Status of CoRoT results

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CoRoT - in brief

A French/European/Brazilian mission
(France : 80%)
in operation since Jan 2007

March 2010 : end of the nominal mission
March 2013 : end of the extended mission

Core Program :

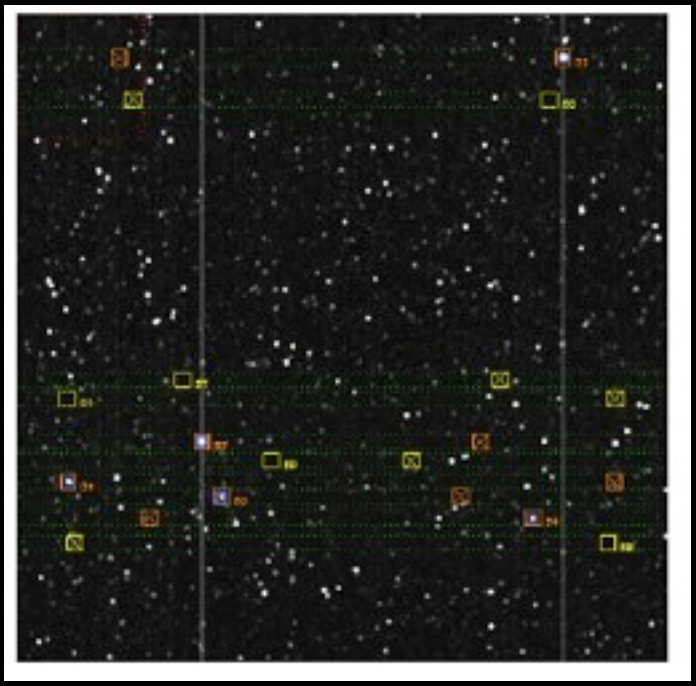
- *stellar structure - asteroseismology*
- *planet search - transit method*

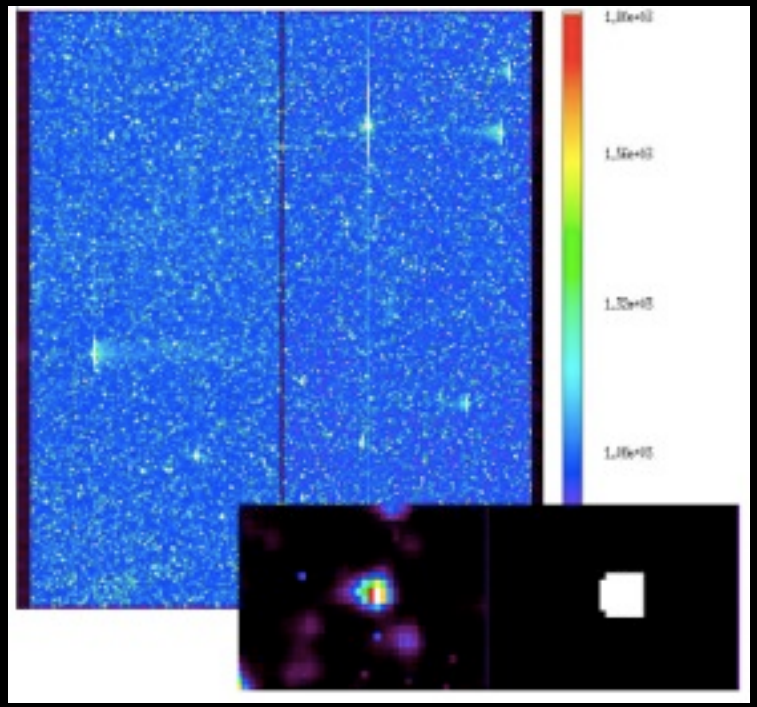
Bonus : stellar physics

Auvergne et al., 2009 A&A

CoRoT focal plane

Exoplanet FOV ~ 3.5°❑

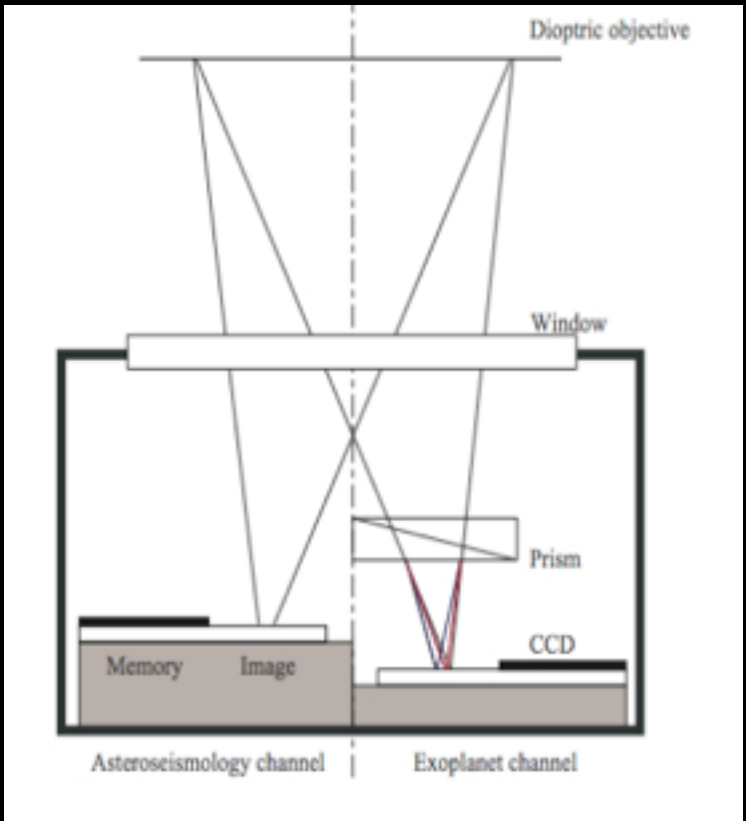


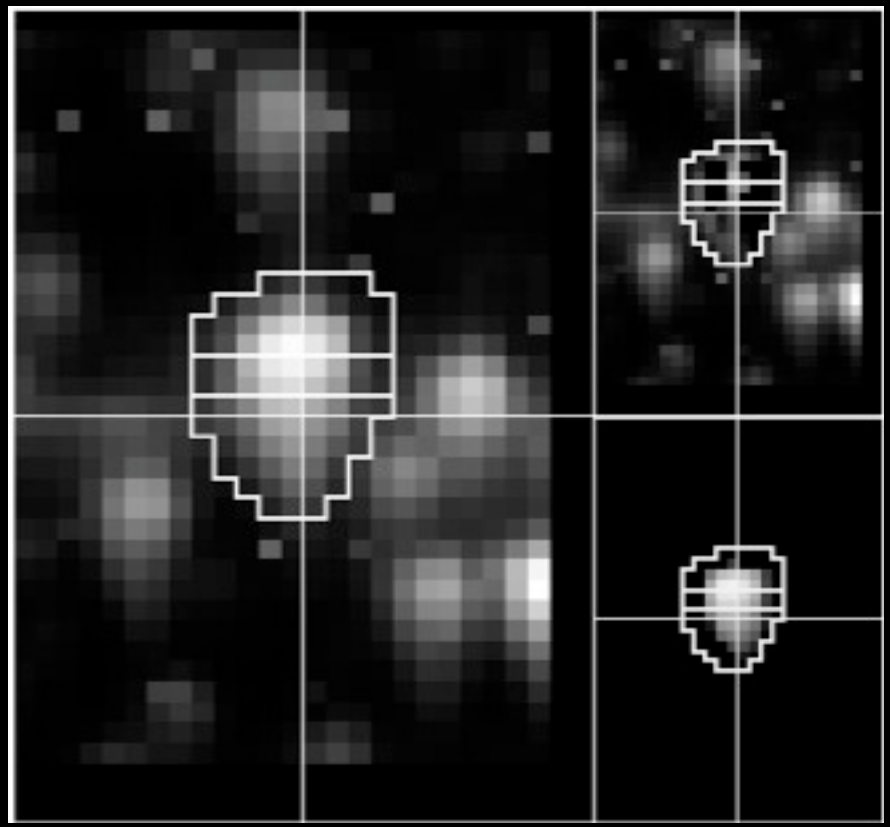


10 bright target m_v ~ 6 - 8
10 background windows

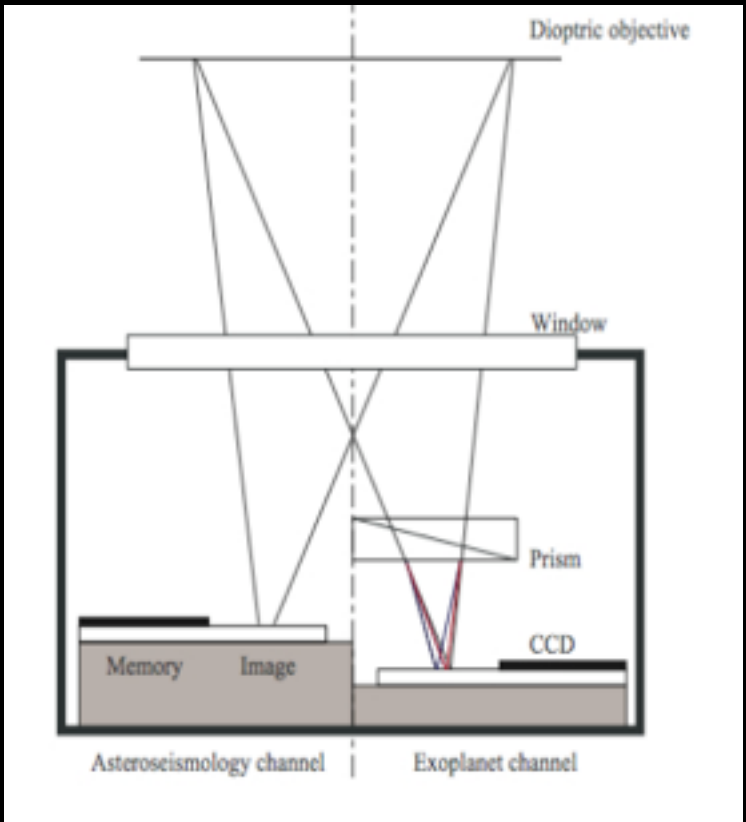
11 600 target m_v ~ 11 - 16
400 background windows

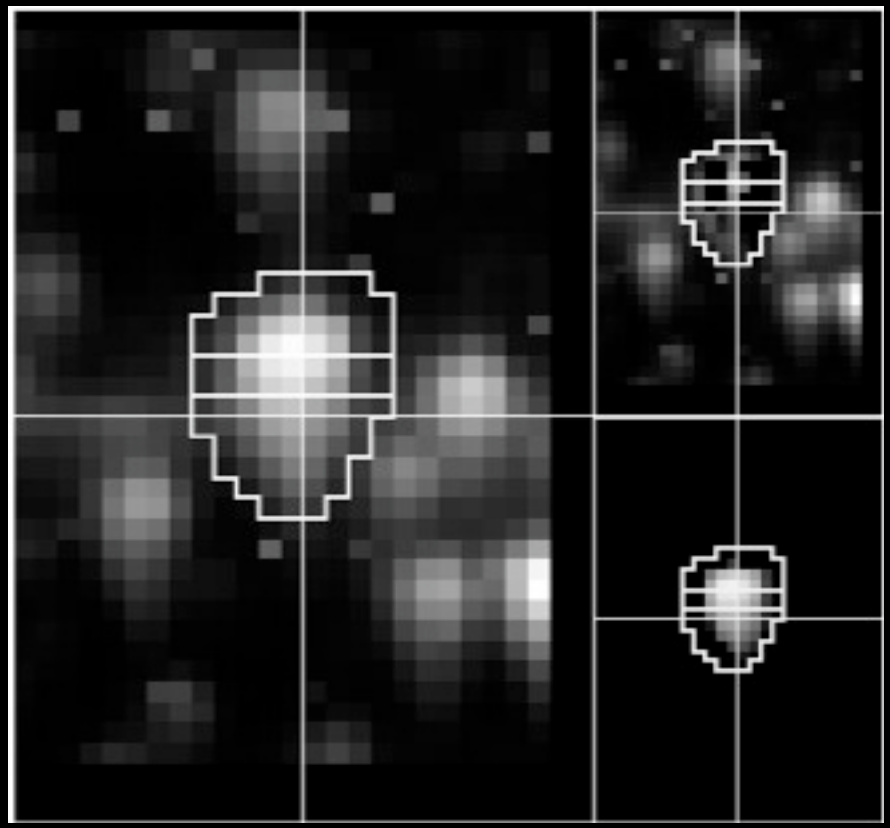
CoRoT photometry





CoRoT photometry



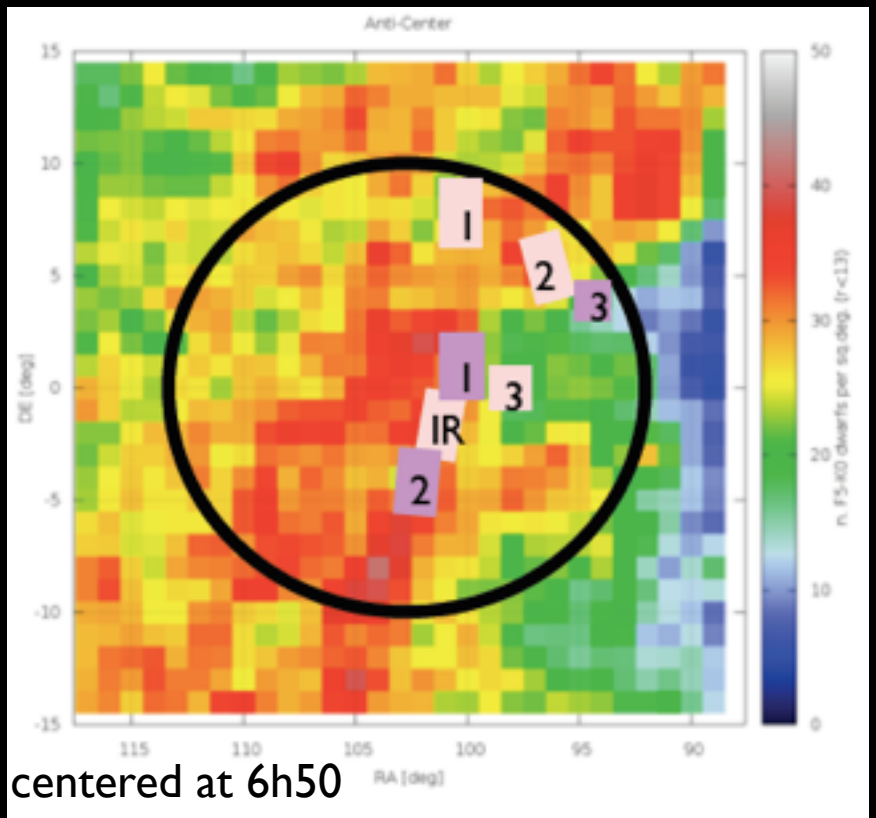


→3 colors light curve (LC) for up to 9 000 targets ($m_V < 15$)

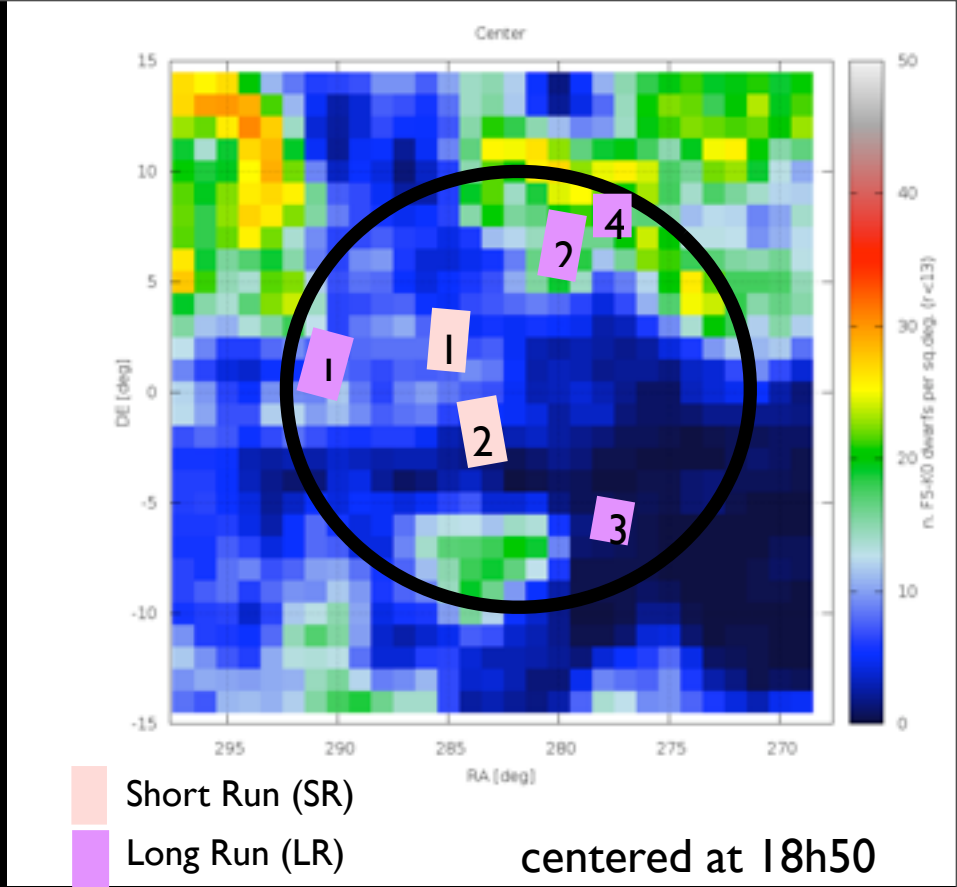
No direct correspondence to any standard photometric band.

CoRoT "eyes": different stellar properties

10° radius circle



centered at 6h50

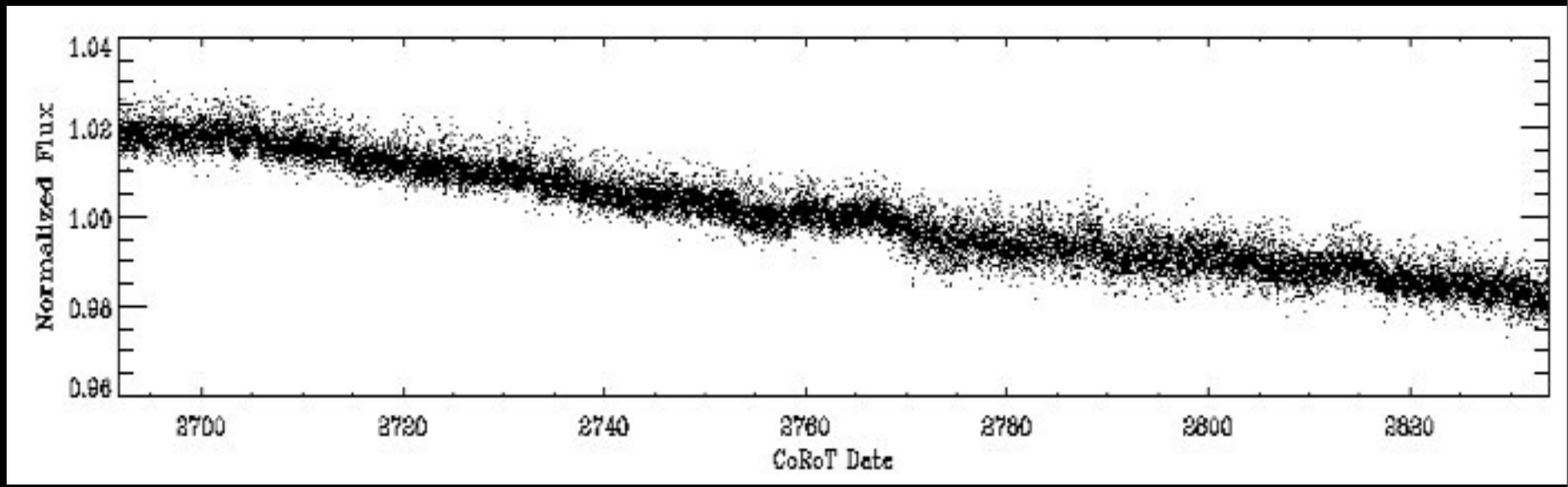


centered at 18h50

13 runs :
~ 75 000 Light Curves (LC) > 60 days
~ 50 000 Light Curves (SR) ~ 25 d

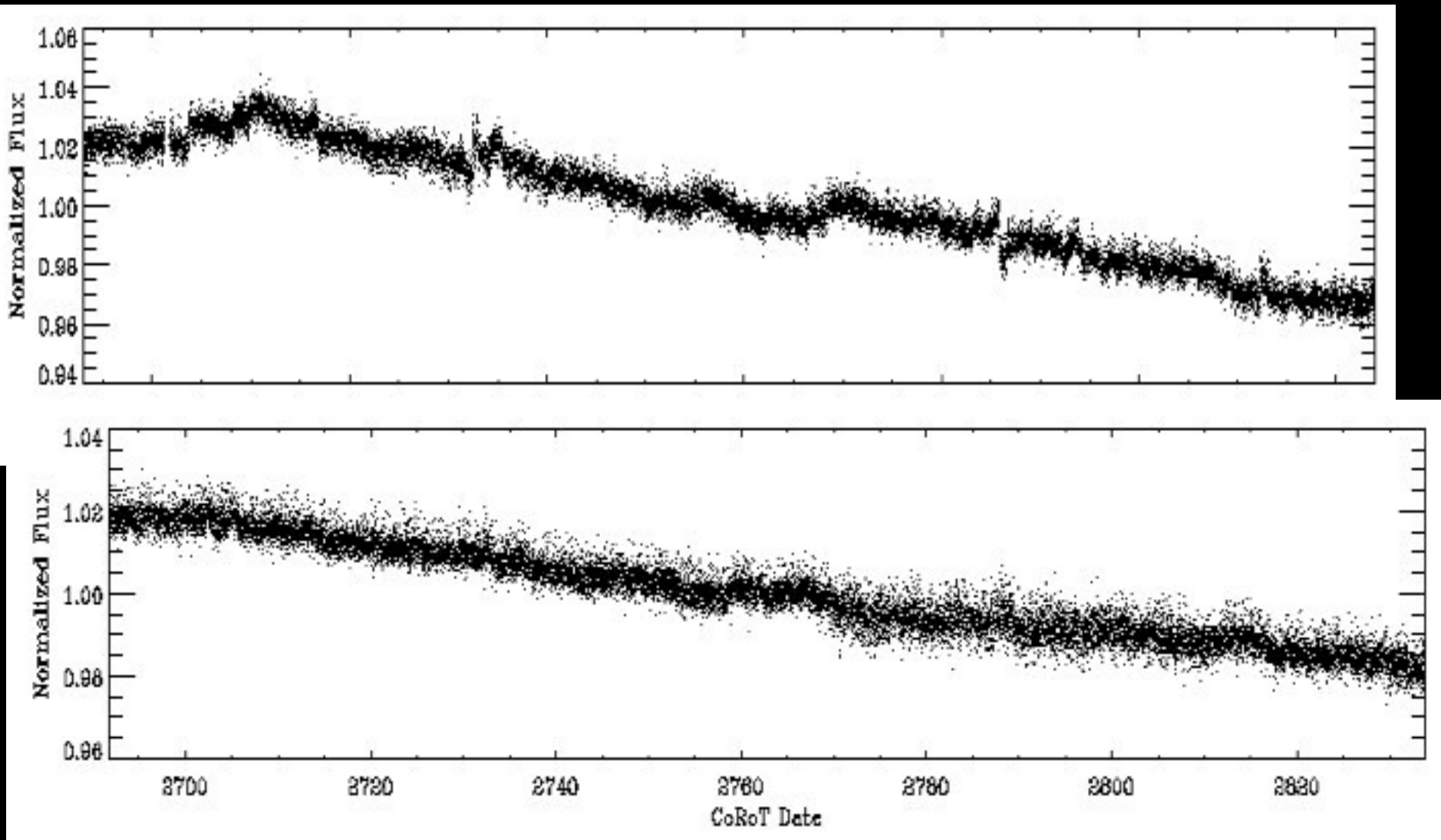
CoRoT Light Curves

A large variety of LC - more than 50% of the stars are variable



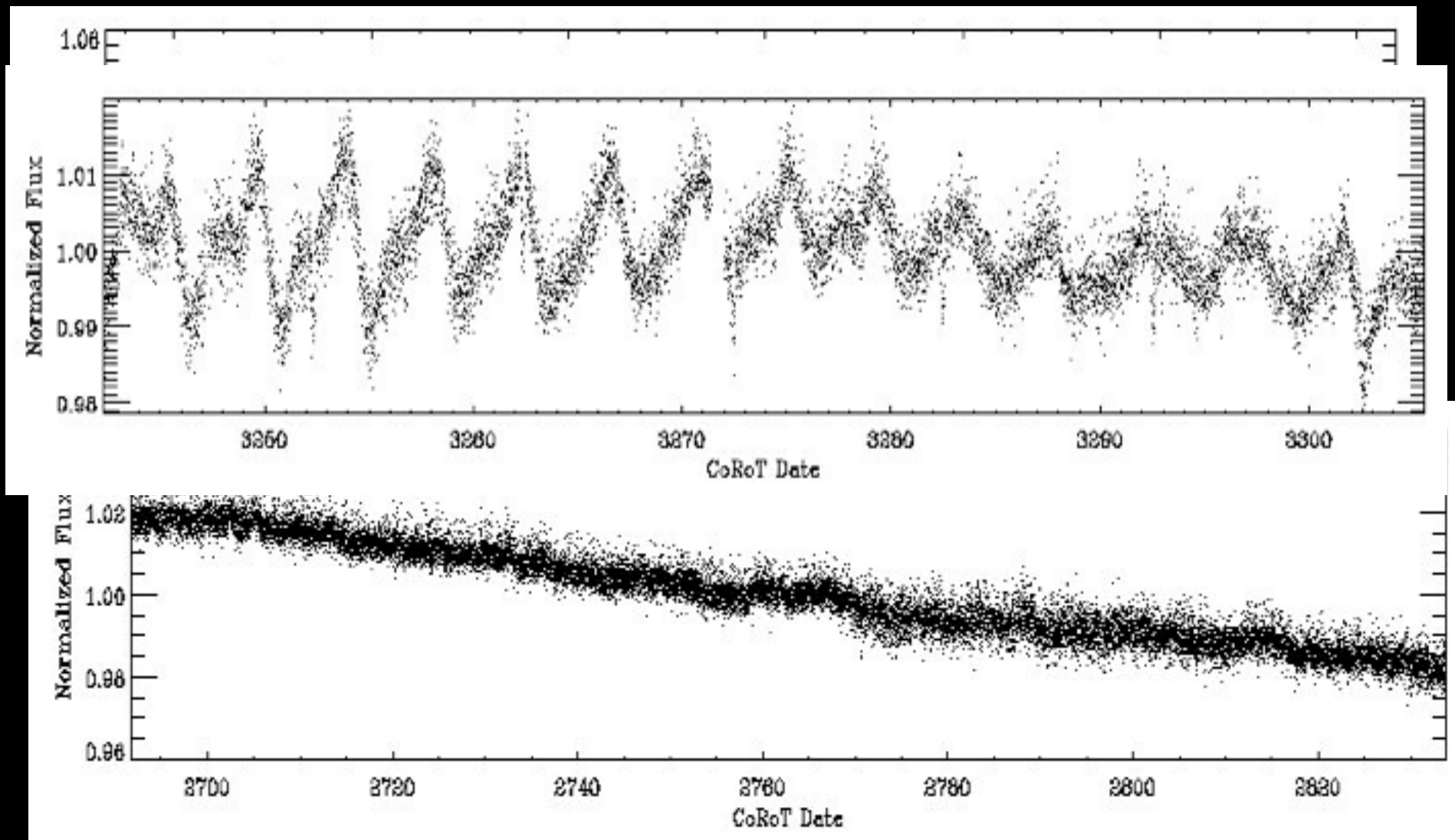
CoRoT Light Curves

A large variety of LC - more than 50% of the stars are variable



CoRoT Light Curves

A large variety of LC - more than 50% of the stars are variable



CoRoT Light Curves

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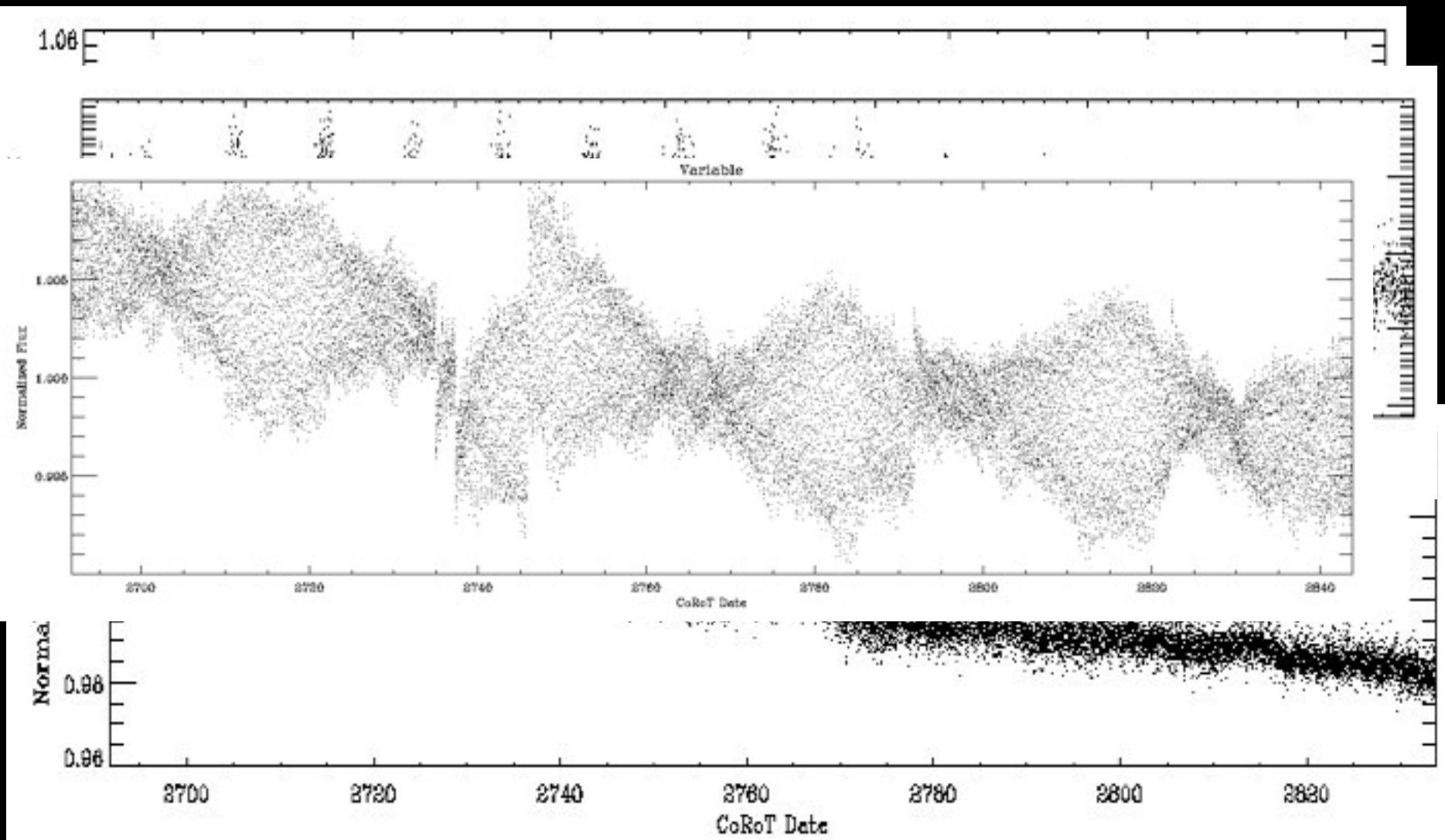
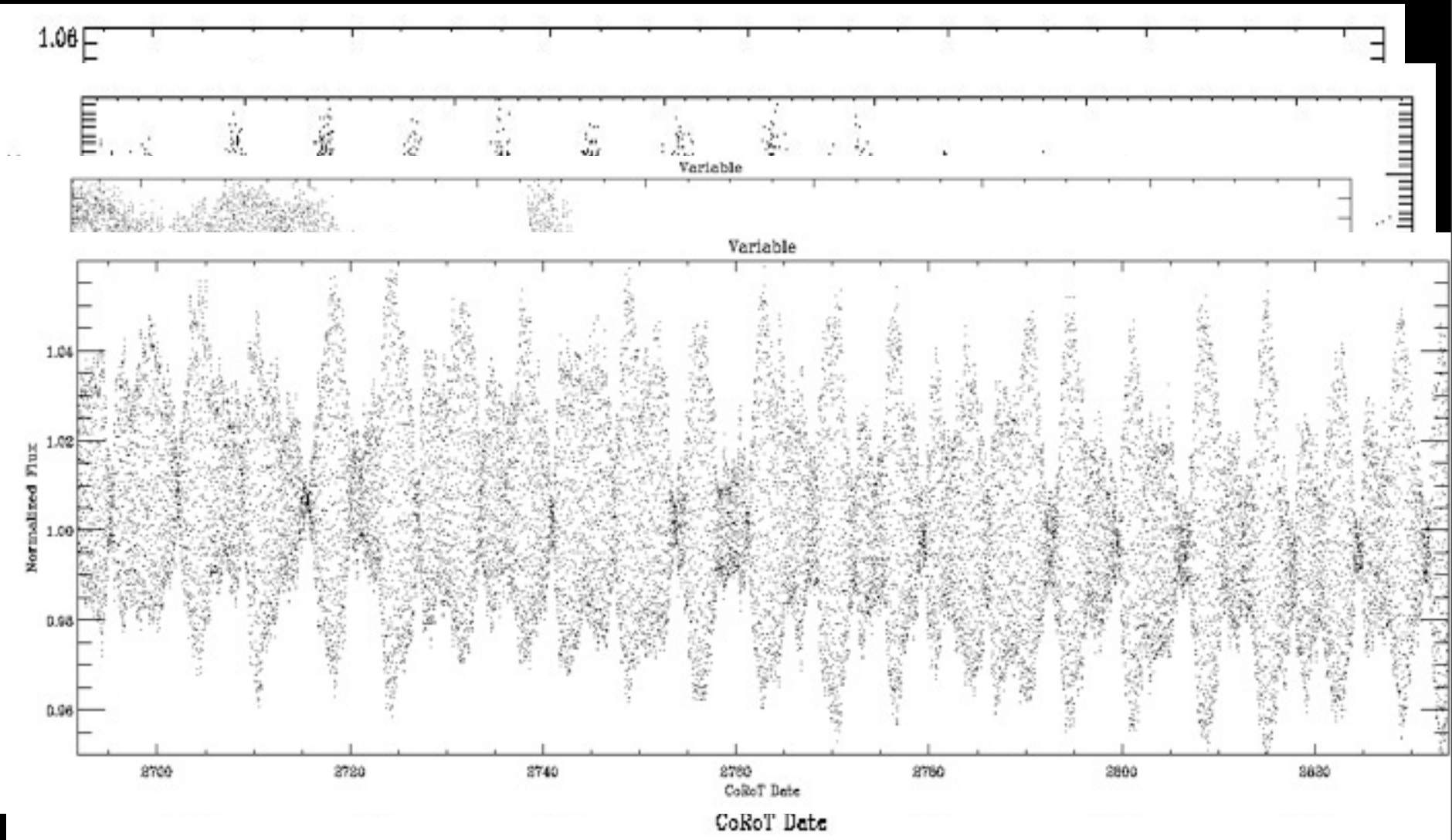


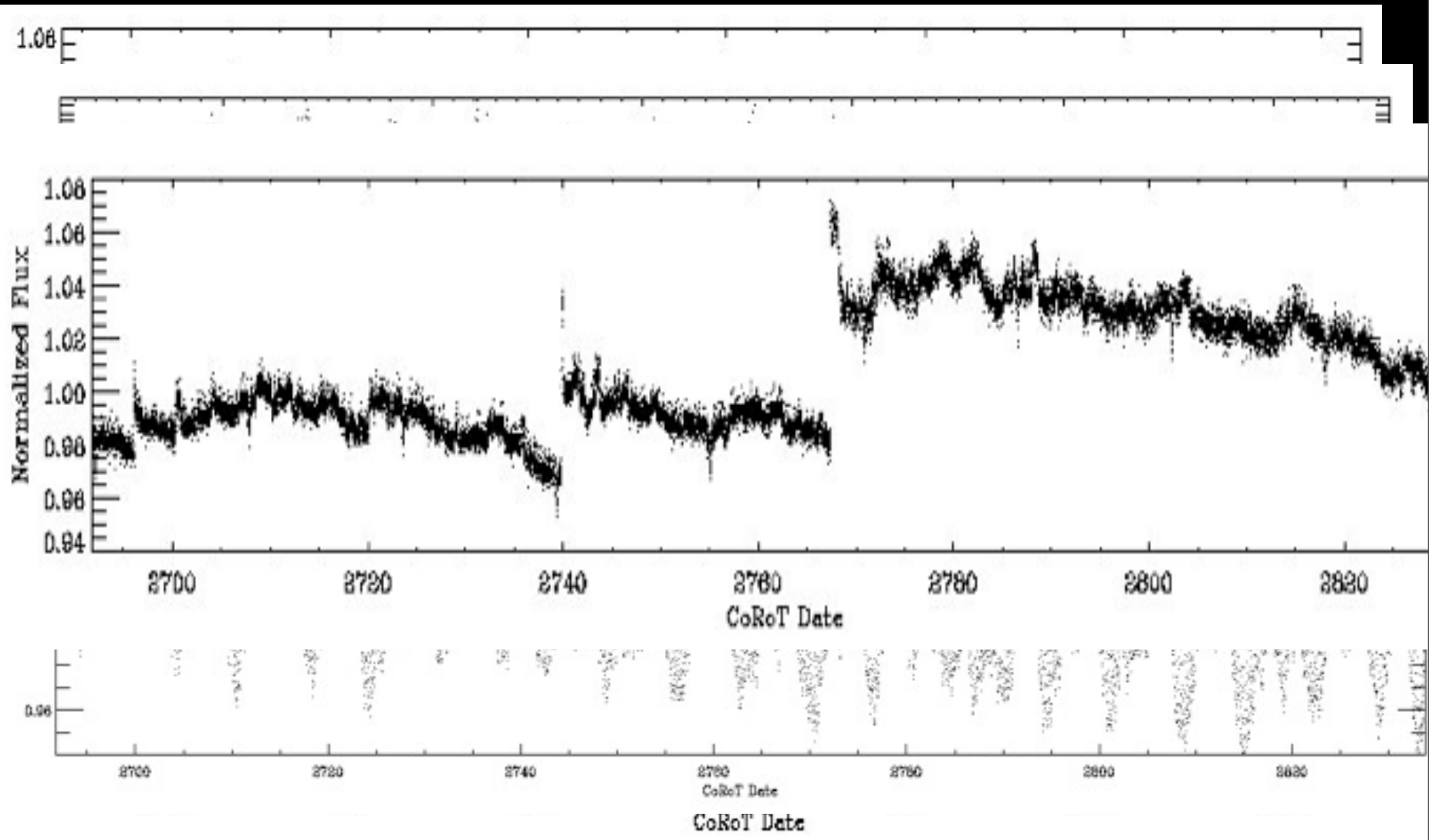
CoRoT Light Curves

A large variety of LC - more than 50% of the stars are variable

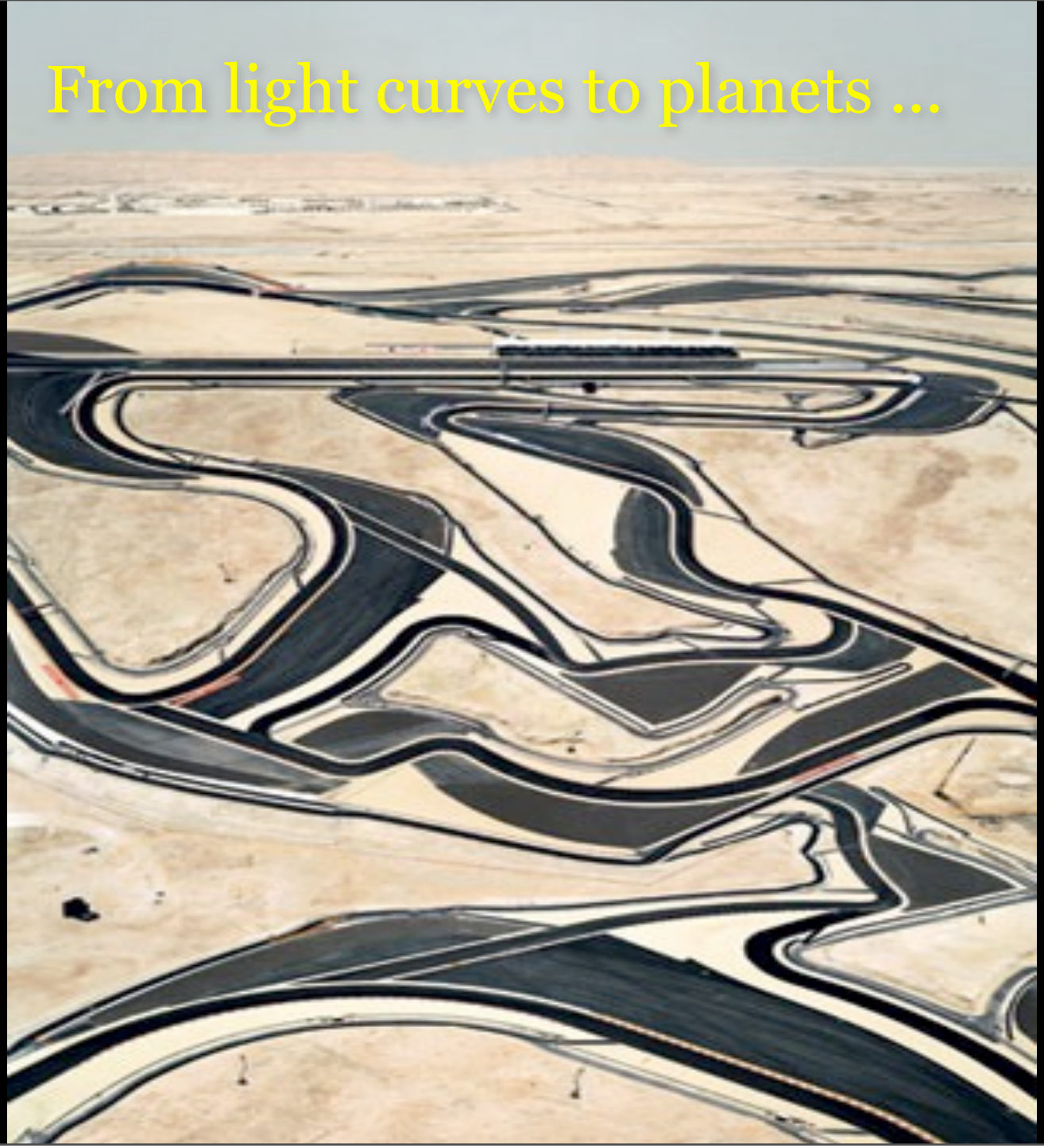


CoRoT Light Curves

A large variety of LC - more than 50% of the stars are variable

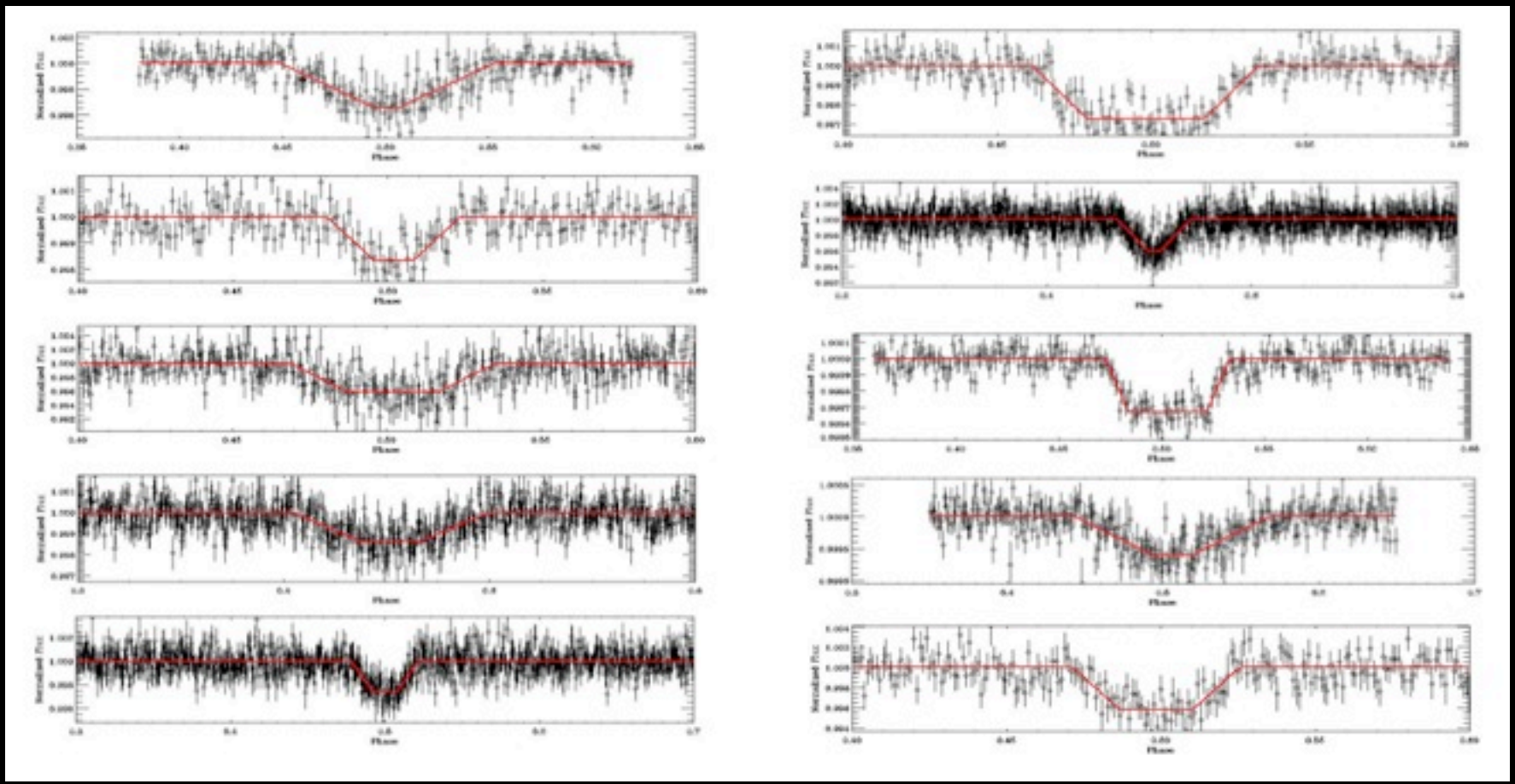


From light curves to planets ...



From CoRoT LC to planets ...

Seeking transits in LC :
~ 300 candidats per run / ~ 1800 in total



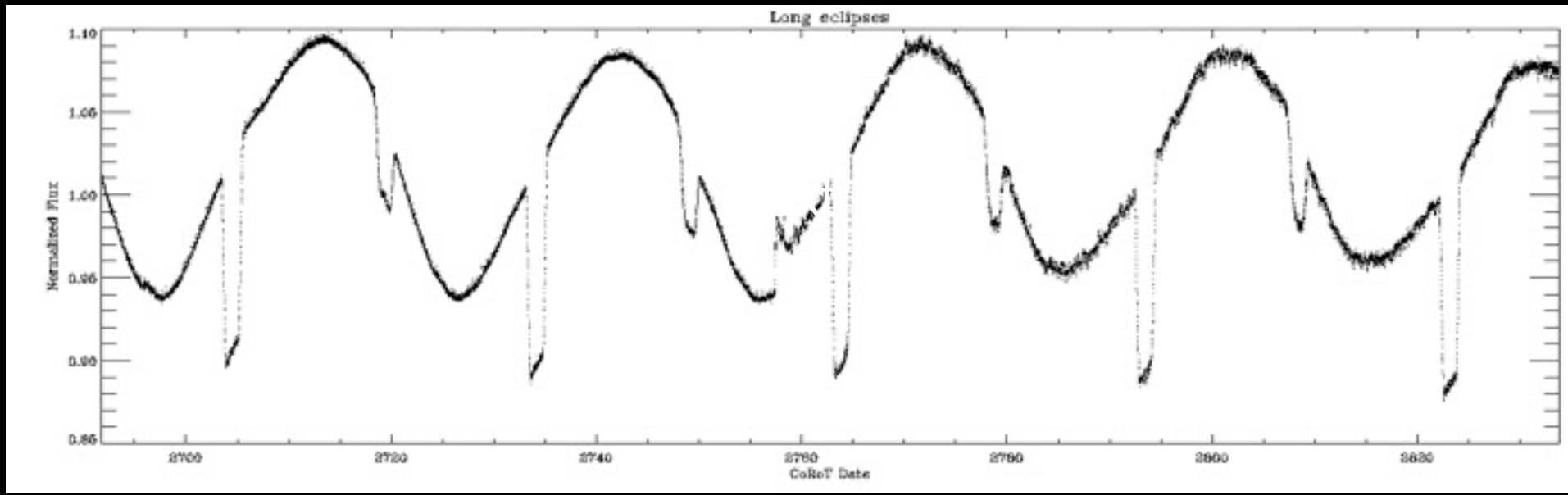
Carpano et al., 2009 A&A; Cabrera et al., 2009 A&A;
Carone et al., Samuel et al., Aigrain et al., *(in prep)*

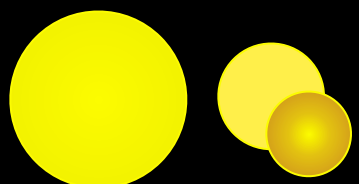
From CoRoT LC to planets ...

Most of detected transits are stellar systems

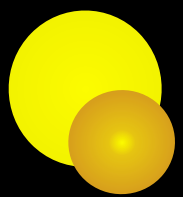
~ 80 % are identified thanks to CoRoT LC analyses.

~ 20 % are characterized thanks to ground-based follow-up observations

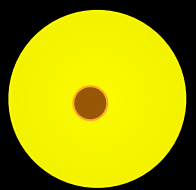




Contaminating EB



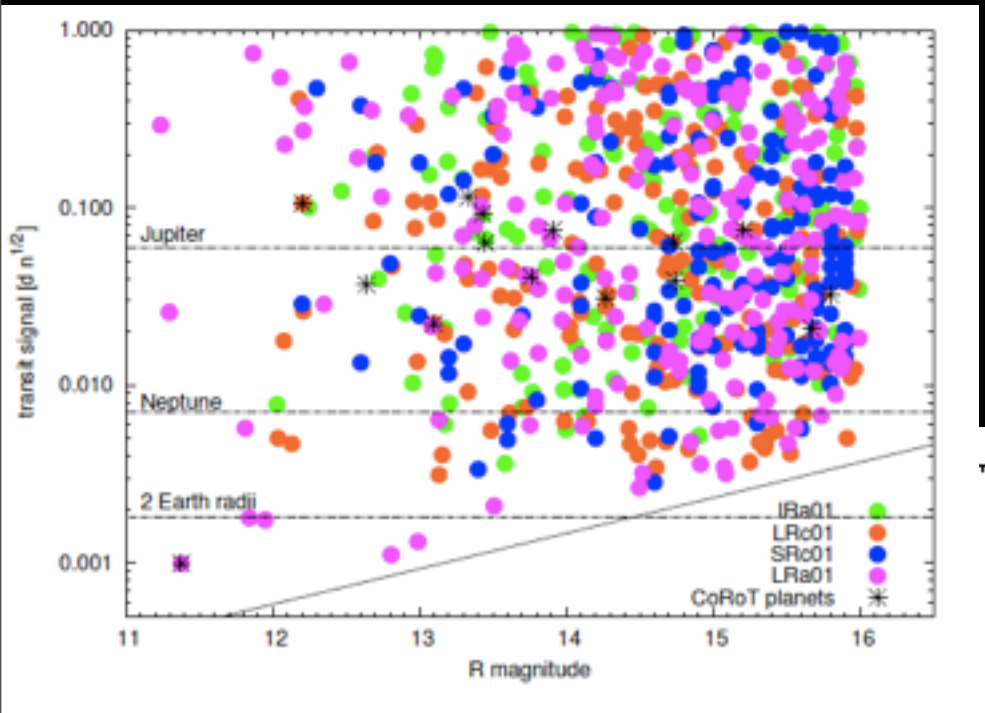
Eclipsing Binary



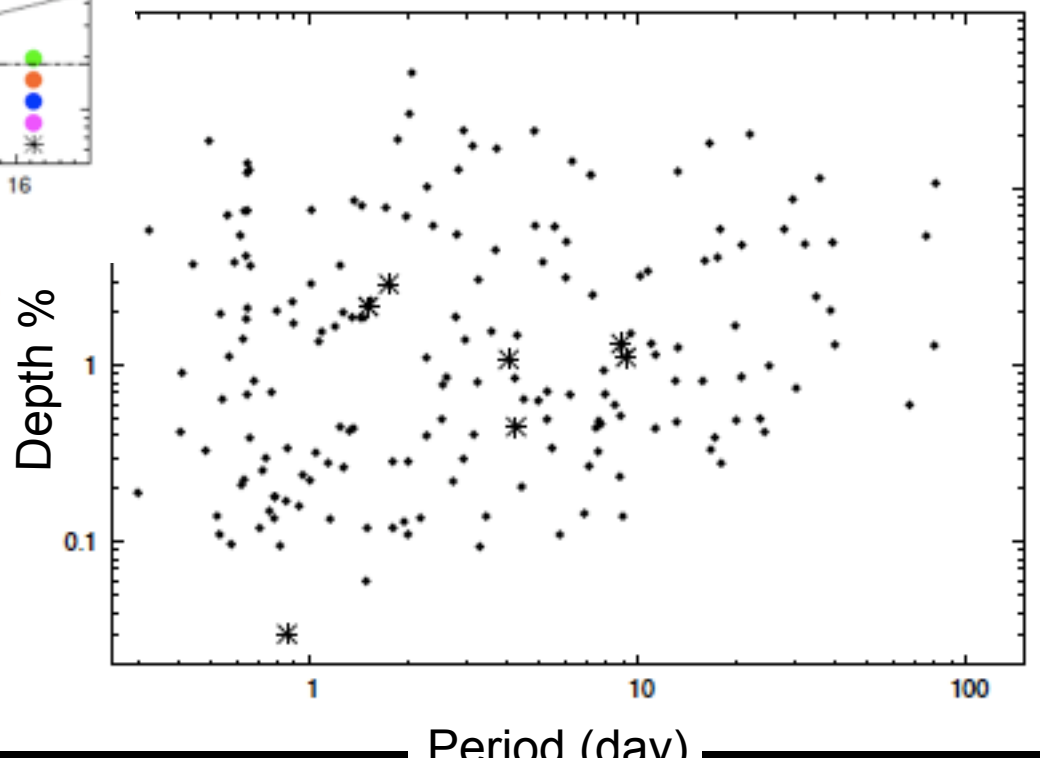
Planet

Moutou et al., 2009 A&A ; Almenara et al., 2009 A&A

Detection : performances

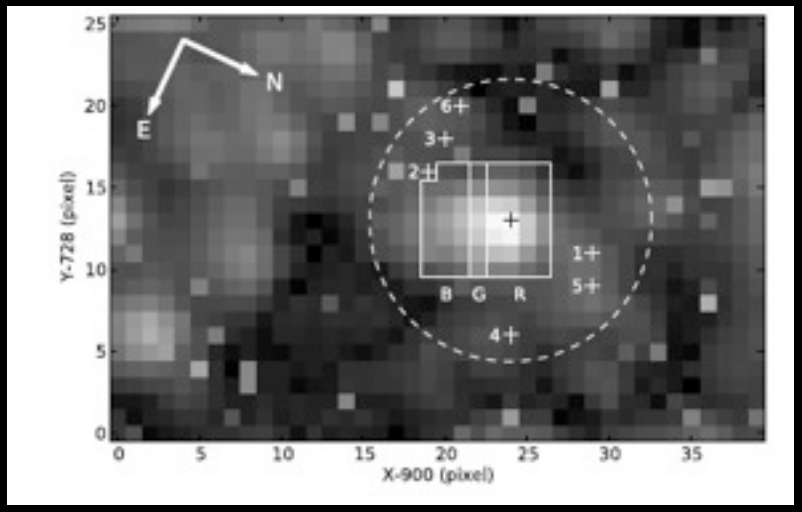


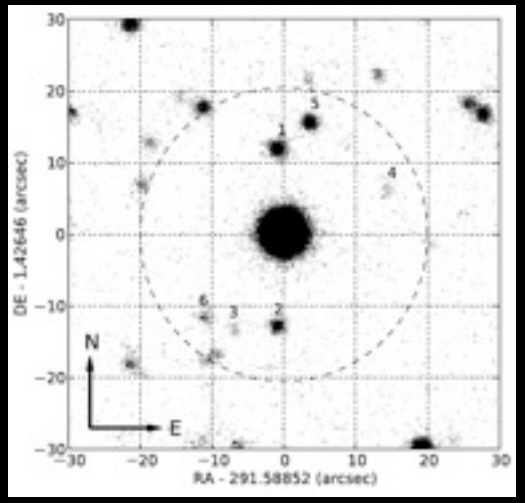
Since Feb 2007
~ 150 planetary candidates
~ 50 with transit depth < 3 mmag



Cabrera et al., 2009 A&A + priv. com.

Photometric check



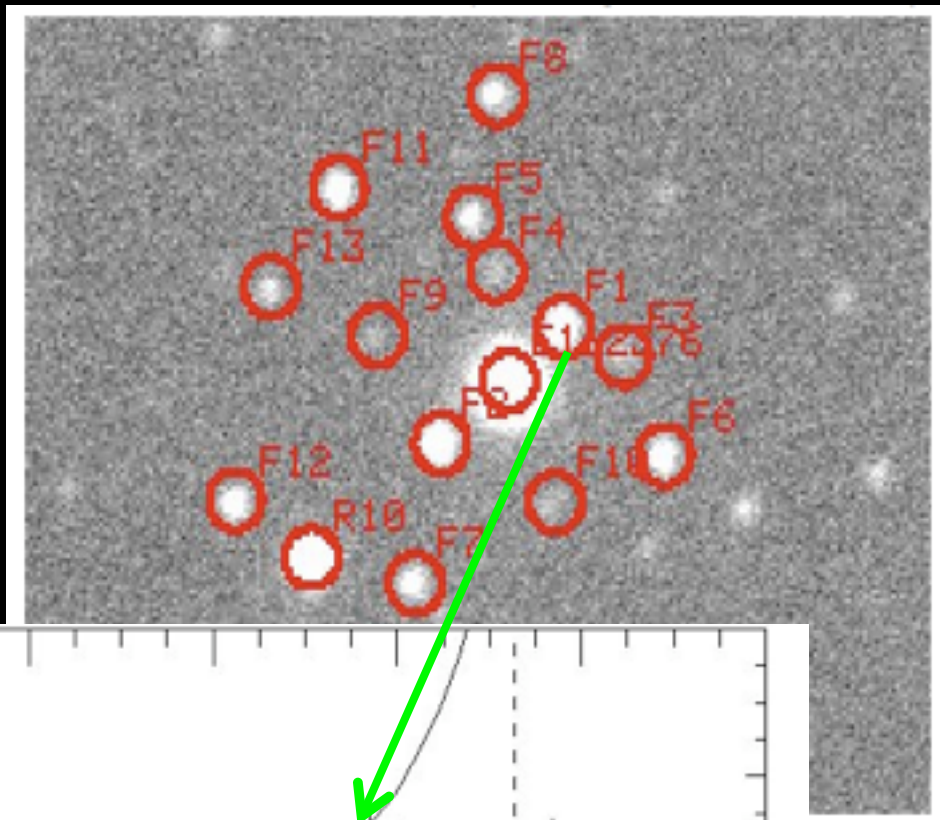


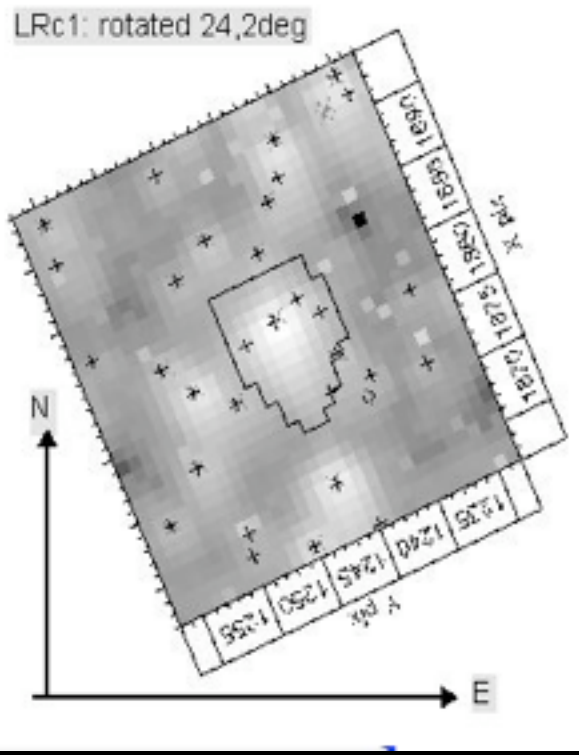
PSF ~30 x 20”

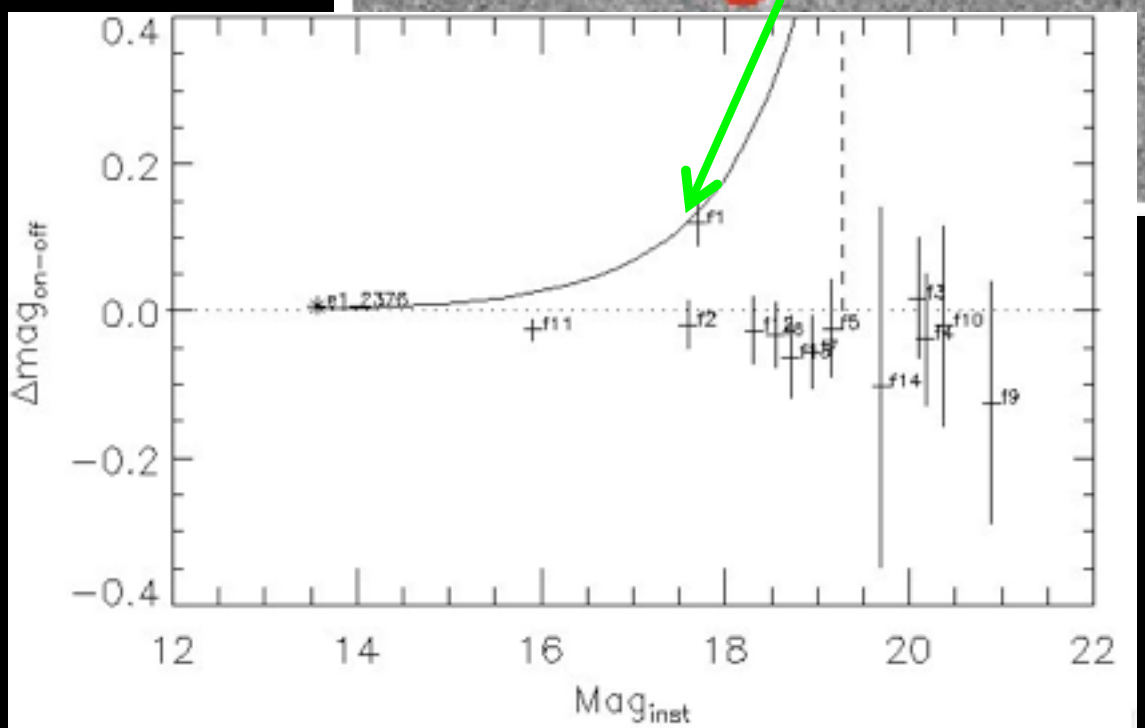
More then 20 nights per semester

Instrument	Observatory
BEST 0.2-m[a]	Observatoire de Haute Provence, France
BESTII 0.25-m[a]	Cerro Armazones, Chile
TEST 0.3-m	Thüringer Landessternwarte, Germany
Vienna 0.8-m	Vienna Observatory, Austria
IAC 80-cm	Observatorio del Teide, Canary Islands, Spain
WISE 0.46-m, 1-m	WISE Observatory, Israel
OHP 1.2-m	Observatoire de Haute Provence, France
Euler 1.2-m telescope	La Silla, Chile
Tautenburg 2-m	Thüringer Landessternwarte, Germany
CFHT/Megacam 3.6-m	Mauna Kea, Hawaii

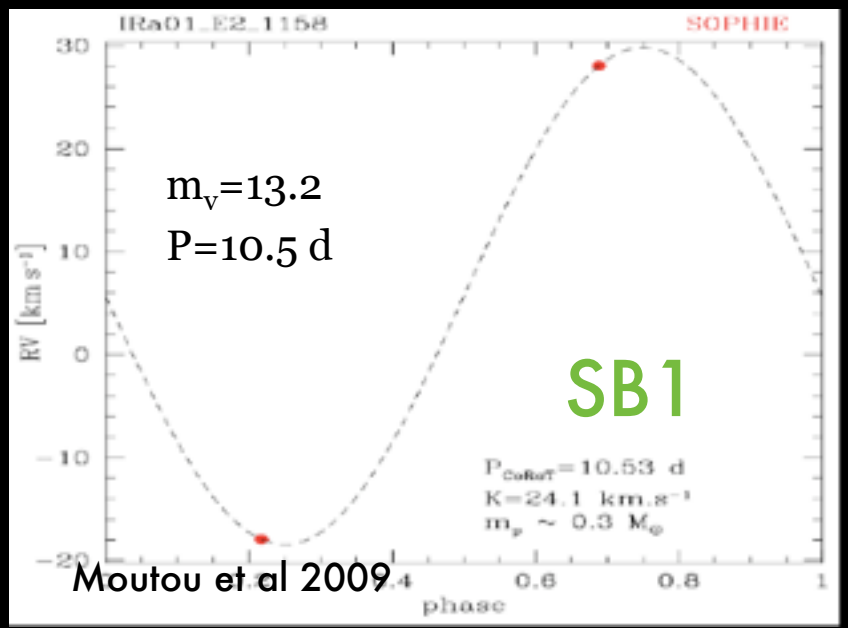
Deeg et al 2009 A&A


F8
F11
F5
F13
F4
F9
F1
F12
F6
R10
F7

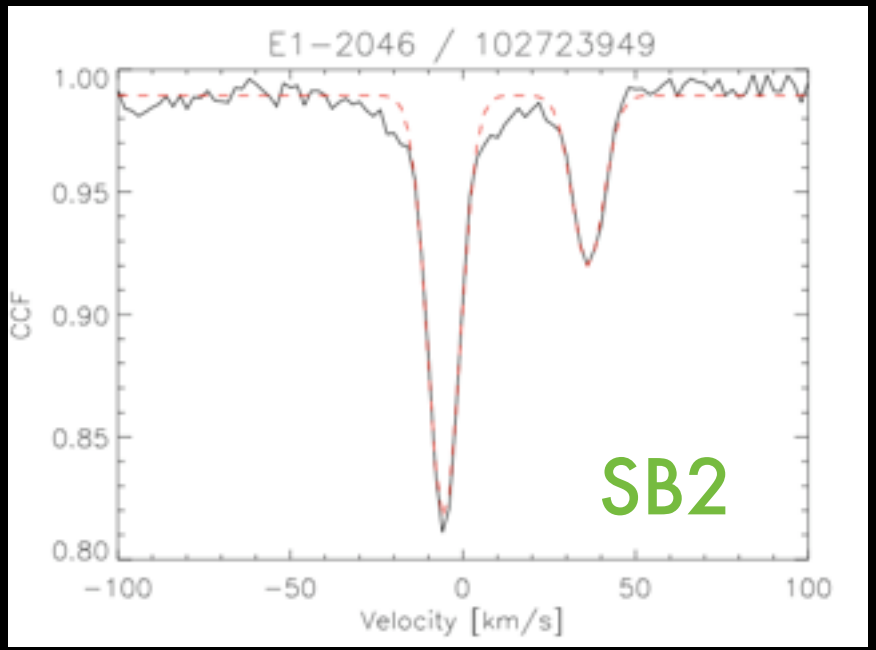

LRc1: rotated 24,2deg
N
E
X pix
Y pix


0.4
0.2
0.0
−0.2
−0.4
12
14
16
18
20
22
Δmag on−off
Mag inst

Spectroscopic check

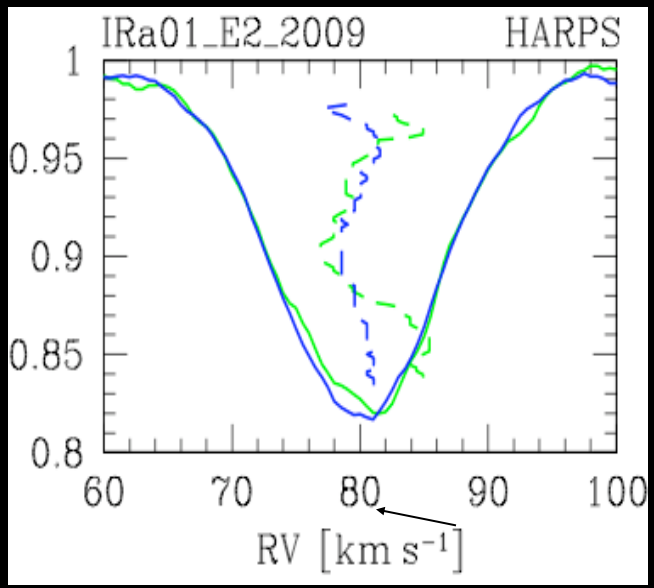


Moutou et al 2009

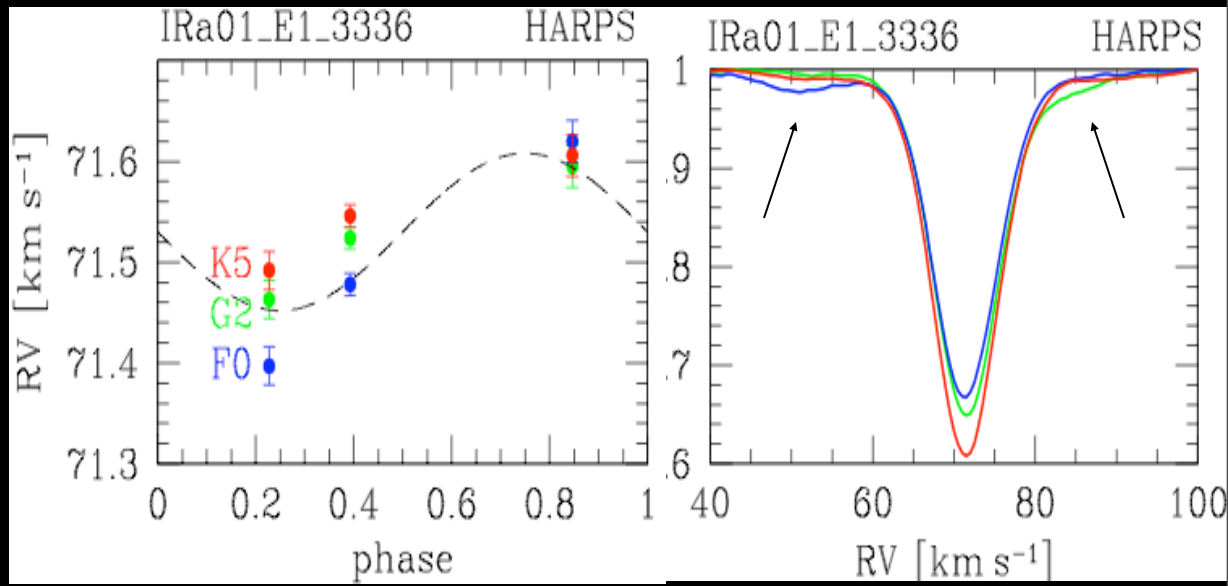


Instrument	Diam Tel	Nb Nights	Method	Measurement
CORALIE	1.2	1	radial velocity	SB identification
SOPHIE	1.93	13	radial velocity	spectroscopic identification, mass characterization
HARPS	3.6	16	radial velocity	spectroscopic identification, mass characterization
UVES	8.0	3	spectroscopy	stellar parameters
KECK	10.0	4	radial velocity & spectroscopy	

Blended Eclipsing Binaries (inside seeing)



Bisector Span

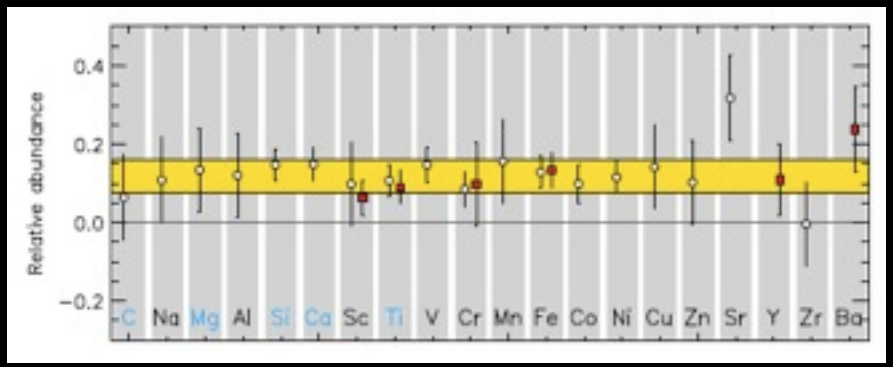


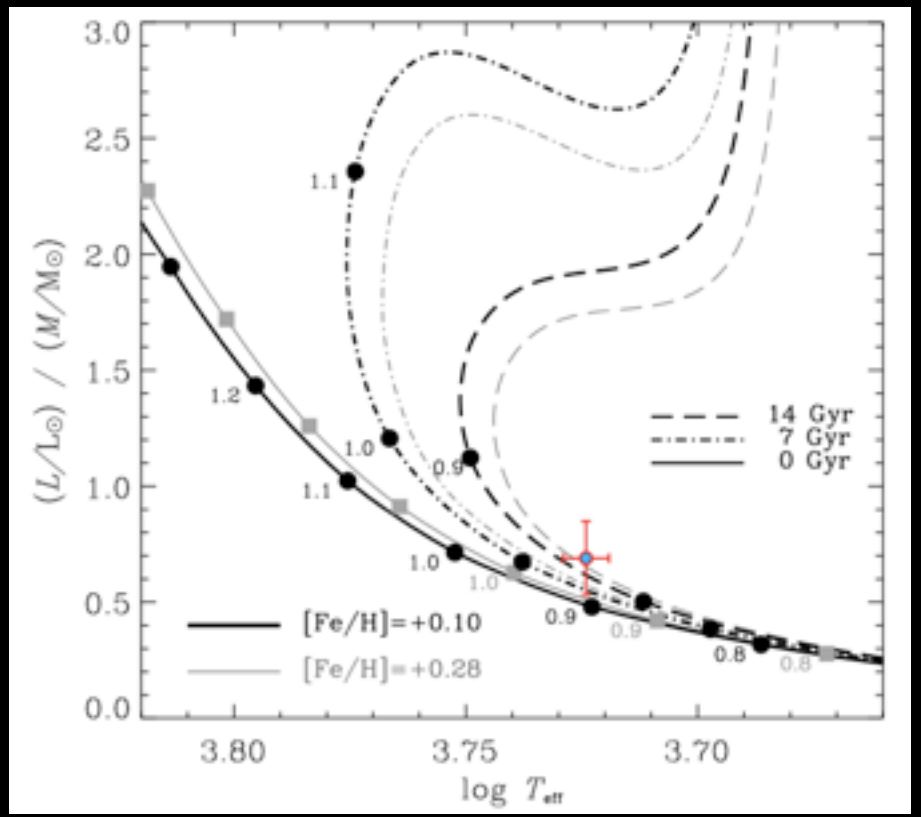
Amplitude change with CCF template

Spectroscopic check : parent star

$$\frac{\Delta F}{F} = \left(\frac{R_p}{R_*}\right)^2$$

$$k = \frac{28.4\ ms^{-1}}{\sqrt{1-e^2}} \frac{m_p \sin i}{M_{Jup}} \left(\frac{P}{1\,yr}\right)^{-1/3} \left(\frac{m_*}{1M_\odot}\right)^{-2/3}$$

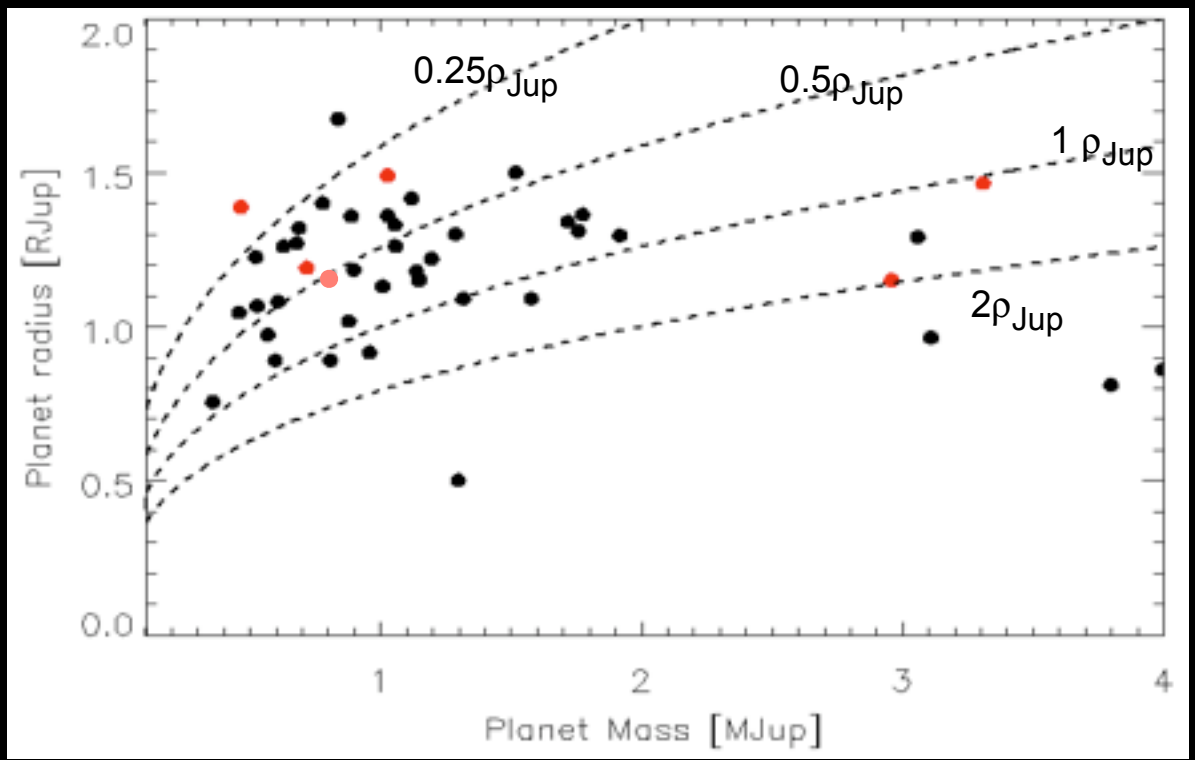




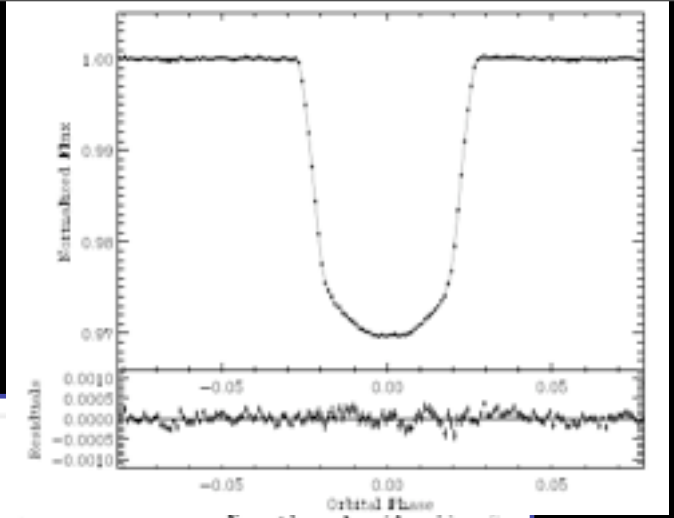
Rp = 1.58 +/- 0.1 $R_\oplus$ (formerly 1.70 +/- 0.1)
ρ = 6.8 +/- 1.7 g cm–3

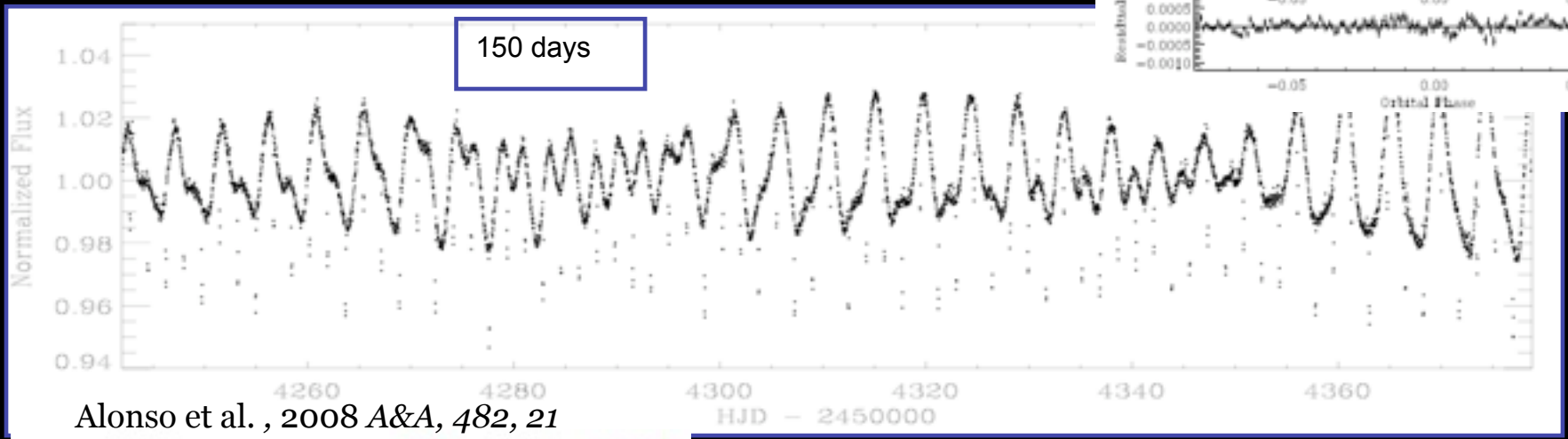
Bruntt et al 2010 (submitted)

The CoRoT planets

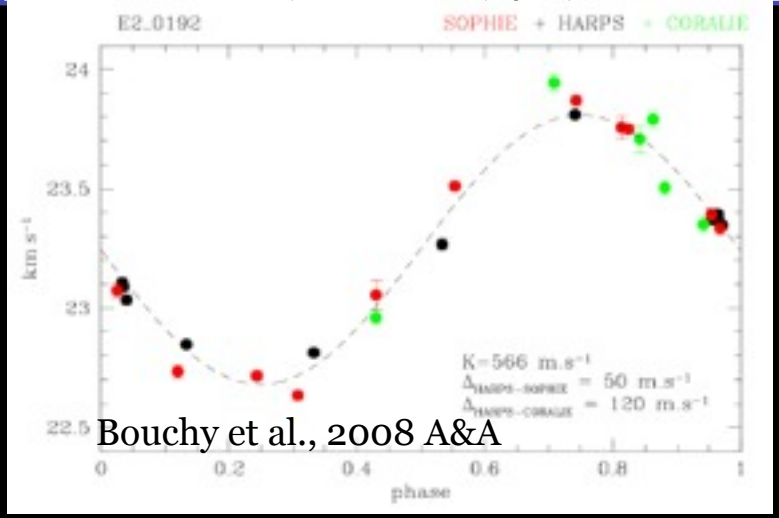


CoRot-2b : a young and active star





Alonso et al. , 2008 *A&A, 482, 21*



Bouchy et al., 2008 A&A

Period = 1.743 days

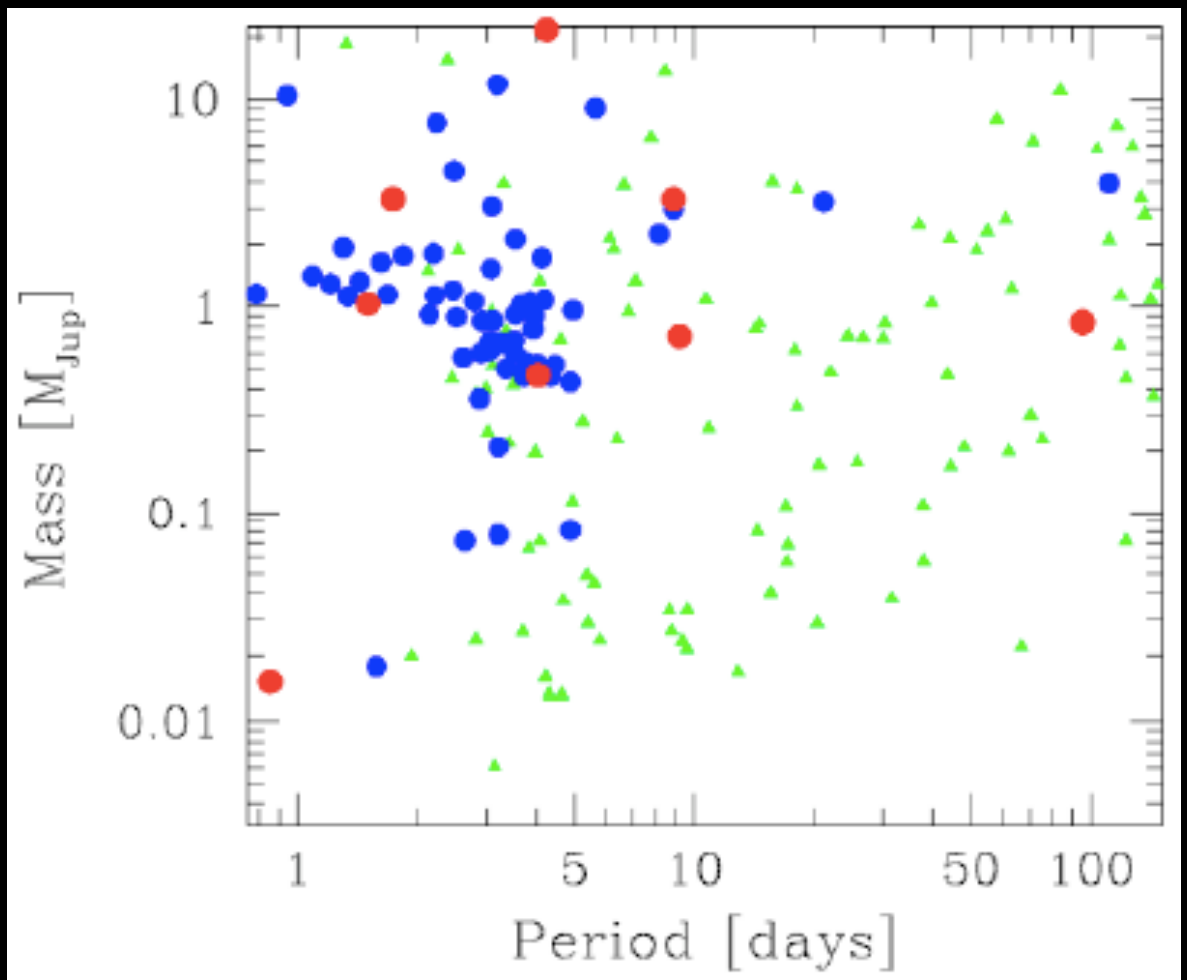
M_p *= 3.31 +/- 0.16M* $_{jup}$

R_p *= 1.465 ± 0.029* R_{Jup}

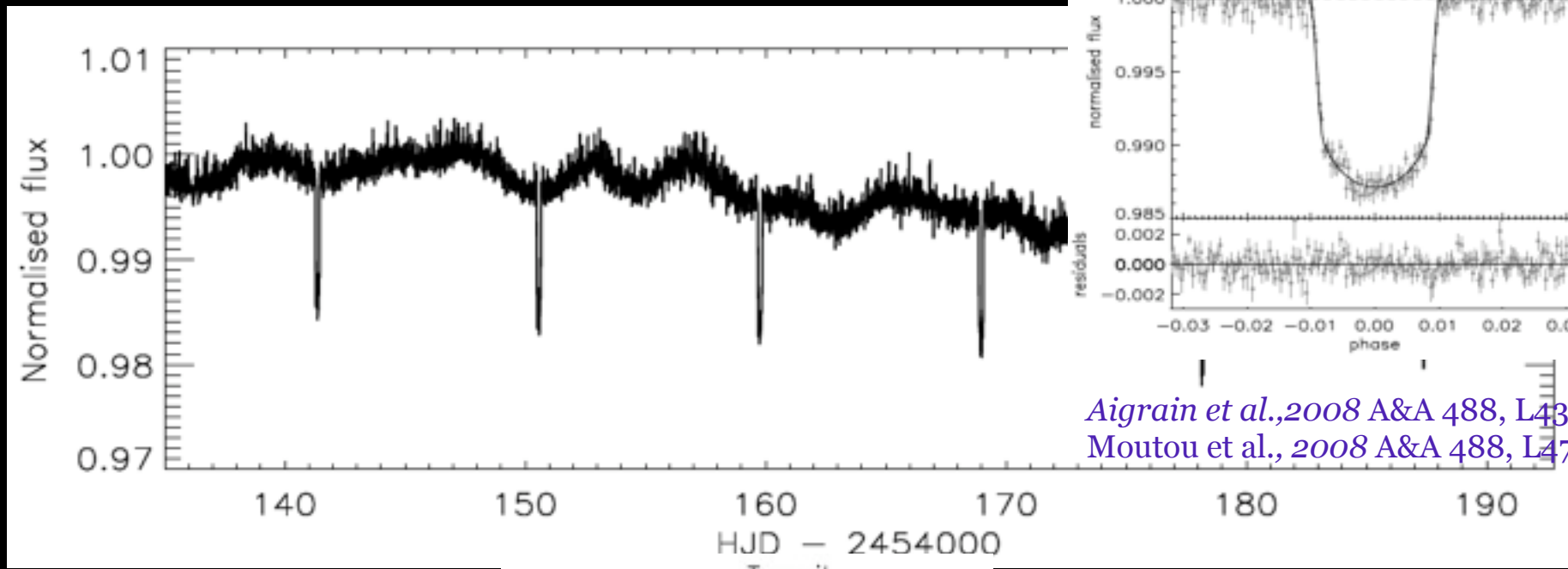
e cos ω = −0.00291 ± 0.00063

Age : a few 100 Myr *Gillon et al., 2009*

The CoRoT planets

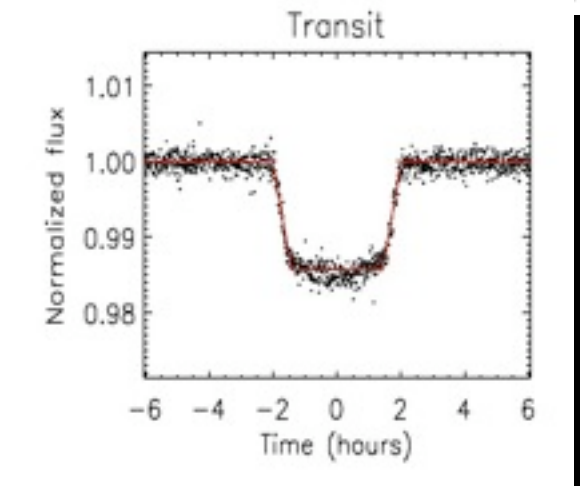


“Long period” systems : CoRoT-4b & CoRoT-6b



Aigrain et al.,2008 A&A 488, L43;
Moutou et al., *2008* A&A 488, L47

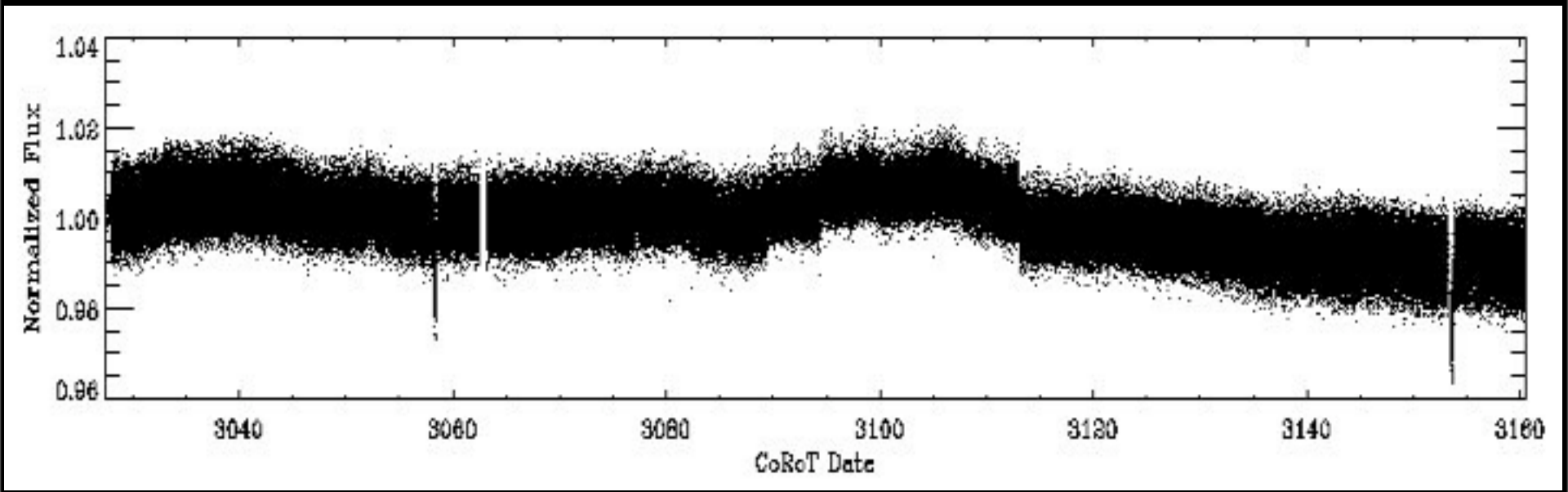
CoRoT-4b : *7 transits*
Period = 9.2 days
M_p= 0.72 ± 0.08 M_{jup}
R_p = 1.19 ± 0.06 R_{Jup}
ρ= 0.525 ± 0.15 g/cm³



CoRoT-6b : *15 transits*
Period = 8.88 days
M_p= 2.96 ± 0.34 M_{jup}
R_p = 1.16 ± 0.03 R_{Jup}
ρ= 2.32 ± 0. g/cm³
[Fe/H] = -0.20

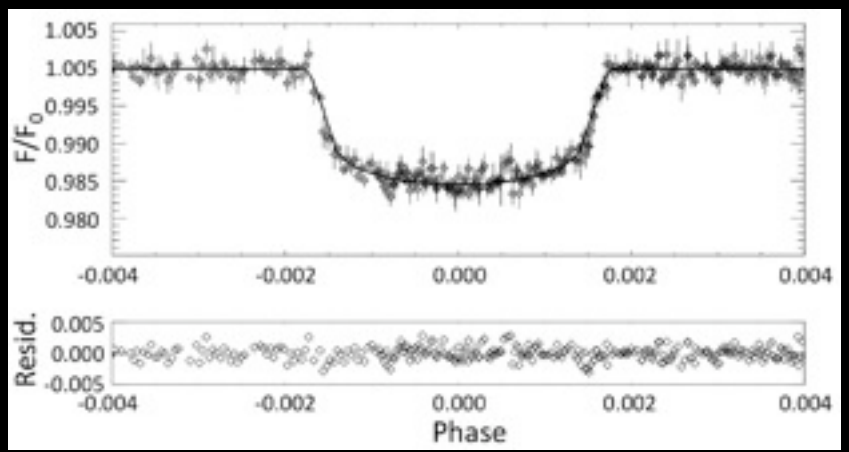
Fridlund et al., *2010* A&A

CoRoT-9b : a transiting Jupiter on a Mercury-like orbit

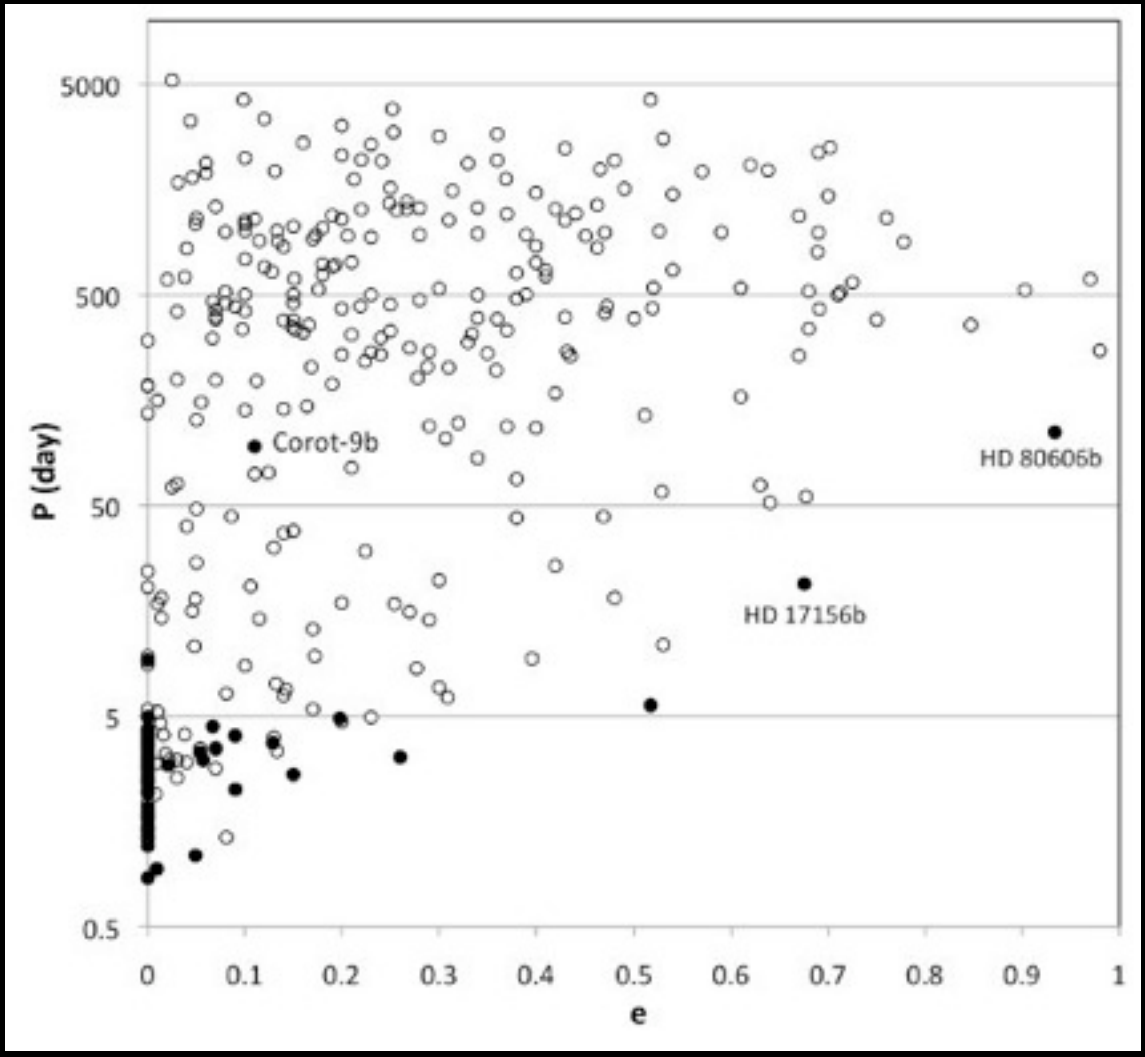


CoRoT-9b : *2 transits*
G3V
Period = 95.27 days
M_p= 0.84 ± 0.07 M_{jup}
R_p = 1.05 ± 0.04 R_{Jup}
ρ= 0.525 ± 0.15 g/cm^3

Deeg et al., Nature 2010

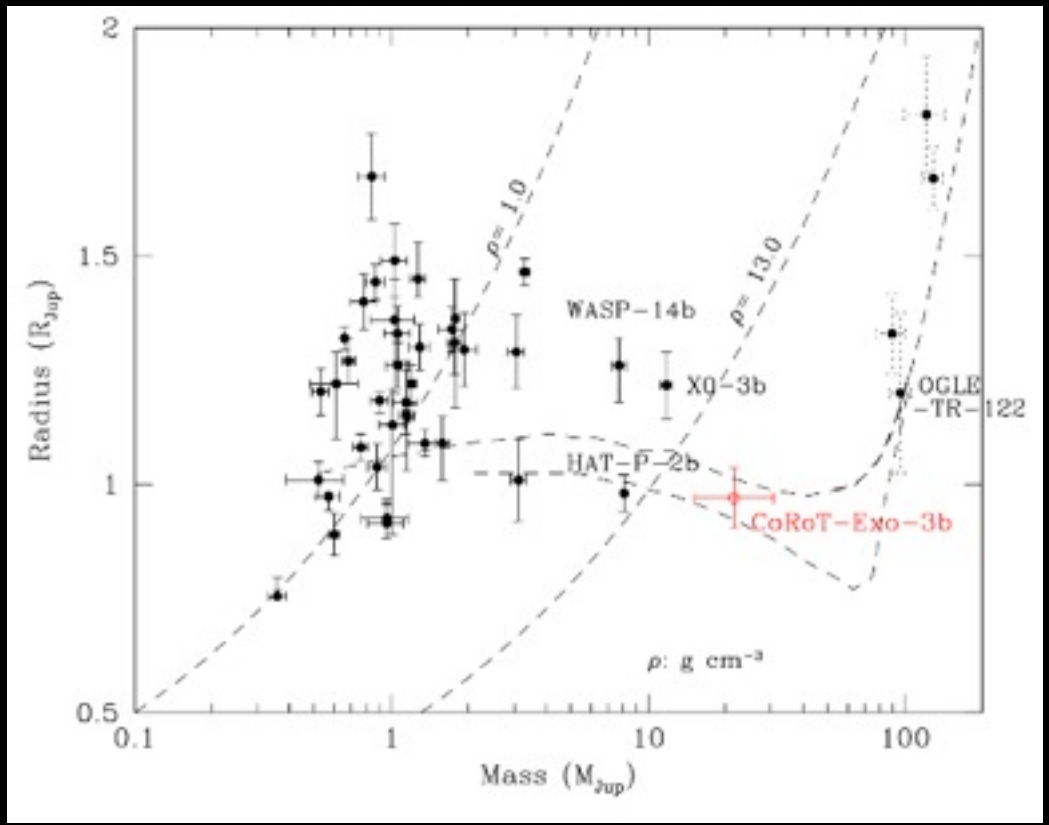


CoRoT-9b : a transiting Jupiter on a Mercury-like orbit



At the extremes of the mass function

CoRoT-3b : *34 transits*
F3V
Period = 4.26 days
M_p= 21.6 ± 1.00 M_{jup}
R_p = 1.01 ± 0.07 R_{Jup}
ρ= 26.4 ± 5.6 g/cm^3

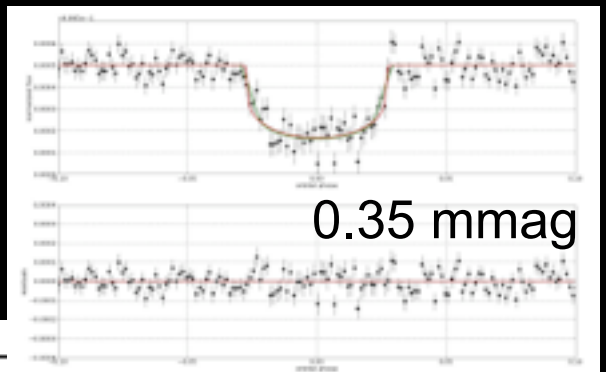


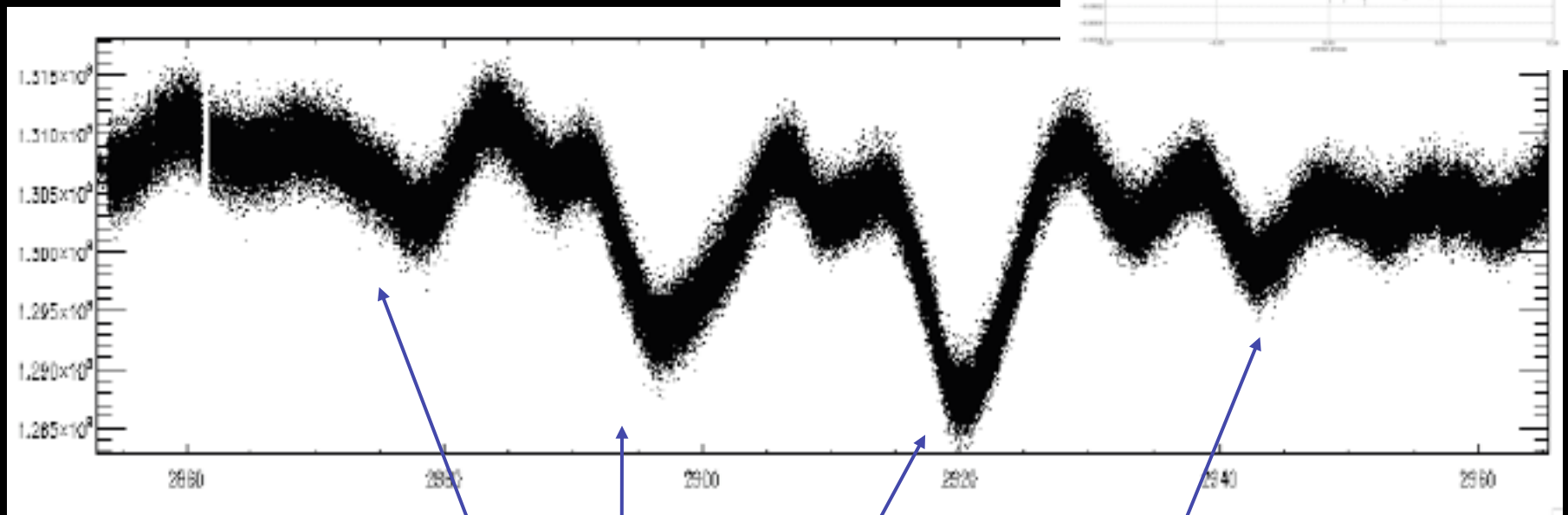
- Super-planet or brown dwarf ?
- an exceptional object or just one member of a new class?
- definition of a planet

Trend : more massive "planets" for massive stars ?

Deleuil et al., 2008 A&A

CoRoT-7b : the first hot super earth

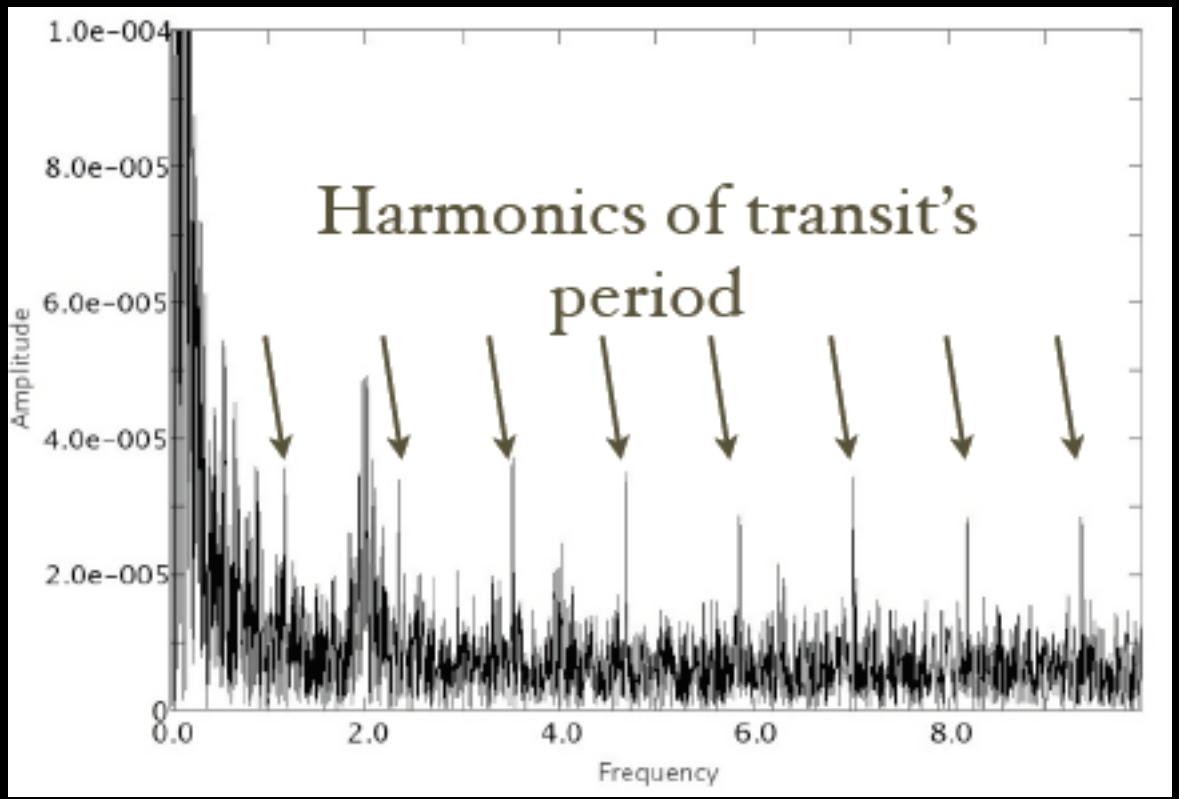




Rotational period ~23 days - star spots evolution

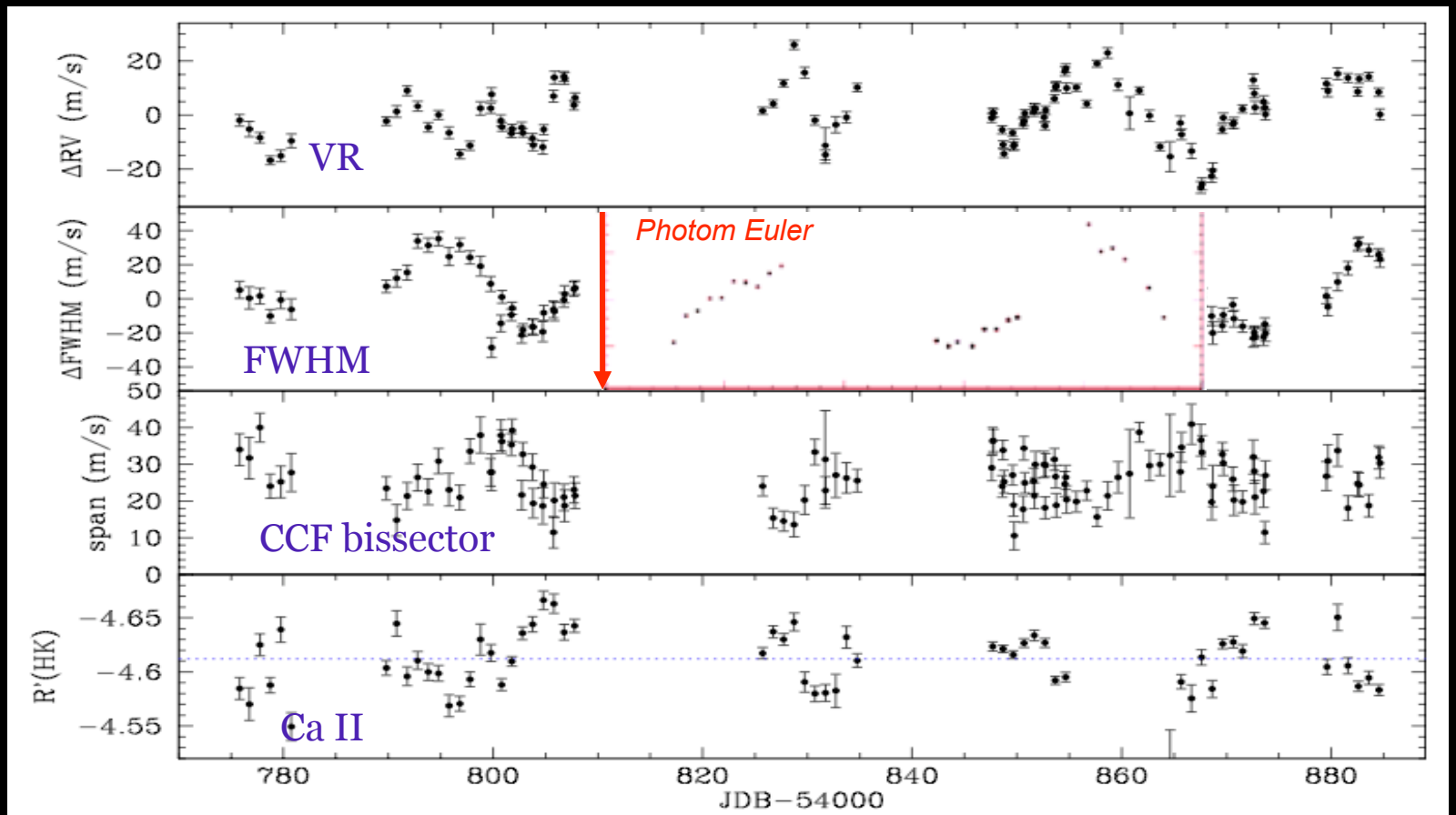
Léger et al., 2009, A&A

CoRoT-7b transit detection



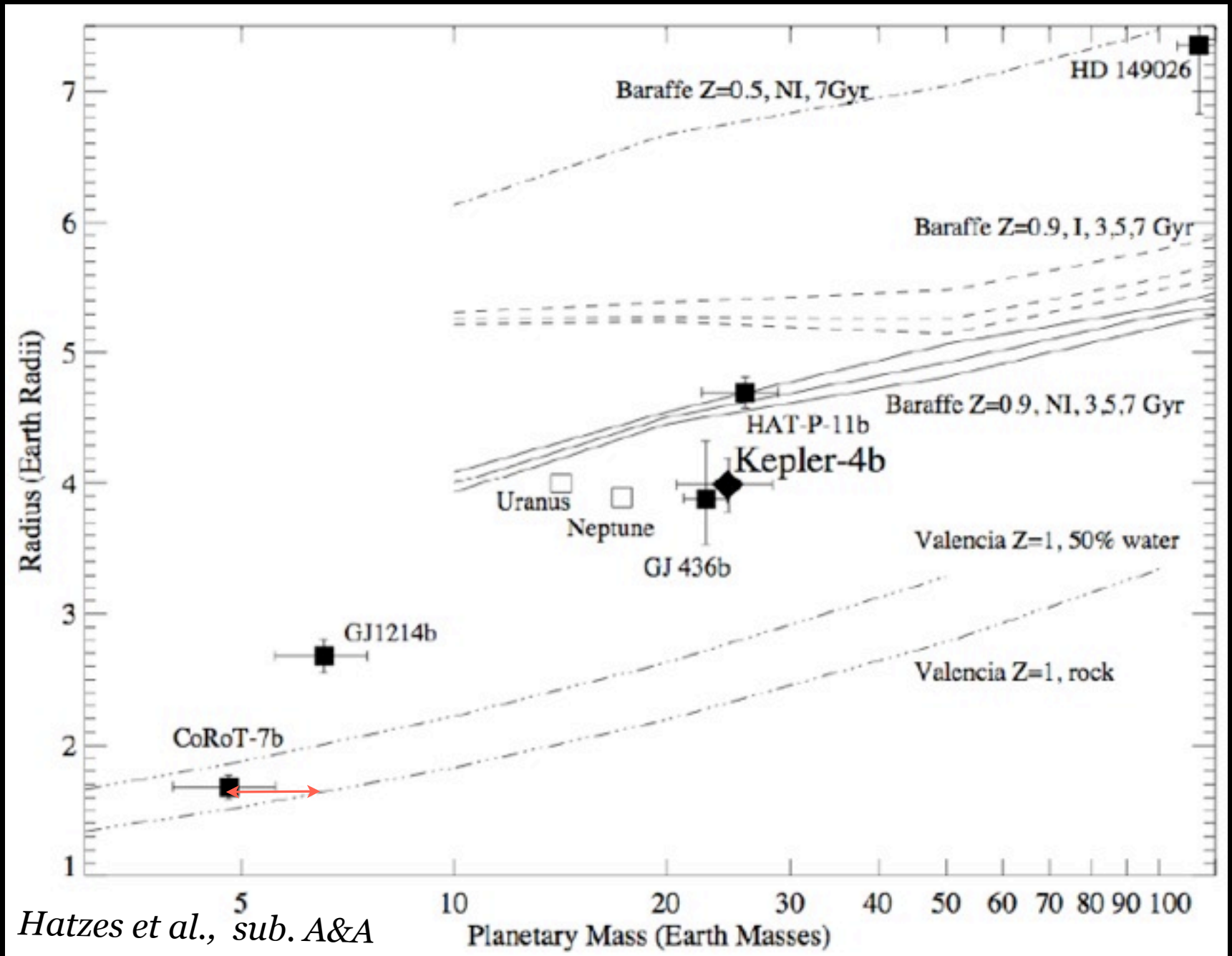
Detected in the "alarm mode" on the first 40 days of CoRoT observations
Period = 0.85365 days
Depth = 0.00034
153 transits observed in the complete light curve

The mass of CoRoT-7b : a challenge!

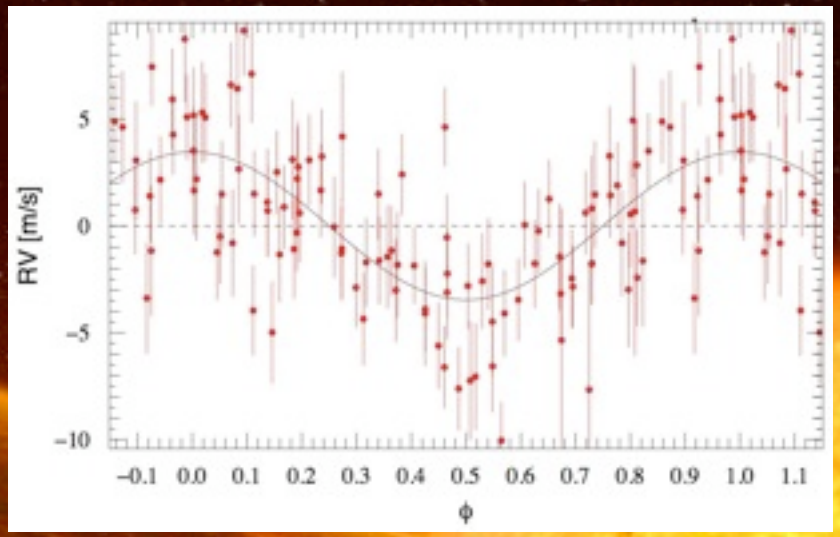


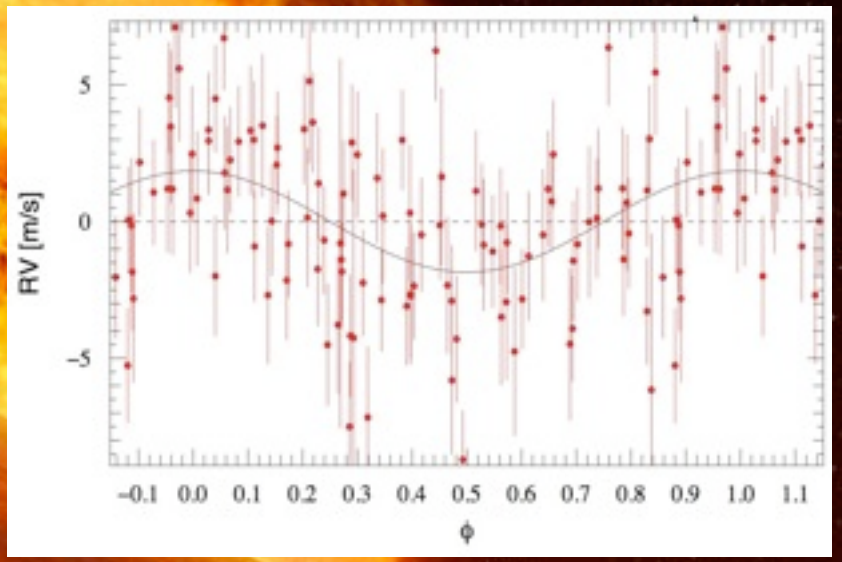
Queloz et al., 2009, A&A

Stars activity : spots challenge radial velocity measurements
More than 100 HARPS spectra collected between Fev 2008 - Fev 2009



Hatzes et al., sub. A&A





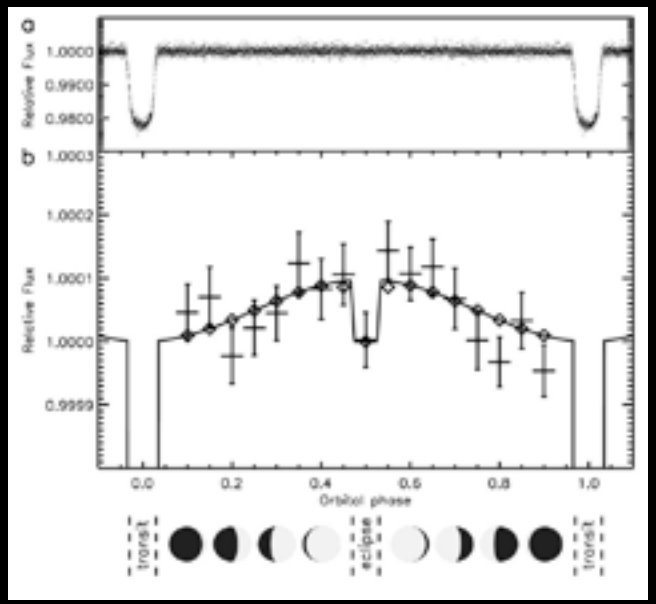
CoRoT-7b
P = 0.8536 d
a = 0.017 AU
e = 0
m = 4.8 ± 0.8 M_{Earth}
r = 1.68 ± 0.09 R_{Earth}
ρ = 5.6 ± 1.3 g.cm^{-3}

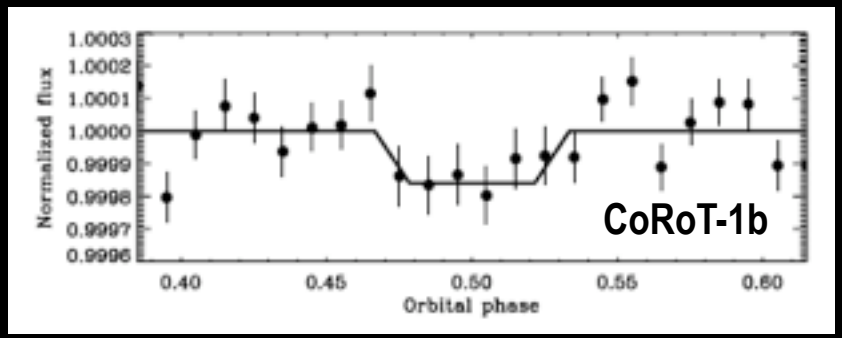
CoRoT-7c
P= 3.70 d
a = 0.046 AU
e = 0
m = 8.4 ± 0.9 M_{Earth}

Hatzes et al., sub. A&A
Lanza et al., sub. to A&A

in phase with CoRoT ephemerid

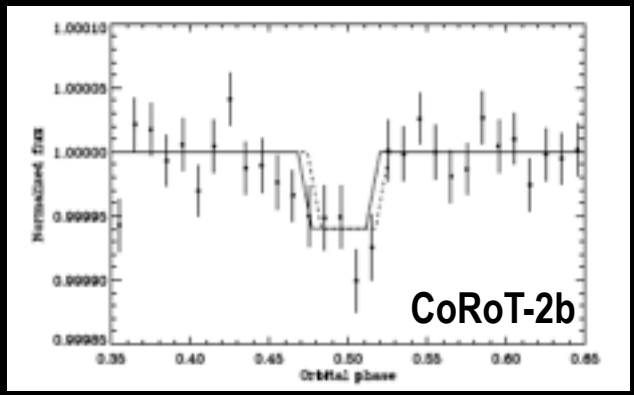
Secondary eclispses





Snellen et al., 2009, Nature
Alonso et al., 2009a A&A

CoRoT-2b
White LC : Depth = 0.006 ± 0.002%
Alonso et al., 2009b A&A



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