The triple stellar system RV Crateris: spectroscopic orbit and accurate absolute dimensions

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Outline

I - Introduction and Motivations

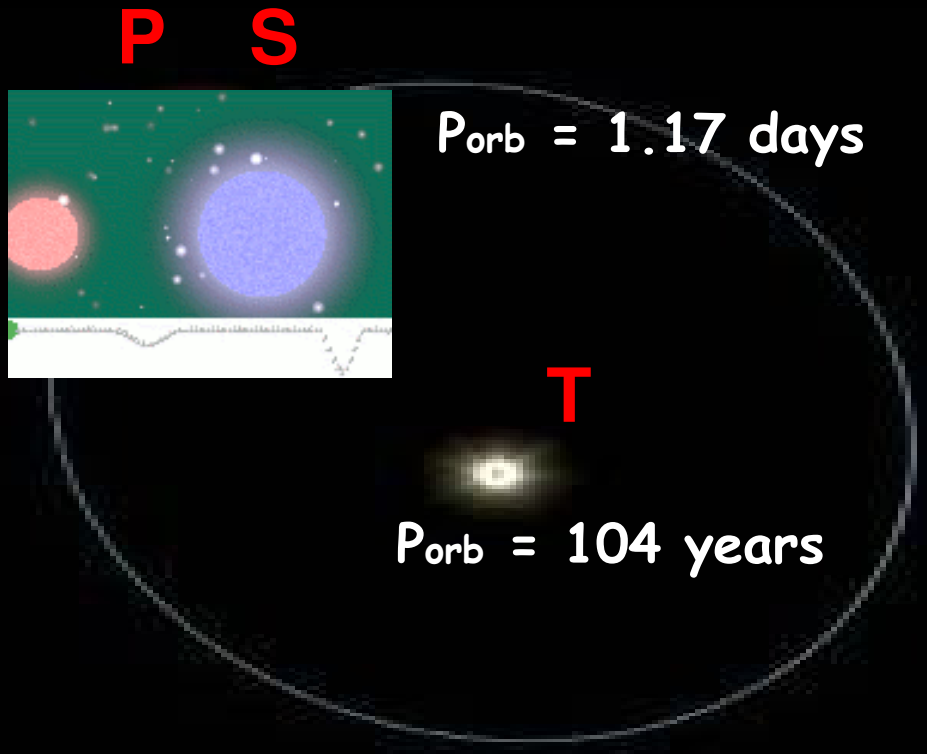
II – Methods of analysis and Observations

III – Results and Discussion

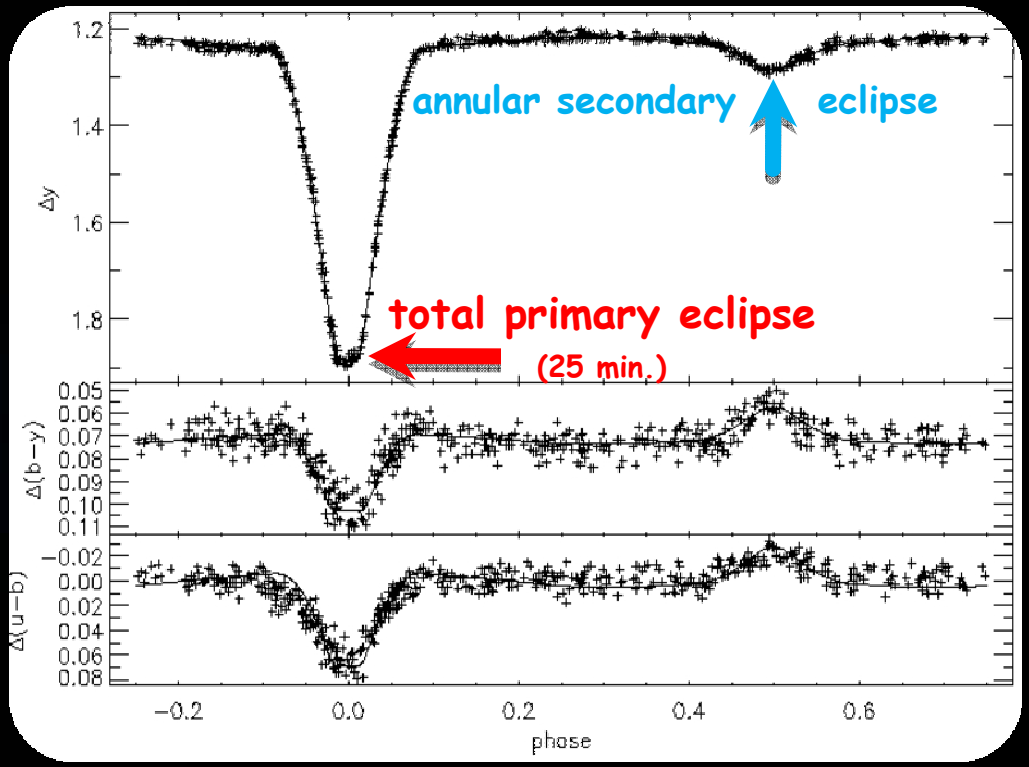
IV – Conclusions and Future work

Introduction: RV Crateris a triple system

Eclipsing binary (F6 + M2) + non-eclipsing wide component (F8)



0.5 m SAT telescope - La Silla, Chile 1987-89



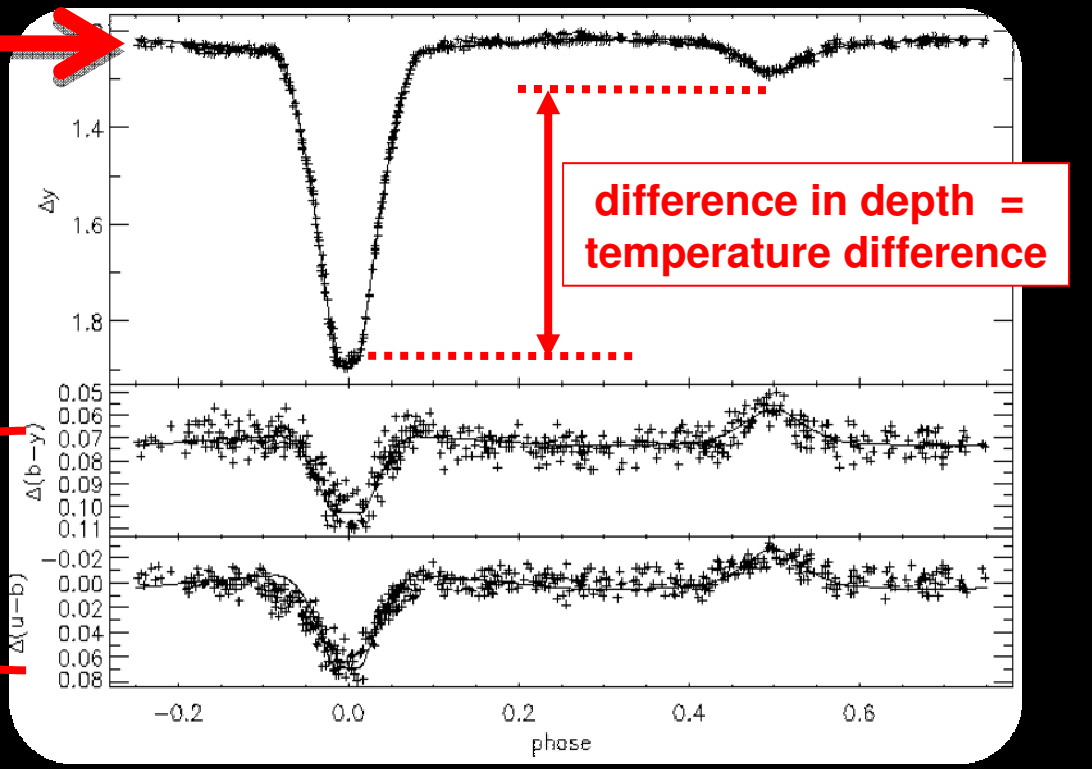
total occultation of a smaller and hotter star (primary) by a larger and colder one (secondary)

Introduction: RV Crateris a triple system

Eclipsing binary (F6 + M2) + non-eclipsing wide component (F8)

0.5 m SAT telescope La Silla, Chile 1987-89

nearly constant brightness = (close) detached system



difference in depth = temperature difference

Colour indices (b-y) and (u-b)

Introduction: Motivation

I - Few accurate absolute dimensions det. for stars with $M \leq 1\ M_{\odot}$

II - Probably a detached system

III - Short period + total primary eclipse
(determination of the fundamental properties, easier and robust) ;

IV – Colder component (secondary) is larger than the hotter one (primary)
(secondary IS NOT on the Main Sequence stage).

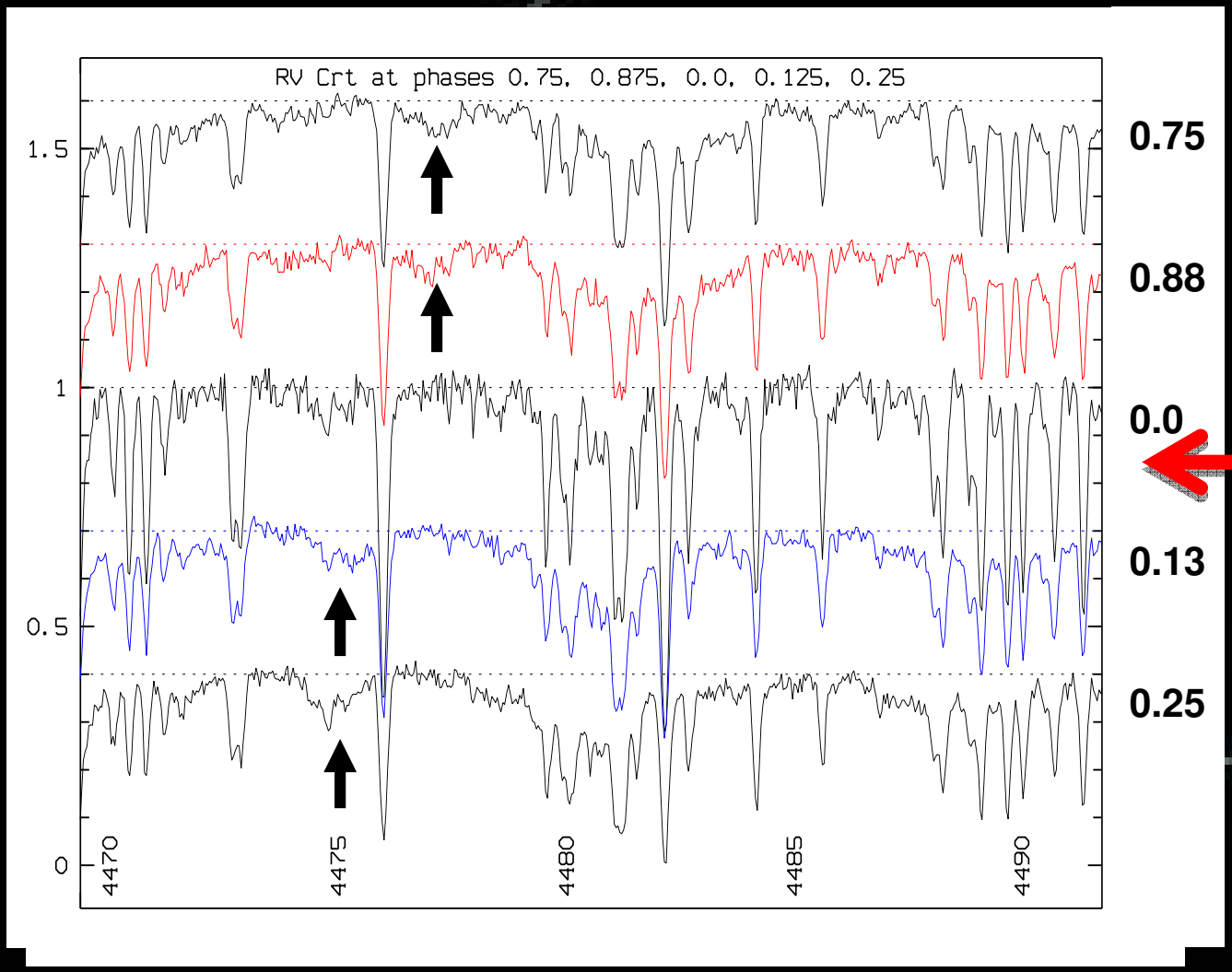
Good candidate

to improve and extend tests of theoretical models

Introduction: Difficulties for determining the mass ratio

Feros échelle spectra

2.2 m ESO telescope - La Silla, Chile (2003)



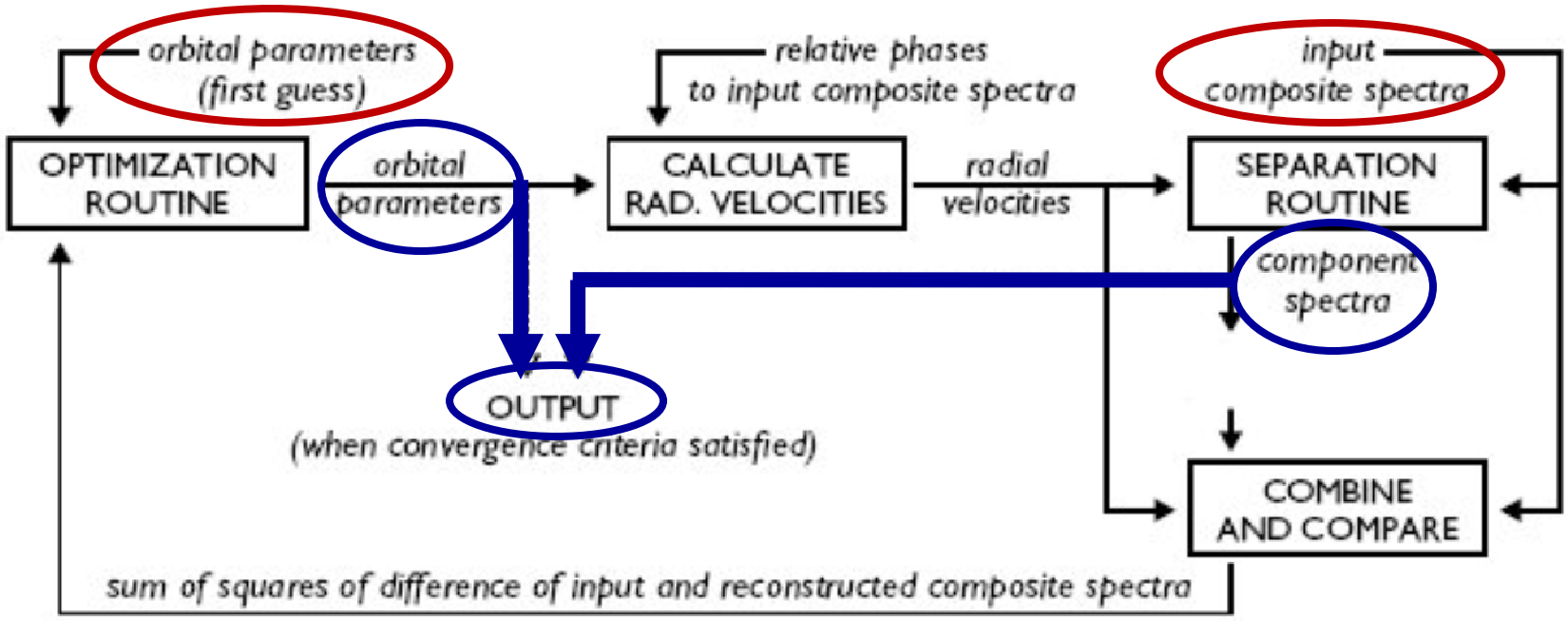
The secondary is nowhere directly visible

Total eclipse phase:

light of the primary disappears;
lines increase in depth;

Methods: Spectra Disentangling

KOREL
Hadrava P. (1995)

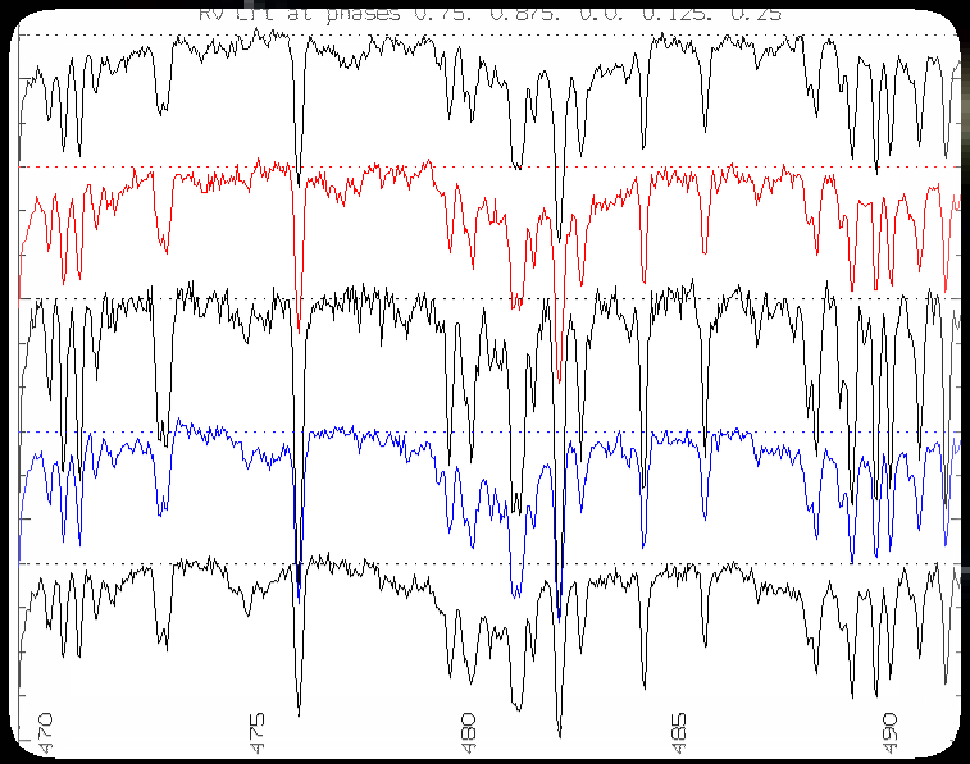


Analysis of the comp. of a multiple stellar system as single stars

Observations

Echelle Spectra

41 high-resolution Feros Spectra
+1 spectrum at primary mid-eclipse (20 min)
2.2m ESO Telescope
La Silla, Chile (2003)

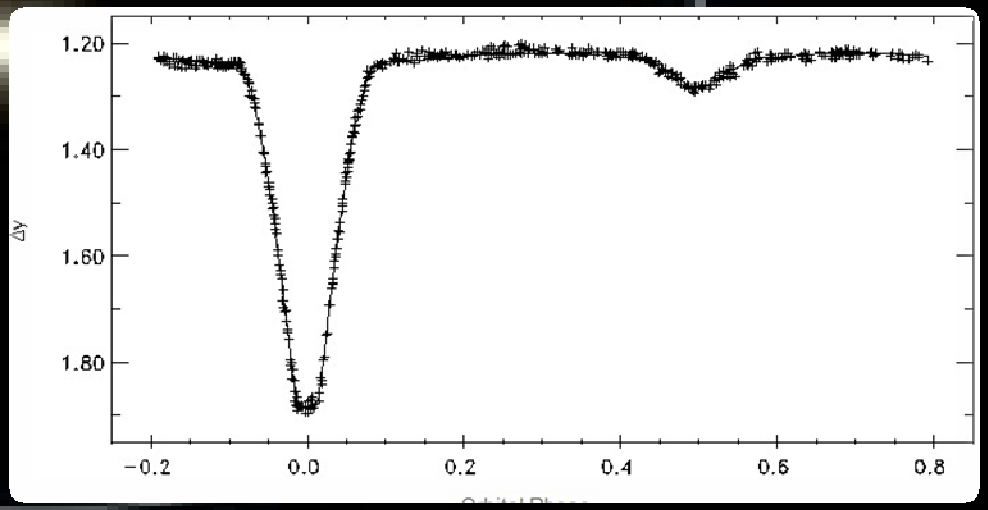


uvby light-curves

61 nights at 0.5 m SAT telescope

La Silla, Chile

1987-89



Combined photometric-spectroscopic analysis

WD

Light curves uvby (t)

+

A sin i
q

$V_1(t)$, $V_2(t)$, $V_3(t)$

→

M_1, M_2
R_1, R_2

A, e, ω …

L_1 / L_2 (λ)
L_1 / L_3 (λ)
i

KOREL

Observed spectra

+

L_1 / L_2 (λ)
L_1 / L_3 (λ)
i

→

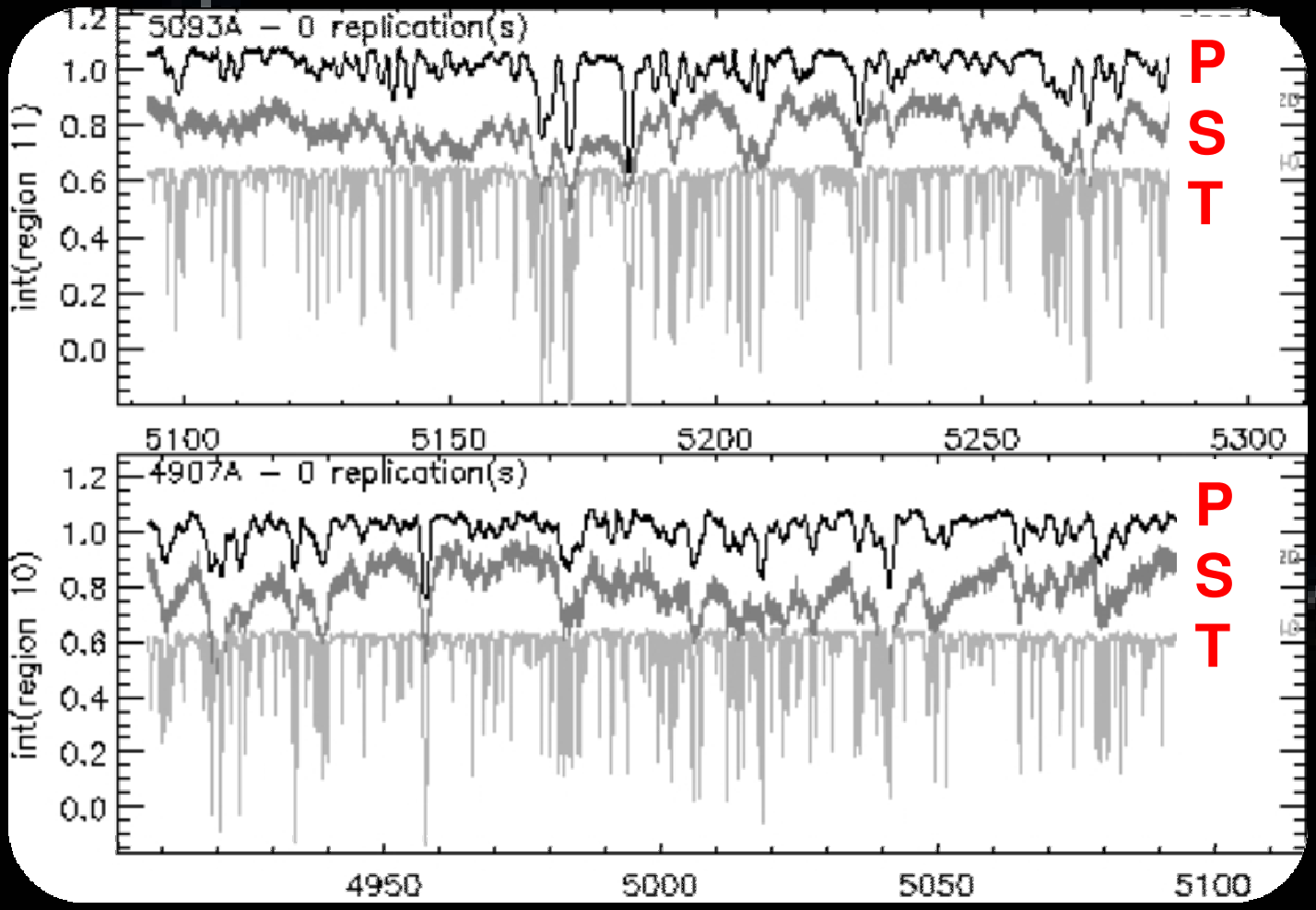
e, ω, q …

$V_1(t)$, $V_2(t)$, $V_3(t)$

Component spectra

Results: Component spectra

The <u>secondary</u> contributes with *~9%* of the total light and the <u>non-eclipsing</u> component with *~49%*.

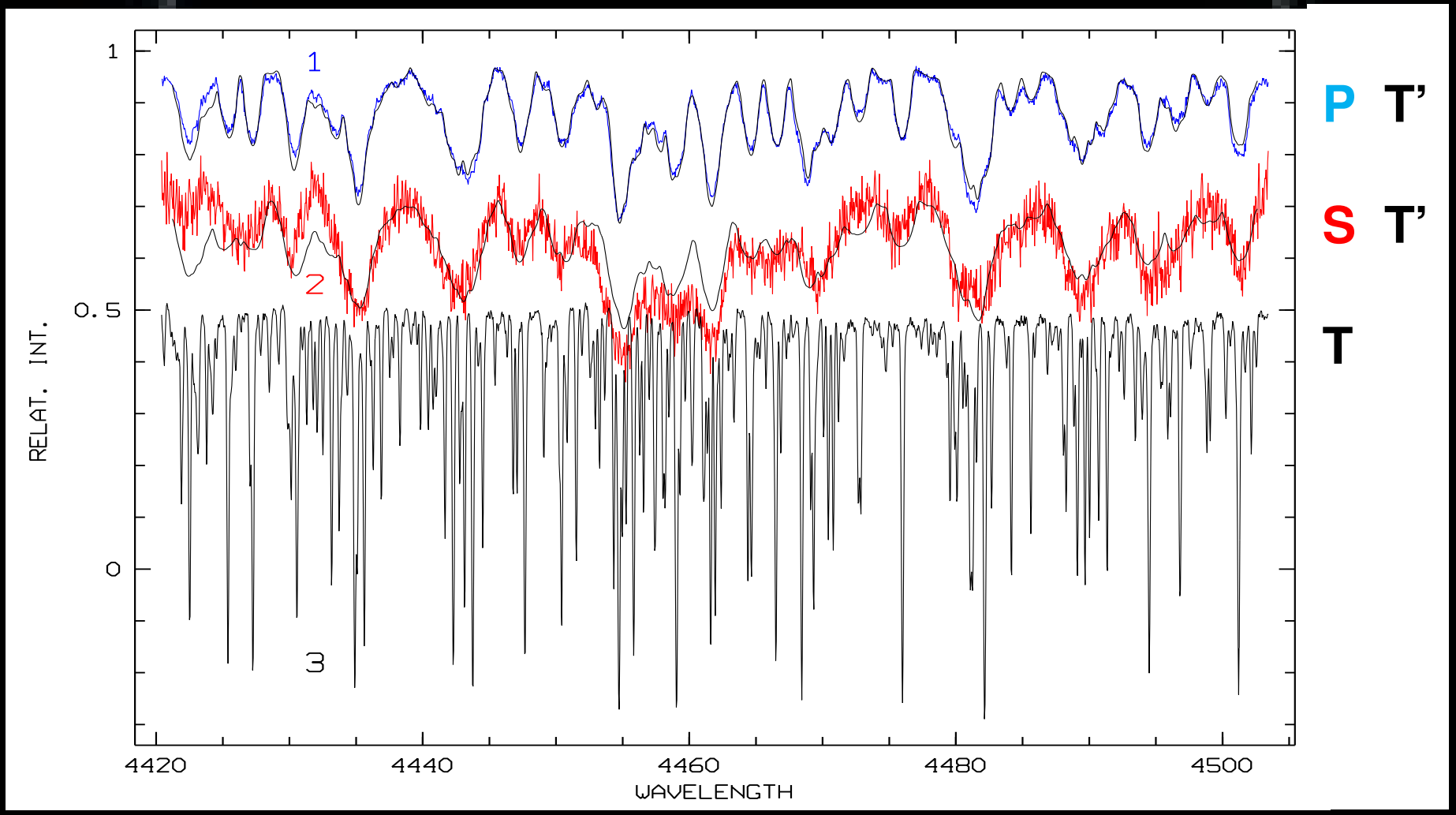


Noise in the <u>secondary</u> spectrum reflects its small light contribution.

Results: Component spectra

Vrot,P = 49 km/s
Vrot,S = 73 km/s

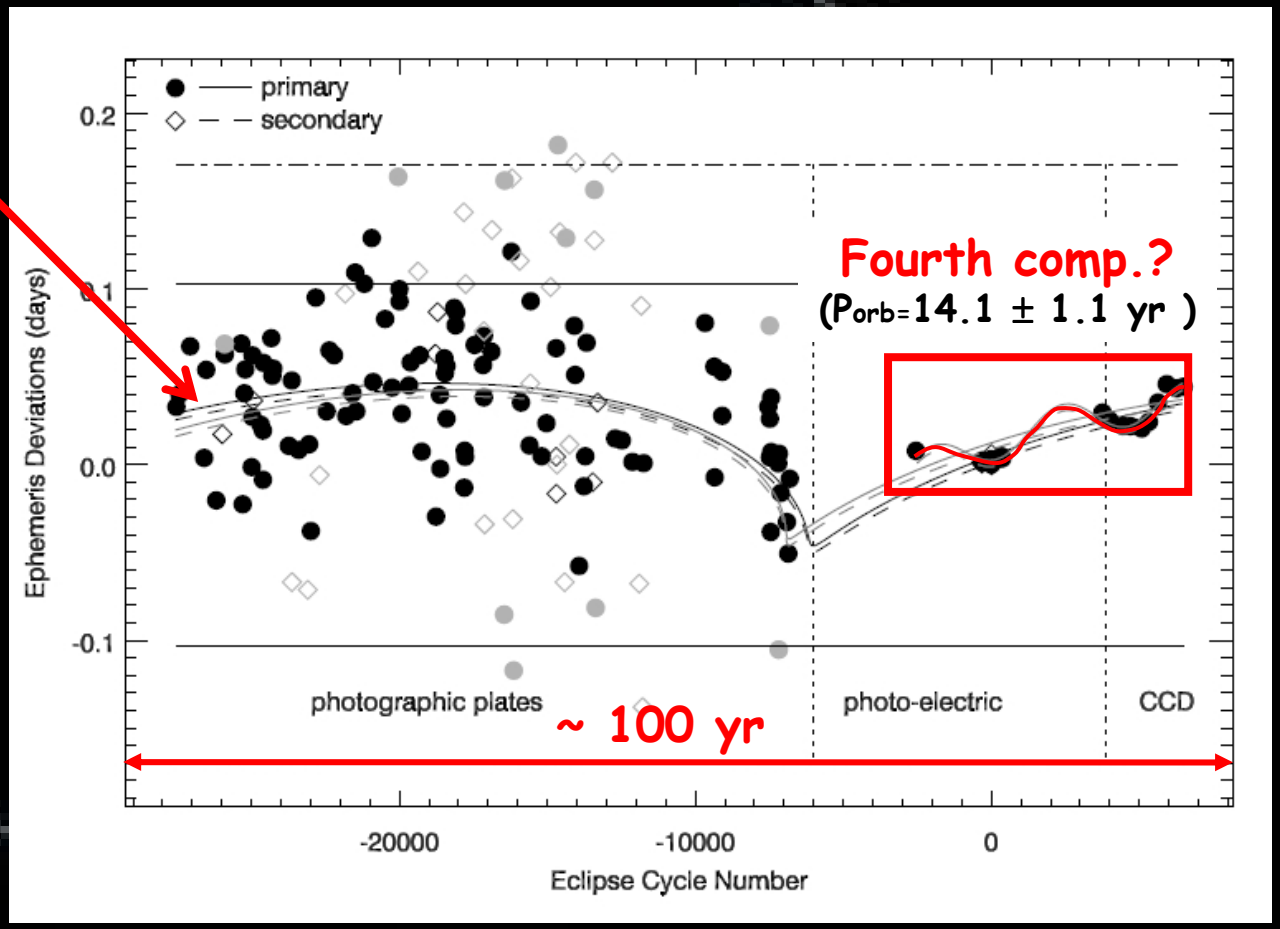
1. The center of the lines coincide very well;
2. Intensity of T' and P agrees very well.
3. S ≠ T' due to the temperature difference;



Third component

Ephemeris Deviations versus eclipse cycle number

Third comp.
(P_{orb}=103.9 ± 6.3 yr)



*Light-travel-time effect on the eclipse timings.

*The wide third component belongs physically to the system.

Results: Fundamental parameters

	Primary	Secondary
Mass ($M_\odot$)	1.14 ± 0.07	0.51± 0.03
Teff (K)	6000 ± 120	3963 ± 120
Radius ($R_\odot$)	1.28 ± 0.03	1.70 ± 0.03
K (km/s)	74	160.8
q (M_B/M_A)	0.45 ± 0.05	
Log g (c.g.s.)	4.28 ± 0.06	3.69 ± 0.03
Log $L/L_\odot$	0.28 ± 0.04	-0.20 ± 0.06
Mv	3.981 ± 0.098	6.119 ± 0.014
Distance (pc)	201 ± 8	

2.2

0.75

3

Evolutionary Status

ATON 2.3 code

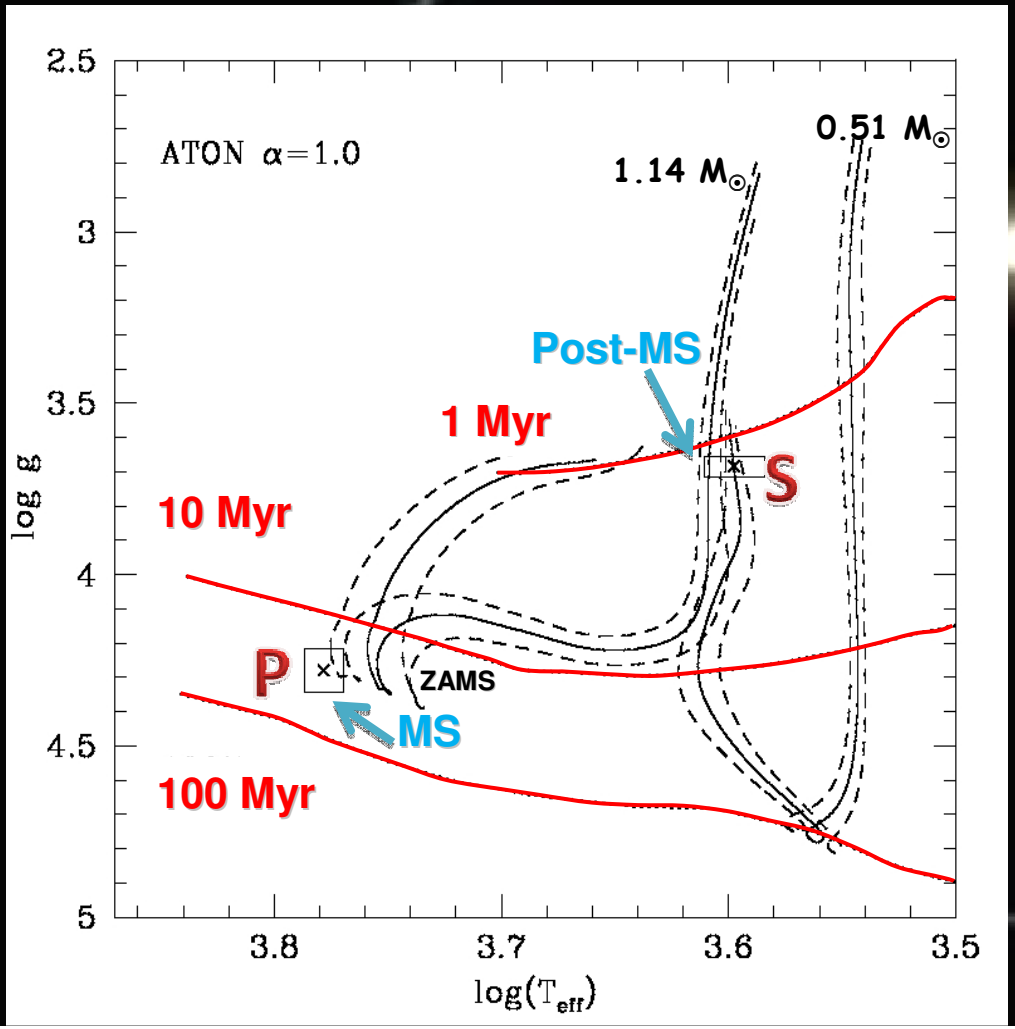
D'Antona & Mazzitelli (1994)

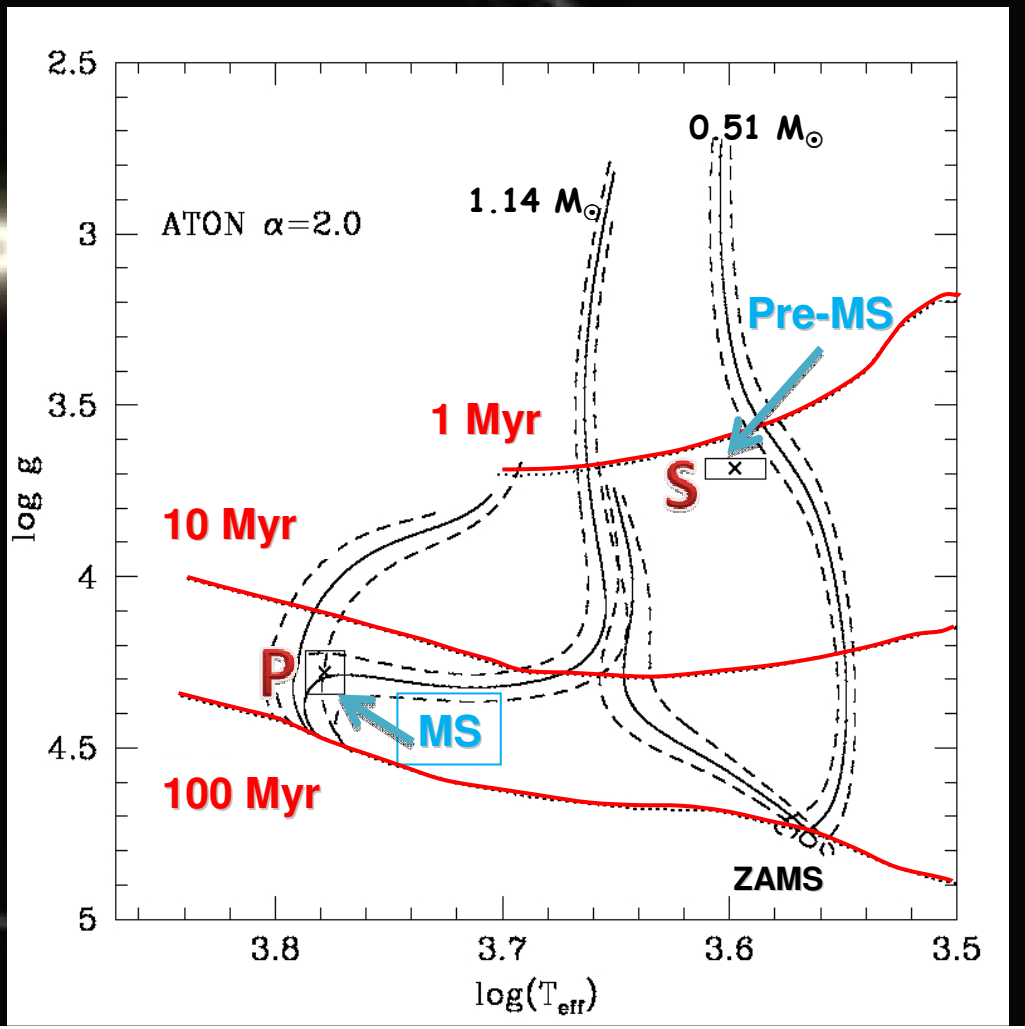
Landin et al (2006;2009;2010)

Isochrones don't fit both components …

Evolved system scenario is a possible solution …

- Secondary transferred mass to the primary, *in the past* ;
- Secondary has ~ 99% of its Roche-lobe filled ! (close semi-detached system)





Conclusions and future work

a. We obtained *accurate fundamental* parameters of RV Crt, from a self-consistent combined photometric-spectroscopic analysis;

b. We successfully determined the *radial velocities* of the *faintest component* (*9 % of total light*) of RV Crt in a direct and independent way (THANKS TO THE SPECTRA DISENTANGLING TECHNIQUE);

c. The *third* component *belongs to the system* ;

d. The *spectra of three components* of RV Crt were obtained and will be independently *analyzed as single stars*;

e. Is *RV Crateris* a *quadruple* system ? ;

f. Is *RV Crateris* an *evolved* system ? ;

g. Obtain precise photometric measurements on the photographic plates to *improve the eclipse epochs*.

Thank

YOU and ...

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