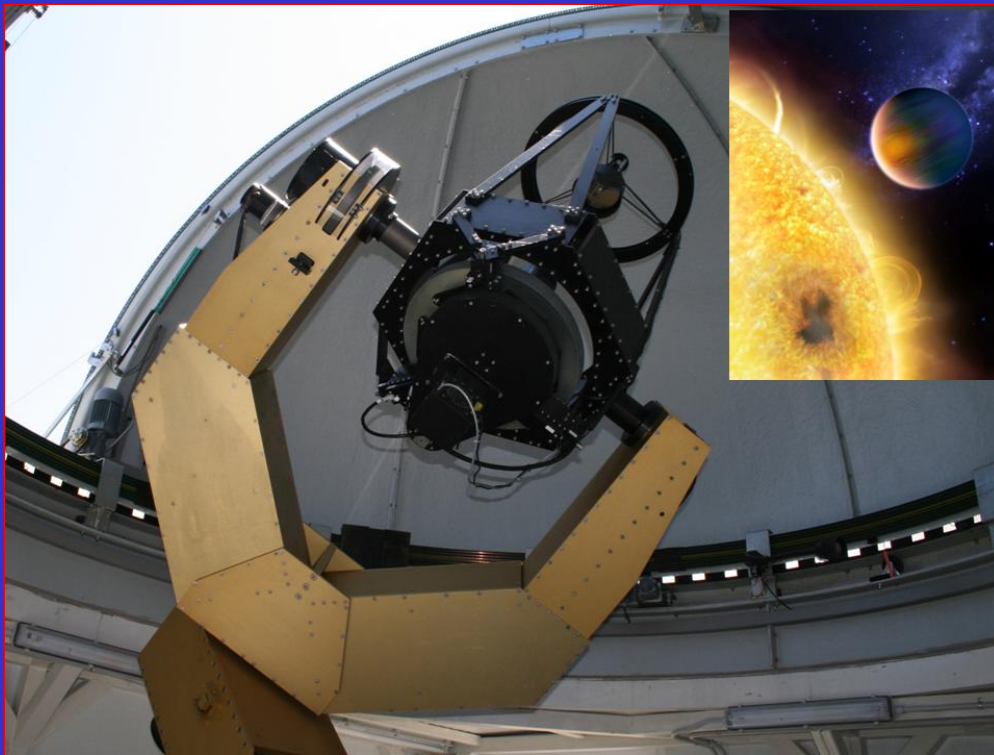


Workshop on Robotic Autonomous Observatories
Málaga, 20 May 2009

Astrobiology with Robotic Telescopes at CAB



Dr. Luis Cuesta
Grupo Telescopios Robóticos
Centro de Astrobiología



Robotic Telescopes



GROUP OF ROBOTIC TELESCOPES AT CAB

★ Head

- Luis Cuesta Crespo

★ Science

- Teresa Eibe García
- Aurora Ullán Nieto

★ Technician

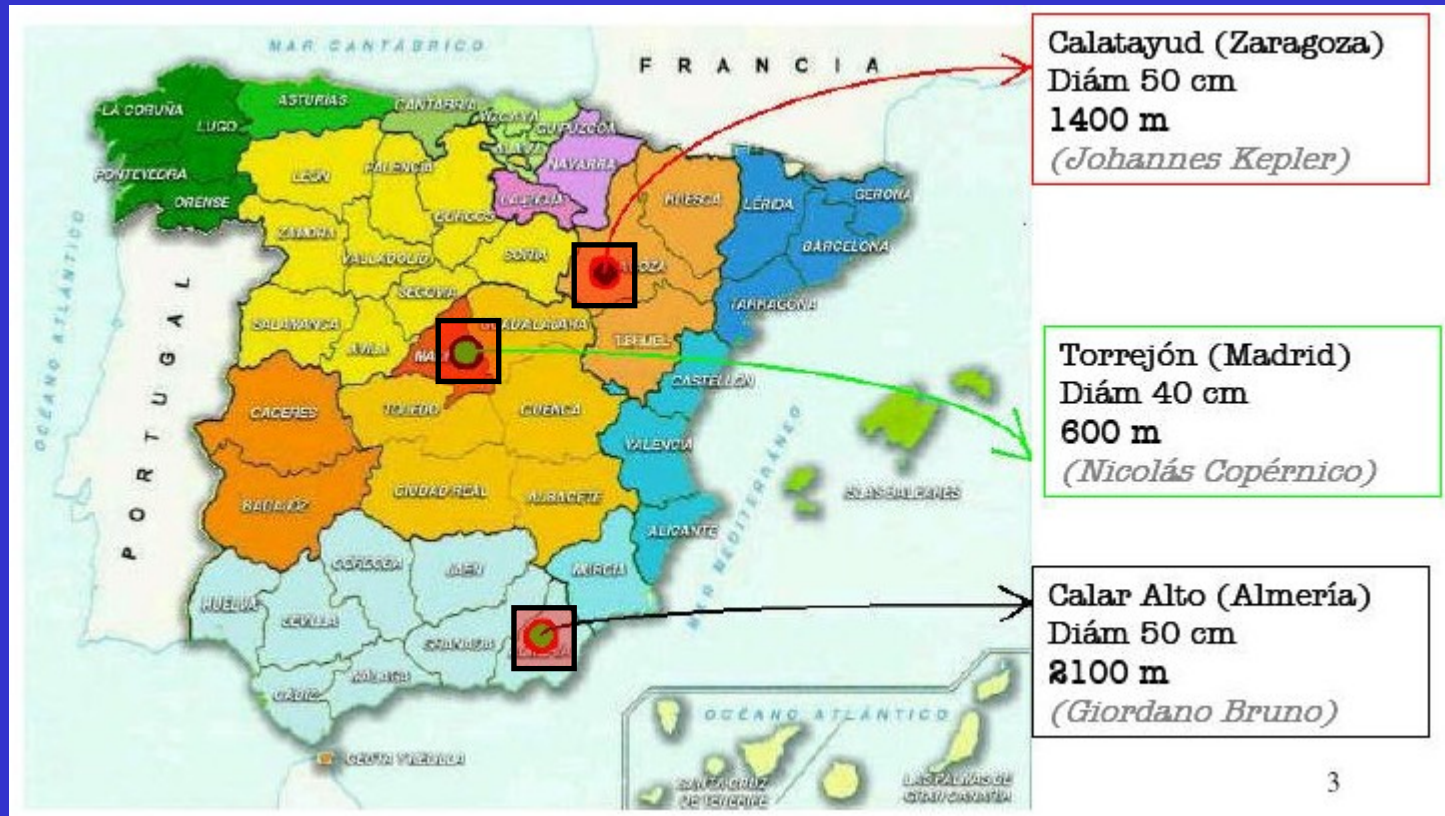
- Jorge Navas Díaz (control)
- Antonio Pérez Verde (electronic)



Robotic Telescopes



WHERE





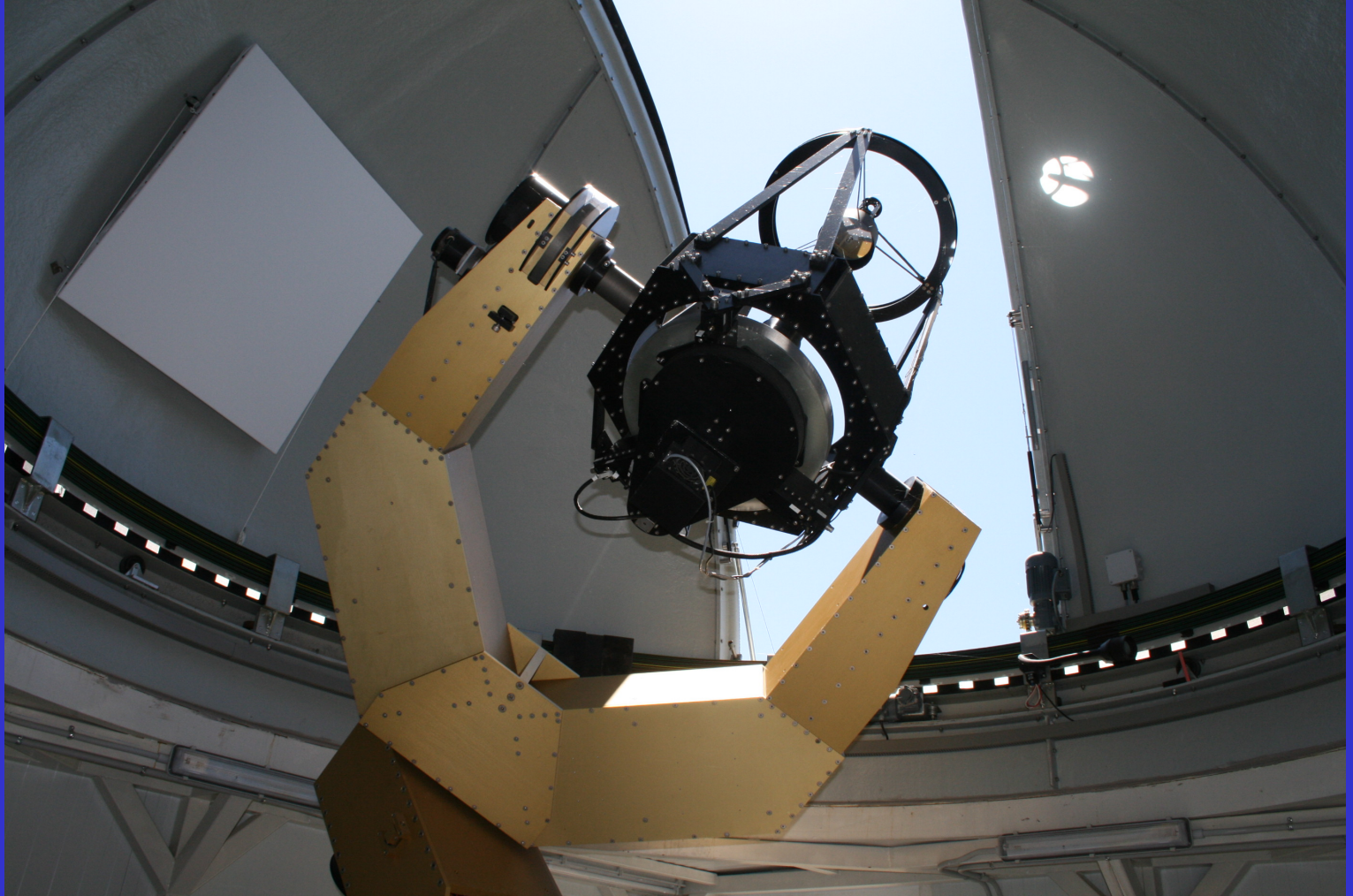
Robotic Telescopes



THE DOME



Robotic Telescopes



THE TELESCOPE



Robotic Telescopes

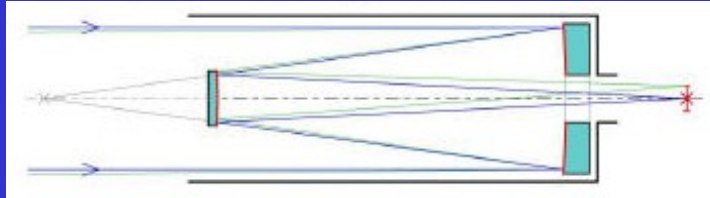


THE TELESCOPE





Robotic Telescopes



★ Reflector telescopes

- 40-50 cm
- f/10 ($\sim 0.5^\circ$)

★ Classic Cassegrain configuration

- Parabolic primary
- Hyperbolic secondary

★ Equatorial mount

- Direct transmission
- Friction

★ Dome

- Form 0° to 90°
- Motorized
- Automatic





Robotic Telescopes



FEATURES

★ CCD Finger Lakes

- **4008 x 2672**
 - 0.37 "/pix
 - 24' x 16'
- **9 μ m**
- **Refrigerated**

★ Filters

- Johnson (UBVRI)
- [OIII], H α , H β , ...
- Red, Green, Blue

★ Presence

- Interactive

★ Remote

- Interactive (from the distance)

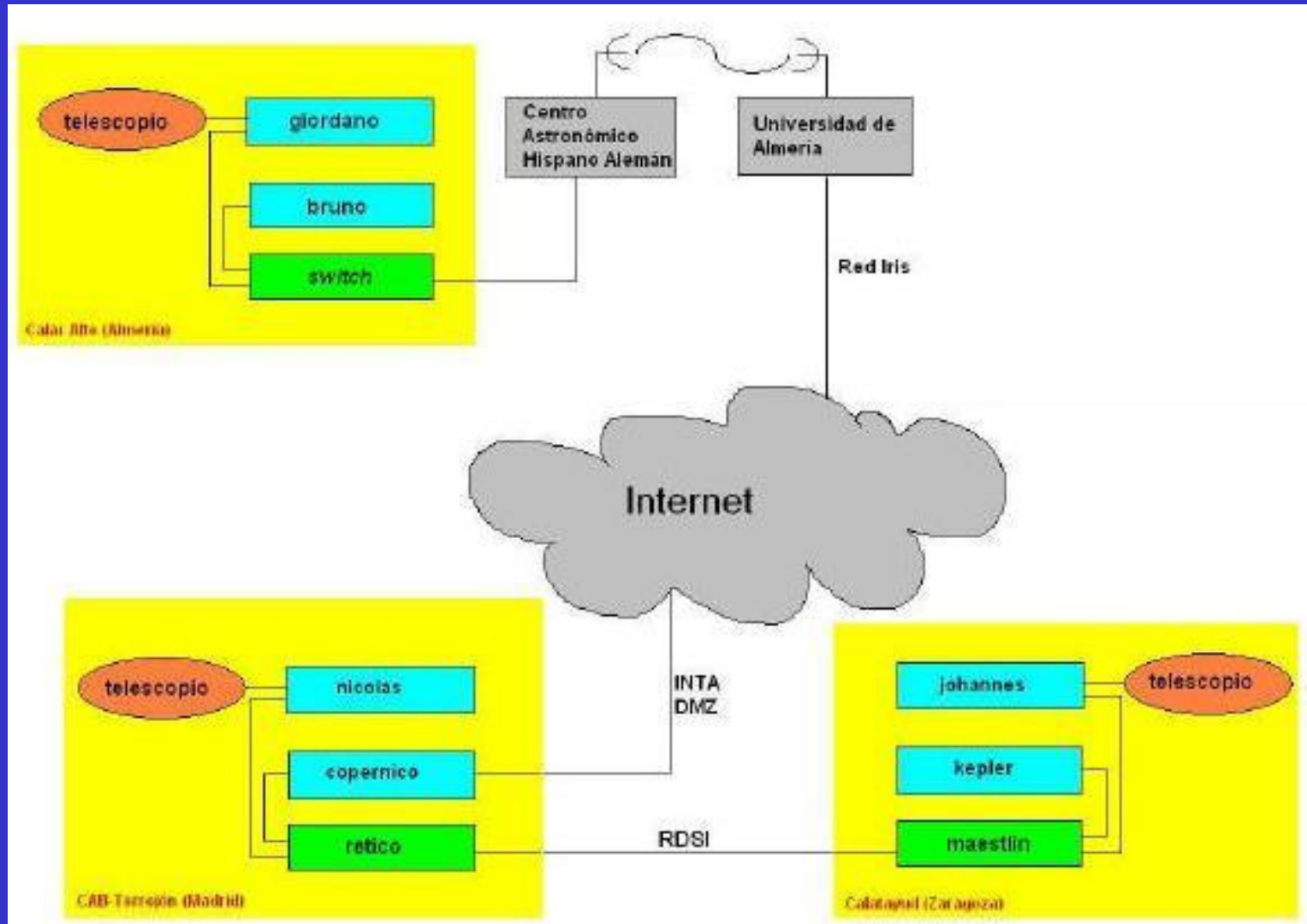
★ Robotic

- Programmed





Robotic Telescopes



NET



Robotic Telescopes



OPERATION

XEphem Pre-3.4.1
File View Tools Data Preferences Help

Make changes then press Update to run.

Local		METDST Calendar	
Torrejón de Ardoz...		May 2007	
Latitude:	40:30:14	Su	Mo Tu We Th Fr Sa
Longitude:	3:28:00	29	30 1 FM 3 4 5
Elevation:	639.0 m	6	7 8 9 10 11 12
Temp:	10.0 °C	13	14 15 NM 17 18 19
Atm Pres:	1010 mB	20	21 22 23 24 25 26
Epoch:	2000.0	27	28 29 30 31 FM 2
		3	4 5 6 7 8 9
		<<	< Now > >>

Time		Night	
Julian:	2454249.27515	Sun Dip:	18°
UTC Date:	5/28/2007	Dawn:	4:50
UTC Time:	18:36:13	Dusk:	23:33
Sidereal:	10:46:03	Length:	5:16
TZ Name:	METDST	LST@0:	14:10:23
TZ Offset:	-2:00:00	Looping	
Local Date:	5/28/2007	Step:	RT Clock
Local Time:	20:36:13	N Steps:	1
Delta T:	(Auto) 72.85	Pause:	0

Update

Camera 3.39
File Tools Expose 0
obturador001s-07205_02.fts

1/8 X
1/4 X
1/2 X
1 X
2 X
4 X

Tip L/R
Tip T/B

AOI
Reset
Gnuplot

up
FLI SI-003A Rev 96

Y: 0 W: 1024 H: 1024
V: 1 1:1
Set from AOI
Second(s) 1
Exposure(s) 1
Open Closed Dbl Mult 0 C
Rows Columns
On Goal: -20 Now: -18 C Ramping
Stop Close



Robotic Telescopes



★ Scientific Activity

- **Astrobiology**
 - Exoplanets
 - **Search**
 - **Characterization**
 - Solar type stars
 - Comets and NEOs
- **Other lines**
 - Variable stars
 - Opportunity objects
 - Galactic surveys (PN, HII, SNR)

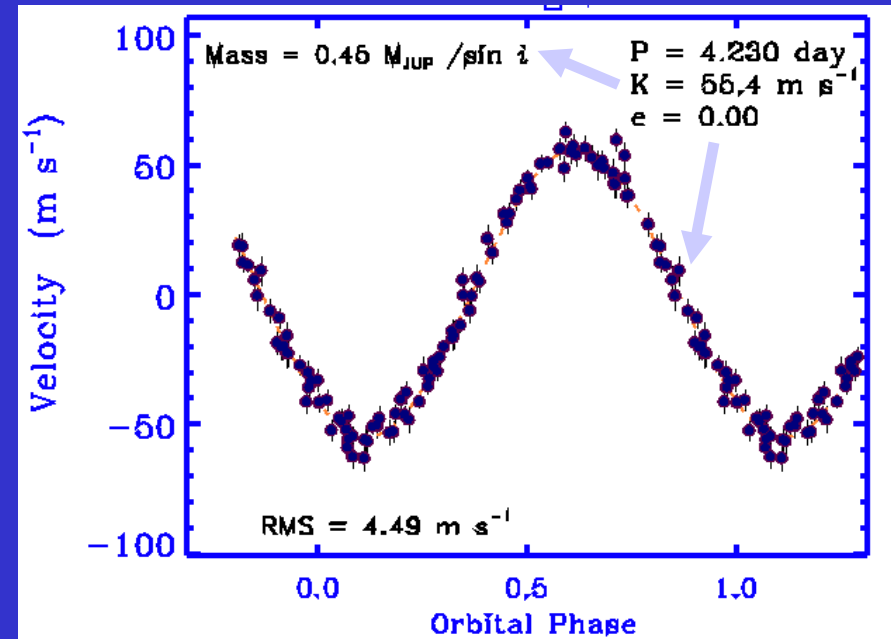


Exoplanets



SEARCH

- ★ **First detection**
 - **Mayor y Queloz**
 - 51 Peg b (1995)
- ★ **~350 detected**

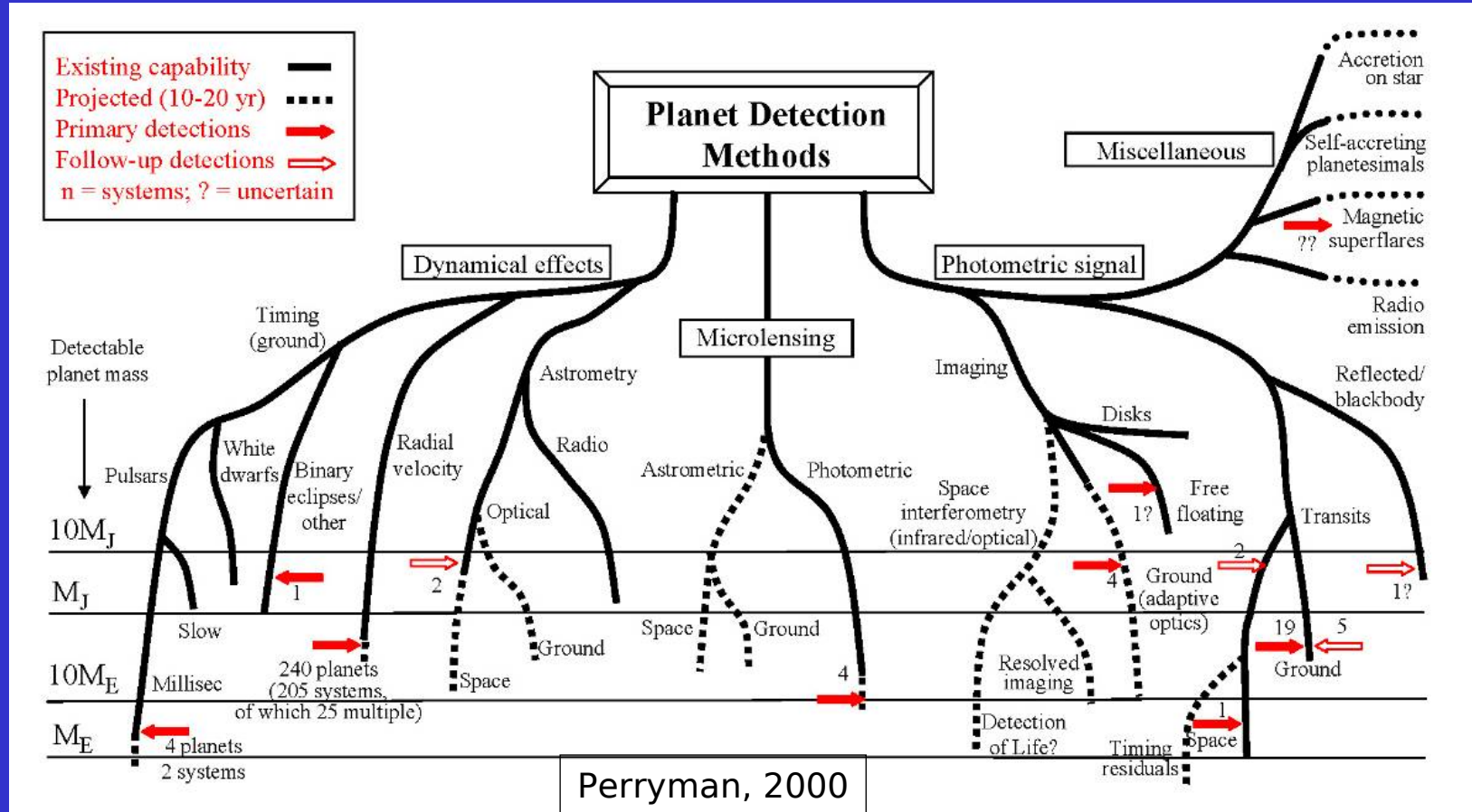




Exoplanets



SEARCH





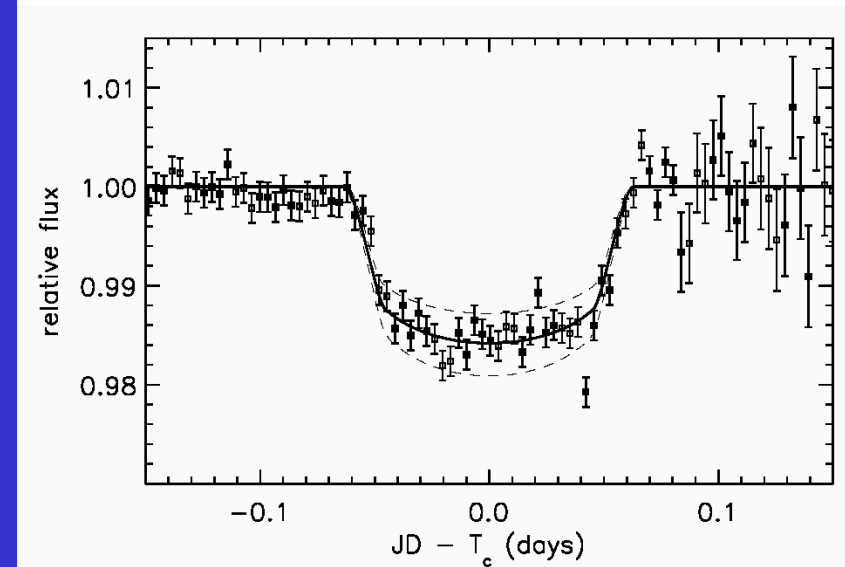
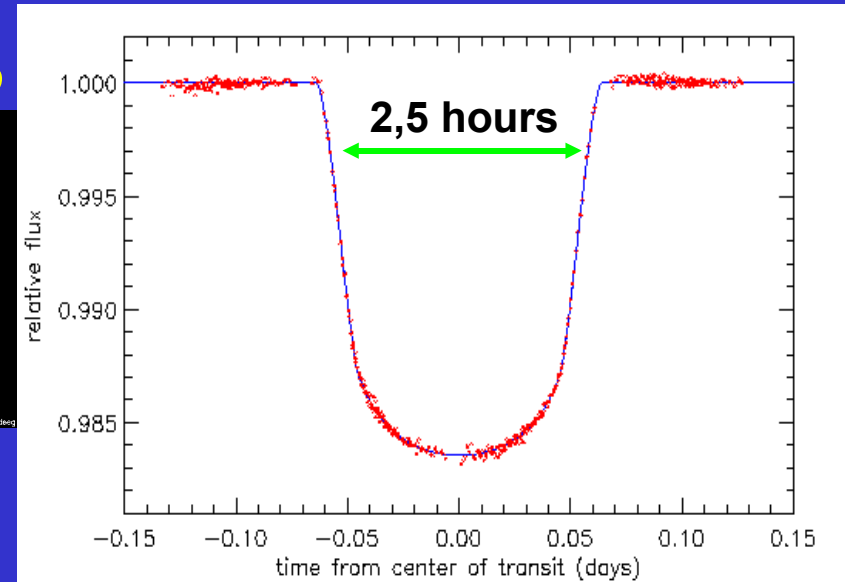
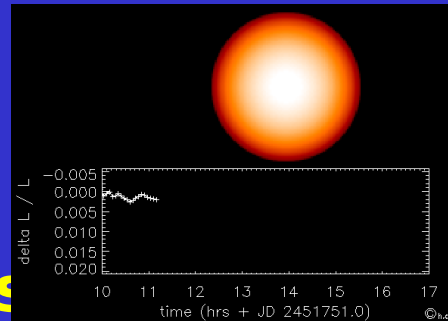
Exoplanets



DETECTION METHODS

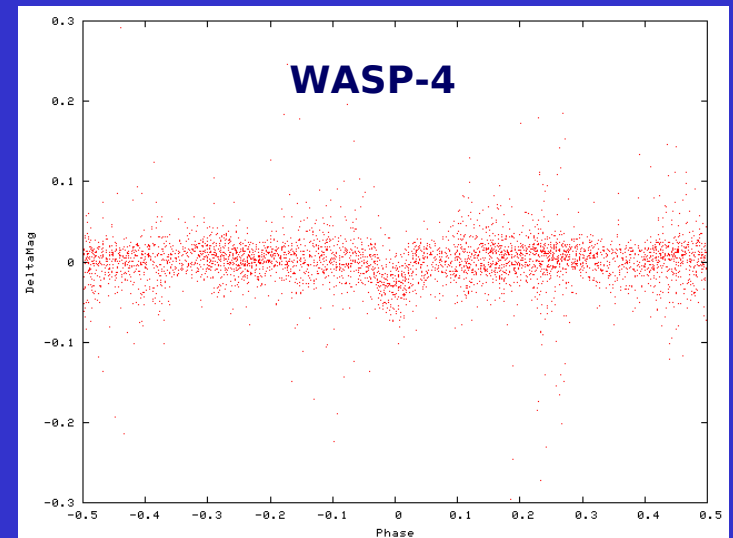
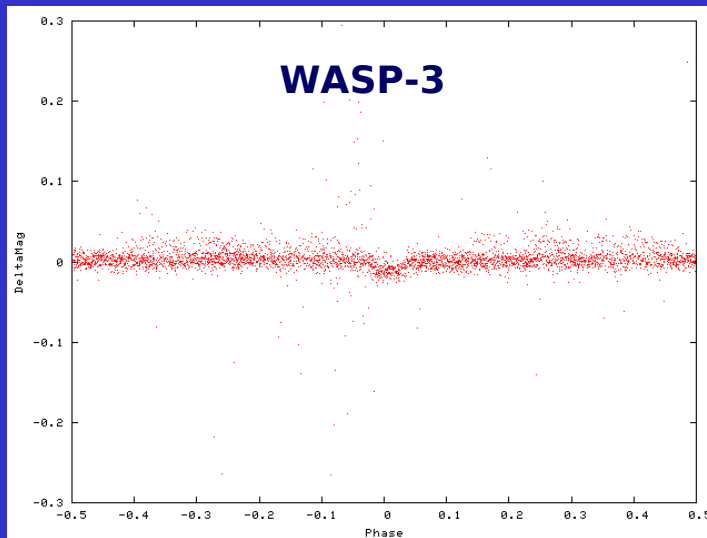
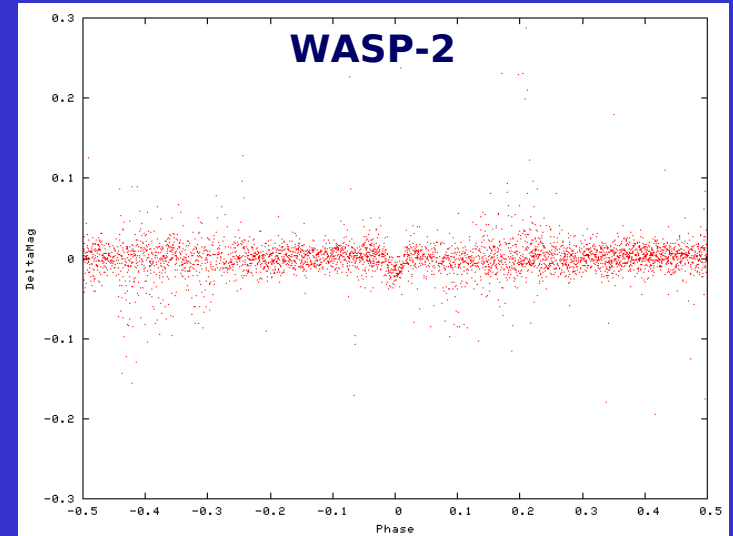
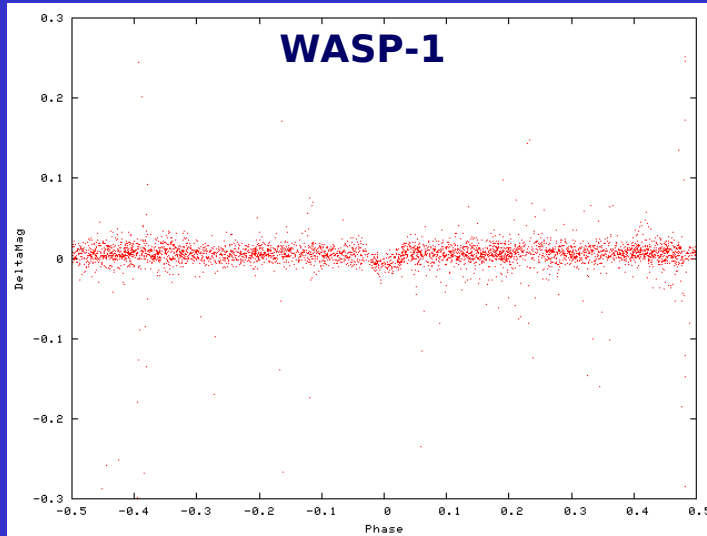
★ Transits

- **Photometry**
 - (0.01-1%)=>mmag
- **Repeatability**
- **59 planets**
- **HD 209458 b (1999)**
 - 47 pc
 - $0.69 M_J$
 - $1.32 R_J$
 - 0.045 UA
 - 3.5 d
 - 86.7°





Exoplanets



SEARCH



Exoplanets



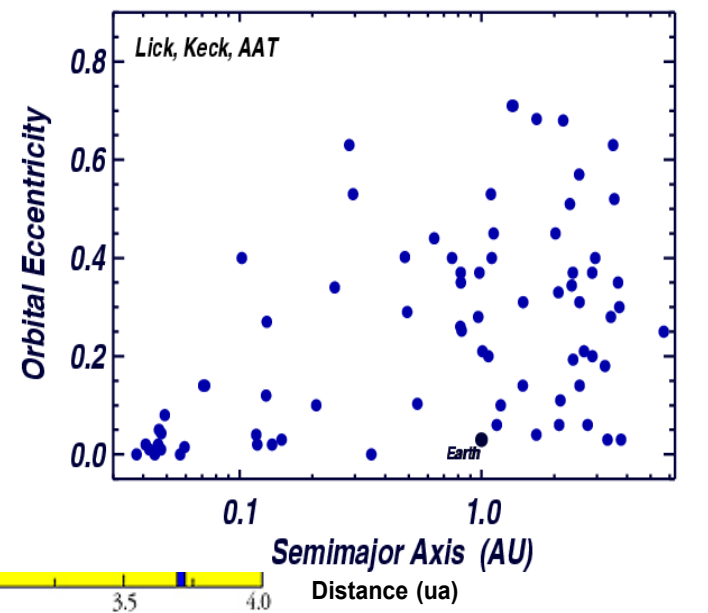
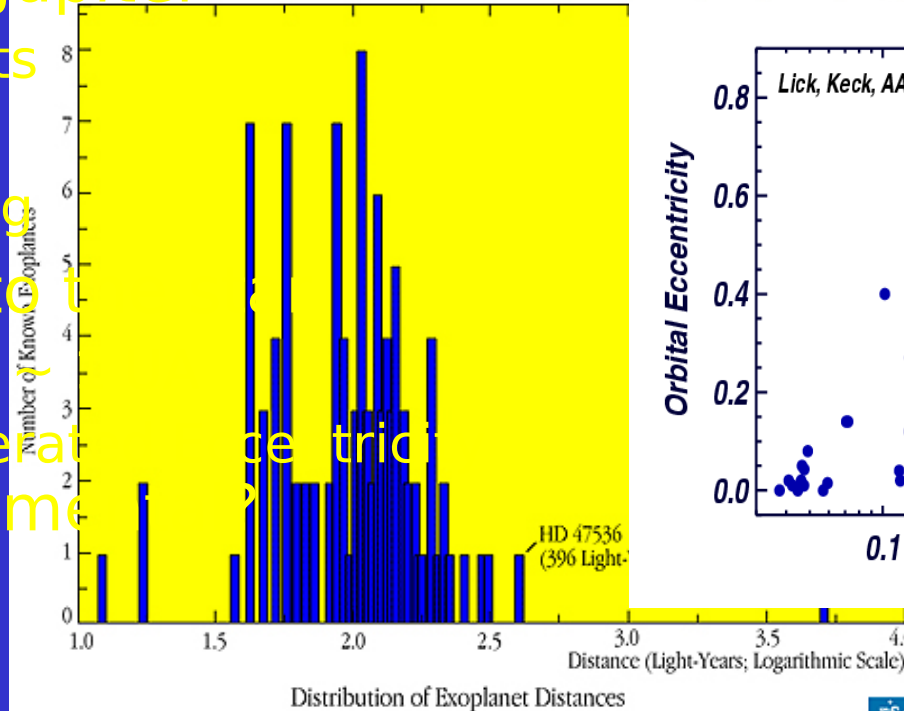
CHARACTERIZATION

- ★ All the sky
- ★ Not at all D
- ★ Super-Jupiter

- Giants
- Hot
- Young

- ★ Close to the Sun
- Most eccentric
- Moderate eccentricity
- ★ Instrumental

They are everywhere!

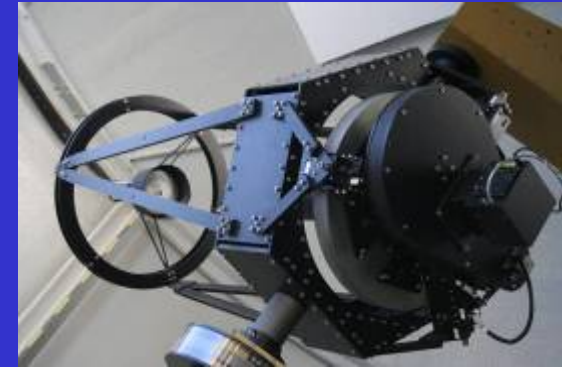




Exoplanets



- ★ **Use of Robotic Telescopes**
- ★ **Data about the planet**
 - **A lot of observation time**
 - **Light curves => increase s/σ**
 - Mass, size and distances
 - **Begin and end**
 - Orbital cycles
 - **Max and min**



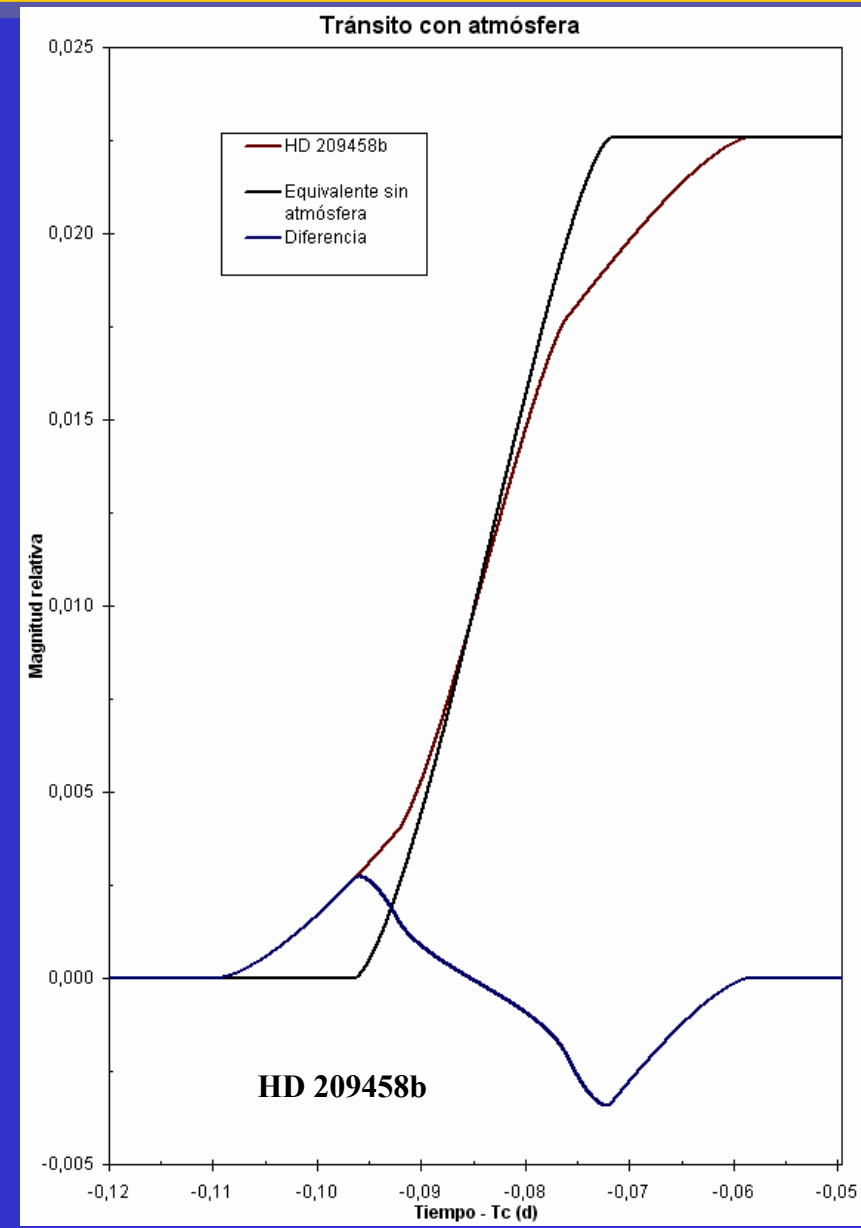


Exoplanets



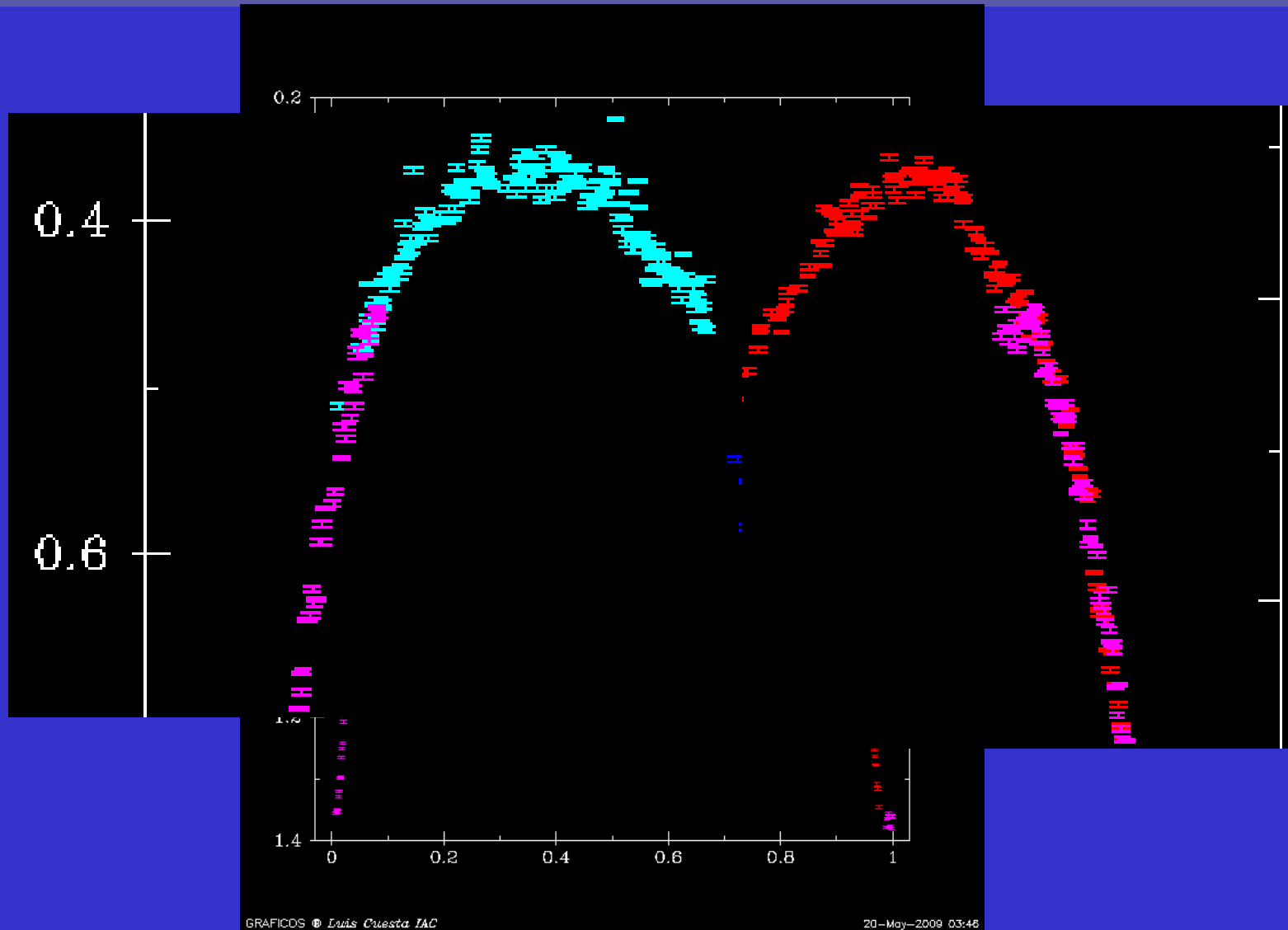
ATMOSPHERES IN THE TRANSIT

- ★ Identification of the atmosphere
 - Fast differential Photometry
 - Entrance and exit phase
 - $\lambda?$ limb effects?





Results



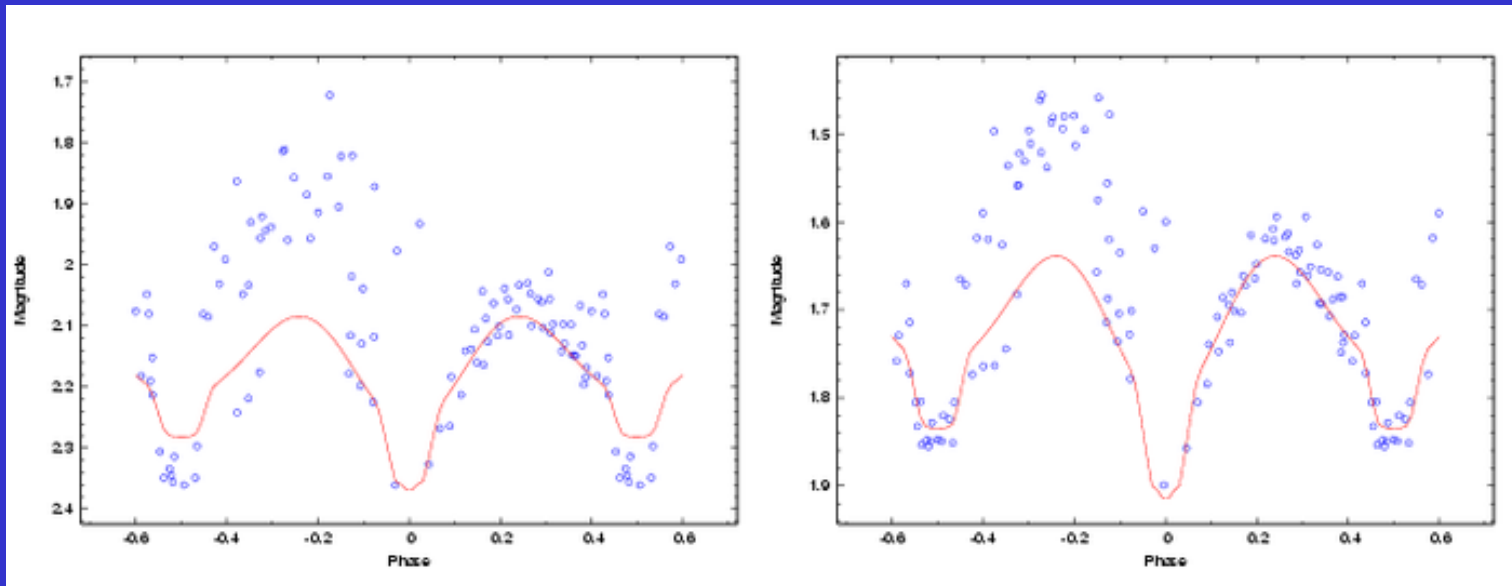
EG Cep



Study of OMC objects

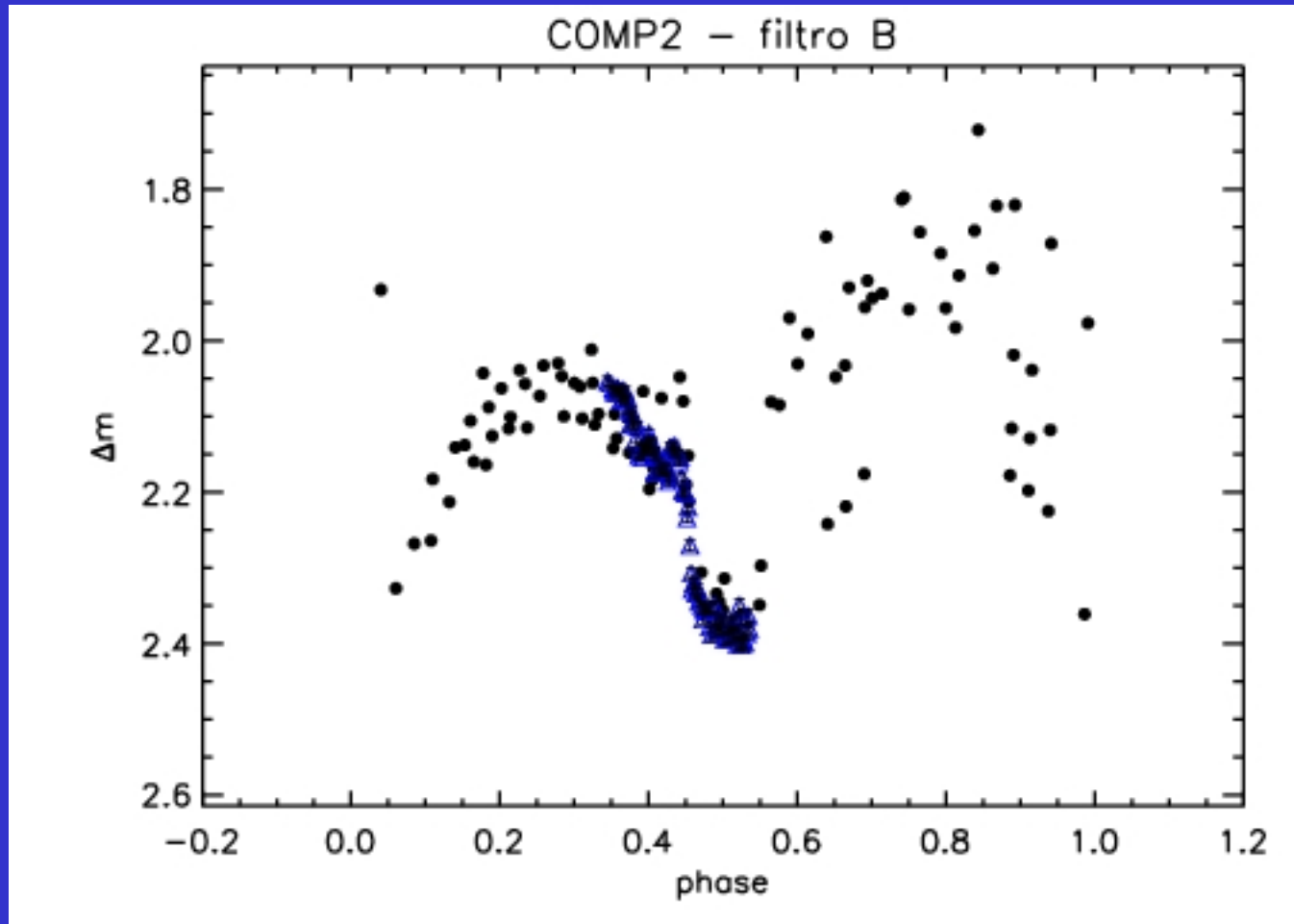


- **Study of light curves with longer time base**
- **Study with multiple filters**
- **Confirmation of orbital periods**





Results



Rs1 IOMC078



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Robotic Telescopes



THE PLACE