CoRoT : a space mission

to explore the exoplanet population at short orbital period

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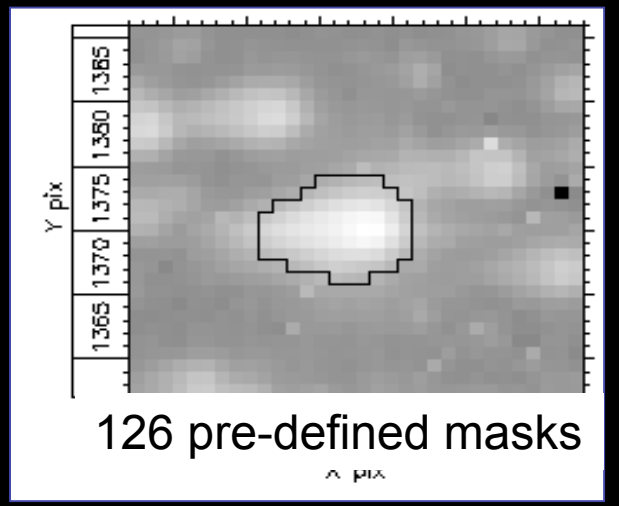
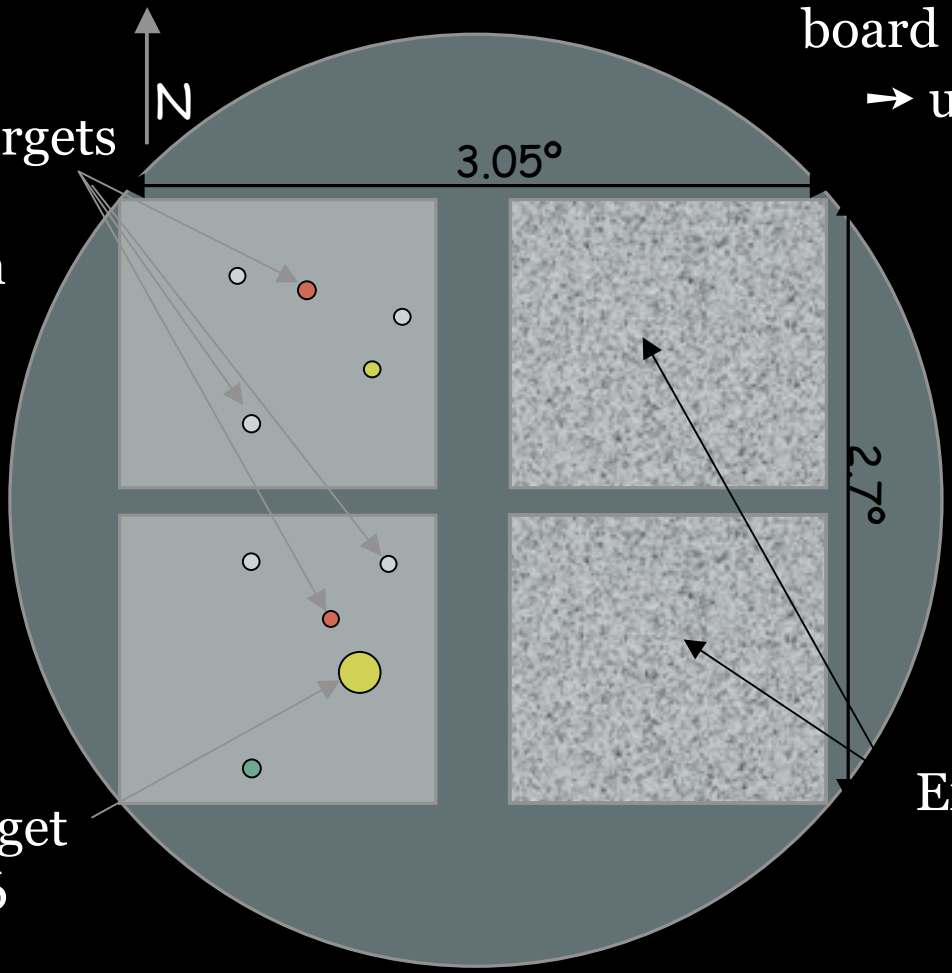
& the CoRoT Exoplanet Science team

CoRoT focal plane

Telemetry limitation : aperture photometry performed on board

→ up to 6 000 targets/ CCD





Secondary targets
$m_v < 9$
10 maximum

Main target
$m_v \sim 6$

Exoplanet field
$11 < m_v < 16$

Exoplanet FOV ~ 3.5°❑

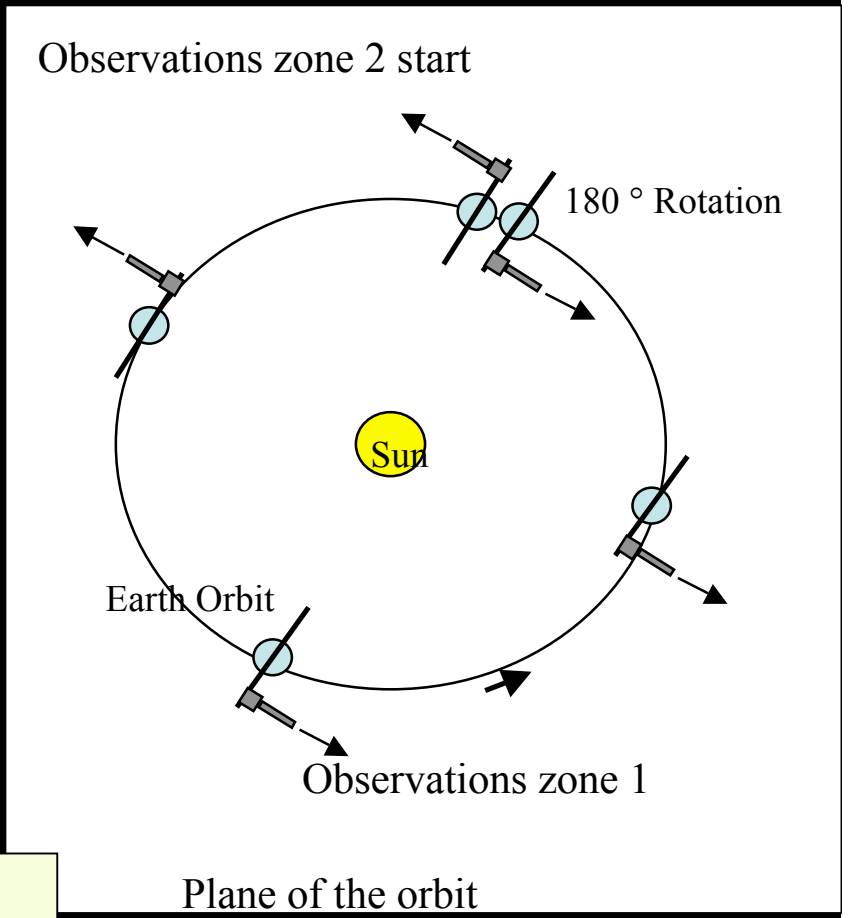
CoRoT - Observations strategy

Polar orbit : 896 km

Per year:

➟ 2 long runs : same field observed continuously during 150 days
Core Program

➟ 2 short runs :
~ 25 days -
Exploratory/Additional Programs



Mission life-time: 3 years nominal

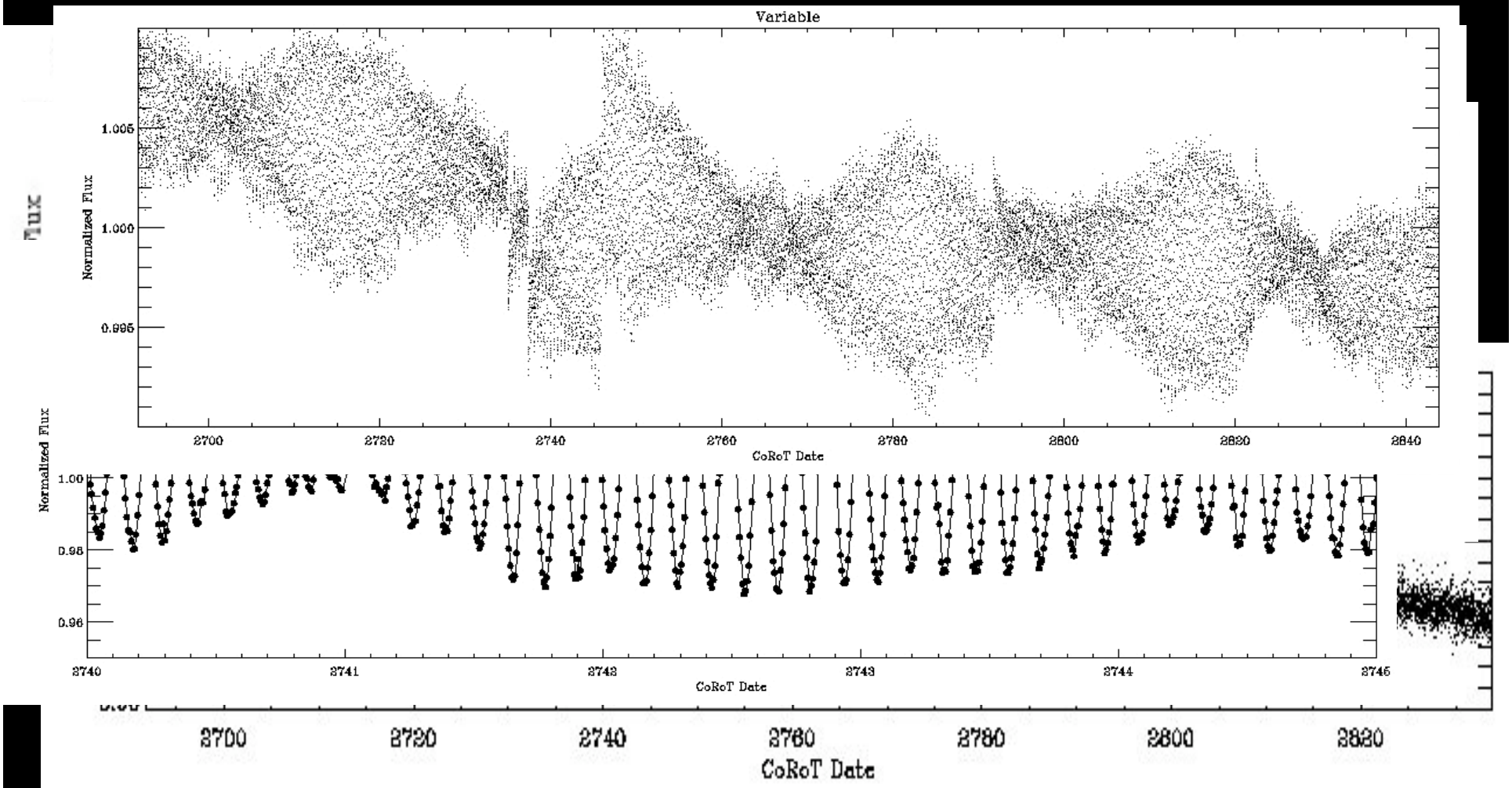
Total :

➟ 70 000 light curves 150 days long

➟ 70 000 light curves ~25 days long

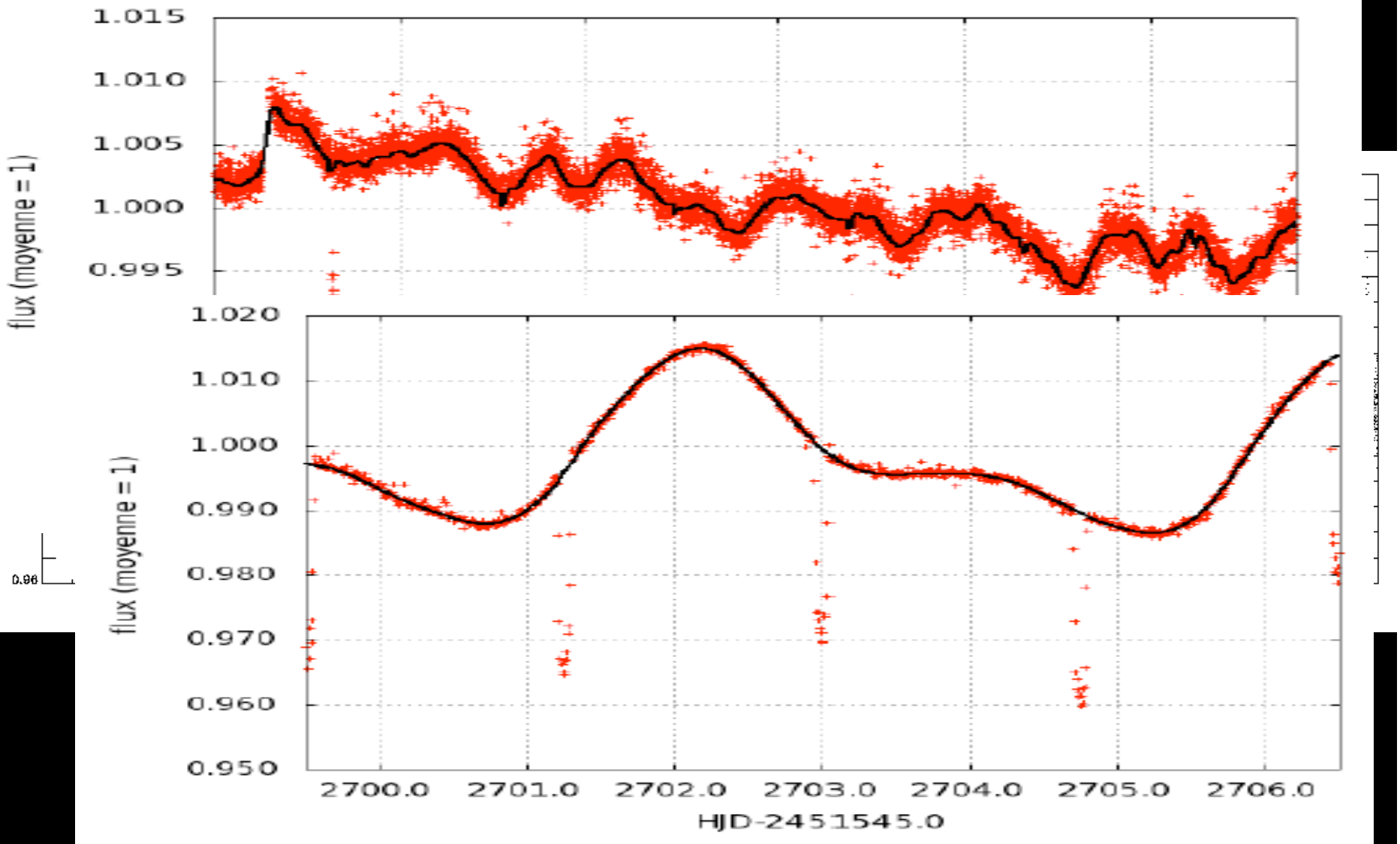
CoRoT Light Curves

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



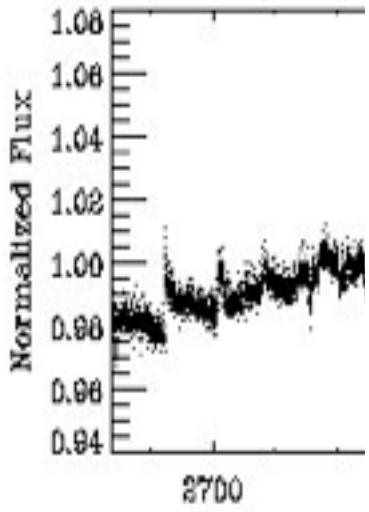
From CoRoT LC to planets ...

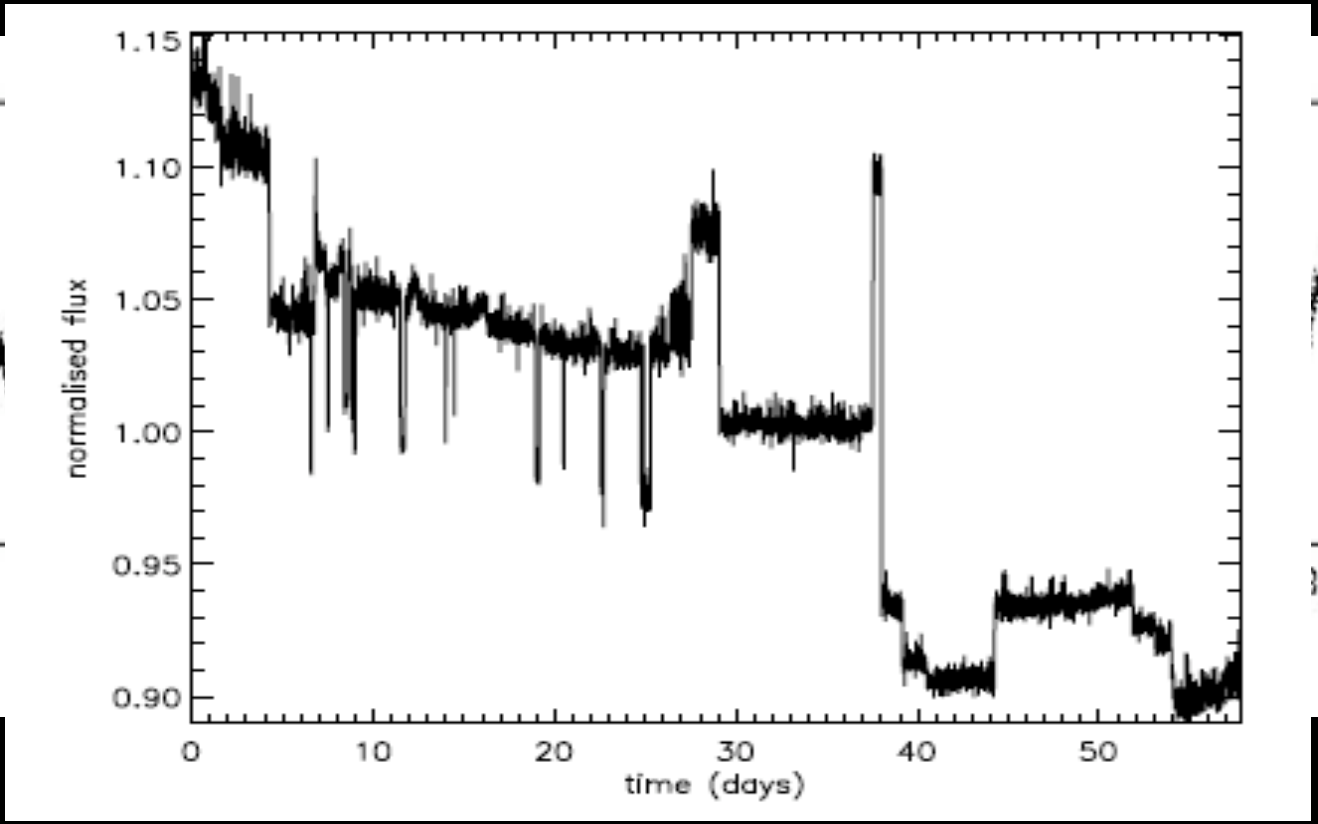
1. Filtering, detrending.. and removing the star's signature

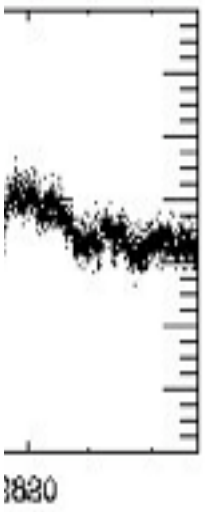


From CoRoT LC to planets ...

1. Filtering, detrending.. Instrumental effects





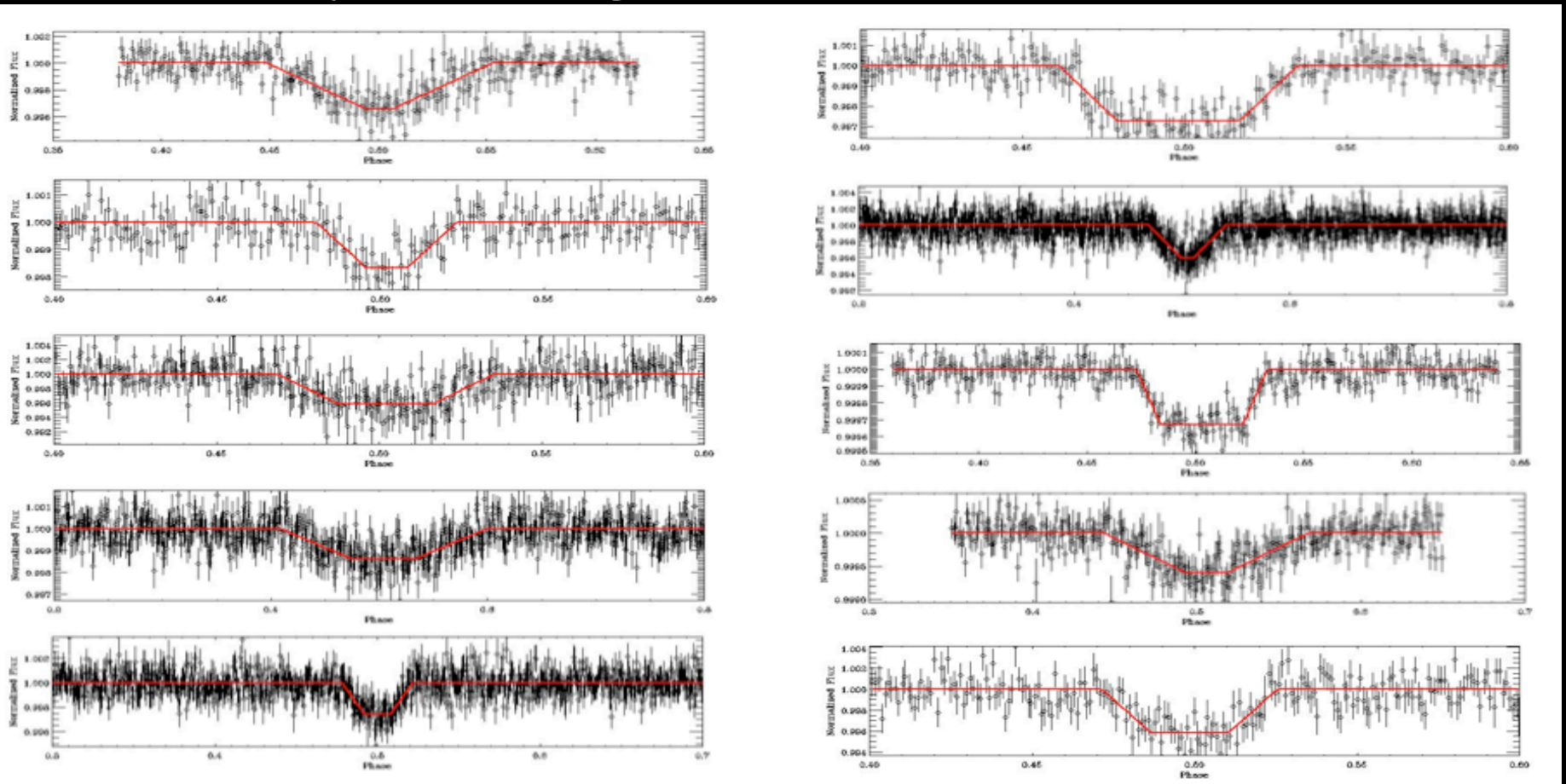


From CoRoT LC to planets ...

2. Seeking transits in the LC

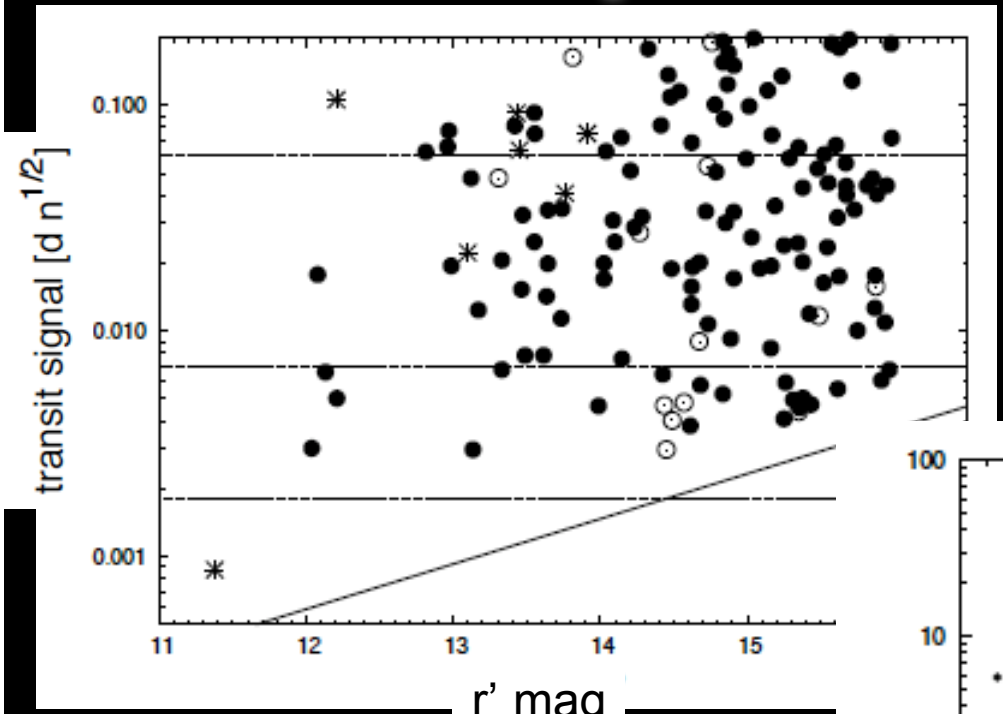
IRa01 : ~ 60 days - 9872 light curves - 191 candidats

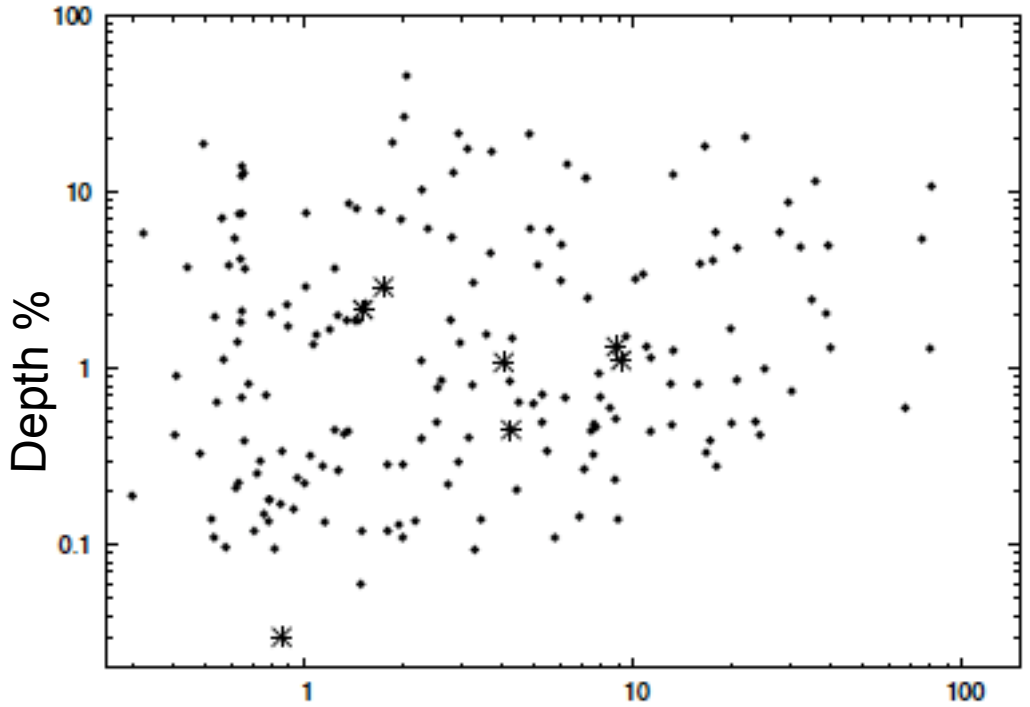
LRc01 : 153 days - 11 408 light curves - 226 candidats



Carpano et al., 2009 A&A, in press ; Cabrera et al., 2009 A&A in press

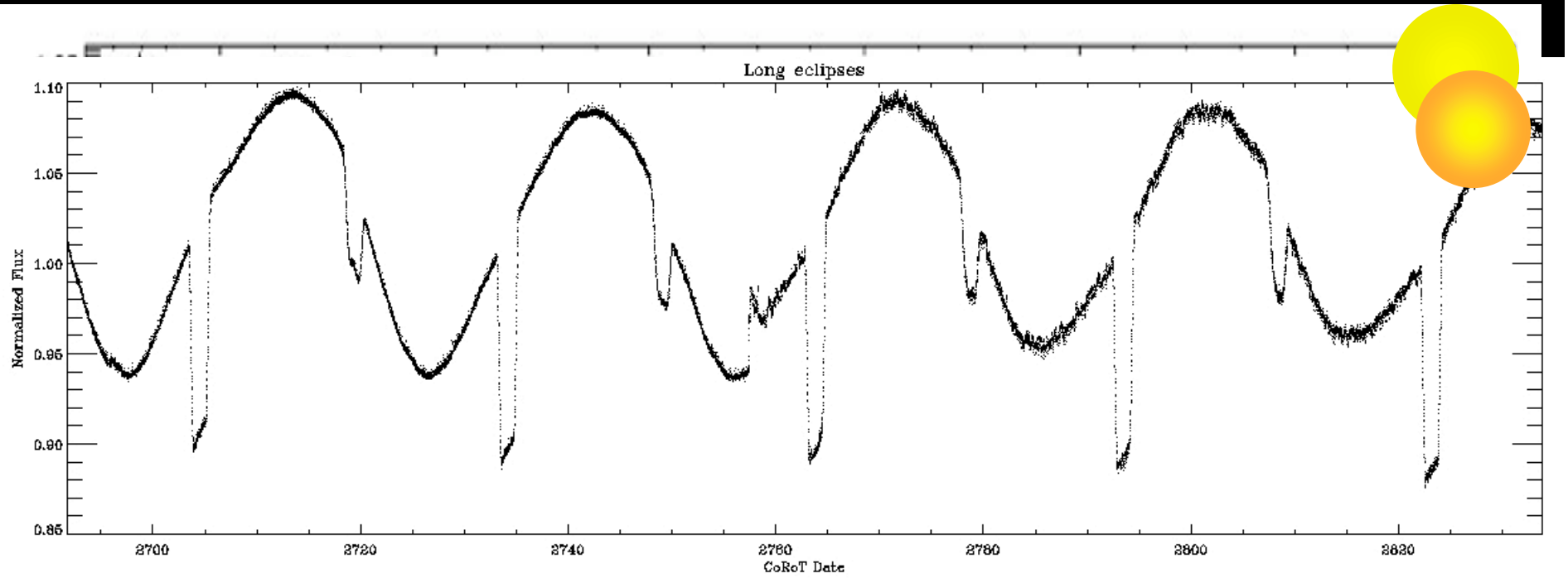
Detection : performances





Cabrera et al., 2009 A&A in press

From CoRoT LC to planets ...



~ 95% of detected transits are stellar systems

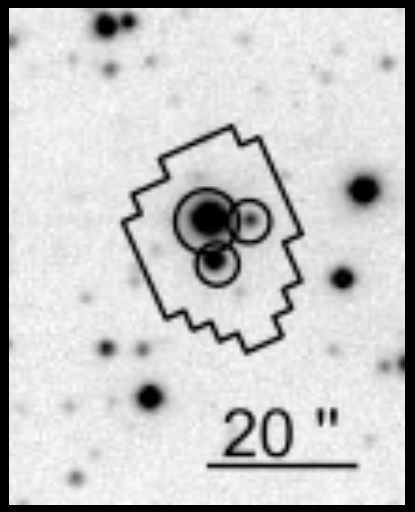
- 83 % are identified thanks to CoRoT LC analyses
  the long duration is an asset !
- 17% are characterized thanks to ground-based follow-up observations

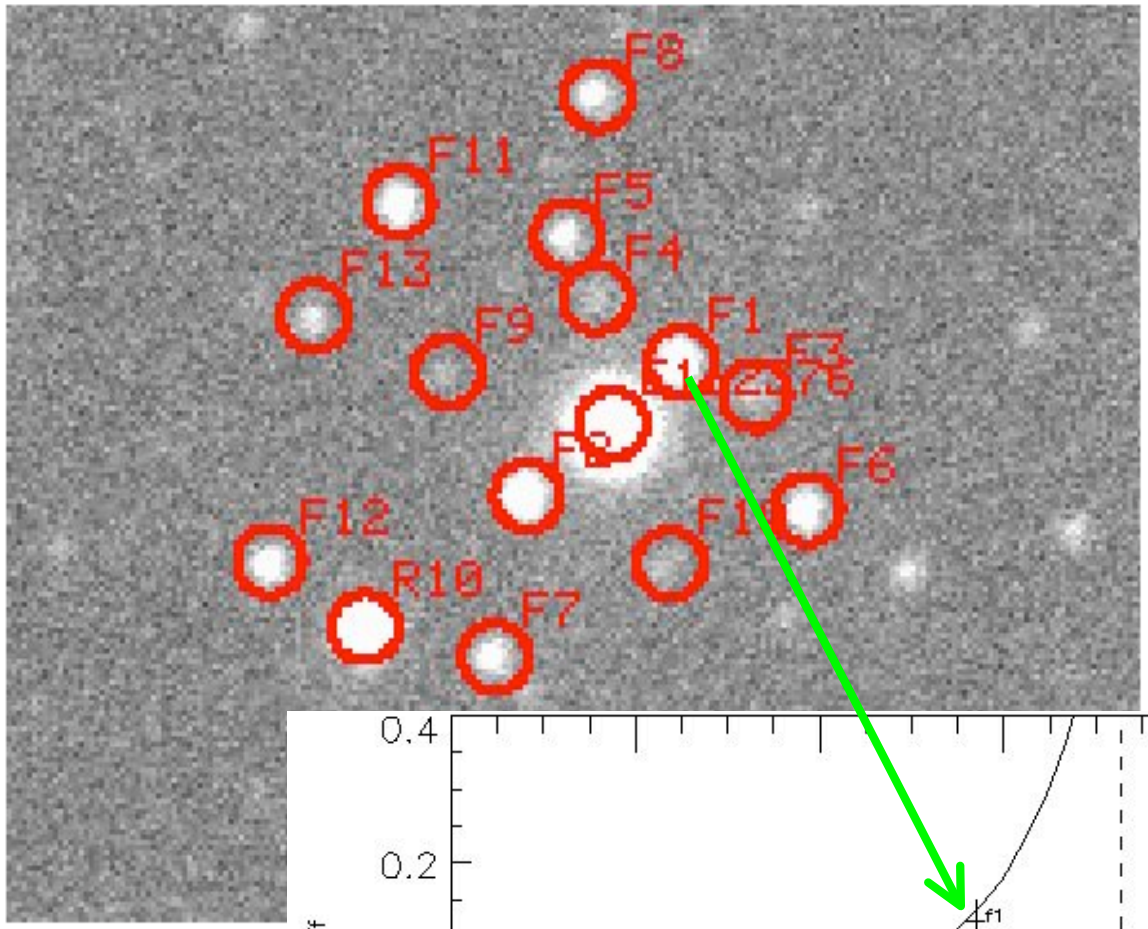
Moutou et al., 2009 A&A, in press; Almenara et al., 2009 A&A in press

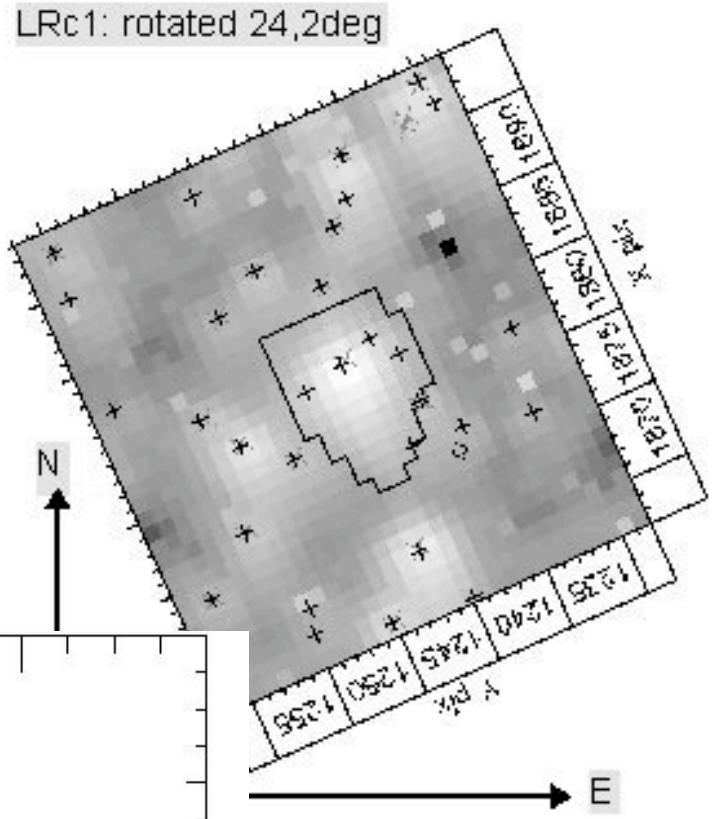
Follow-up observations : necessity

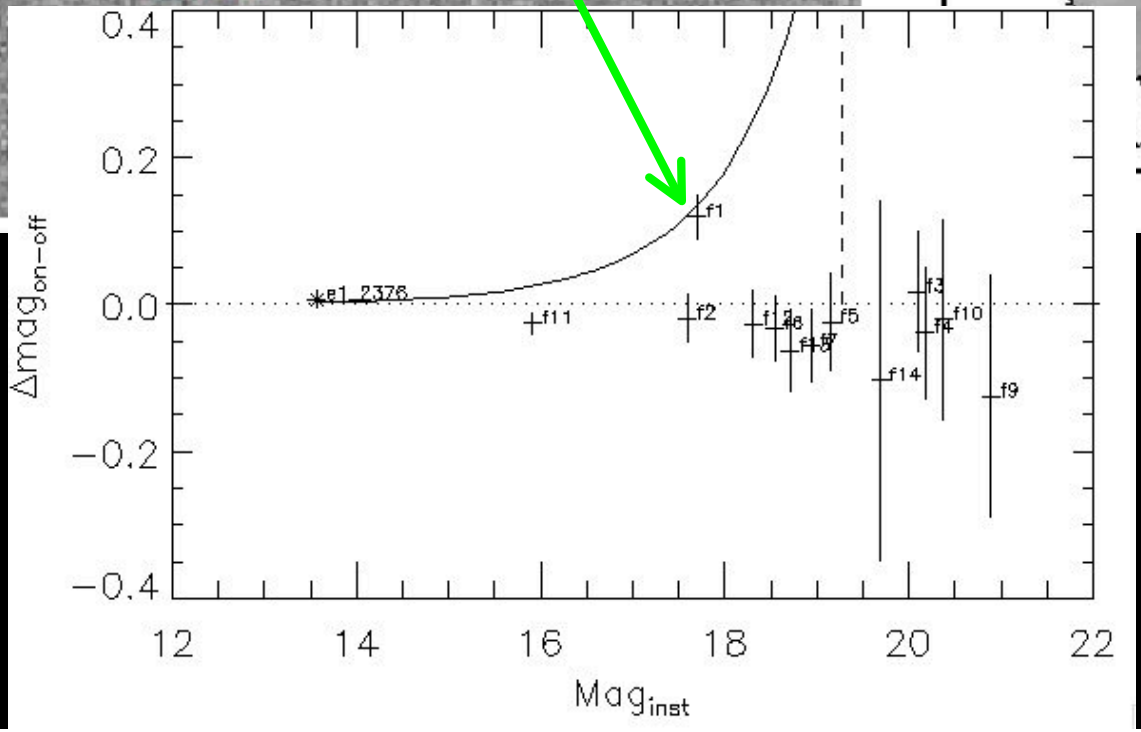
- Impostors :
  - binaries or multiple systems
  - contaminants within the CoRoT photometric mask

  Ground-based photometric observations
  or radial velocity measurements




F8
F11
F5
F13
F4
F9
F1
F3
F6
F12
R10
F7


LRc1: rotated 24,2deg
N
E


0.4
0.2
0.0
−0.2
−0.4
12
14
16
18
20
22
Δmag on−off
Mag inst
f1
f11
f2
f5
f3
f4
f10
f14
f9

Follow-up observations : necessity

- Impostors :
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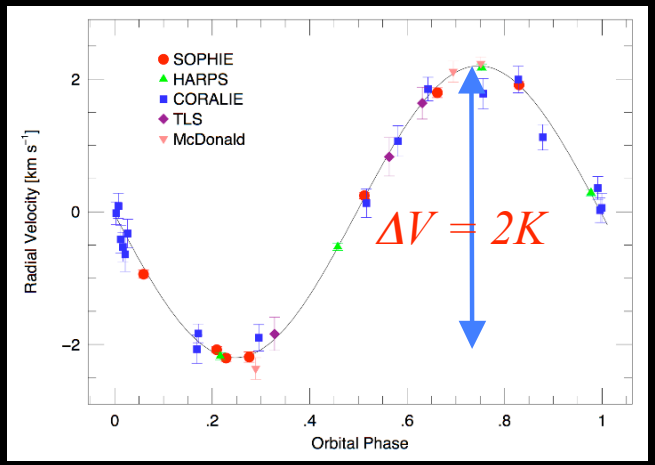
  or radial velocity measurements

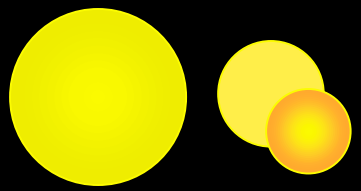
- Planets :
  - Light curve : planet radius
  - Radial velocities : planet mass --> density

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



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

Follow-up observations : necessity



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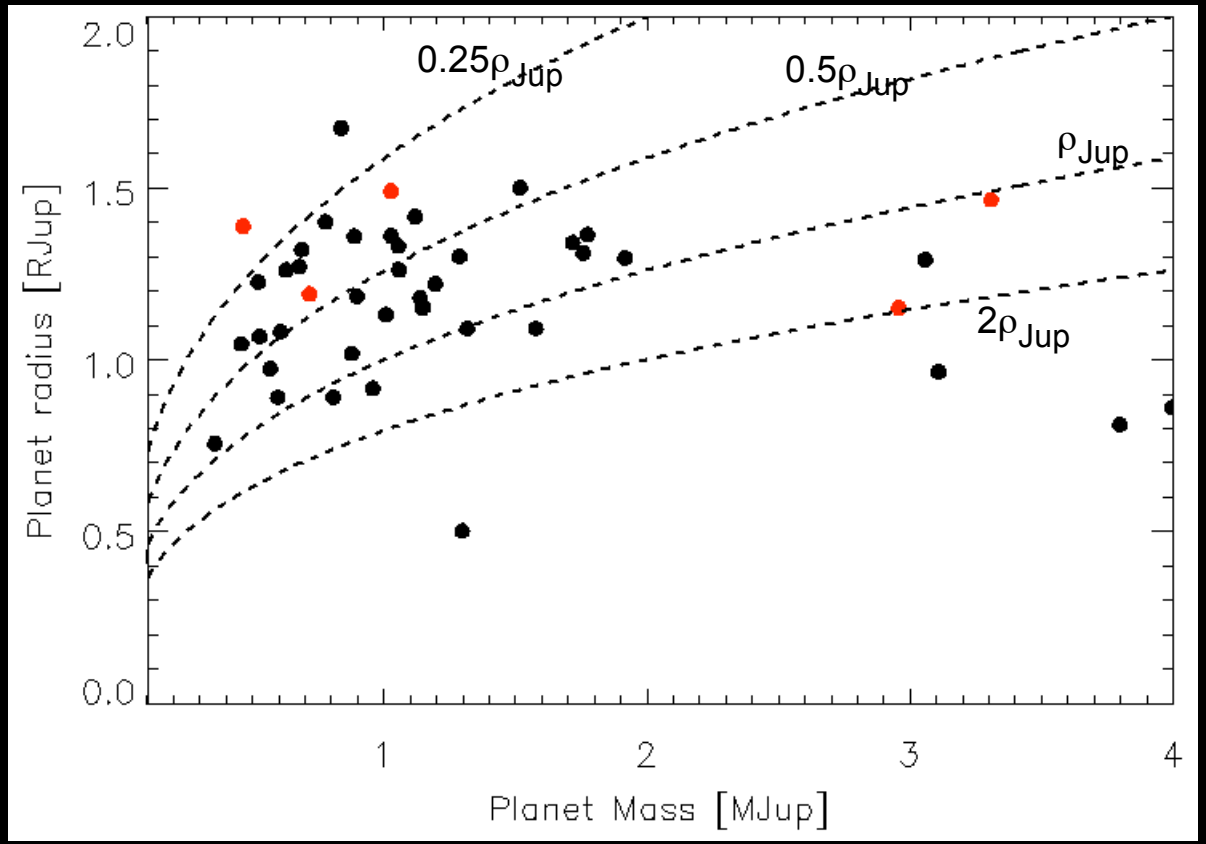
- Star's fundamental parameters (mass & radius)
  spectroscoppic analyses

- Complementary analyses ..

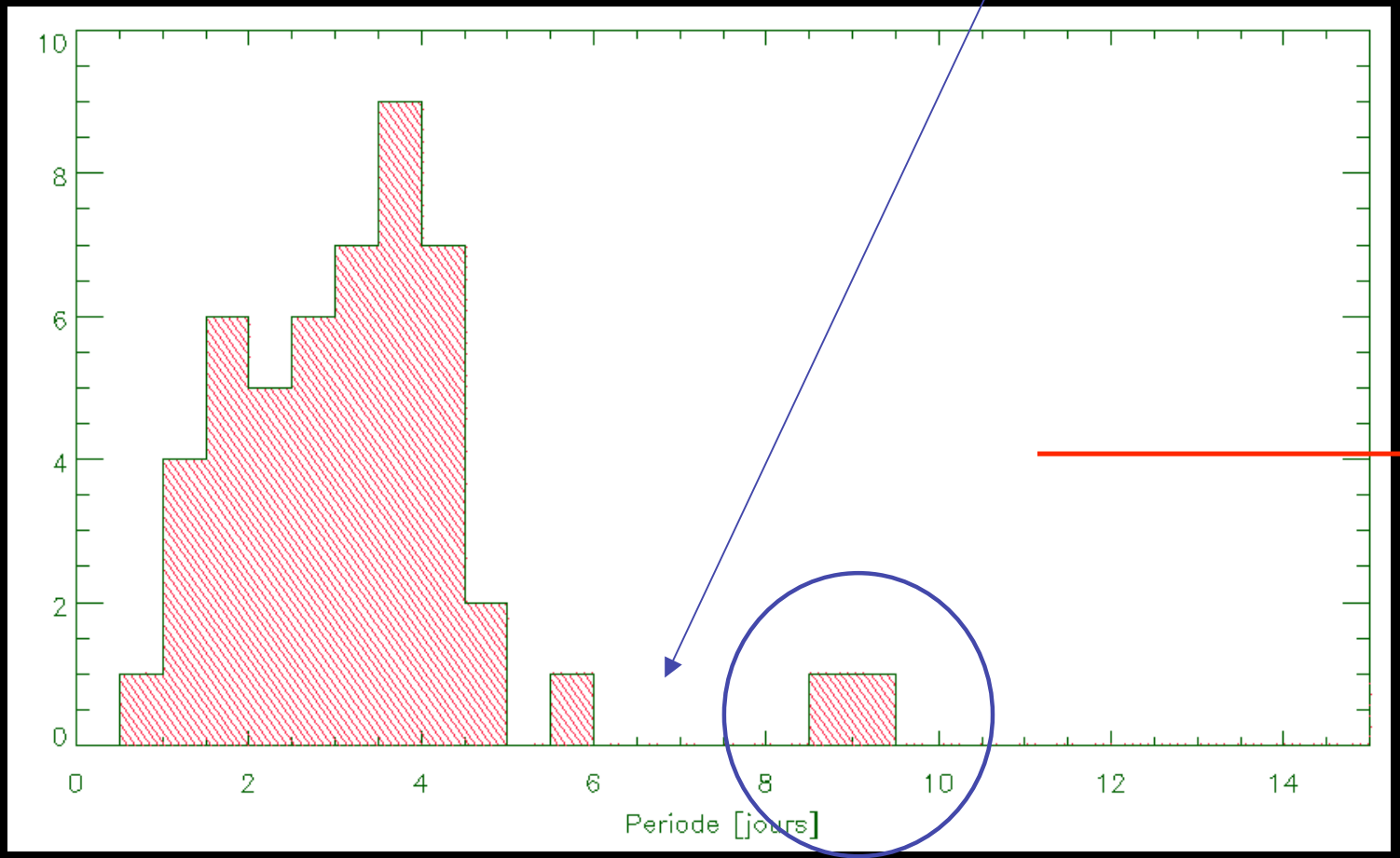
The CoRoT planets

Most of them in the domain of gaseous giants



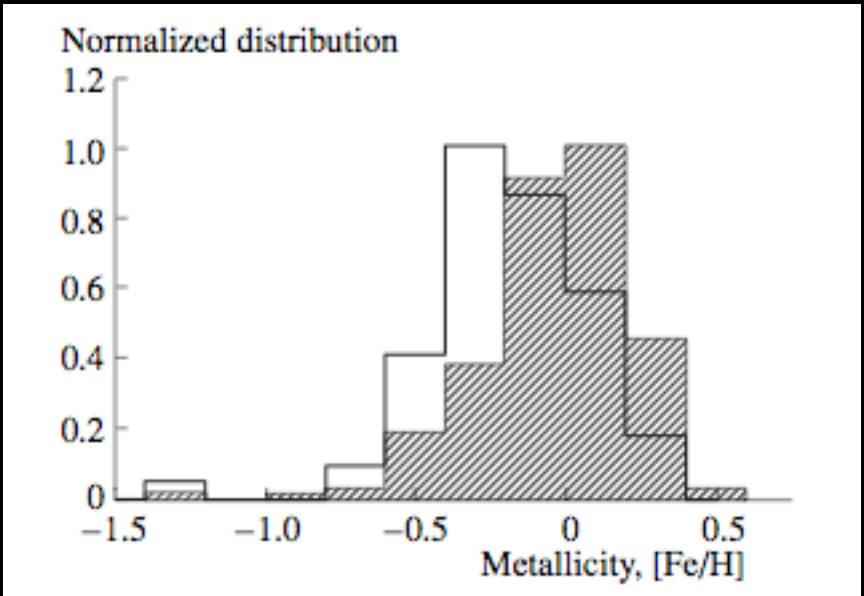
Aigrain et al.,2008 A&A 488, L43;
Barge et al., 2008 A&A ; Alonso et al., 2008; Rauer et al.,2009 A&A in press
Fridlund et al., 2009 in press

The CoRoT planets - period



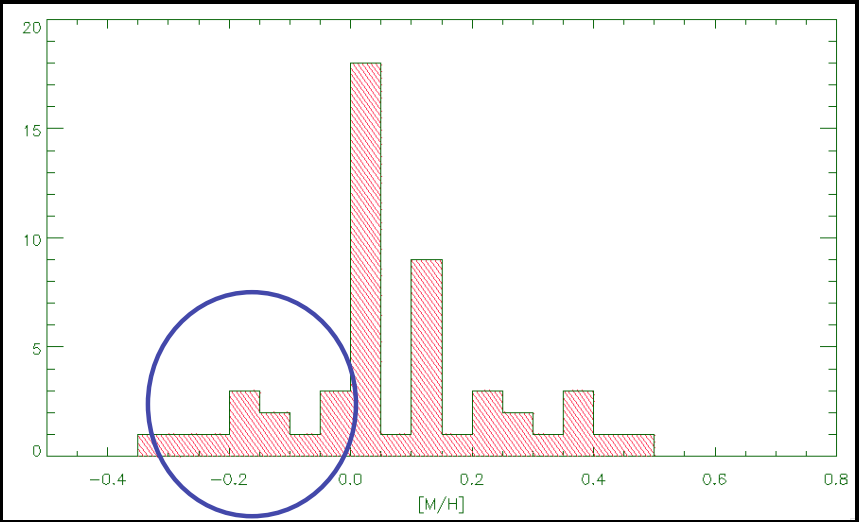
Transiting planets with a long orbital period : low probability of detection

The CoRoT planet - host star properties



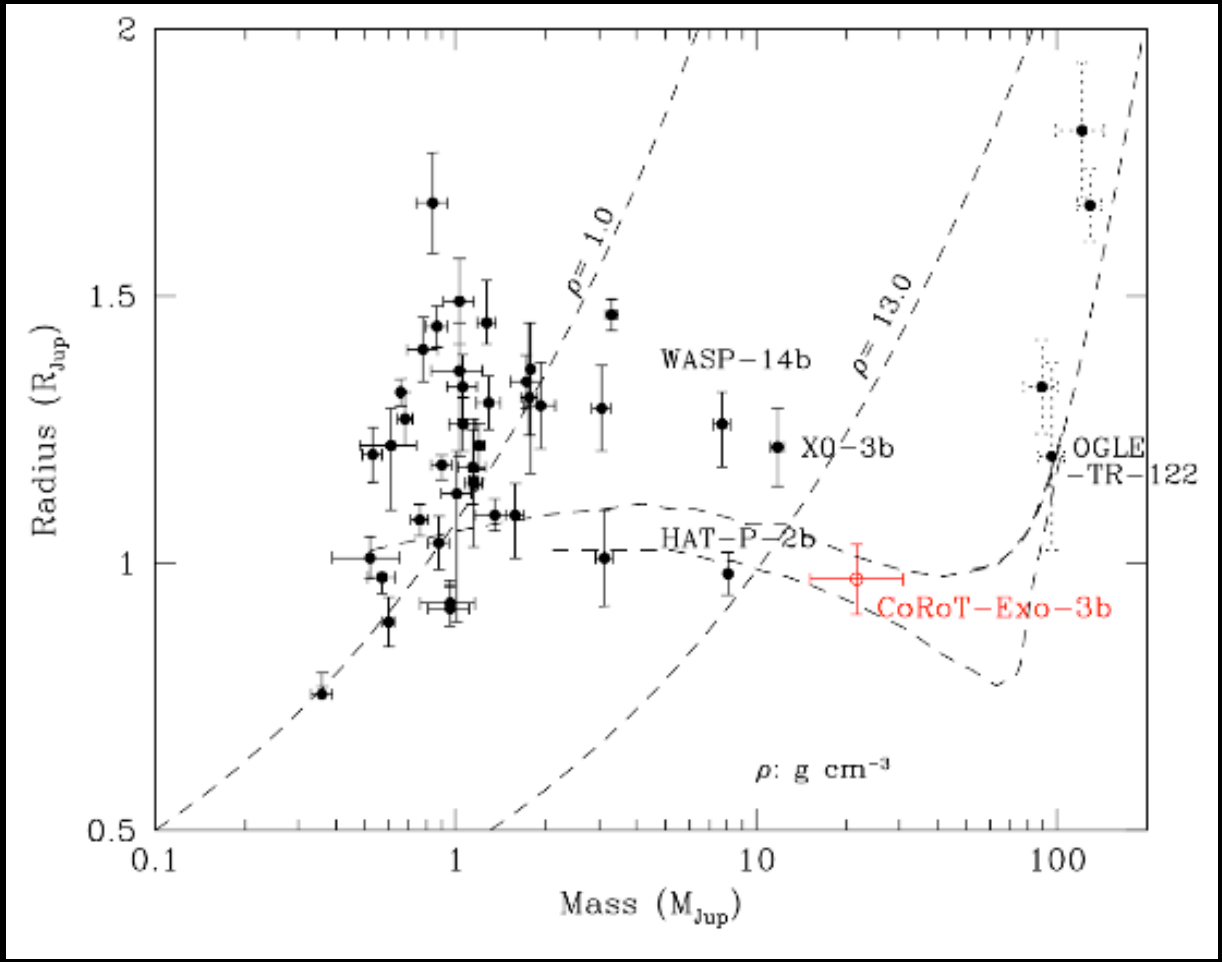
Radial velocity

Transits



3 over 5 of CoRoT hot Jupiters have [M/H] < 0.00
CoRoT Fields : 2 regions in opposite direction in the galactic plane

At the extremes of the mass function

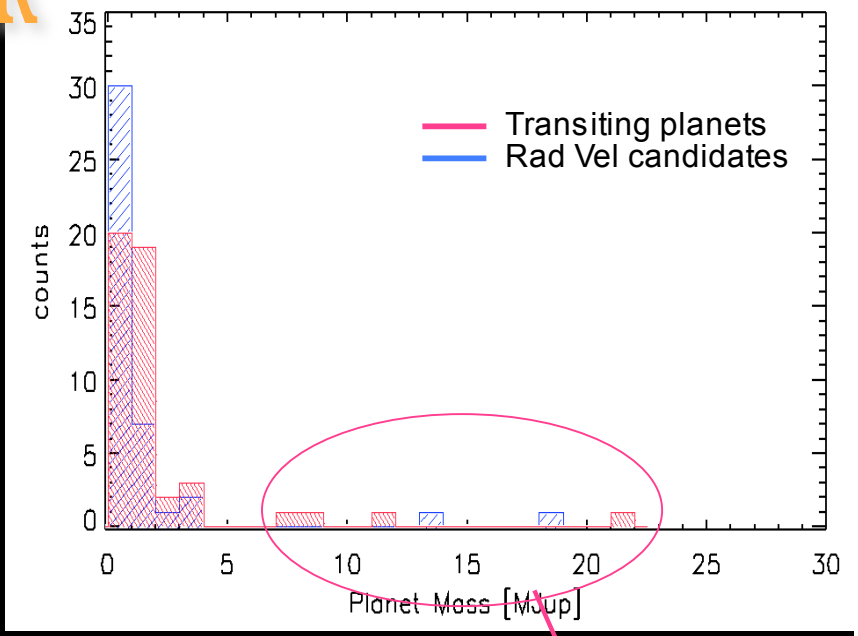


CoRoT-3b : super massive planet or brown dwarf ?

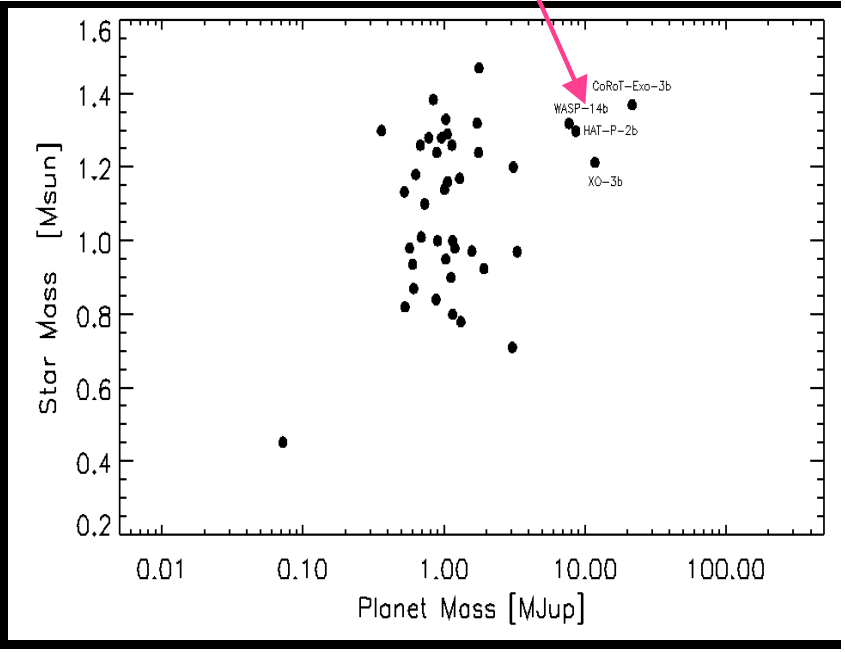
Deleuil et al., 2008 A&A 491, 889

CoRoT-3b : the missing link

ID :
Period = 4.26 days
M_p = 21.6 +/- 1.0
R_p = 1.01 +/- 0.07
ρ = 26.4 +/- 5.6 g/cm^3
log g = 4.72 +/- 0.07

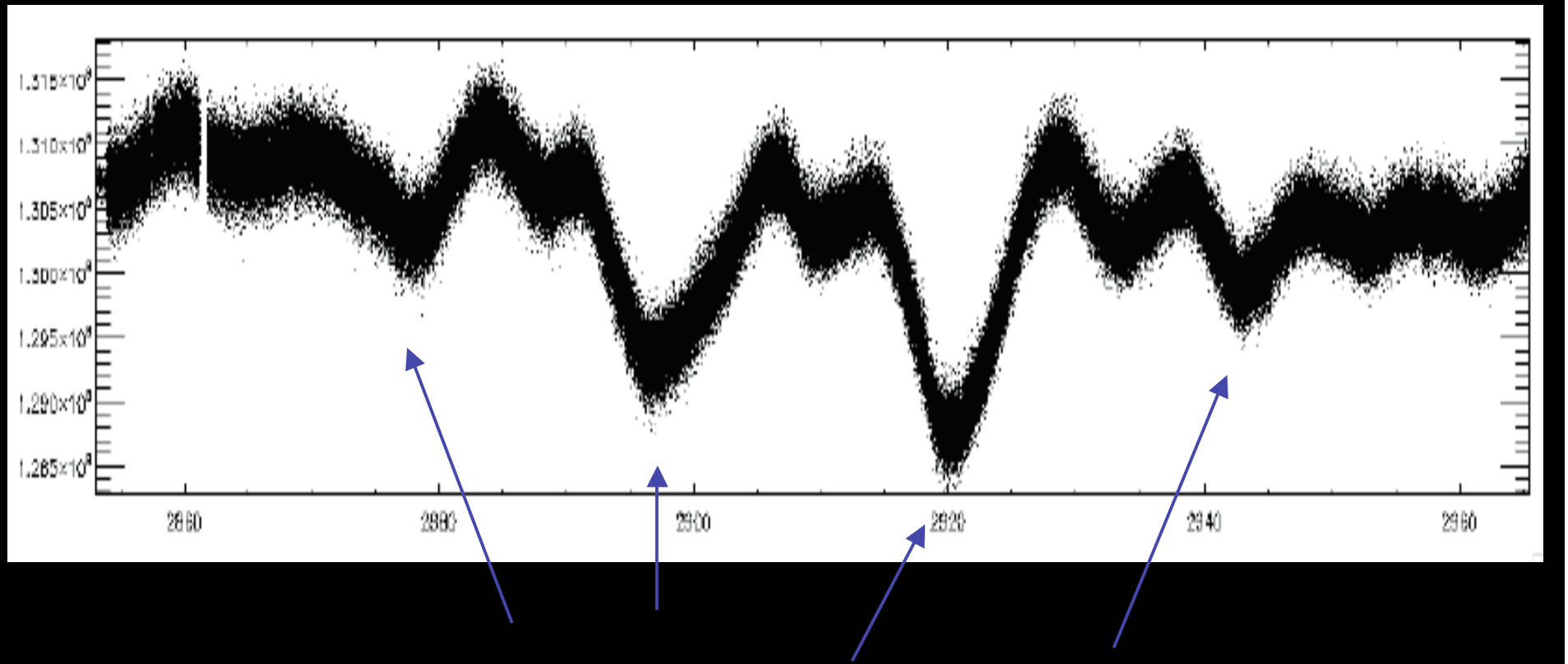


A very rare object or
the member of a new class of exoplanet ?



Trend : more massive "planets" for massive stars ?

CoRoT-7b : the first hot super earth



Rotational period ~23 days - star spots evolution

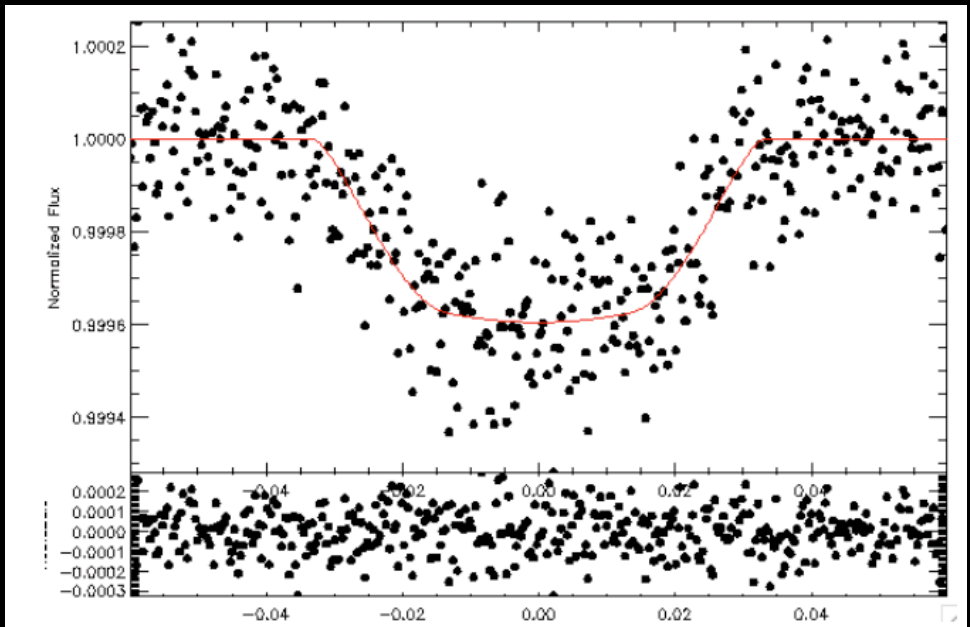
CoRoT-7b : the first hot super earth

CoRoT-7 - ID

Star : 5250K ; logg =4.50

Period = 0.8536 days
k = 0.0178

R_p = 1.7 R⊕ +/- 0.13



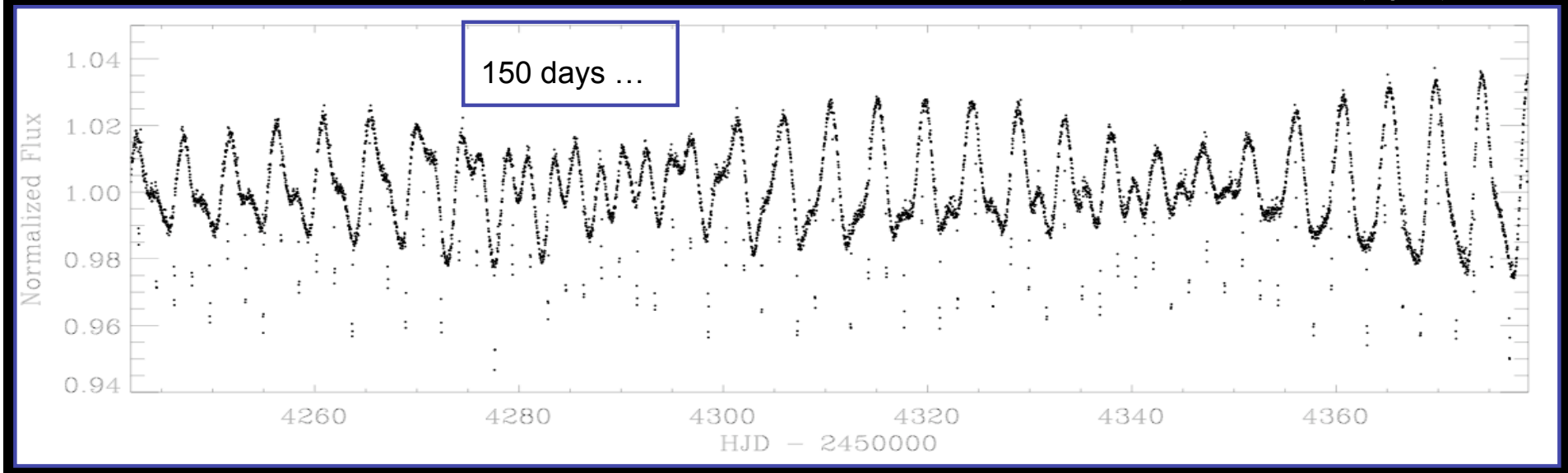
i = 59.6, u+=0.6, u-=0.2

Léger et al., 2009, A&A submitted

CoRoT LC advantages : young stars/high rotators

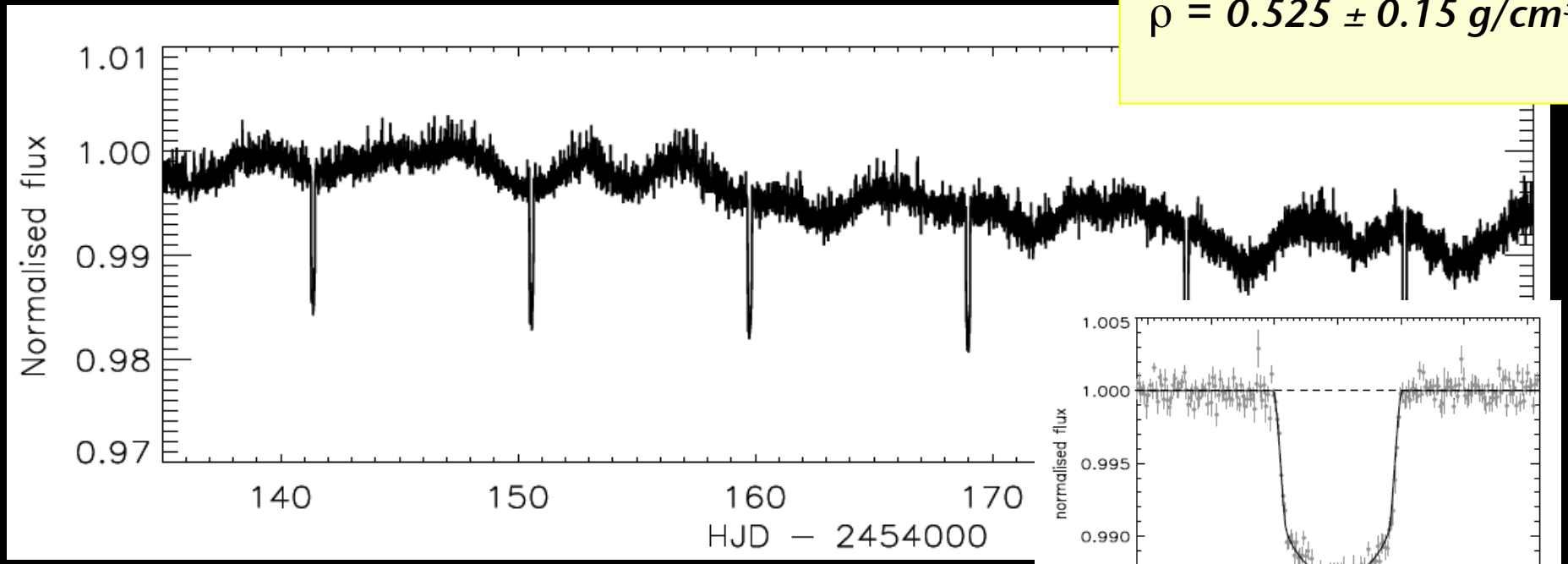
CoRoT- 2 : a young & active star
78 transits

$M_p = 3.31 \pm 0.16\ M_{jup}$
$R_p = 1.465 \pm 0.029\ R_{Jup}$
$\rho = 1.31 \pm 0.04\ g/cm^3$
Alonso et al. , 2008 *A&A, 482, 21*



CoRoT LC long duration : planet - star interaction

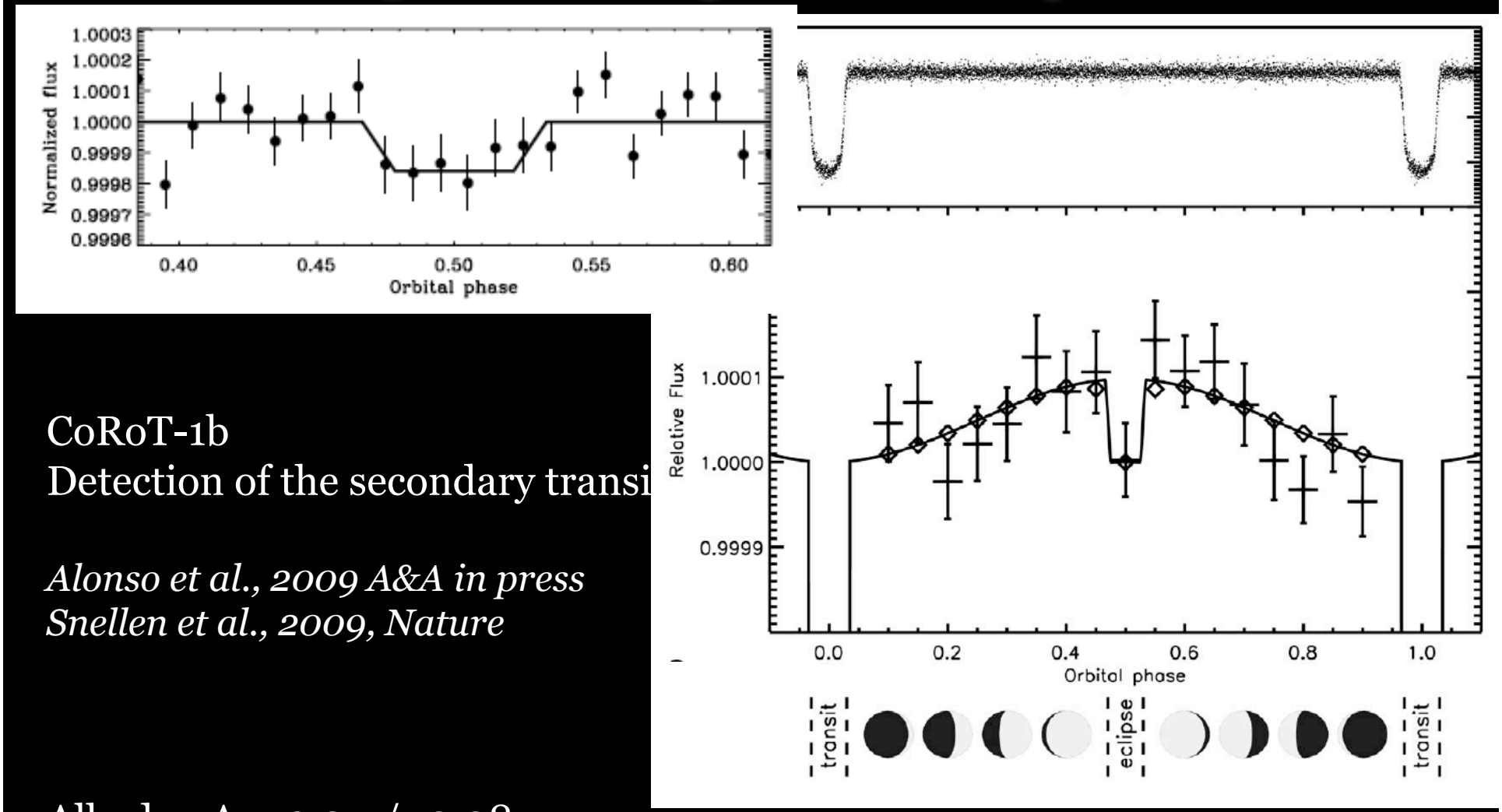
CoRoT-4b - ID
Period = 9.2020 days
M_p = *0.72 ± 0.08* M_{jup}
R_p = *1.19 ± 0.06* R_{Jup}
ρ = *0.525 ± 0.15 g/cm³*



Rotation of the host star synchronized to the planet orbital period

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

CoRoT LC long duration : planet atmosphere



CoRoT-1b
Detection of the secondary transi

Alonso et al., 2009 A&A in press
Snellen et al., 2009, Nature

Albedo : A = 0.2 +/- 0.08

Conclusion

Long duration & high photometric precision - photon noise limited over most of the magnitude range.

It allows to explore :

- the transition regime between the giants and the terrestrial planet at short & moderate orbital period.
- planets characterization : atmosphere properties & star - planet interaction
- multiple planets systems (TTV)
- enlarge the range of properties of planetary systems & host-stars: actives stars, fast rotators ..

Optimization of the reduction pipeline on-going: hot pixels & systematics → small size planet easier to detect