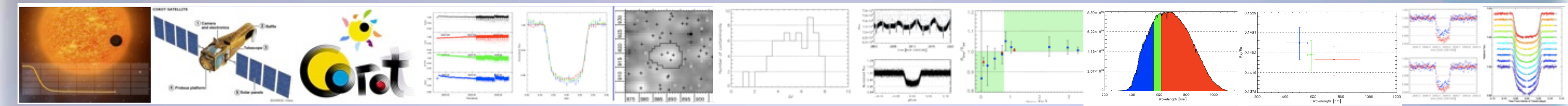


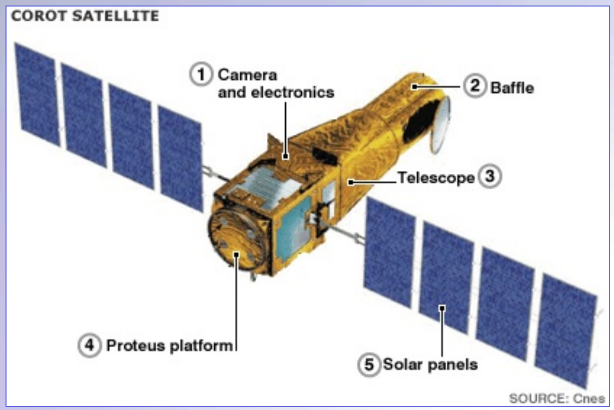
F. Borsa[1,2] & E. Poretti[1]

The CoRoT colours: a promising data mining

11th CoRoT Week, La Laguna, Tenerife

(1) INAF - Osservatorio Astronomico di Brera, via E. Bianchi 46, 23807 Merate (LC), Italy
(2) Dipartimento di Scienza e Alta Tecnologia - Università dell'Insubria, via Valleggio 11, 22100 Como, Italy

THE CoRoT COLOURS

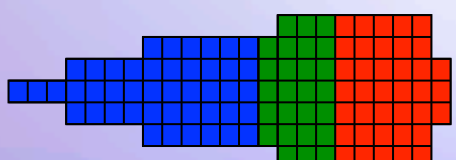


CoRoT: Convection, Rotation and planetary Transits

Simultaneous coloured light curves: an **uniqueness** in space missions

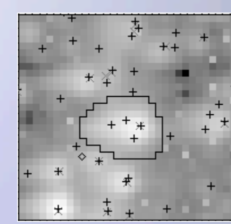
The analysis of CoRoT colours is a complicated task

The dispersion device is a prism, not passbands

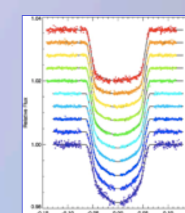


Mask changes for each target

→ Contamination of background stars affects differently the 3 colours



→ The limb-darkening coefficients are not theoretically determined

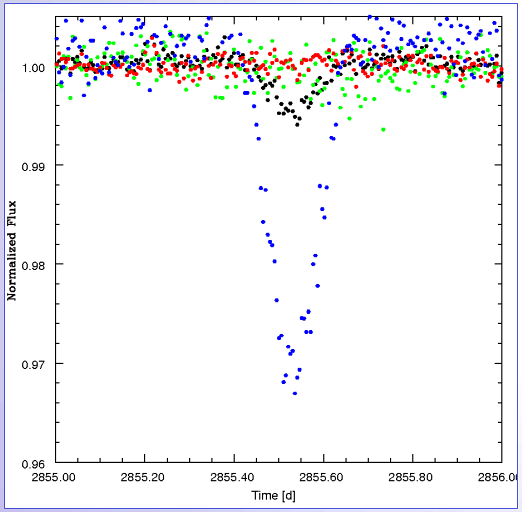


SUCCESSFUL USE OF COLOURS

Identifying false candidates

e.g. Cabrera et al. 2009, Carpano et al. 2009

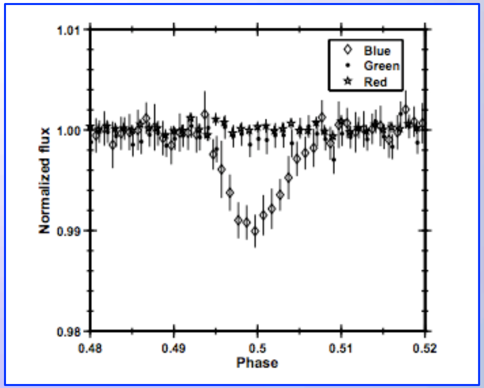
- Immediate
- Does not need an accurate analysis



Transit signal only in one colour

Coloured depths very different

It's not a planet!



Carone et al. 2012

Allows us to save follow up time

SUCCESSFUL USE OF COLOURS

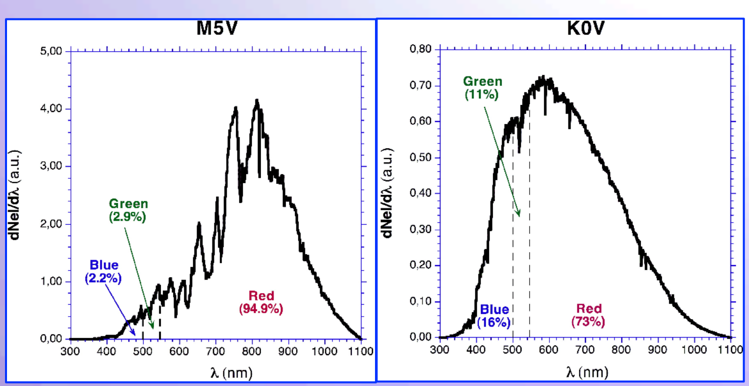
Seismo-channel

- Discriminate between radial and non-radial nature of the pulsation mode
  Poretti et al. 2011

- Identify different sources altering the white light curve of a single target
  Paparò et al. 2011

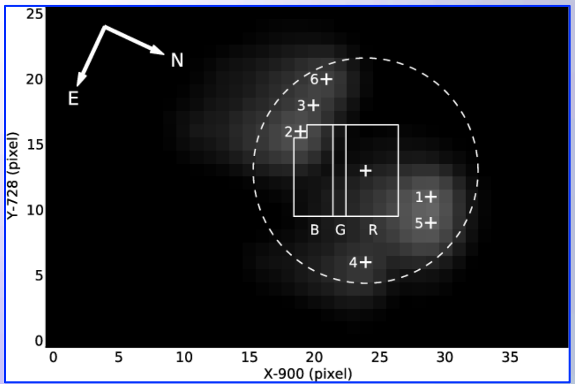
Exo-channel

- Confirming the transit coming from the main target



Léger et al. 2009, CoRoT-7b

- Contamination+tentative analysis of coloured transits



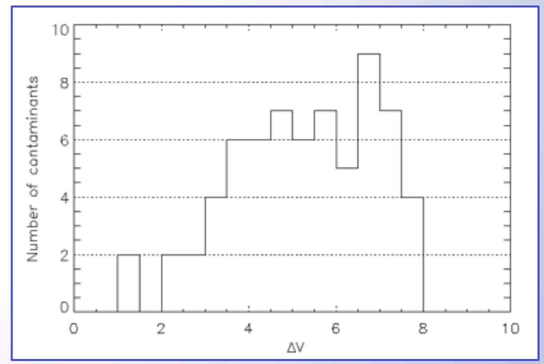
Bordé et al. 2010, CoRoT-8b

1st PROBLEM: CONTAMINATION

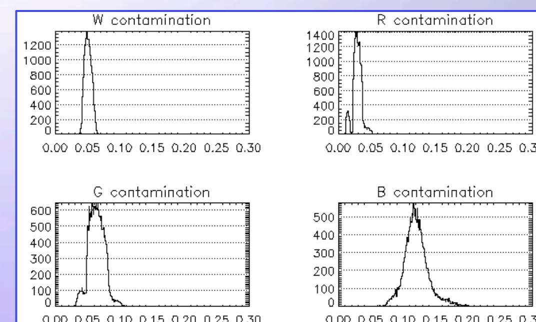
CoRoT colours as a characterization tool?

Different masks, optimized for each case, low contamination expected

Analysis of contamination in the mask & three submasks necessary



- PSF of main target
- Projected image on the CCD of nearby stars up to 20'' (EXODAT+USNO-A2)
- Apply colour information (B-V)
  - ±0.3 V&B mag
  - ±0.6 B-V
  - 3x3 pixel^2 box
- Estimation of contamination & errors



1st PROBLEM: CONTAMINATION

Planet	CoRoT colour contamination			
	White	Red	Green	Blue
CoRoT-1b	$1.02^{+0.31}_{-0.23}$%	$1.43^{+0.44}_{-0.32}$%	$0.36^{+0.14}_{-0.11}$%	$0.16^{+0.07}_{-0.06}$%
CoRoT-2b	$5.09^{+0.60}_{-0.53}$%	$2.94^{+0.58}_{-0.52}$%	$6.41^{+1.27}_{-1.14}$%	$11.95^{+1.72}_{-1.53}$%
CoRoT-4b	$0.01^{+0.00}_{-0.00}$%	$0.01^{+0.00}_{-0.00}$%	$0.00^{+0.00}_{-0.00}$%	$0.00^{+0.00}_{-0.00}$%
CoRoT-5b	$3.28^{+0.90}_{-0.61}$%	$2.59^{+0.87}_{-0.65}$%	$1.55^{+0.50}_{-0.33}$%	$6.38^{+1.50}_{-1.18}$%
CoRoT-6b	$0.96^{+0.24}_{-0.16}$%	$1.12^{+0.32}_{-0.21}$%	$0.42^{+0.11}_{-0.09}$%	$0.60^{+0.22}_{-0.17}$%
CoRoT-7b	$0.71^{+0.19}_{-0.19}$%	$0.08^{+0.03}_{-0.02}$%	$0.08^{+0.02}_{-0.02}$%	$3.77^{+1.11}_{-1.18}$%
CoRoT-8b	$0.96^{+0.24}_{-0.20}$%	$0.71^{+0.26}_{-0.19}$%	$0.22^{+0.07}_{-0.05}$%	$2.79^{+0.83}_{-0.91}$%
CoRoT-9b	$0.56^{+0.13}_{-0.13}$%	$0.08^{+0.02}_{-0.01}$%	$0.02^{+0.02}_{-0.01}$%	$3.01^{+0.74}_{-0.70}$%
CoRoT-11b	$4.00^{+0.65}_{-0.55}$%	$5.17^{+0.99}_{-0.82}$%	$1.08^{+0.37}_{-0.23}$%	$1.90^{+0.44}_{-0.34}$%
CoRoT-3b	$7.02^{+0.97}_{-0.84}$%	$2.19^{+0.45}_{-0.41}$%	$11.14^{+1.99}_{-1.84}$%	$17.60^{+3.49}_{-2.74}$%

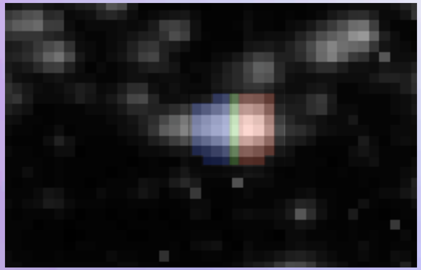
Borsa & Poretti 2013

CoRoT-8b, agreement with Bordé et al. 2010:

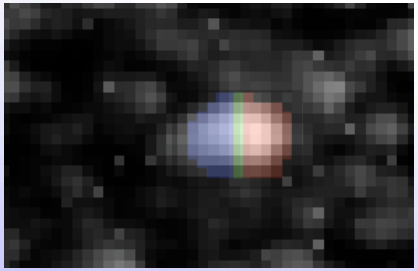
0.9%W - 0.7%R - 0.2%G - 2.4%B

Cases of both null & huge contamination

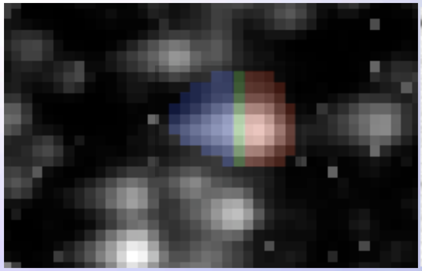
Large contamination → Large error



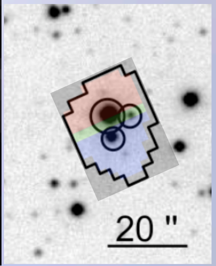
CoRoT-4



CoRoT-2

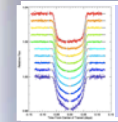


CoRoT-3



Deleuil et al. 2009

Removing contamination allows us to compare homogeneous transits



2^{nd} PROBLEM: LIMB DARKENING

Efforts to calculate LD for CoRoT range of sensitivity

Sing (2010), Claret & Bloemen (2011)

Disagreement has been probed between theoretical & fitted limb darkening coefficients

Howarth (2011), Csizmadia et al. (2013)

But no estimation of LD coefficients for the CoRoT colours

We can learn LD from transits

Choice to fit for the limb darkening coefficients

- ⇨ Theoretical LD coefficients for the white light curves are within errorbars
- ⇨ Test keeping fixed LD coefficients to median values

Relative transit depths do not change significantly

A CHROMATIC CLUE

All orbital parameters in agreement with literature

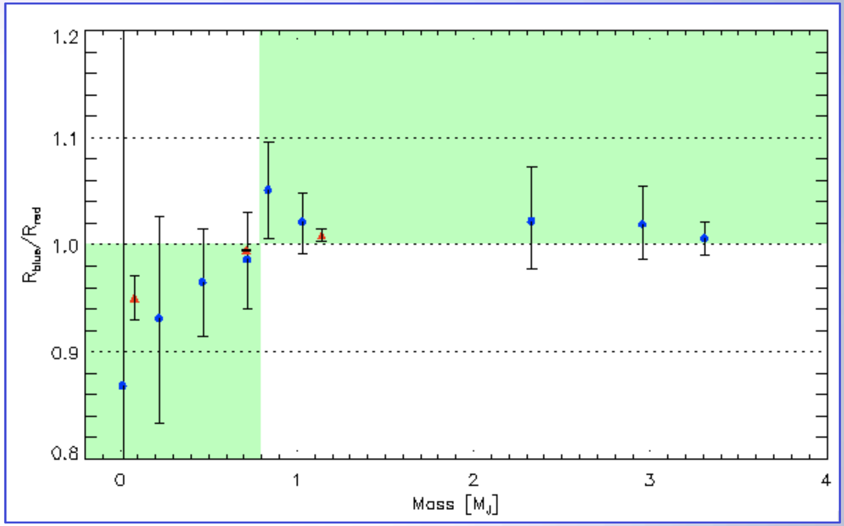
At first order, transits are achromatic

- Large dispersion of blue
- Error on contamination factors

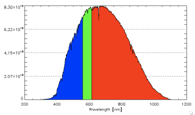
The distribution does not seem to be random

Literature data at similar wavelengths behave the same way

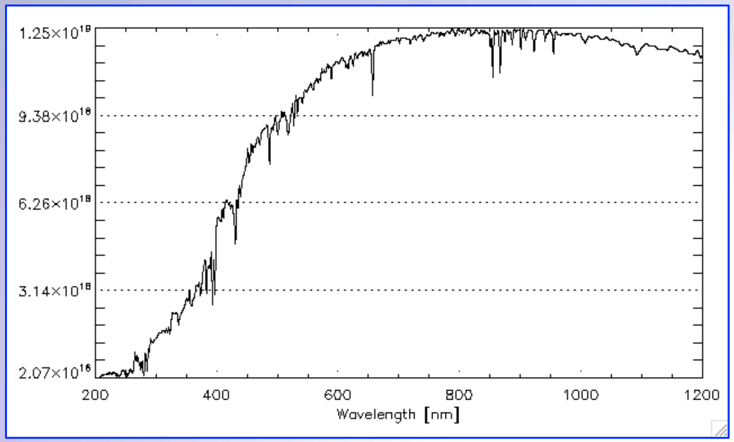
Comparing transit depths in B & R CoRoT colours:



Borsa & Poretti 2013

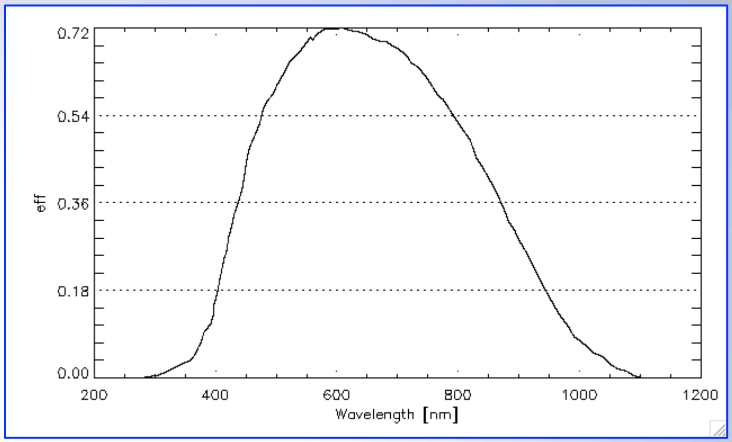


LAMBDA ESTIMATION



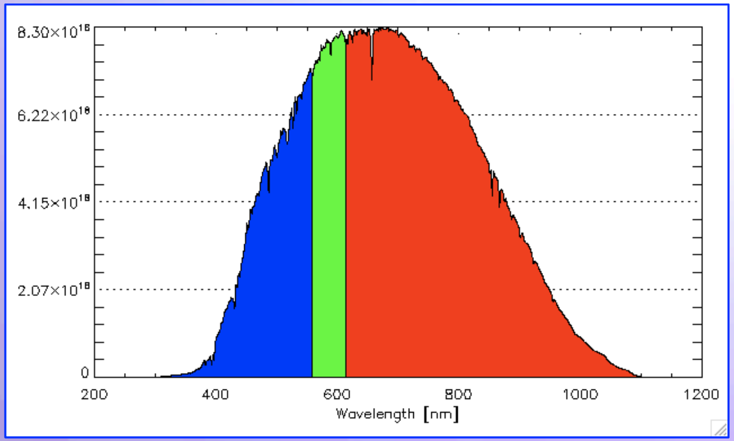
ESA VOSpec

Kurucz stellar models



Auvergne et al. 2009

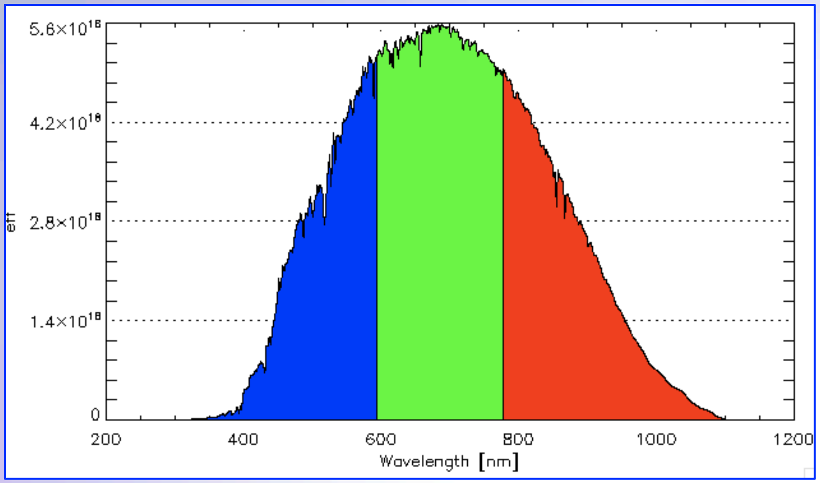
CoRoT spectral response



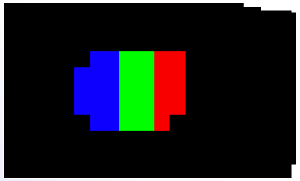
Using information on colour counts and contamination:

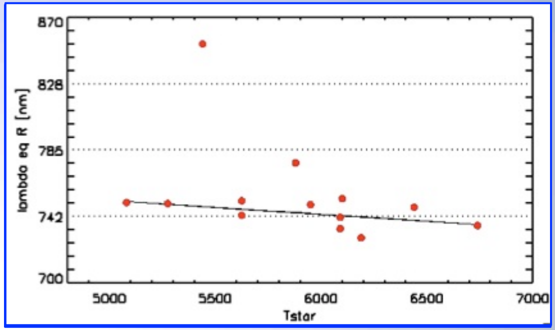
- Width of colours
- Equivalent lambda

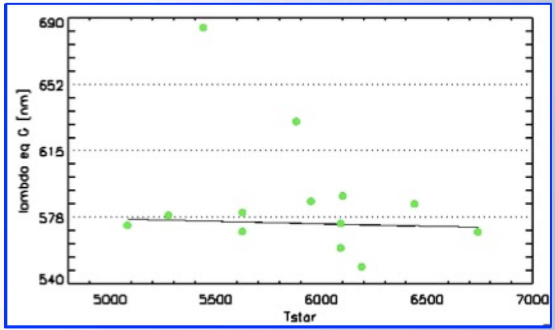
LAMBDA ESTIMATION

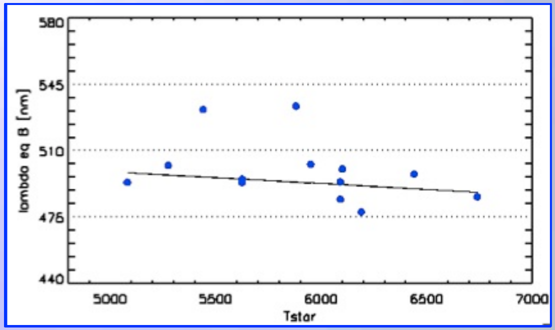


CoRoT-[illegible]

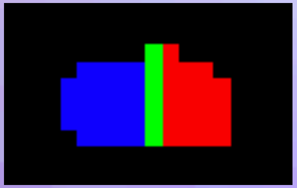


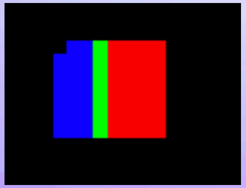


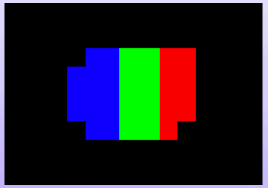


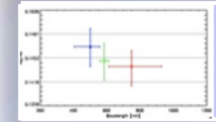


→ For a “standard” mask, lambda eq scales linearly with the star temperature





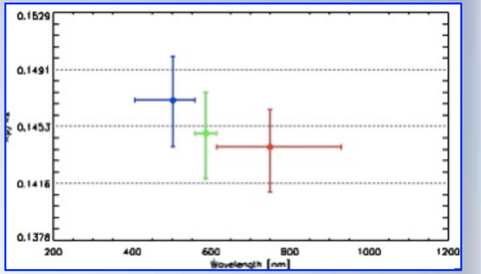


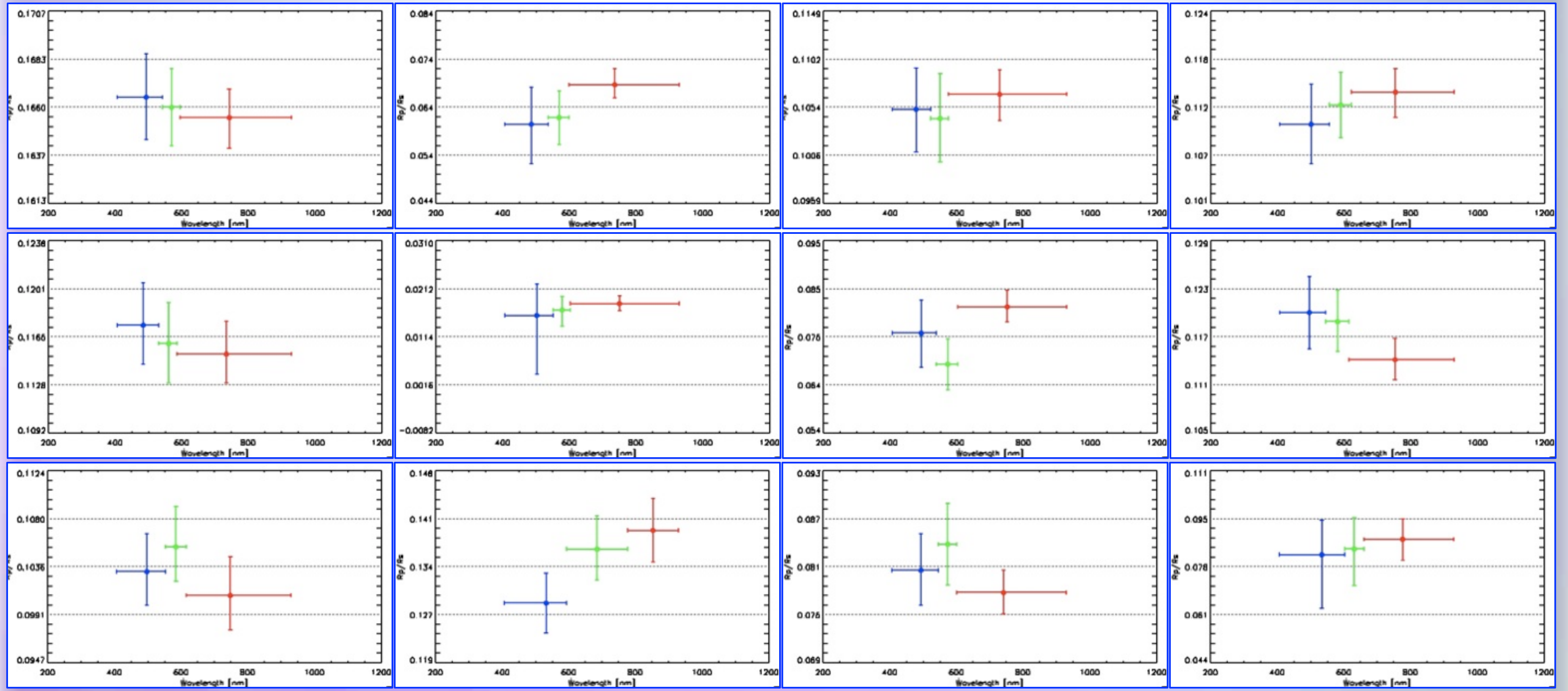


FAMILY PORTRAIT

With the information from these analysis…

Radius in function of the wavelength





CONCLUSIONS

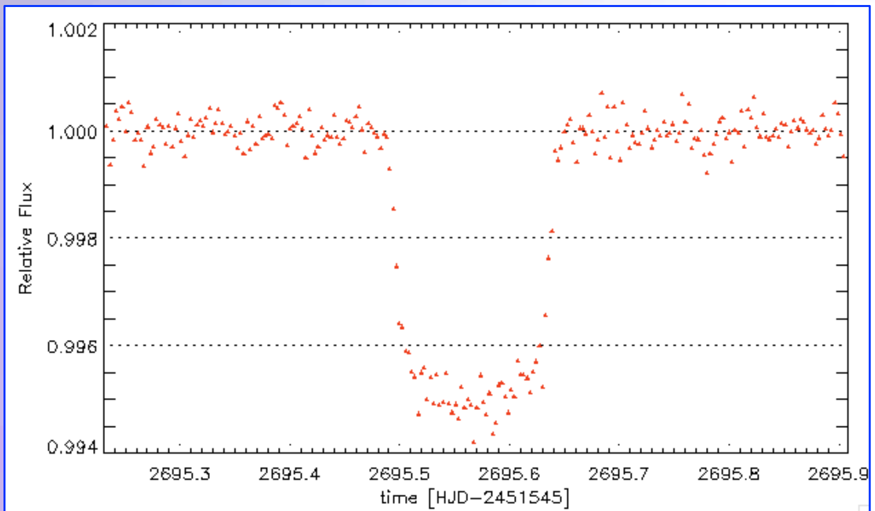
- CoRoT colours can be useful not only as an “exclusion” tool, but also as a characterization one
- The problems of contamination can be handled, so to analyse homogeneous coloured light curves
- The wavelength of the three colours can be determined
- CoRoT colours contain info otherwise undetected in the white light curves
- Lots of unpublished data, let’s take advantage of the uniqueness of CoRoT

⇨

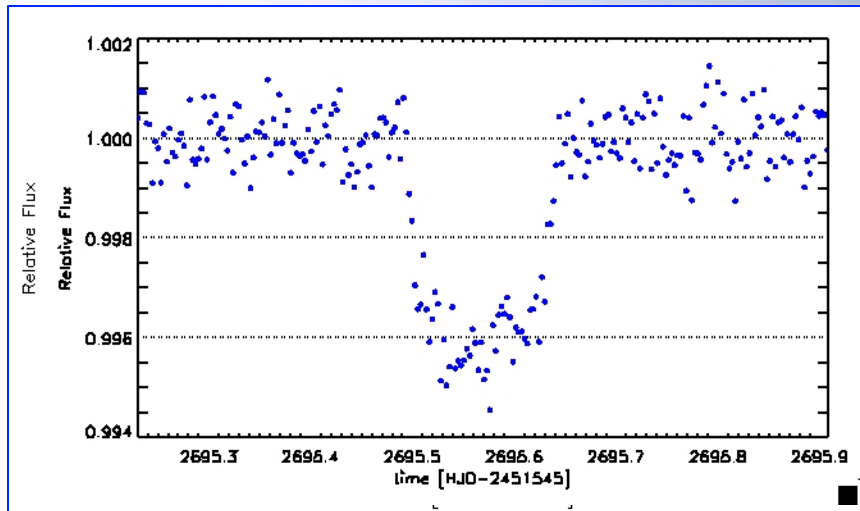
COLOURED
IT’S
BETTER!

COLOURED FEATURES

Colours allow to detect features!



CoRoT-3b R



CoRoT-3b B

Period synchronized with stellar rotation → Inhomogeneity on the F3V parent star surface?