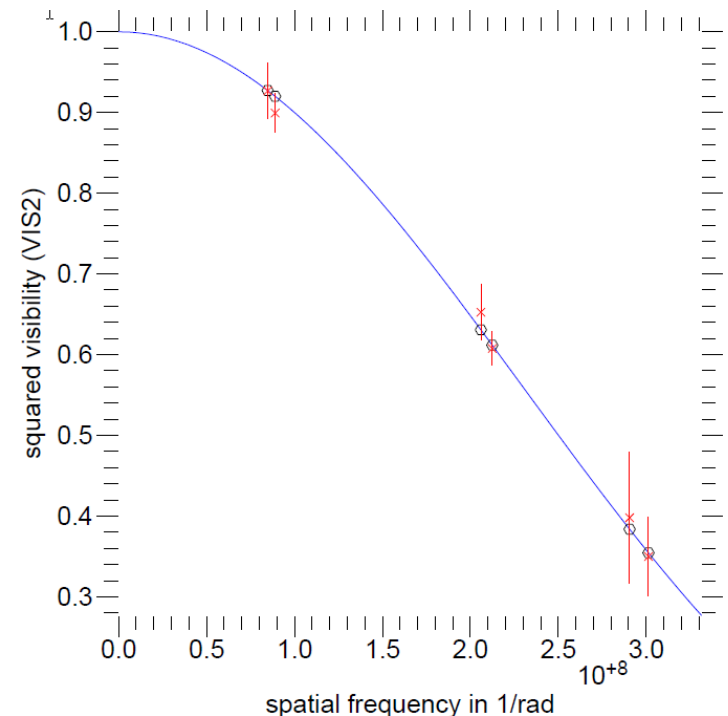


Observatoire de la CÔTE d'AZUR



The CoRoT Target: HD49933

- Effective T between 6450 and 6750 K
- Asteroseismology for frequencies, age and mass determination.
- Two solutions for the radius :1.39 or 1.44 R_{\odot}
- Active stars (photometry and spectroscopy)
- VEGA + CLIMB observations in oct. 2010
- $\theta_{UD} = 0.417 \pm 0.008$ mas
- $\theta_{LD} = 0.432 \pm 0.008$ mas (linear Claret 0.42)
- $R = 1.38 \pm 0.03 R_{\odot}$
- $T_{eff} = 6710 \pm 73$ K
- Next step:
 - 3D modeling in progress.
 - Publication





α Cephei (Alderamin)

Delaa et al. + Coll. MIRC

Goals:

Study of differential rotation on the surface of the star

Study of the gravity darkening :

$$T_{\text{eff}}(\theta) \propto g(\theta)^\beta \text{ (Von Zeipel effect)}$$

$\beta = 0.25 \rightarrow$ Radiative envelope purely

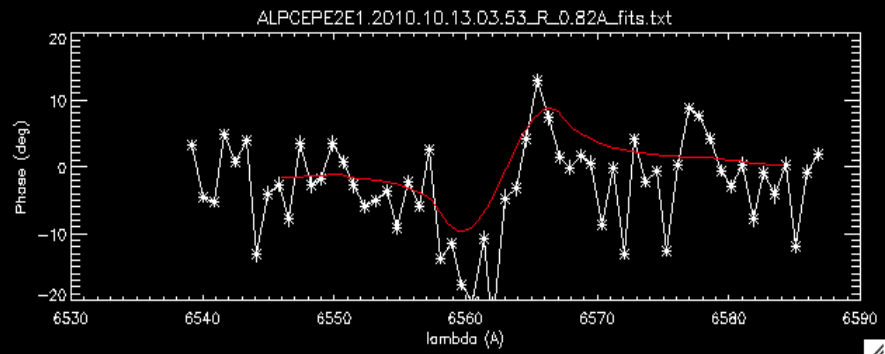
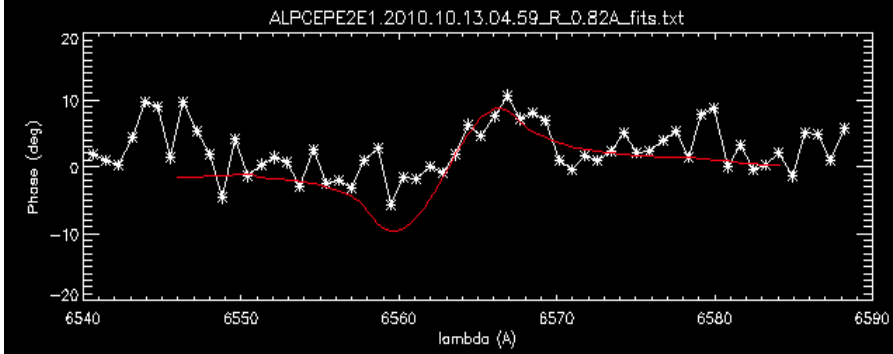
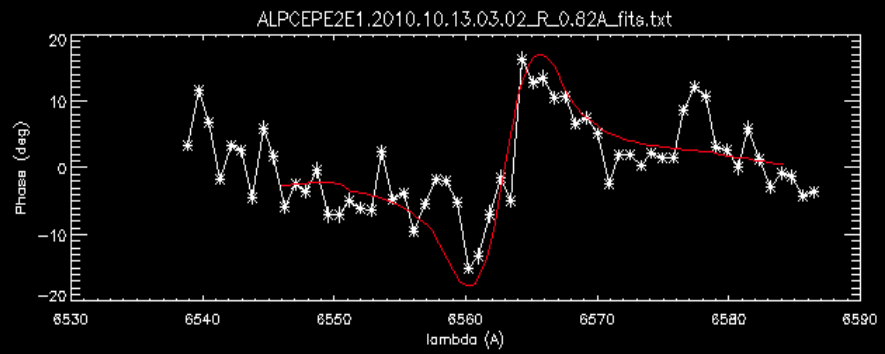
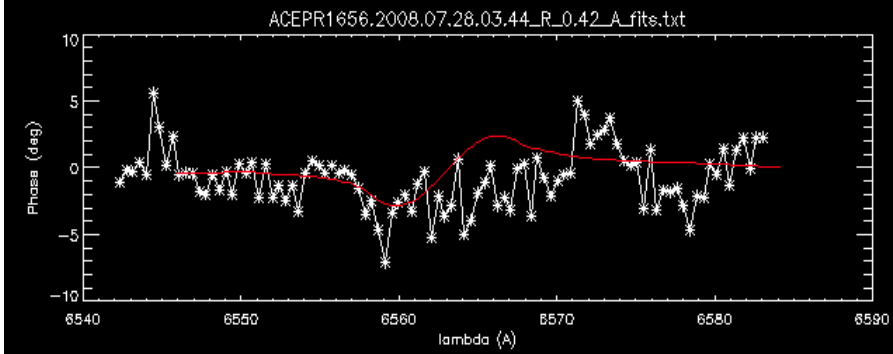
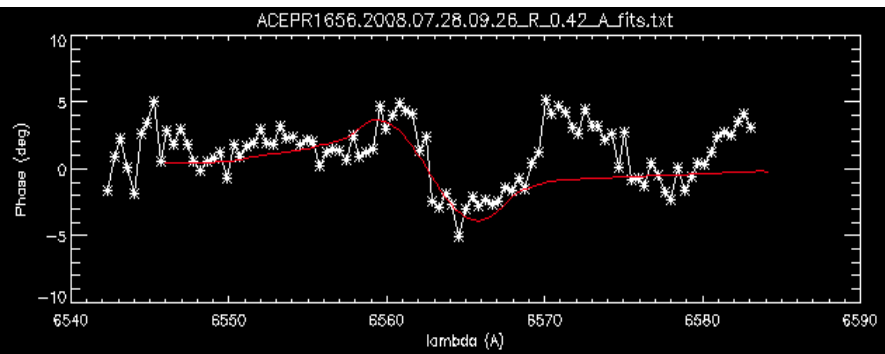
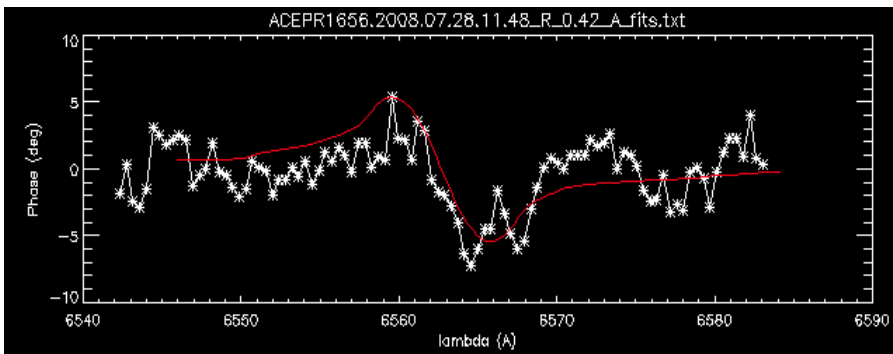
$\beta = 0.08 \rightarrow$ Convective envelope purely

Constrain the Position Angle of the star

6 observations of α Cep in HR



Differential phases : α Cep



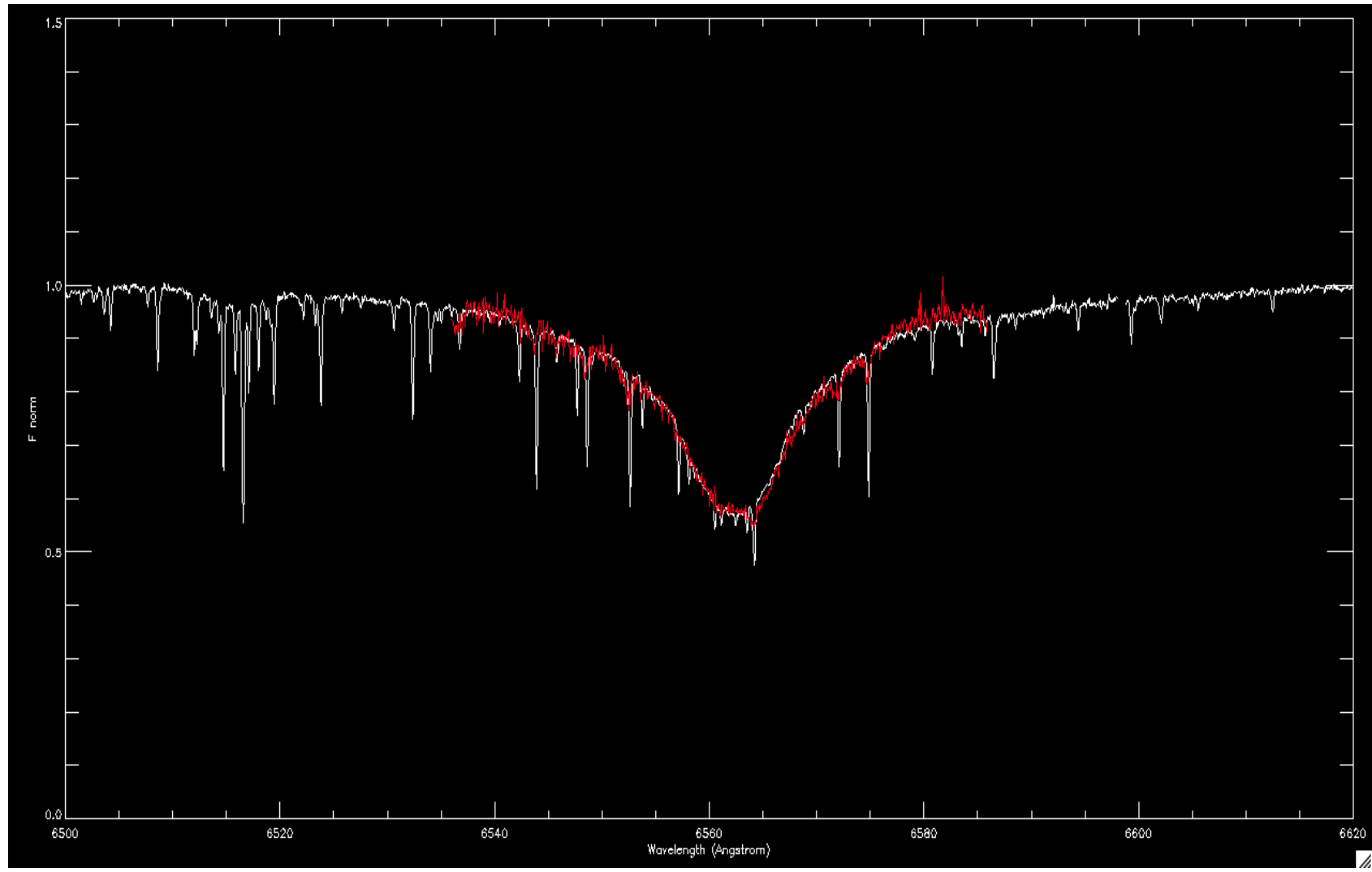
LESIA



Observatoire de la CÔTE d'AZUR



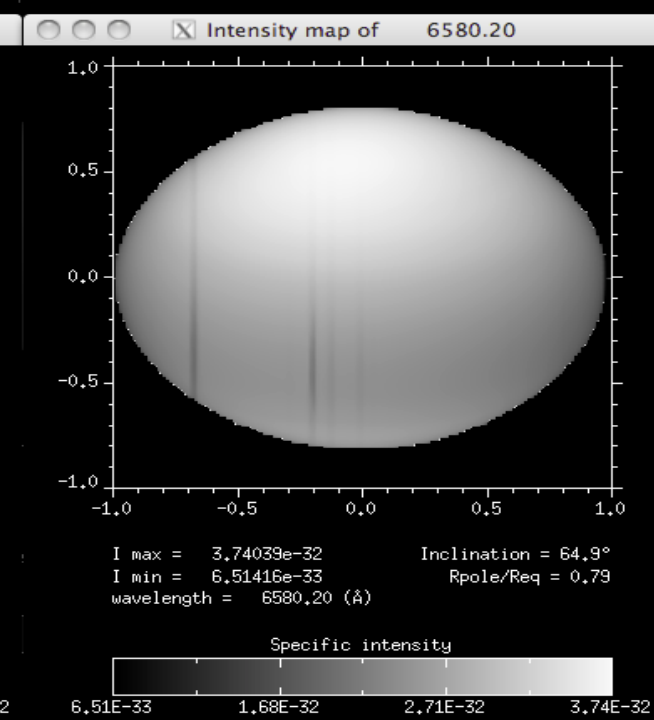
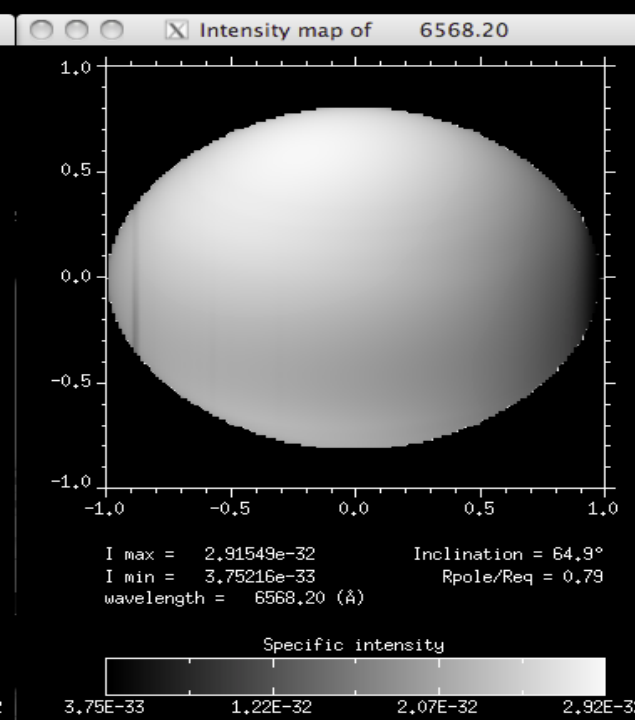
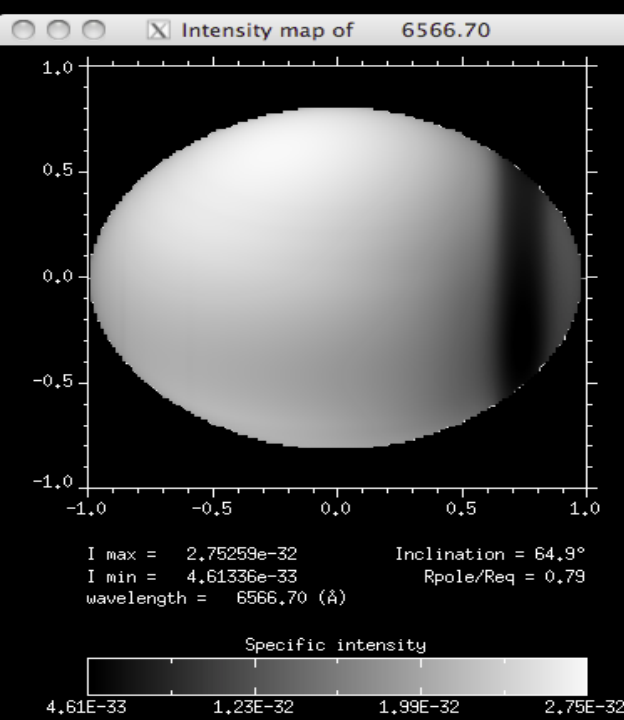
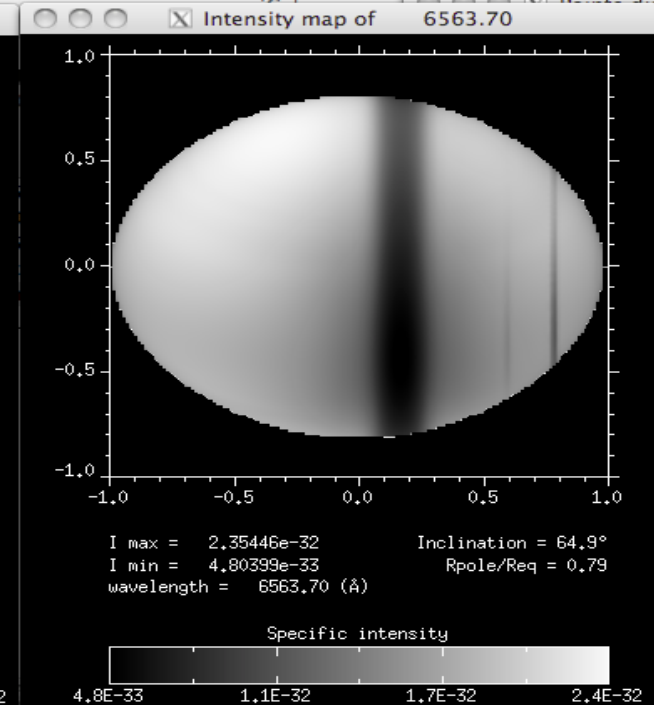
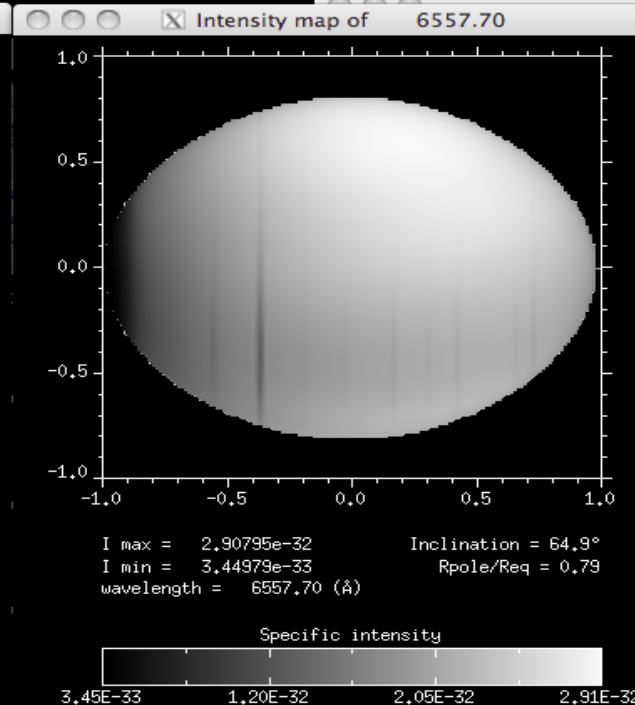
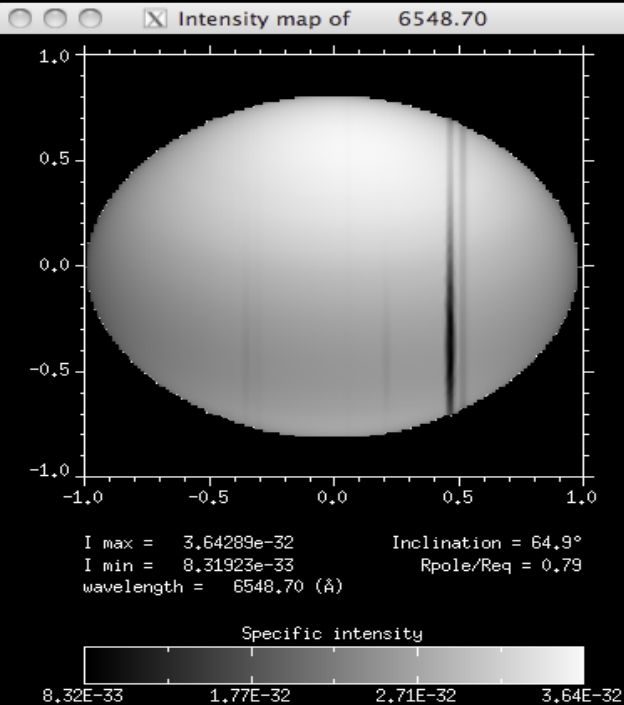
H α line: α Cephei

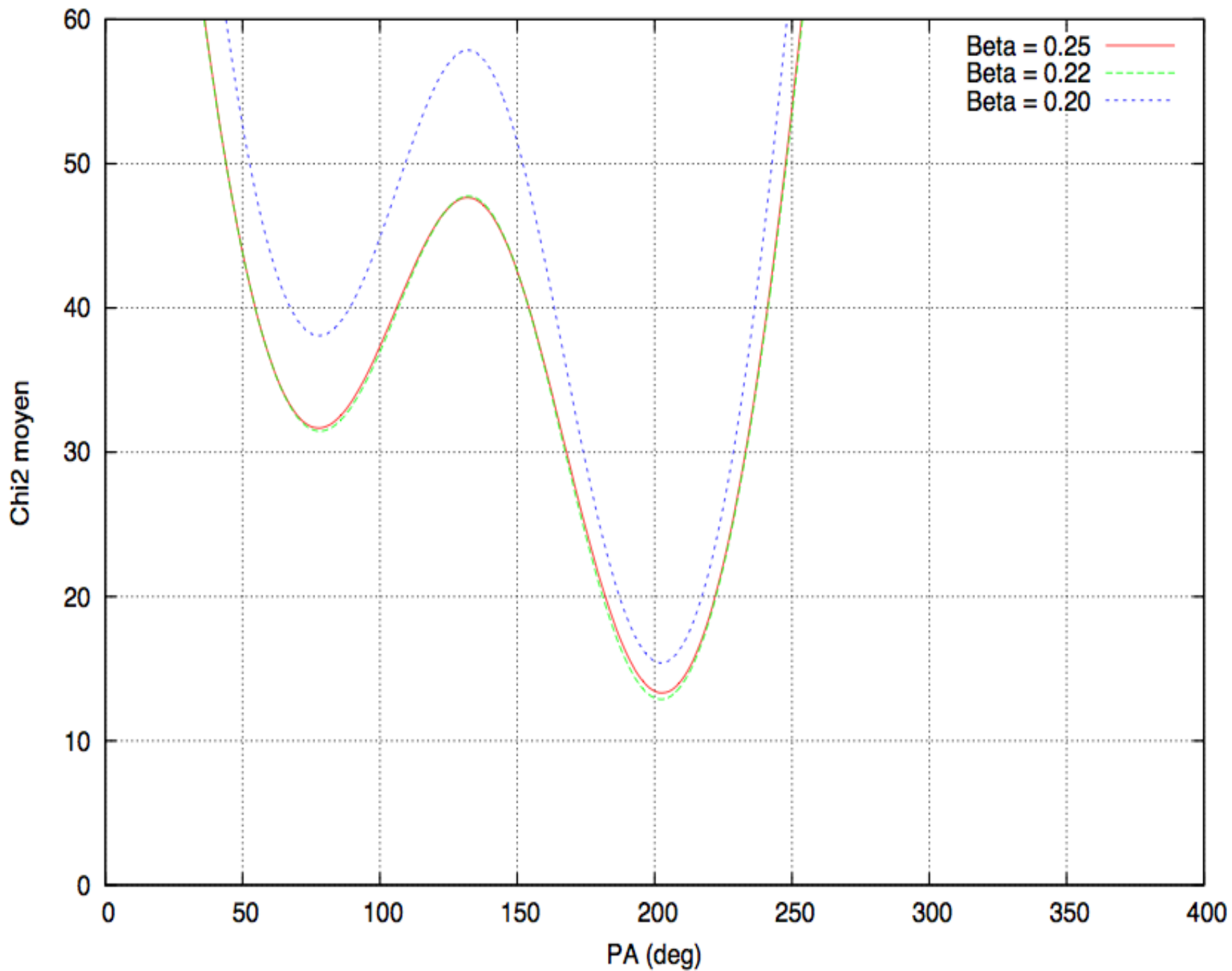


LESIA



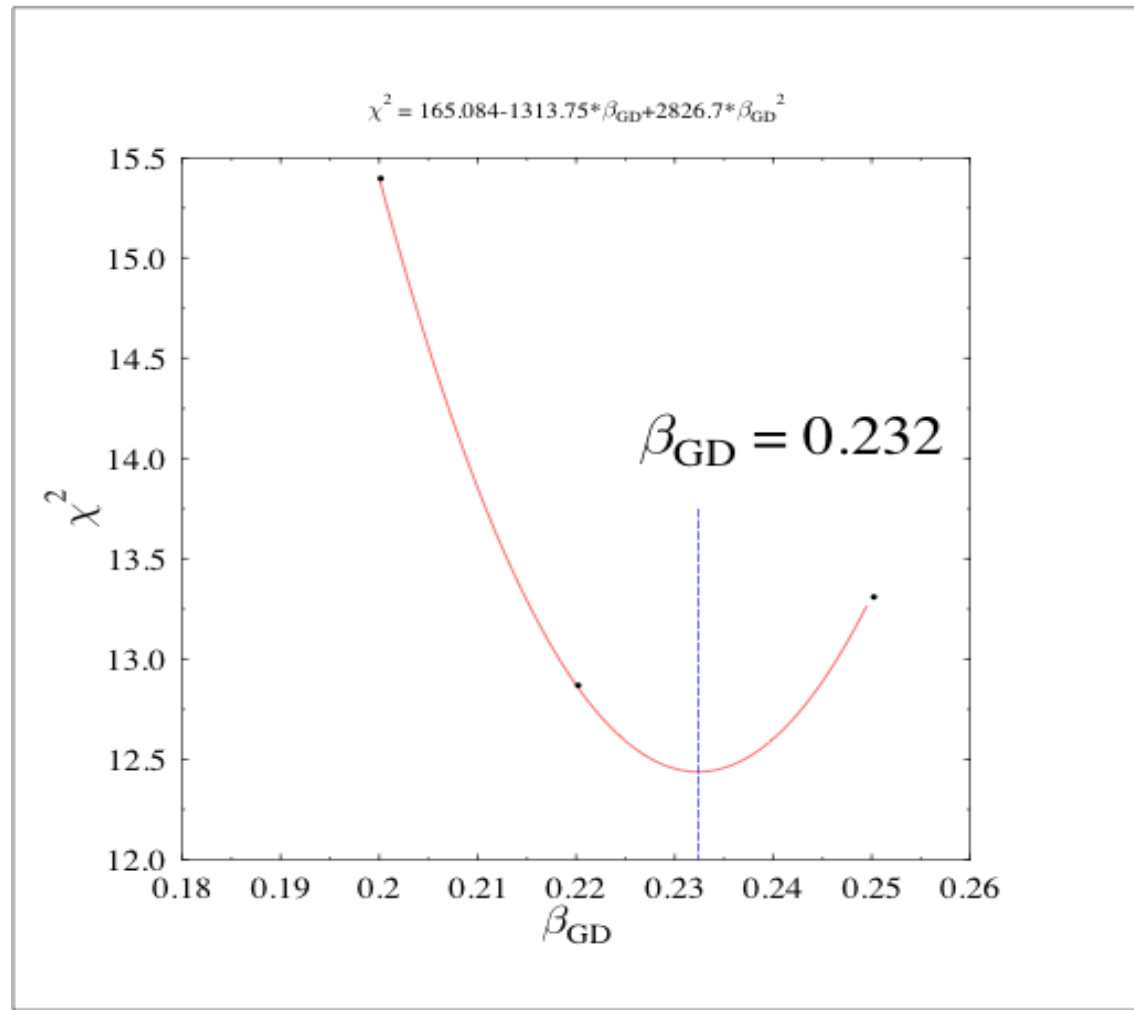
Observatoire de la CÔTE d'AZUR







α Cephei (Alderamin) $\chi^2 = f(\beta)$





Summary

- Rapid summary of 2010 papers
- General presentations of programs that have been engaged
- Example of works on
 - Circumstellar environment: ϵ Aur
 - Stellar atmospheres : Chromospheres of K giant stars
 - Fundamental parameters:
 - Diameter and effective temperature of HD 49933
 - Rotation of α Cep
- **Conclusion on new large programs: Limb Darkening et Surface Brightness**



Two Large Programs

- Exoplanet host stars
 - Unique potential of CHARA in terms of angular resolution in visible 3T mode with IR tracking.
 - Important needs of characterizing the exoplanets host stars for a better knowledge of the exoplanets parameters:
 - Stellar noises related to LD, spots, activity.
 - Consequences on RV and transit measurements.
 - Many papers recently published in that field dealing either with the large surveys HARPS/SOPHIE or for the data analysis of CoRoT/KEPLER missions.
 - Preparatory phase of PLATO: WP on host stars characterization.

- Calibration of the surface brightness relation AB stars (proposal for this period)

ANR funding request for post-doc and PhD position



Conclusion

Accurate measurements of sub-mas diameters

→ Fundamental parameters of stars

Circumstellar environments thanks to the spectral resolution and the possibility of spectral line analysis

Combination of Vis & IR measurements +++