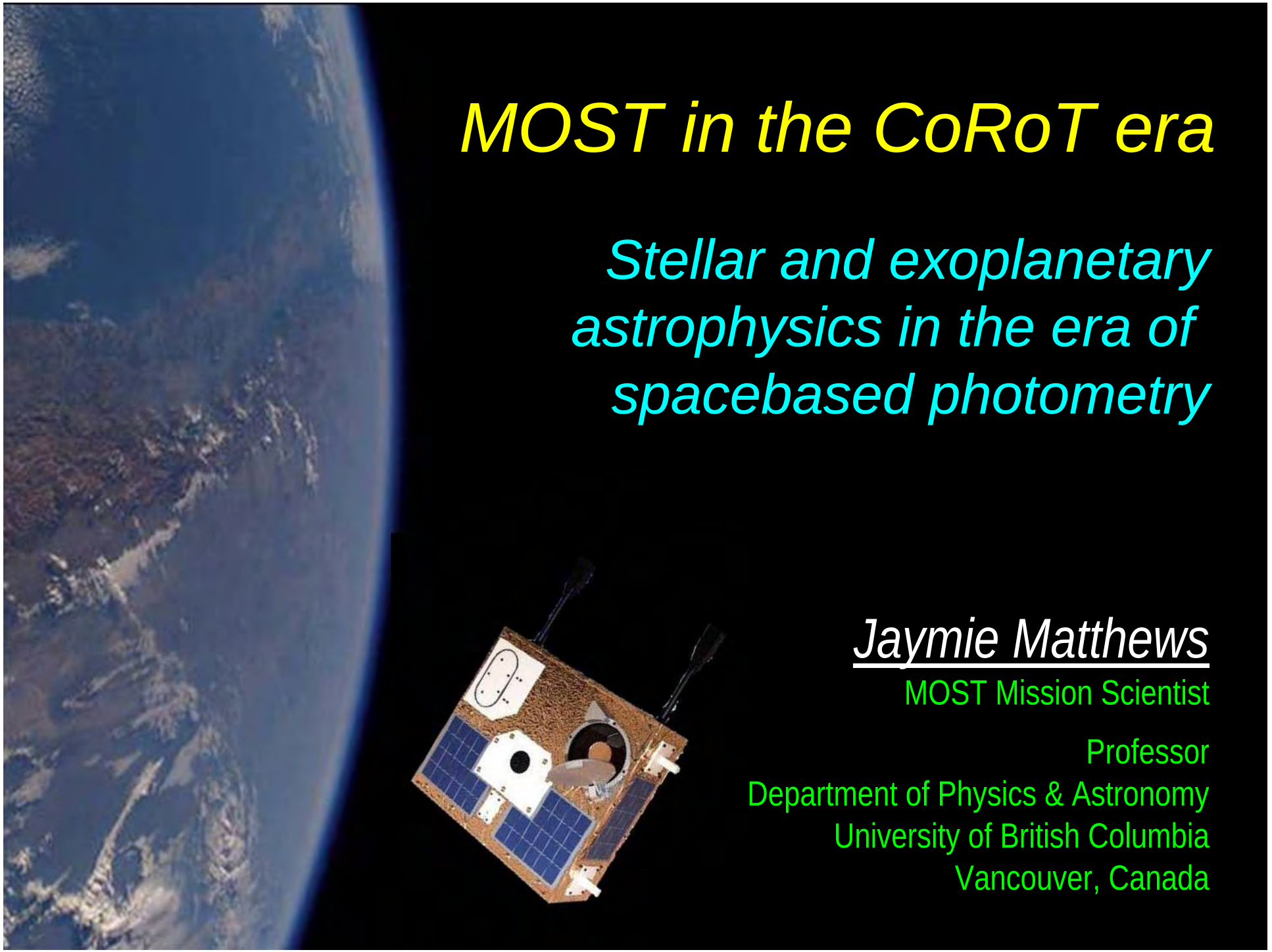


MOST in the CoRoT era

Stellar and exoplanetary astrophysics in the era of spacebased photometry

Jaymie Matthews

MOST Mission Scientist

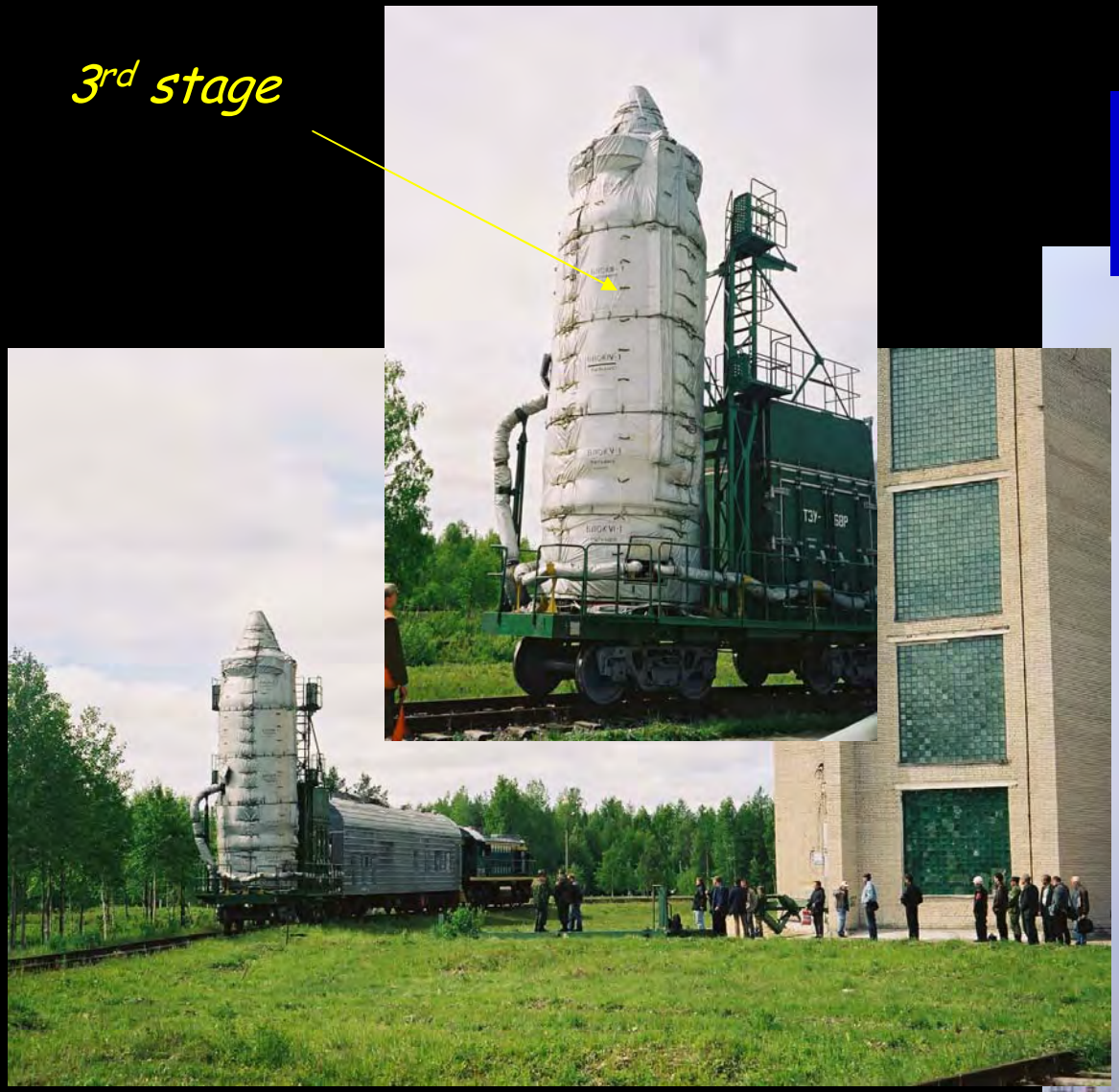
Professor
Department of Physics & Astronomy
University of British Columbia
Vancouver, Canada


the CoRoT era begins
27
December
2006

ROCKOT

3-stage former ICBM (SS-19) with low-orbit lift capacity ~1900 kg

3rd stage



mass = 107 tonnes

Eurockot = Astrium + Khrunichev Space Research Centre


Jaymie M.


88:88
1
0
Jaymie M.
George W.


88:88
1
0
Jaymie M.
George W.
Winner!


as of 20 Jan 2009

30 June 2003 - 16:15:00.323 UTC

the MOST era begins

Plesetsk Cosmodrome

CoRoT

http://smsc.cnes.fr/COROT

Woman with a Pearl

CoRoT CVZ

© O. Daudet/C&EP

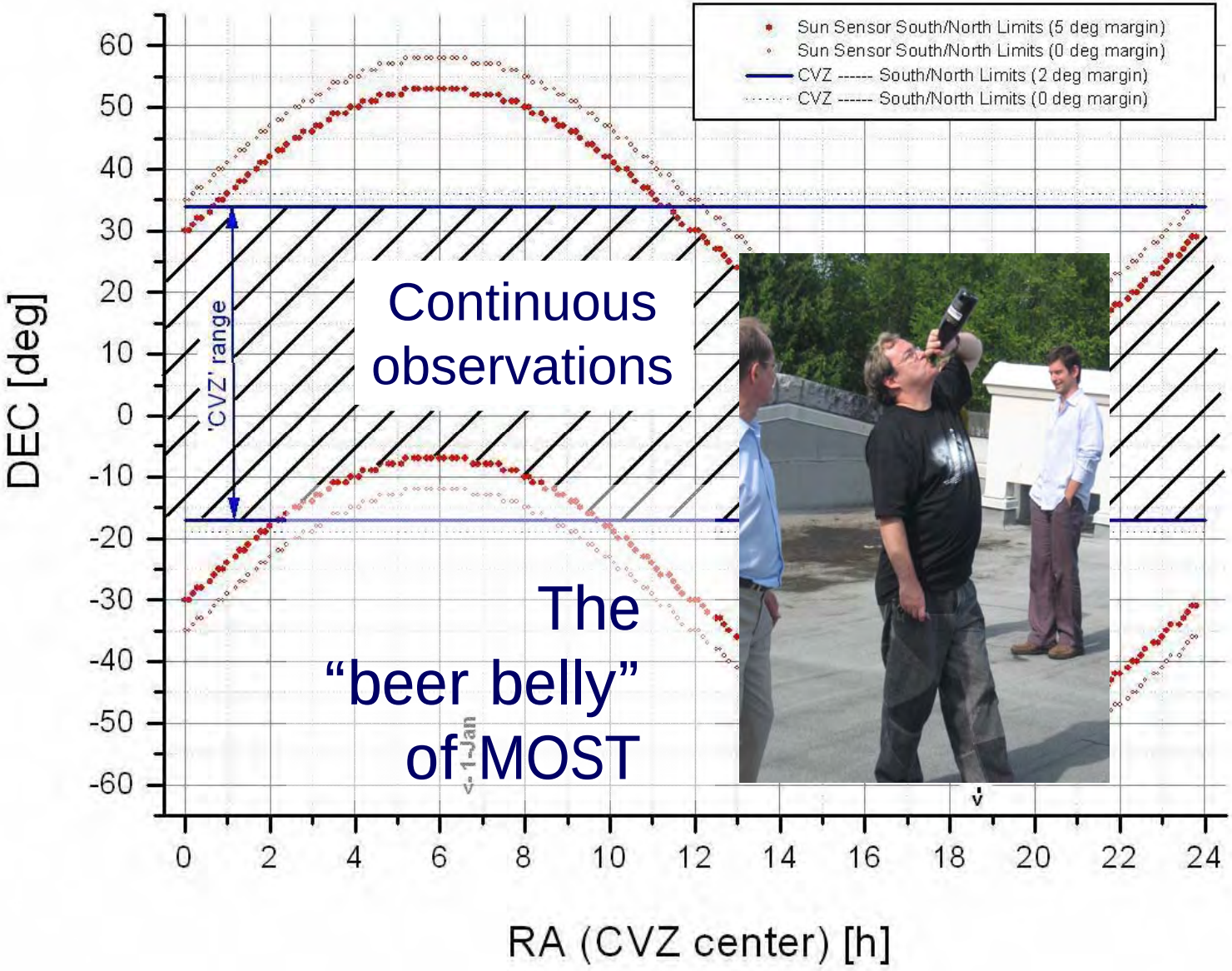
The "eyes" of CoRoT

Woman
with a
Pearl

CoRoT CVZ

The “eyes” of CoRoT

MOST CVZ


Sun Sensor South/North Limits (5 deg margin)
Sun Sensor South/North Limits (0 deg margin)
CVZ ------ South/North Limits (2 deg margin)
CVZ ------ South/North Limits (0 deg margin)
DEC [deg]
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
'CVZ' range
Continuous observations
The "beer belly" of MOST
<- 1-Jan
v
0
2
4
6
8
10
12
14
16
18
20
22
24
RA (CVZ center) [h]

Big belly = big appetite

HD 209458	*transiting exoplanet*	7 Aug – 15 Sept
gamma Peg	*hybrid β Cephei – SPB*	15 Sept – 16 Oct
II Peg	*RS CVn binary*	
HR 1030	*red giant on cool border of instability strip*	16 Oct – 15 Nov
Aldebaran	*red giant with p-modes*	15 Nov – 15 Dec
Betelgeuse	*supergiant*	15 Dec – 15 Jan
V 1247 Ori	*field PMS star*	15 Dec – 3 Jan
rho Pup	*CP delta Scuti*	15 Jan – 8 Feb
FI Cnc	*red giant (activity)*	15 Jan – 8 Feb

Recent target fields

HD 209458	*transiting exoplanet*	7 Aug – 15 Sept
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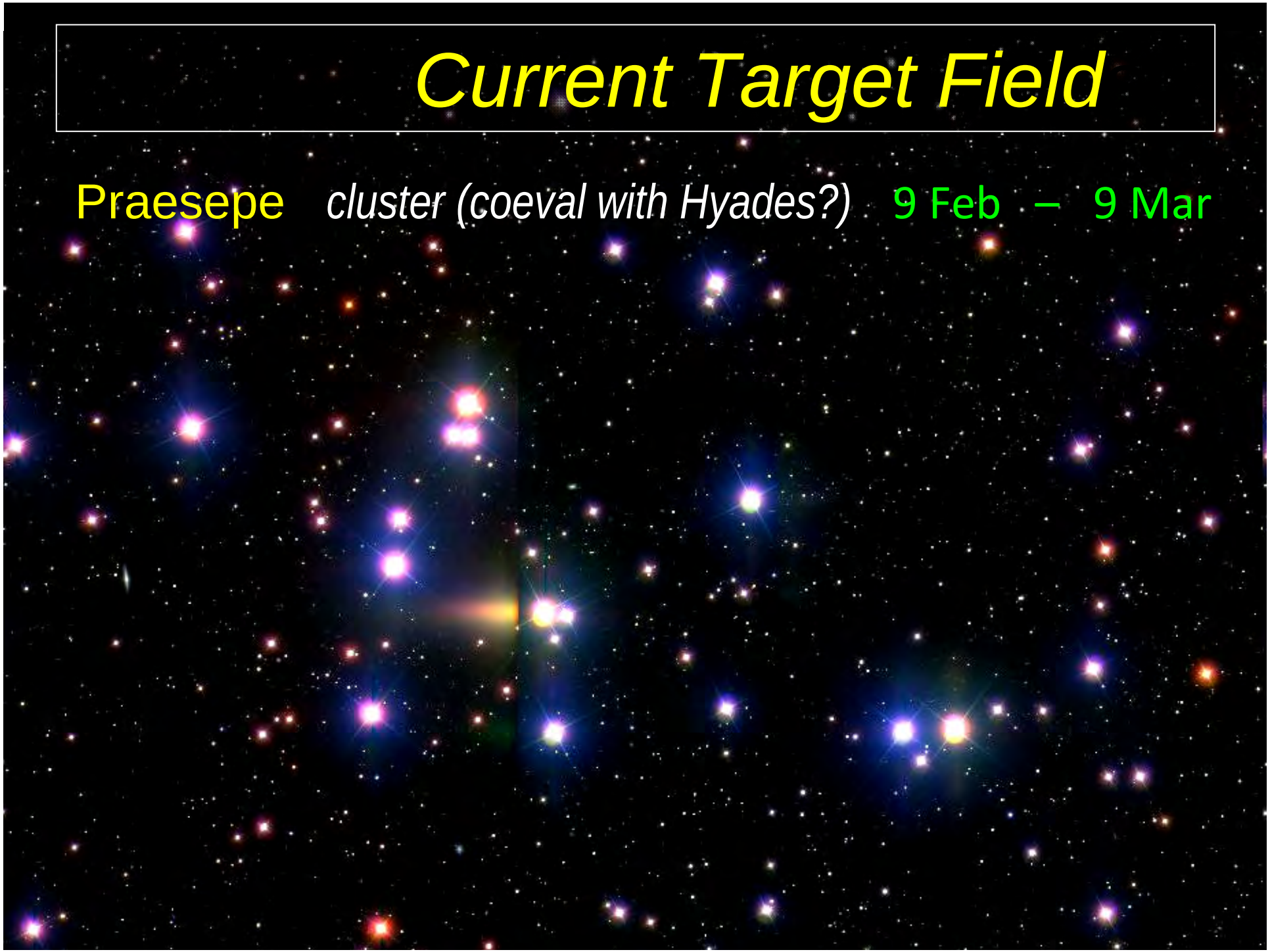
FI Cnc	*red giant (activity)*	

PhD thesis

Vichi Antoci

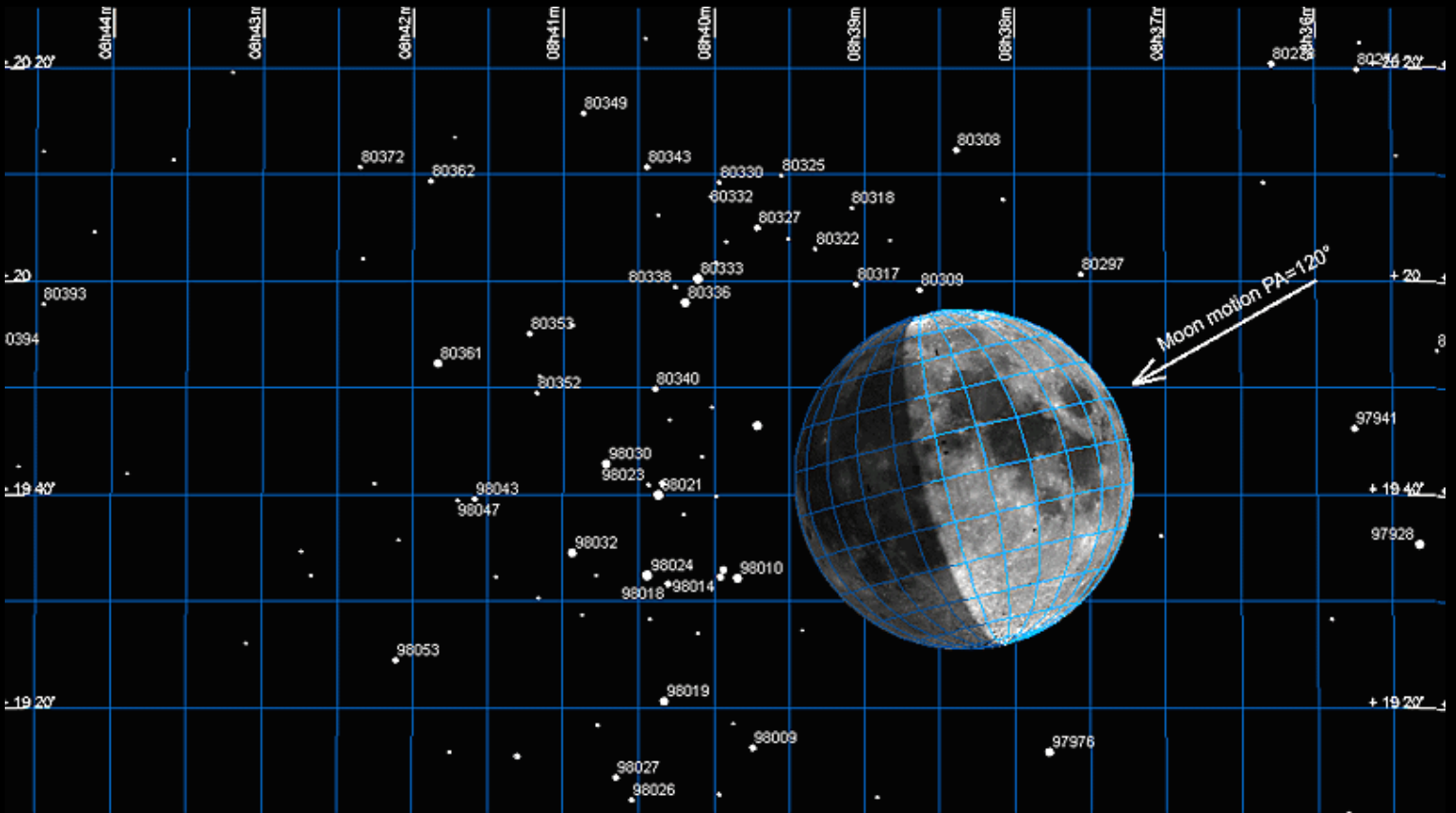
P – VI – 65

Current Target Field

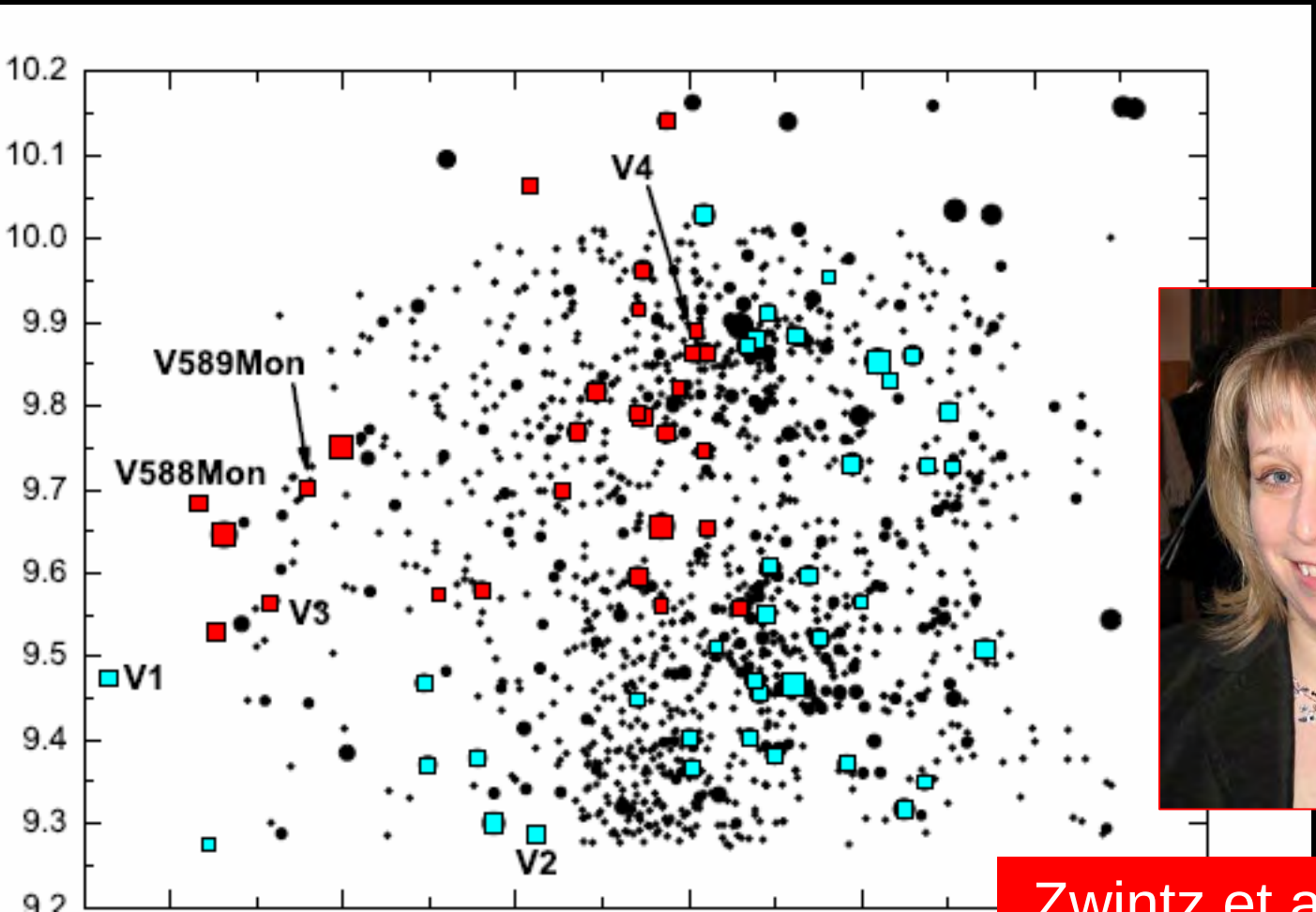


Current Target Field

aesepe *cluster (coeval with Hyades?)* 9 Feb – 9 Mar



Young cluster NGC 2264



Zwintz et al. 2009

Young cluster NGC 2264

MOST monitored field for *22.7 days* in December 2006

68 stars in two different pointing fields as ‘switch’ targets
38 stars in field A, 30 stars in field B

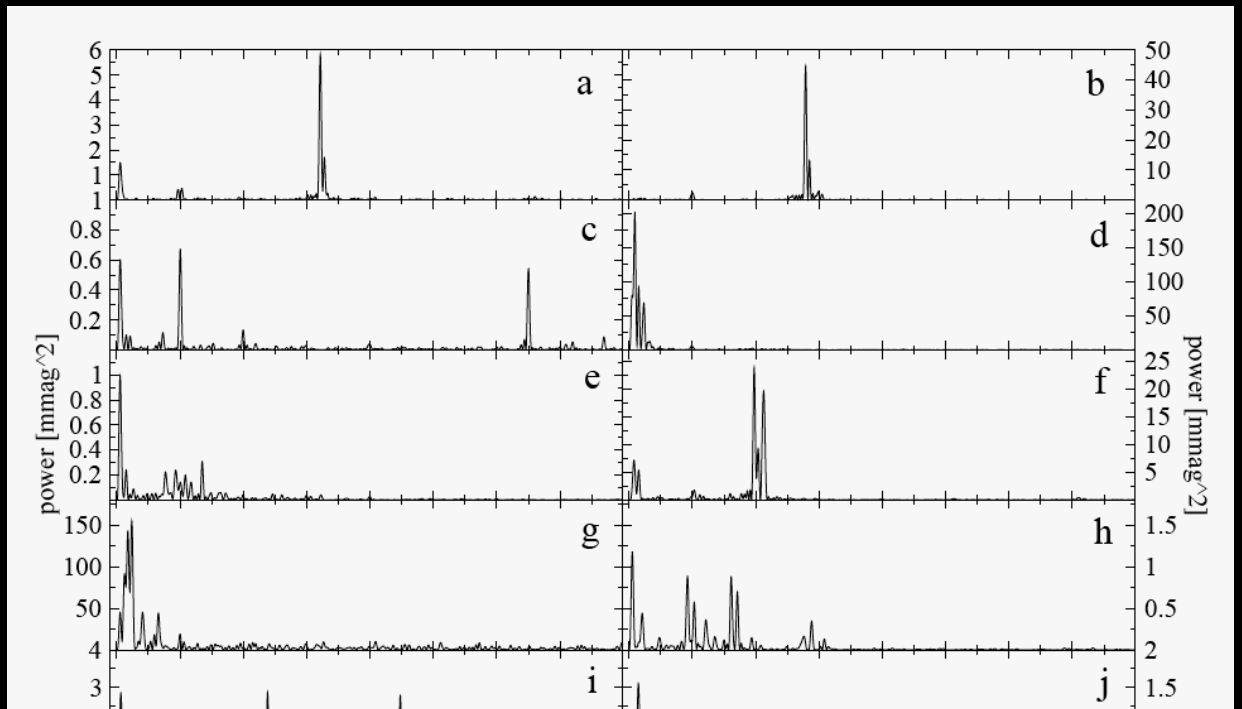
32 A and F type stars → candidates for PMS pulsation
36 stars of other spectral types
known pulsators *V 588 Mon* and *V589 Mon* observed

Result: *30 variable stars* and *38 ‘constant’ stars*

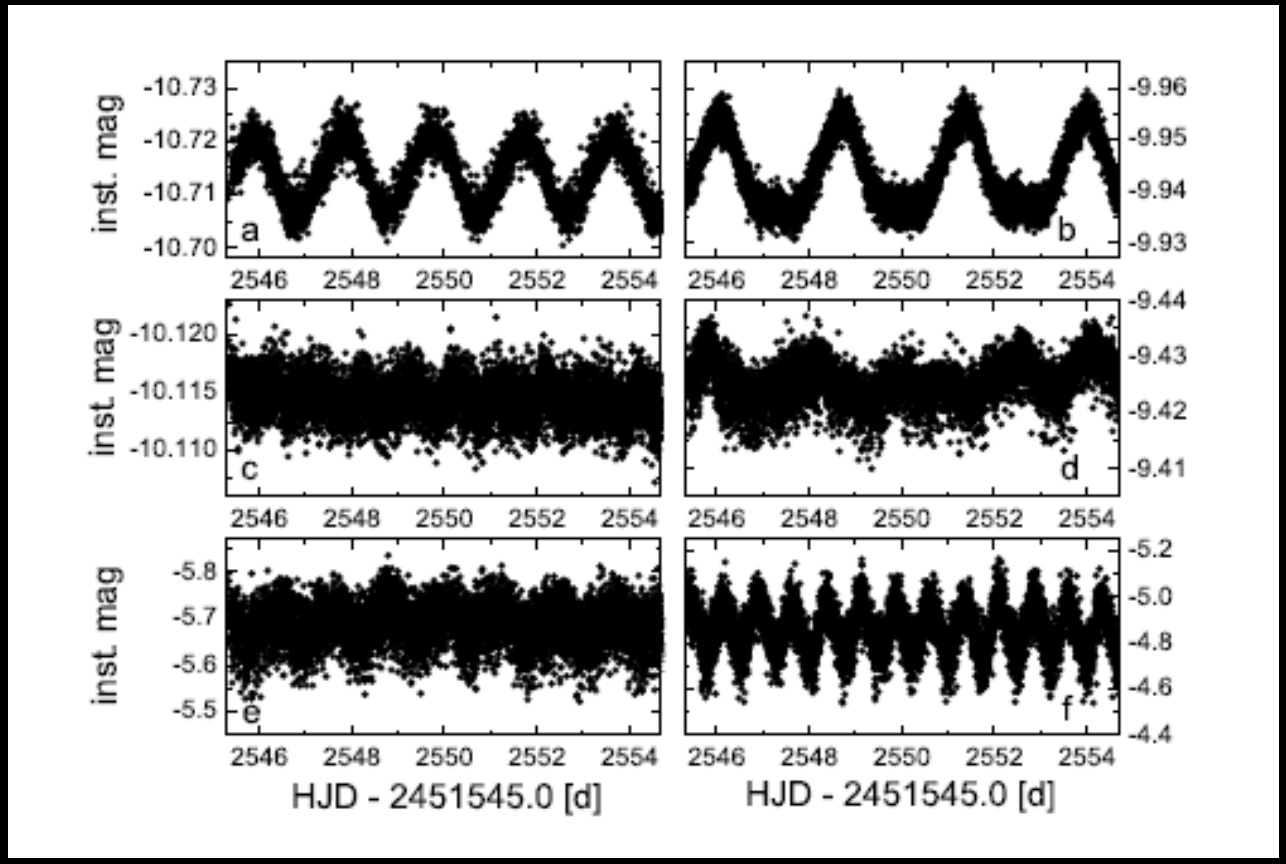
Young cluster NGC 2264

recall Pieter Degroote's presentation

10 Slowly Pulsating B (SPB) stars



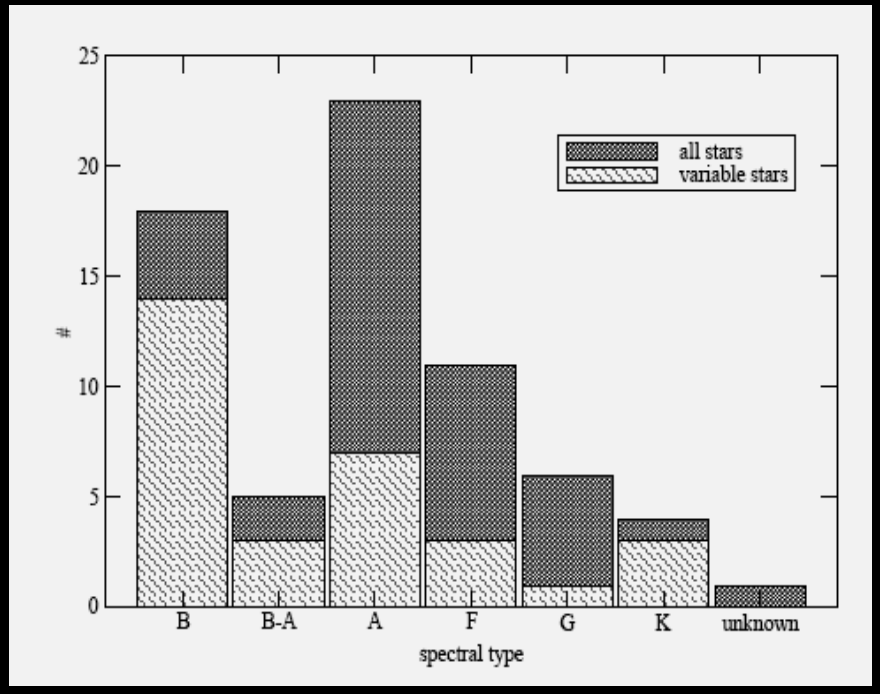
Young cluster NGC 2264



6 spotted stars (showing rotational modulation)

Young cluster NGC 2264

- 4 new PMS pulsators
- 10 SPB stars
- 2 gamma Doradus pulsators
  (not cluster members)
- 1 pulsating red giant
- 4 eclipsing binaries
- 2 peculiar B stars
- 6 spotted stars (showing rotational modulation)



Young cluster NGC 2264

C 2264 is the *only* young star-forming cluster
ilable to CoRoT

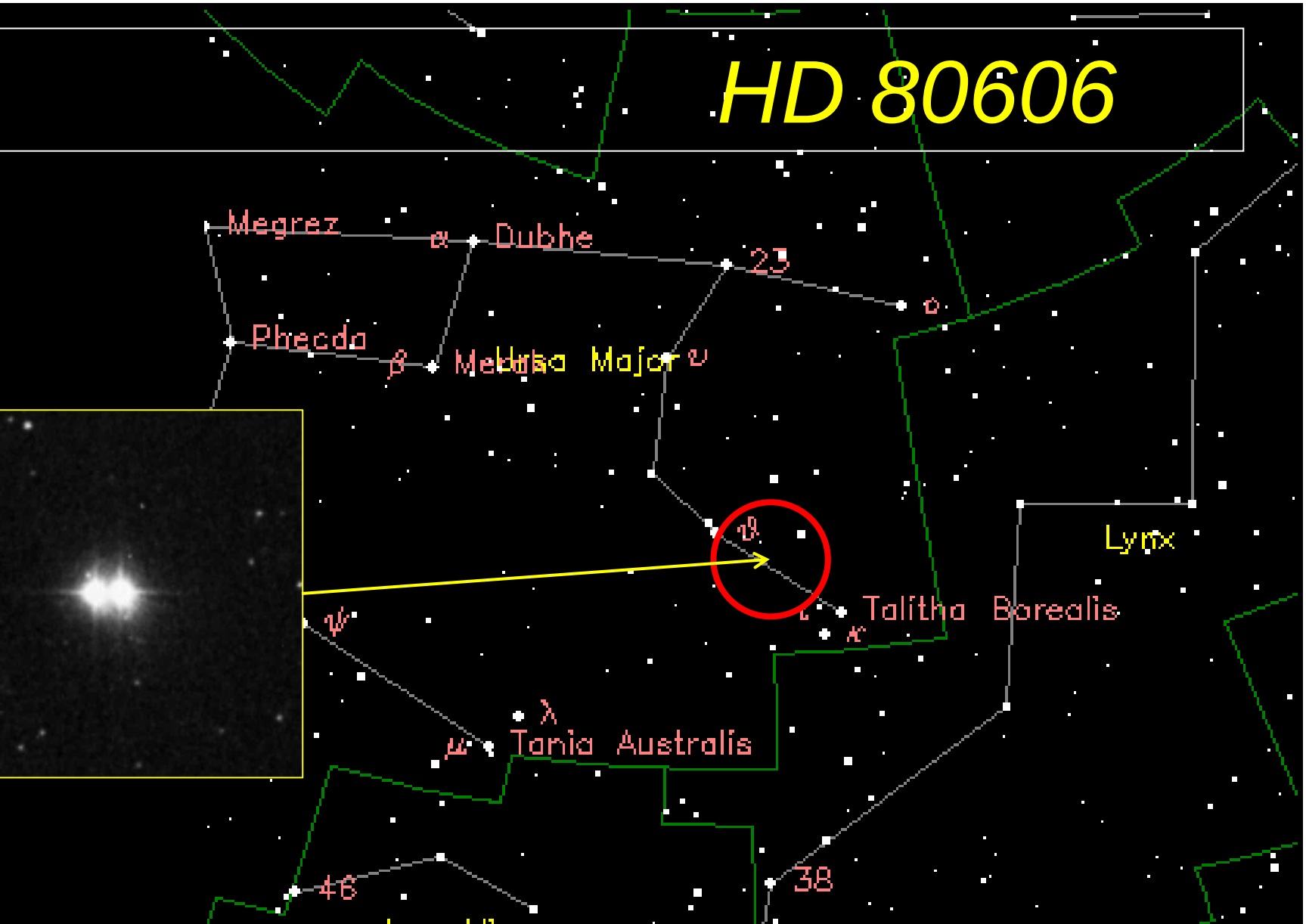
MOST can extend and supplement the CoRoT findings,
not only in NGC 2264, but in other clusters in its CVZ

Current Target Field

aesepe *cluster (coeval with Hyades?)* 9 Feb – 9 Mar

Current Target Fields

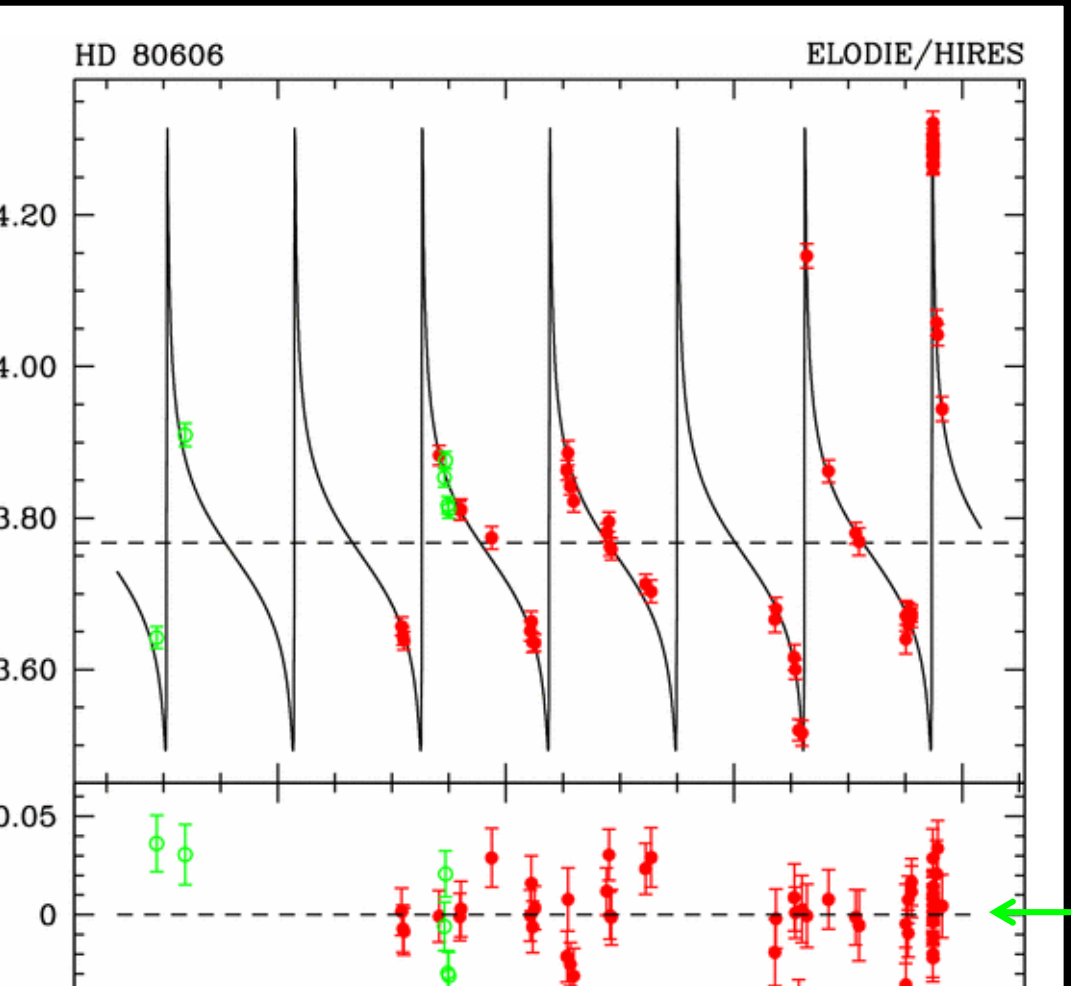
aesepe	*cluster (coeval with Hyades?)*	9 Feb – 9 Mar
80606	*exoplanet in eccentric orbit*	5 Feb – 15 Feb


HD 80606
Megrez
Dubhe
23
Phecda
Ursa Major
Lynx
Talitha Borealis
Tania Australis
46
38

HD 80606


Star: HD 80606
Distance from Earth: 58.38 ly
Magnitude: 8.93
Mass: 0.9 (Sun = 1)
Coordinates:
RA = 09 22 37.5679
DEC = +50 36 13.397

Exoplanet HD 80606 b

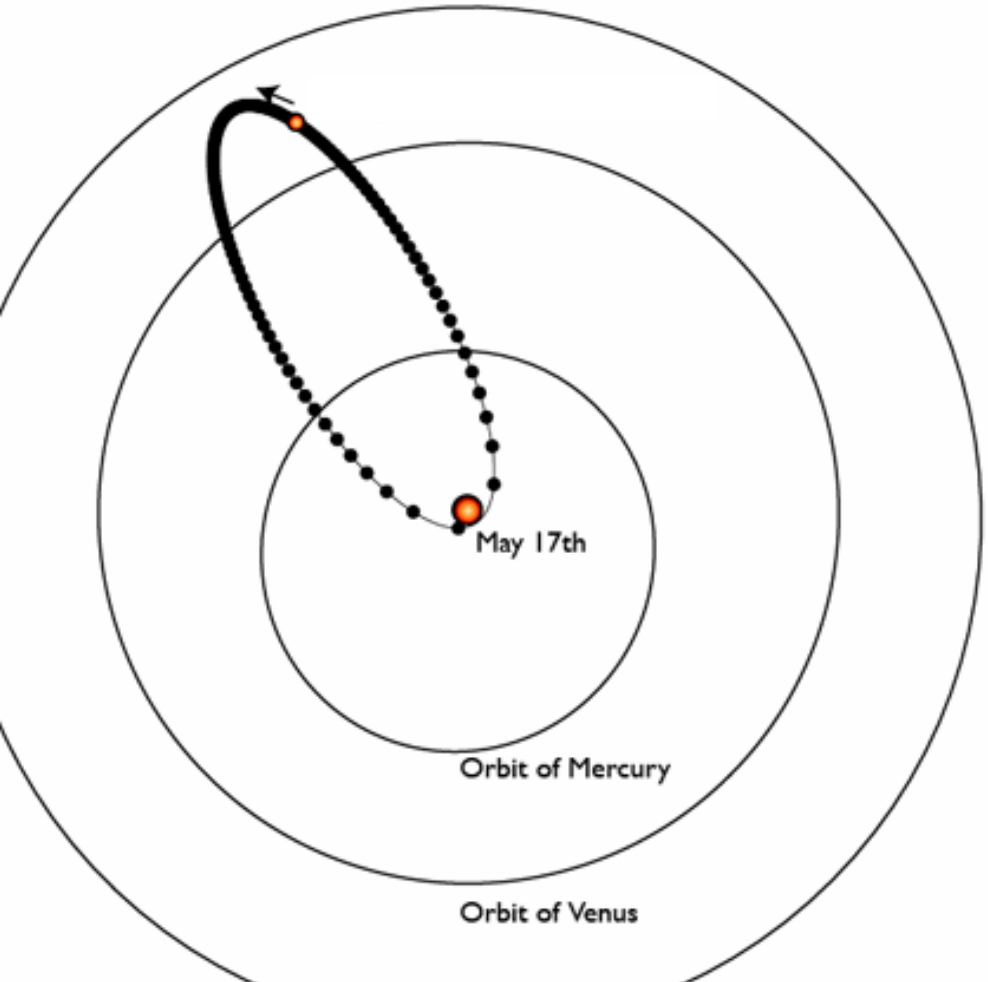


The radial velocity variations of the star reveal reflex motions due to the unseen exoplanet

The saw-toothed RV curve means *very high orbital eccentricity*

residuals to orbital solution

Exoplanet HD 80606 b



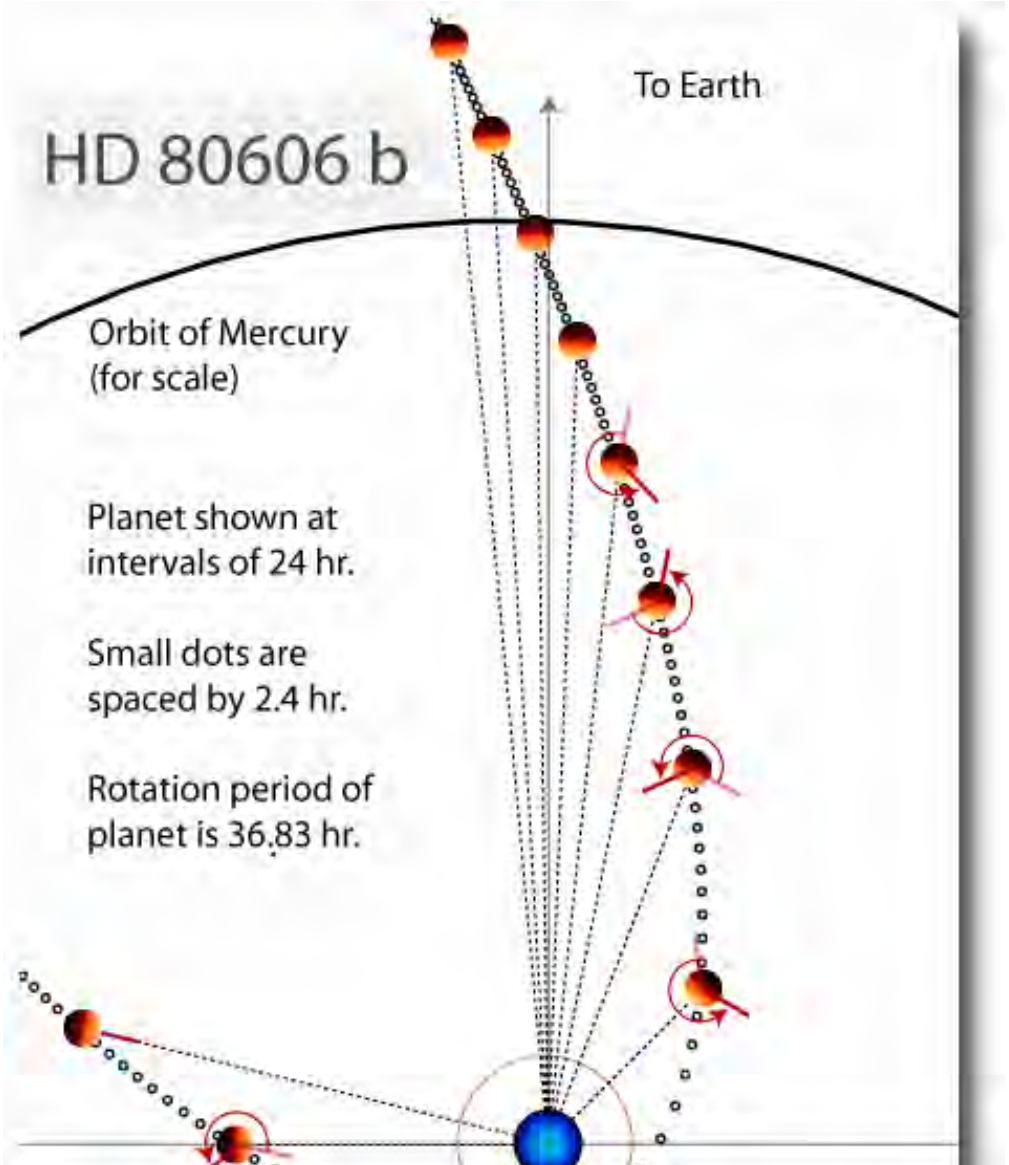
The radial velocity variations of the star reveal reflex motions due to the unseen exoplanet

The saw-toothed RV curve means *very high orbital eccentricity*

$e_{HD80606} = 0.93$

e planet moves fastest
ng periastron passage

distance from the star
changes dramatically
in only a few days



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signal from the planet
likely the atmospheric
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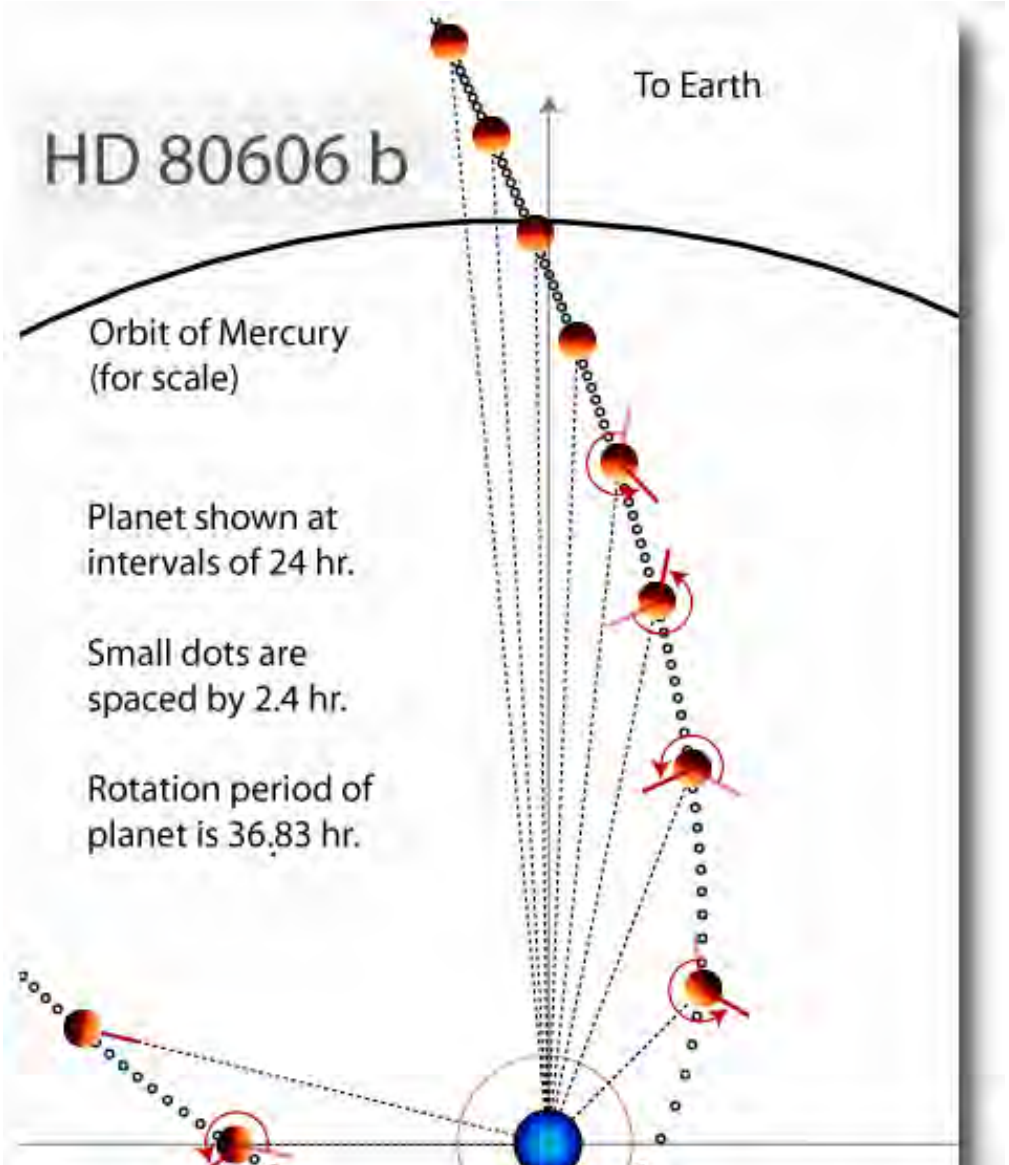
on a short timescale



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changes dramatically
in only a few days

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nsolation (instaration?)
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likely the atmospheric
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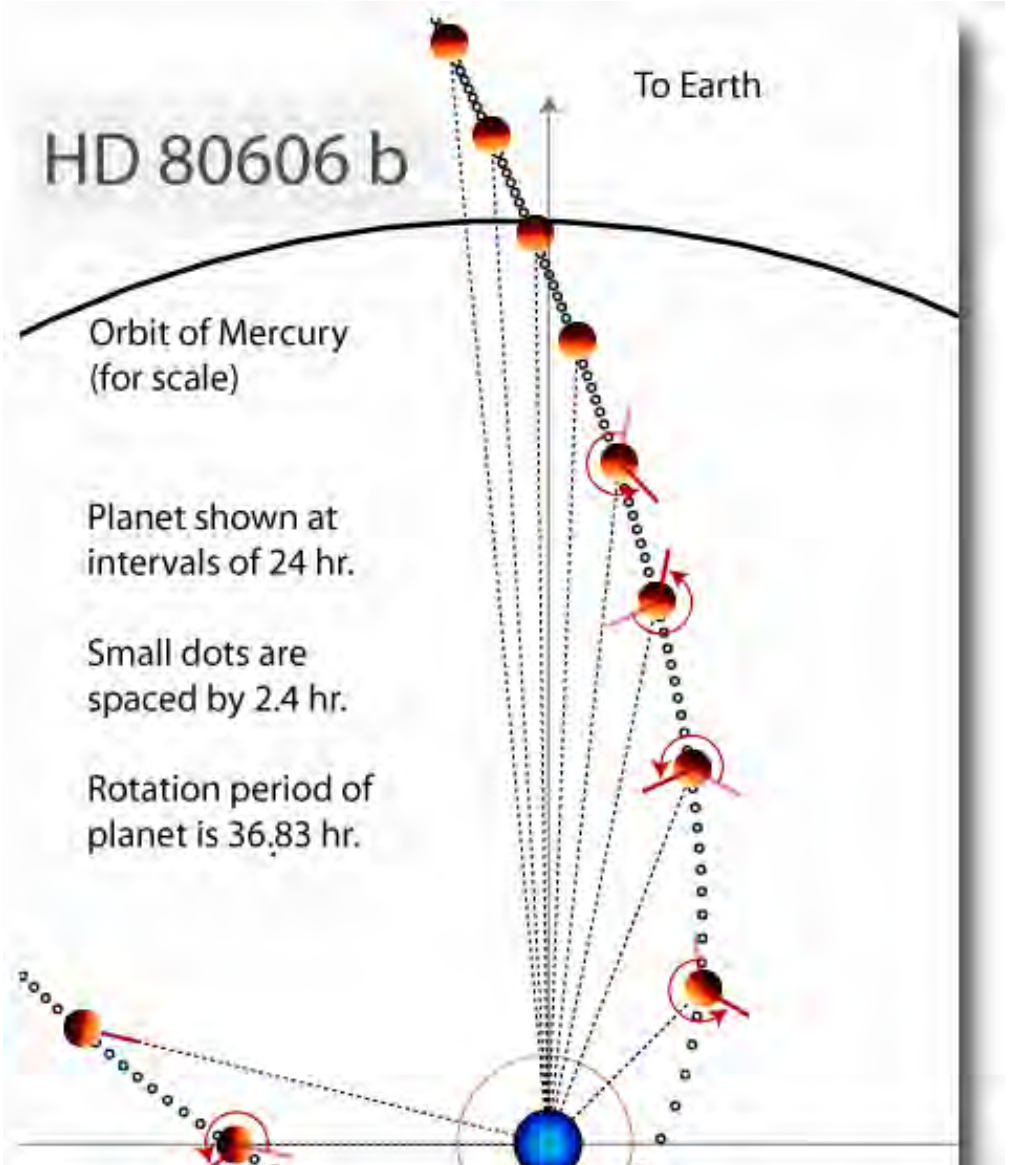
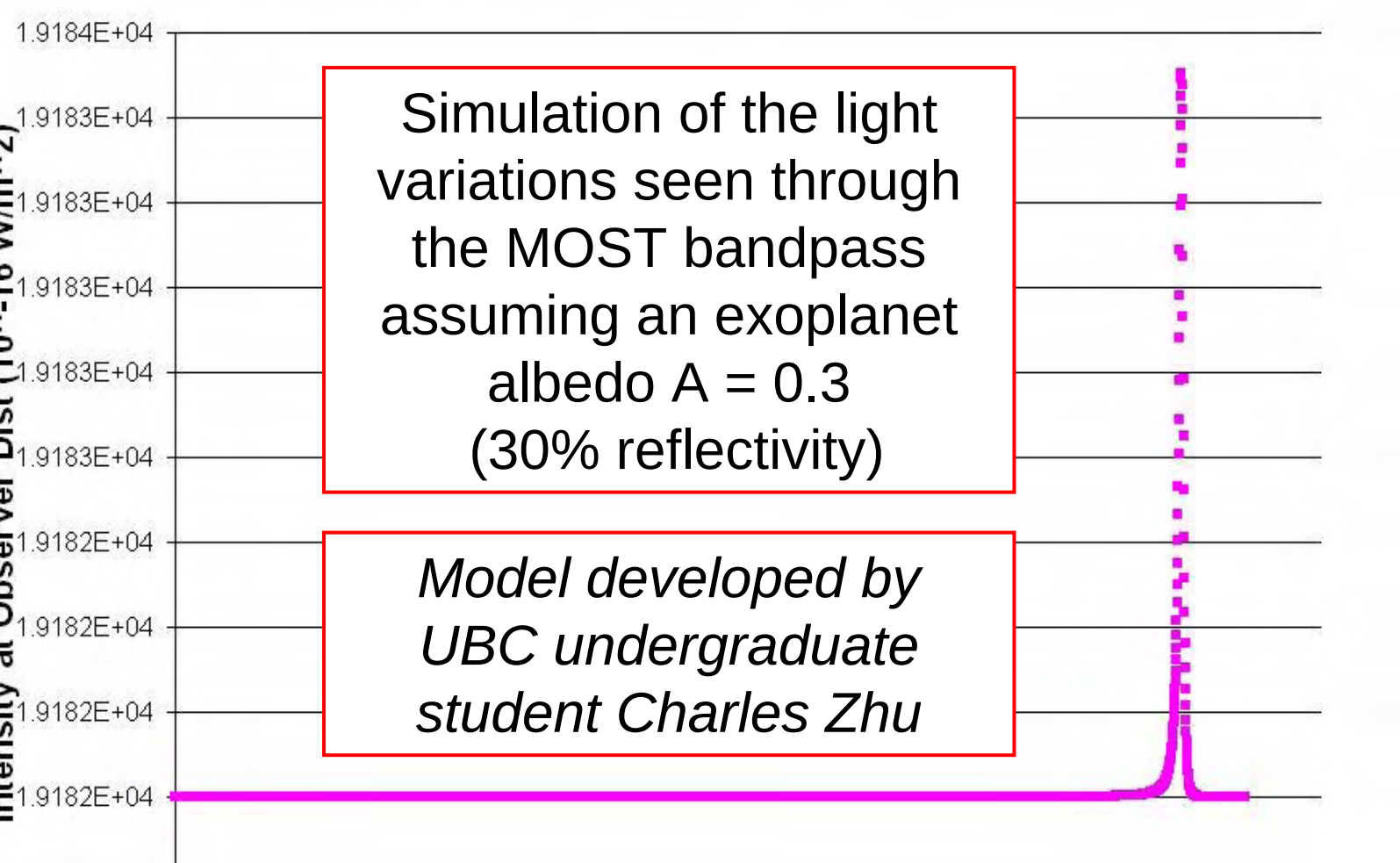
on a short timescale

OST can measure this



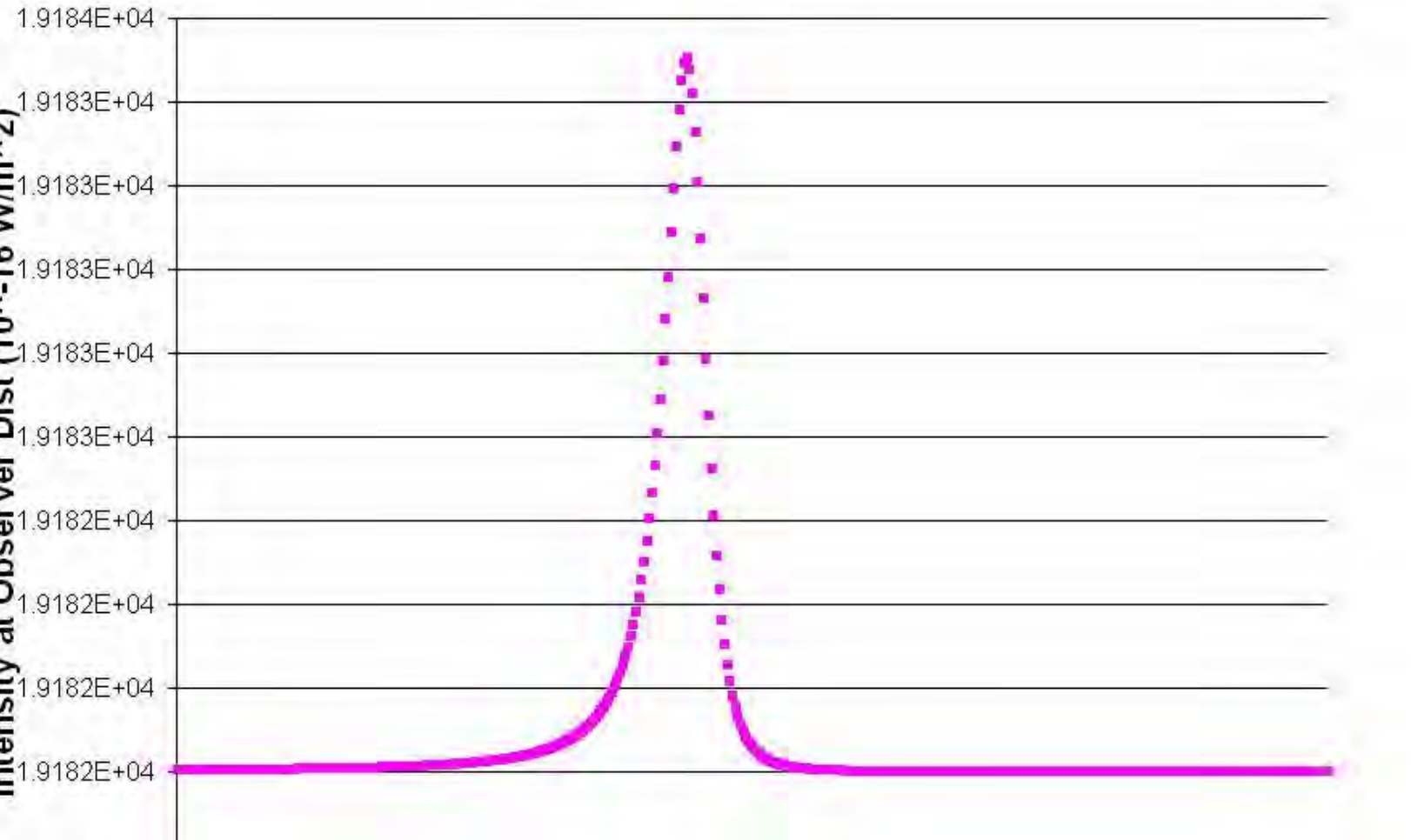
Exoplanet HD 80606 b



Simulation of the light variations seen through the MOST bandpass assuming an exoplanet albedo A = 0.3 (30% reflectivity)

Model developed by UBC undergraduate student Charles Zhu

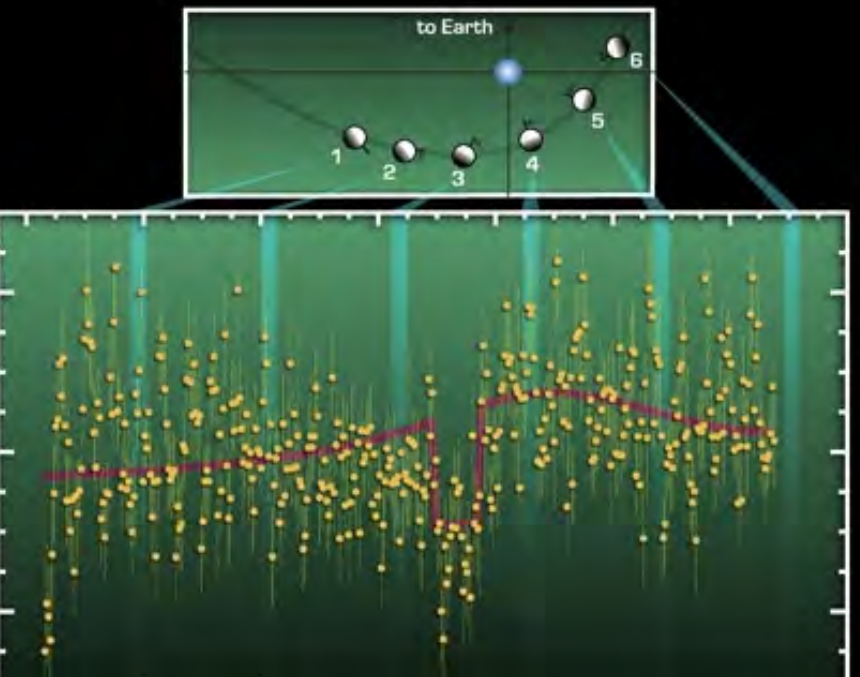
Exoplanet HD 80606 b

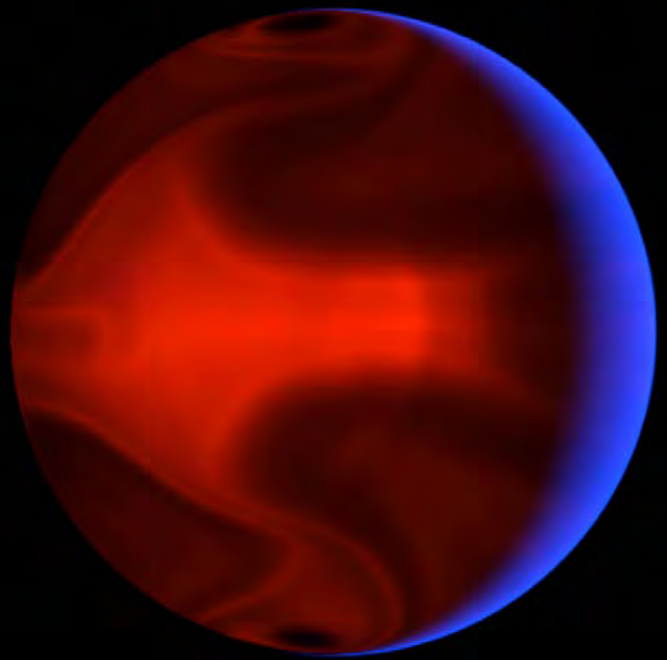


Exoplanet HD 80606 b

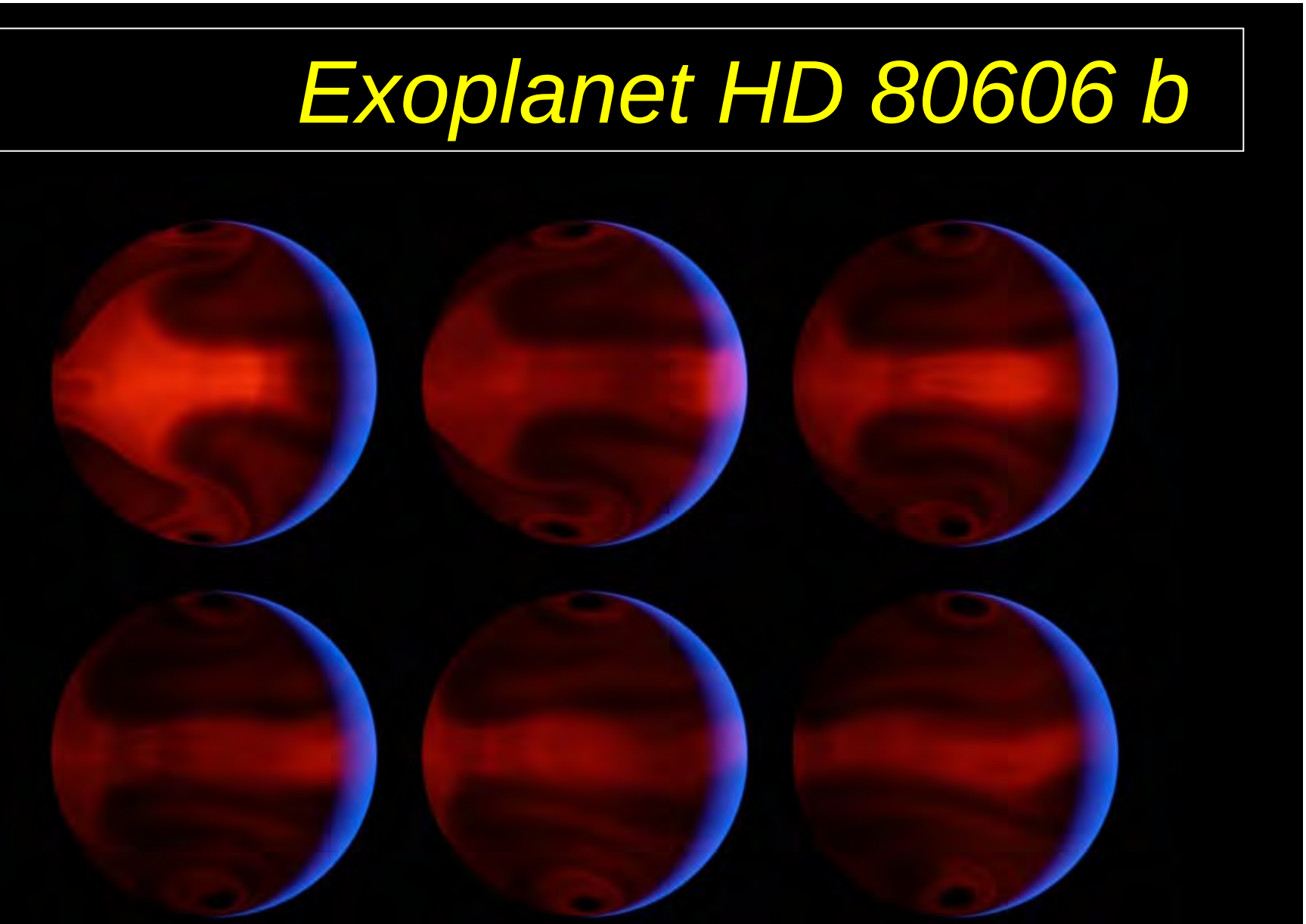
itzer 8μ photometry

bid heating of the atmosphere of an extrasolar planet
gory Laughlin et al. *Nature* 457, 562–564 (29 Jan 2009)





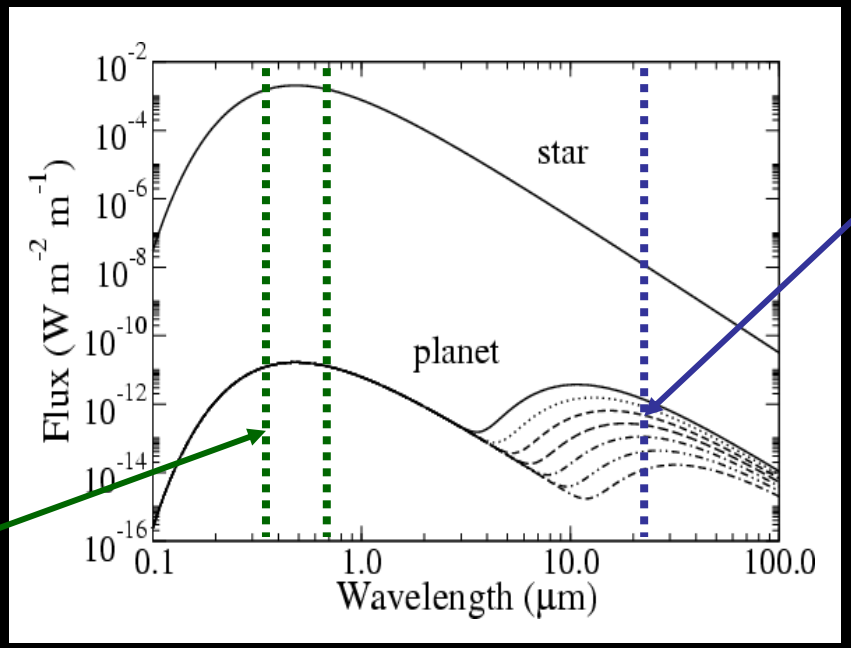
Exoplanet HD 80606 b

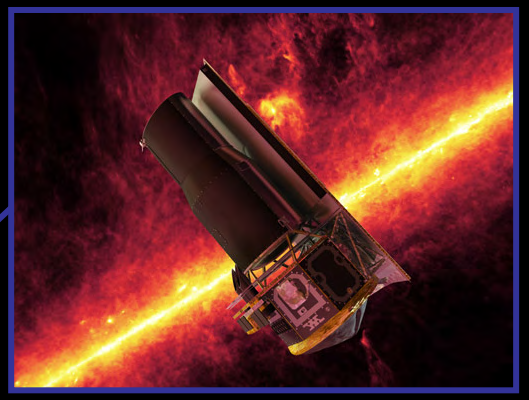


HD 209458 b

MOST
ptical

et al. 2008
hysical Journal



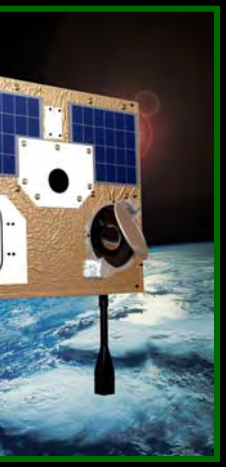


Spitzer
infrared

Deming et al. 2005
Nature 111, 111

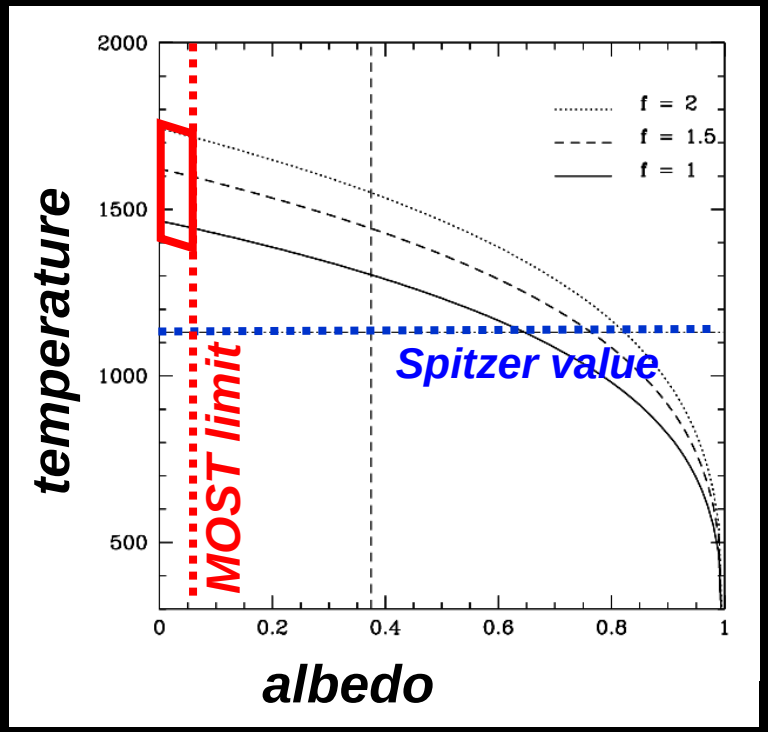
HD 209458 b

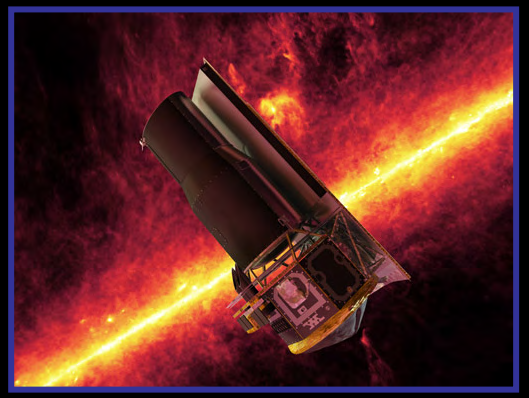
MOST
optical



et al. 2008
hysical Journal

models of planet atmosphere





Spitzer
infrared

Deming et al. 2005
Nature 111, 111

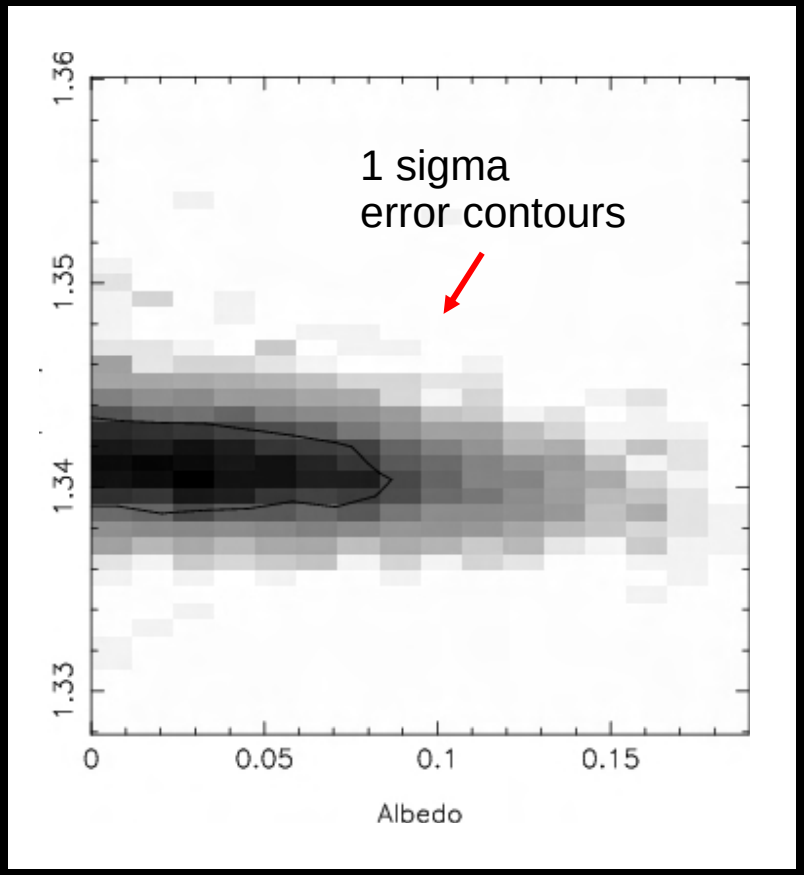
HD 209458 b

est fit parameters:

lbedo = 0.04 ± 0.04

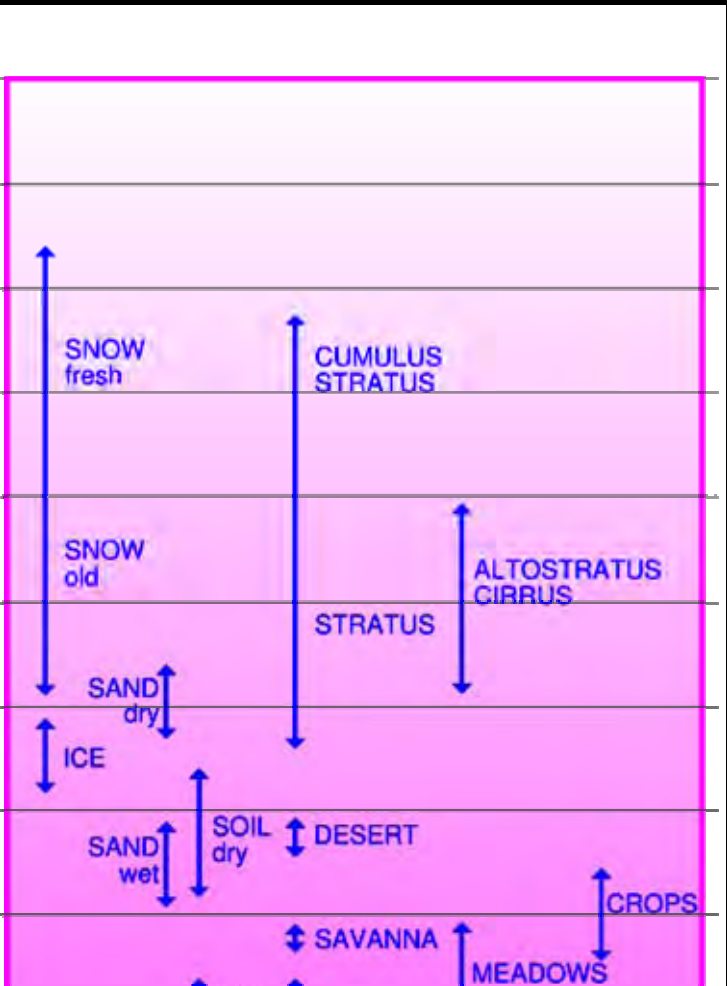
tellar radius :
1.339 ± 0.001 $R_{Jupiter}$
tellar mass
1.084 ± 0.005 M_{Sun}

i = 86.937° ± 0.003°
P = 3.5247489 d



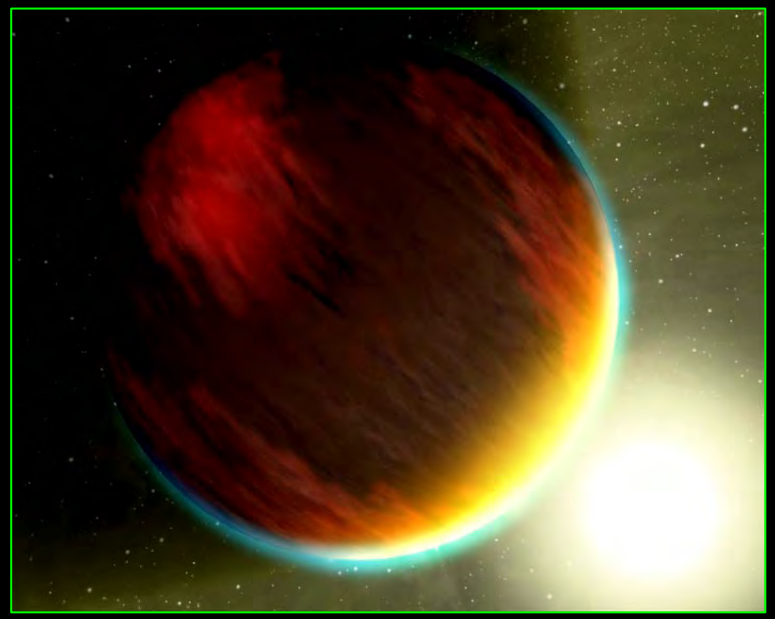
Geometric Albedo

HD 209458 b

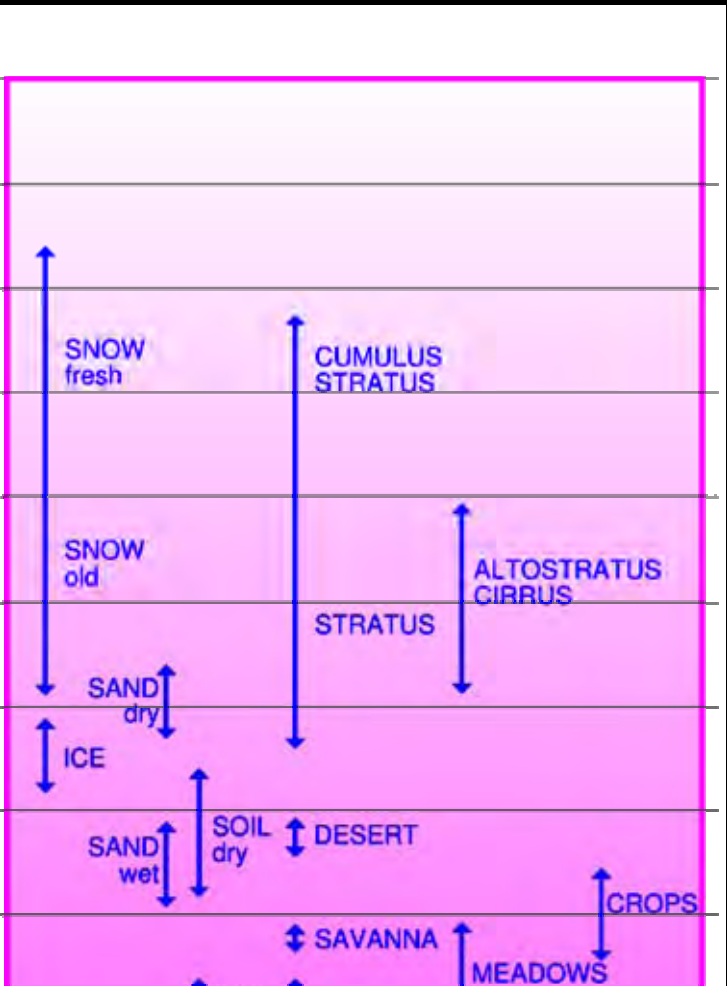


albedo = reflectivity →

artist's conception

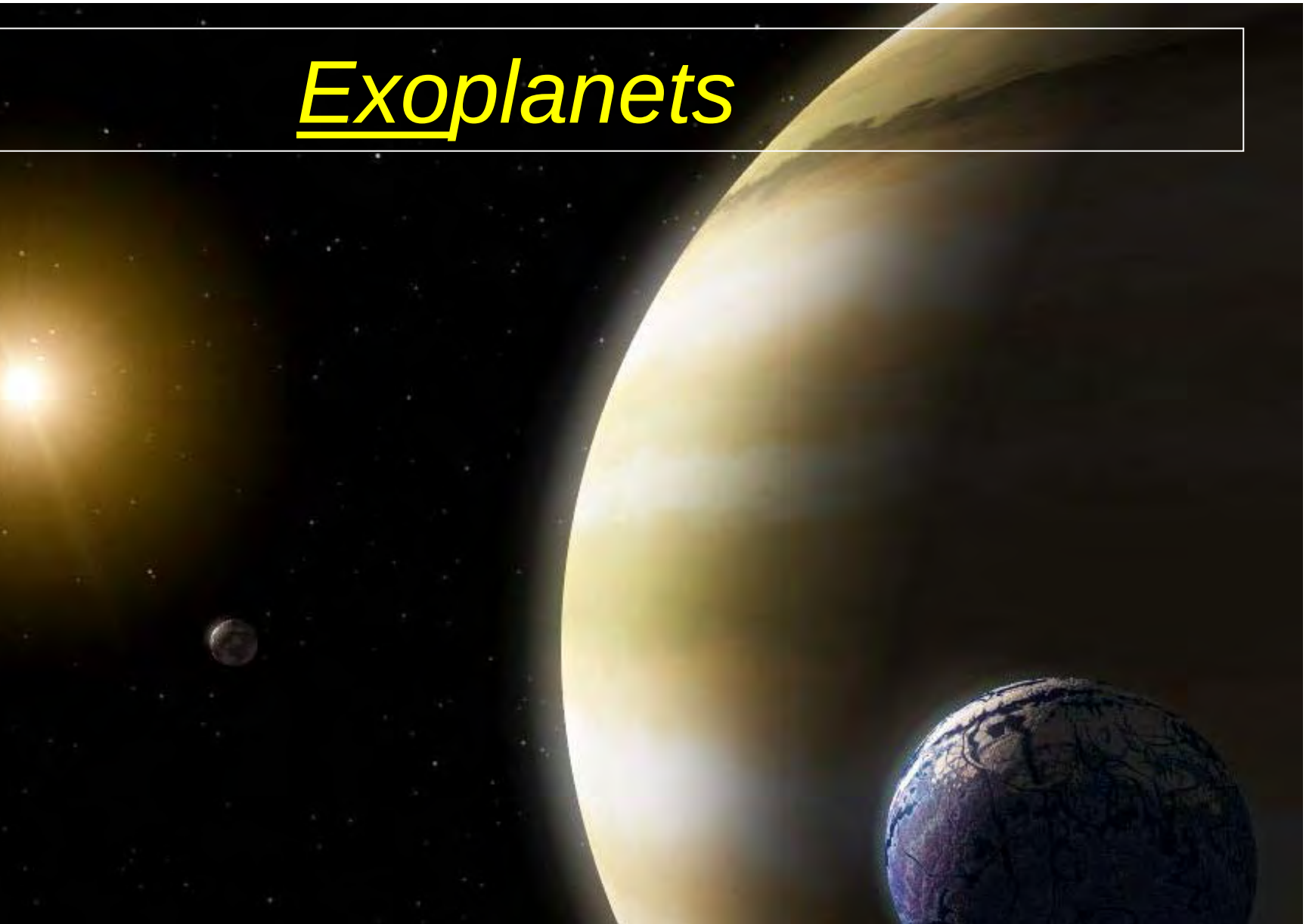


HD 209458 b

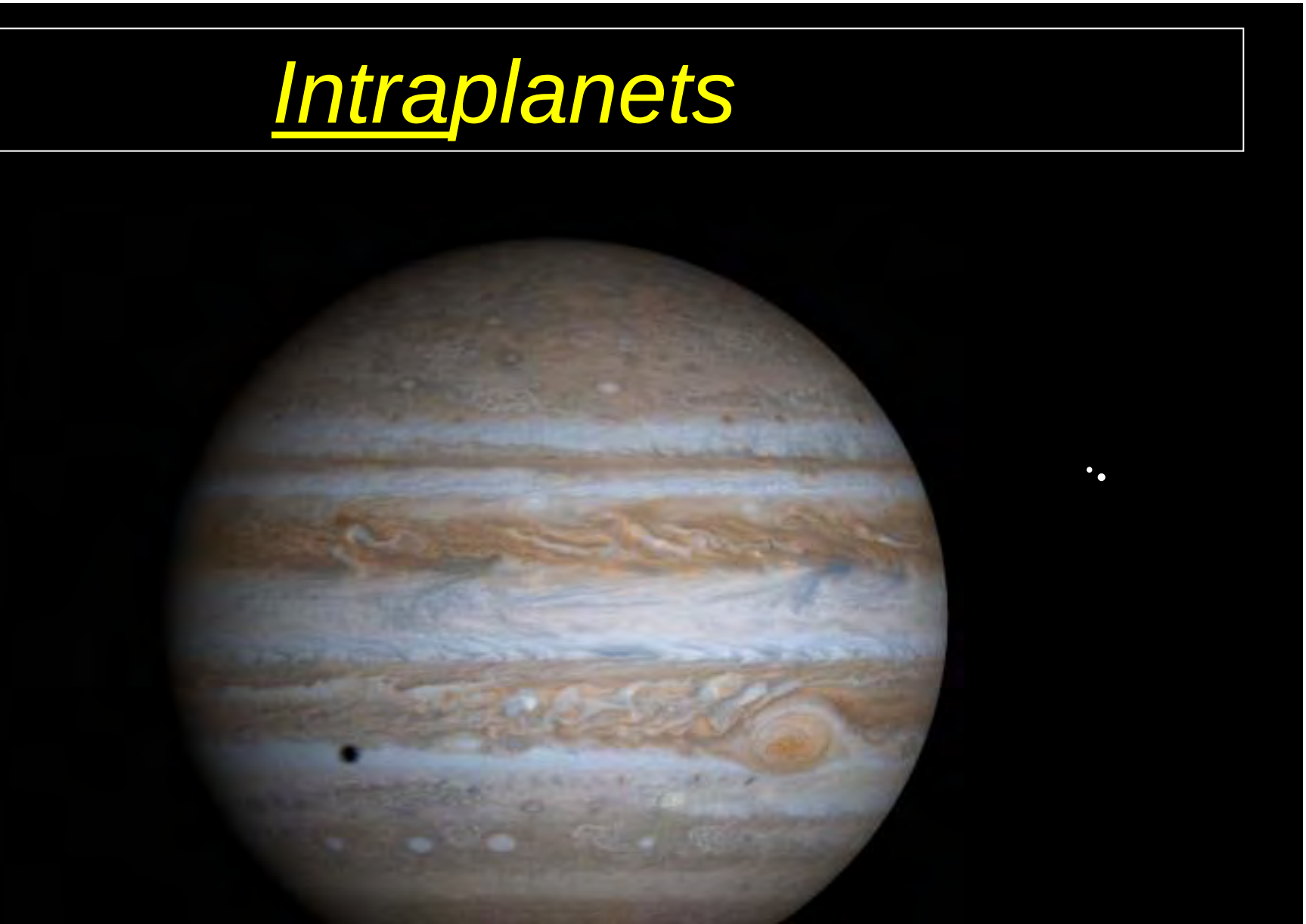


albedo = *reflectivity* →

Exoplanets

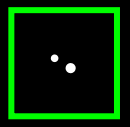


Intraplanets



Intraplanets

background
eclipsing
binary?



Intraplanets

background
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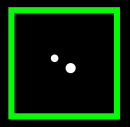
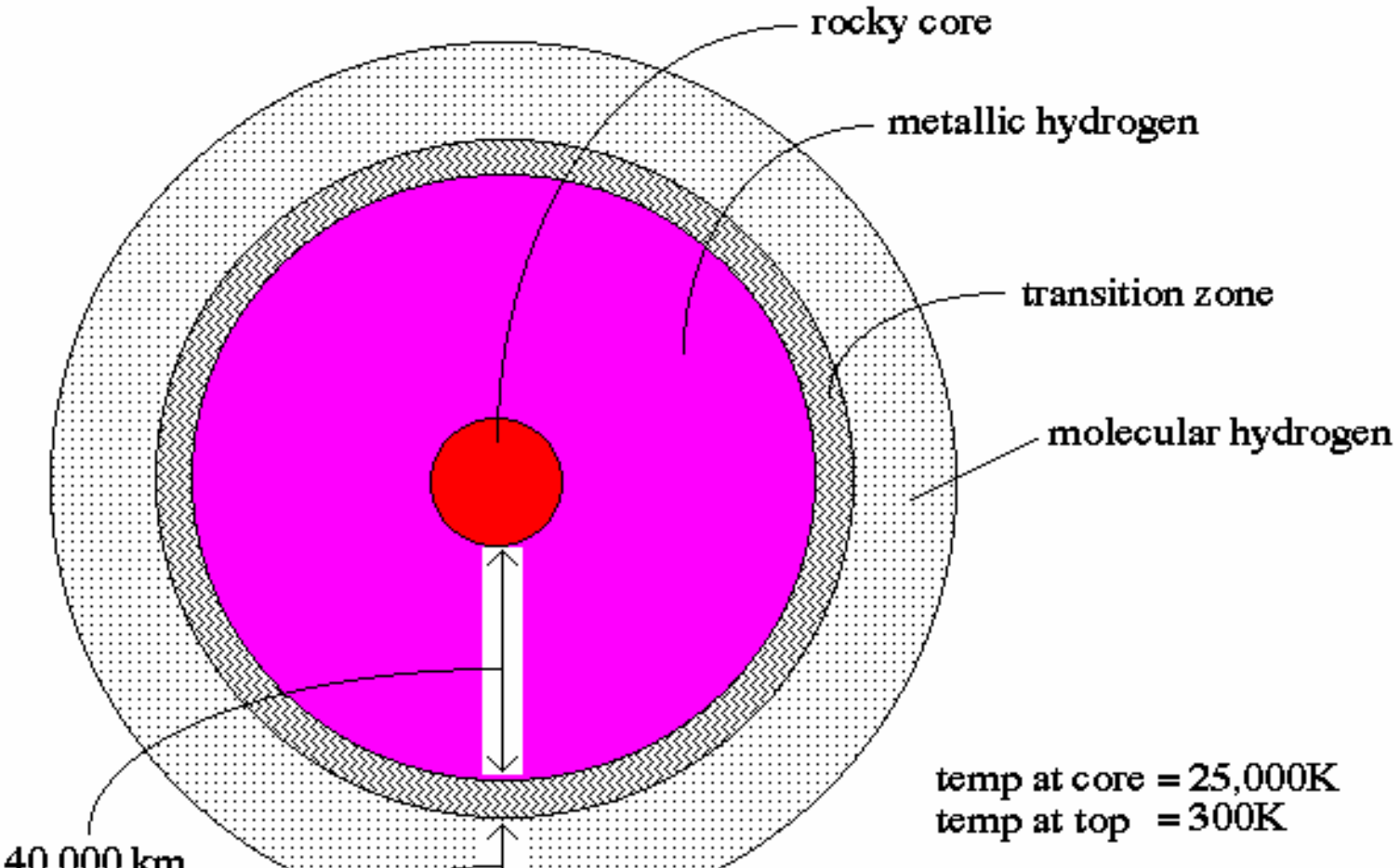


nitely *not* a

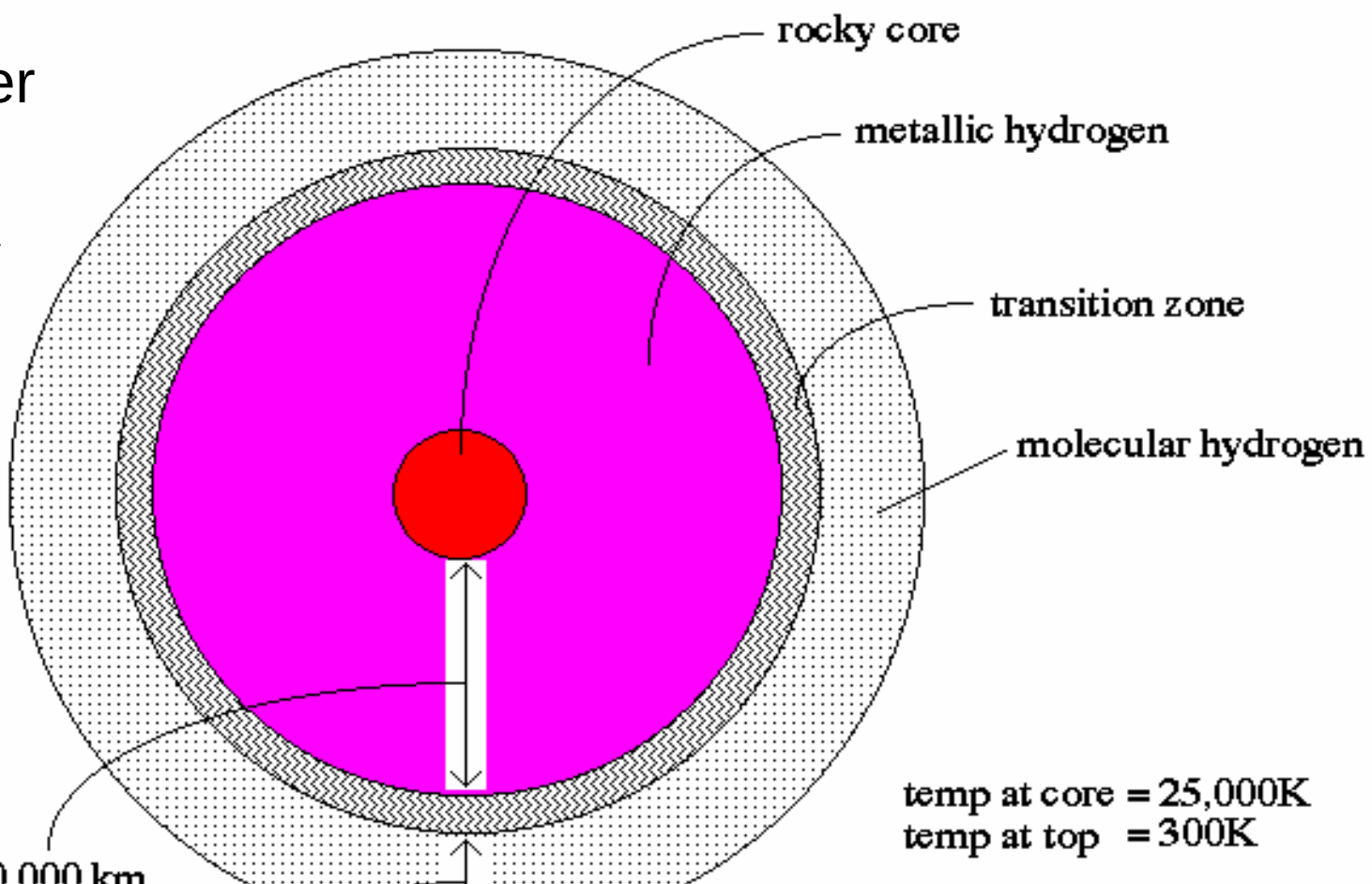
Intraplanet



Jovian seismology?

k Marley
k Lissauer
on Rowe
SA Ames

sibility
t run
n
OST
heduled



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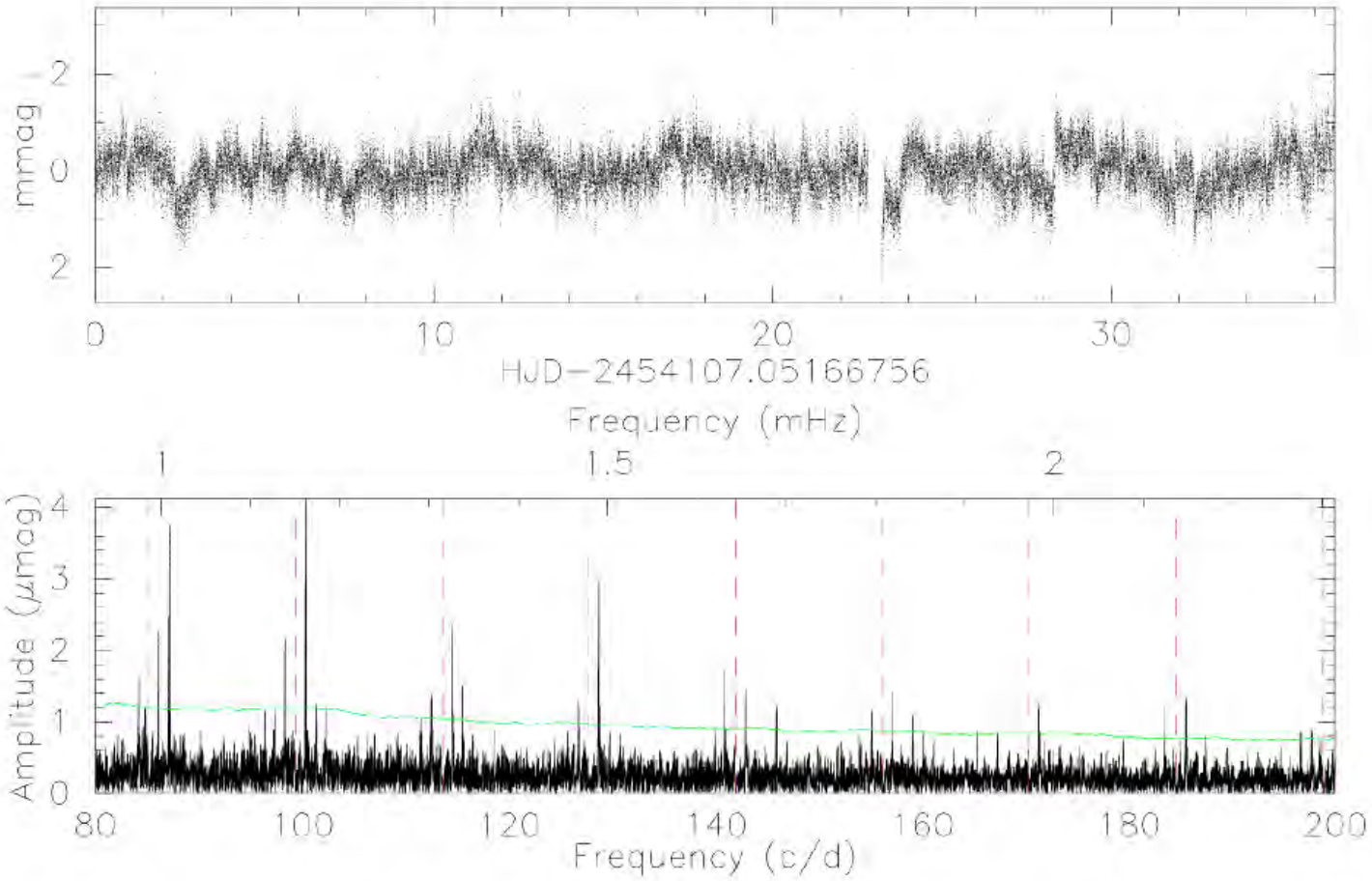
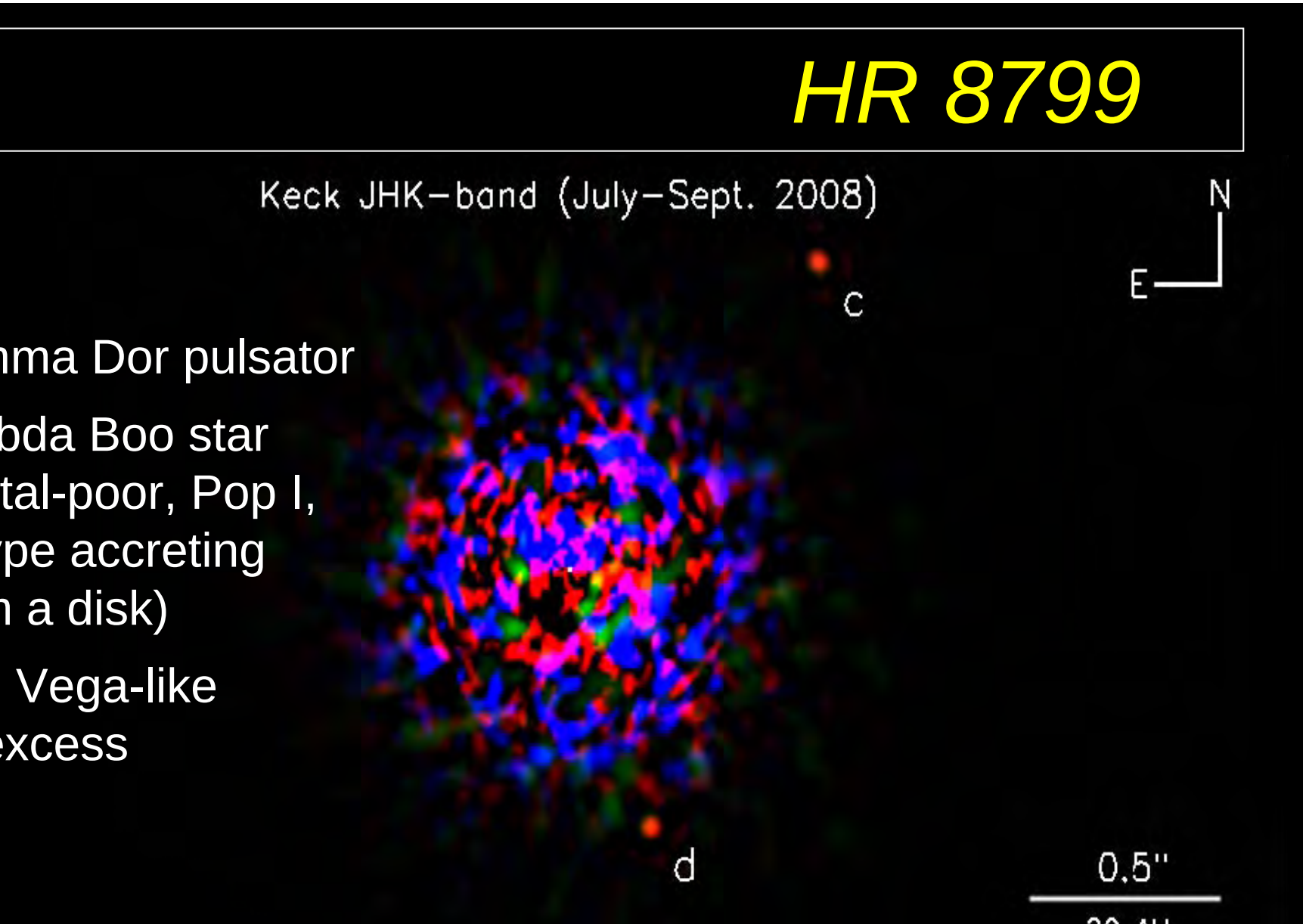


Figure 2: The top panel shows MOST Fabry photometry of Procyon for the 2007 year (gap is

HR 8799

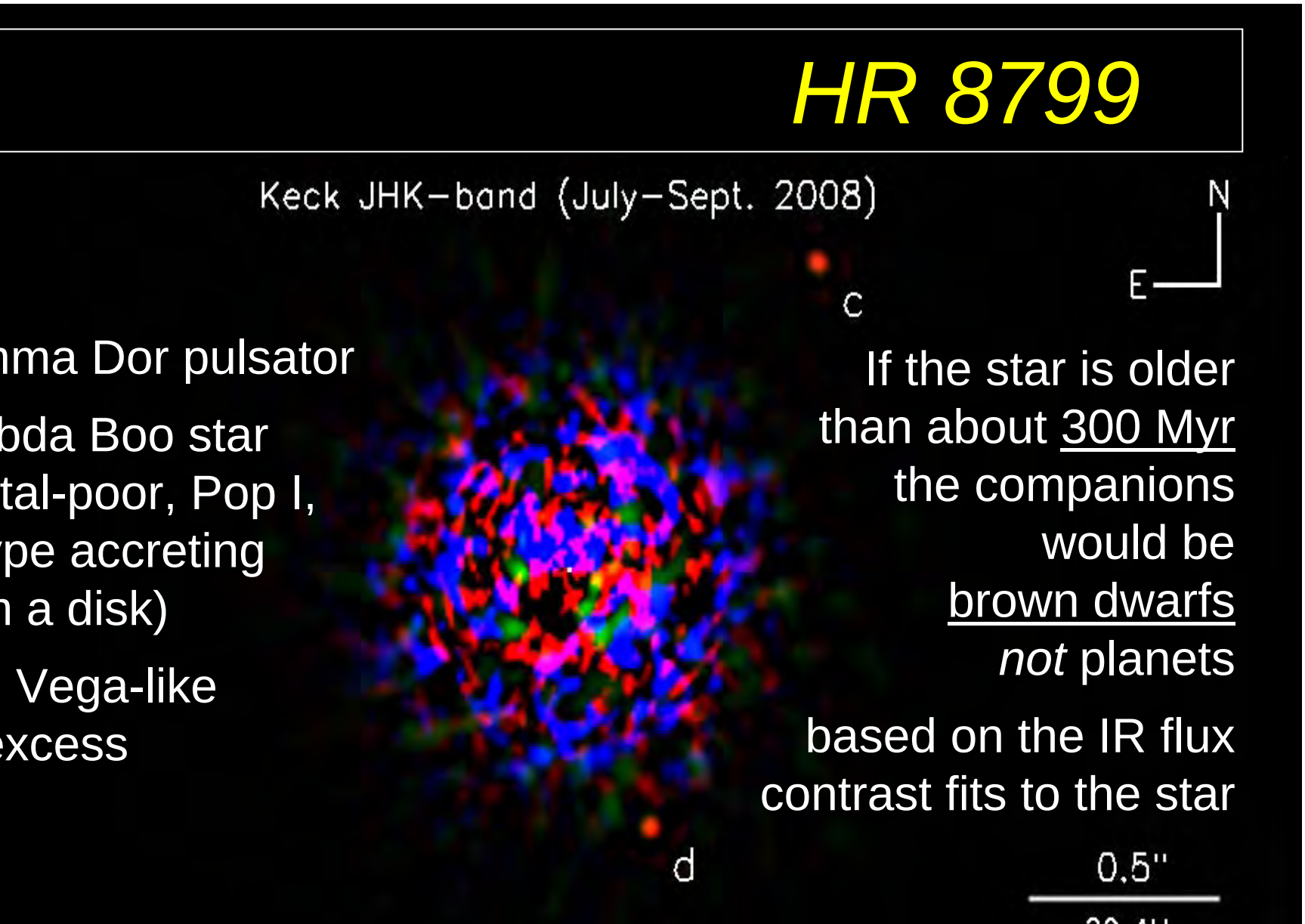


nma Dor pulsator

bda Boo star
tal-poor, Pop I,
ype accreting
n a disk)

Vega-like
excess

HR 8799



nma Dor pulsator

bda Boo star

tal-poor, Pop I,

pe accreting

n a disk)

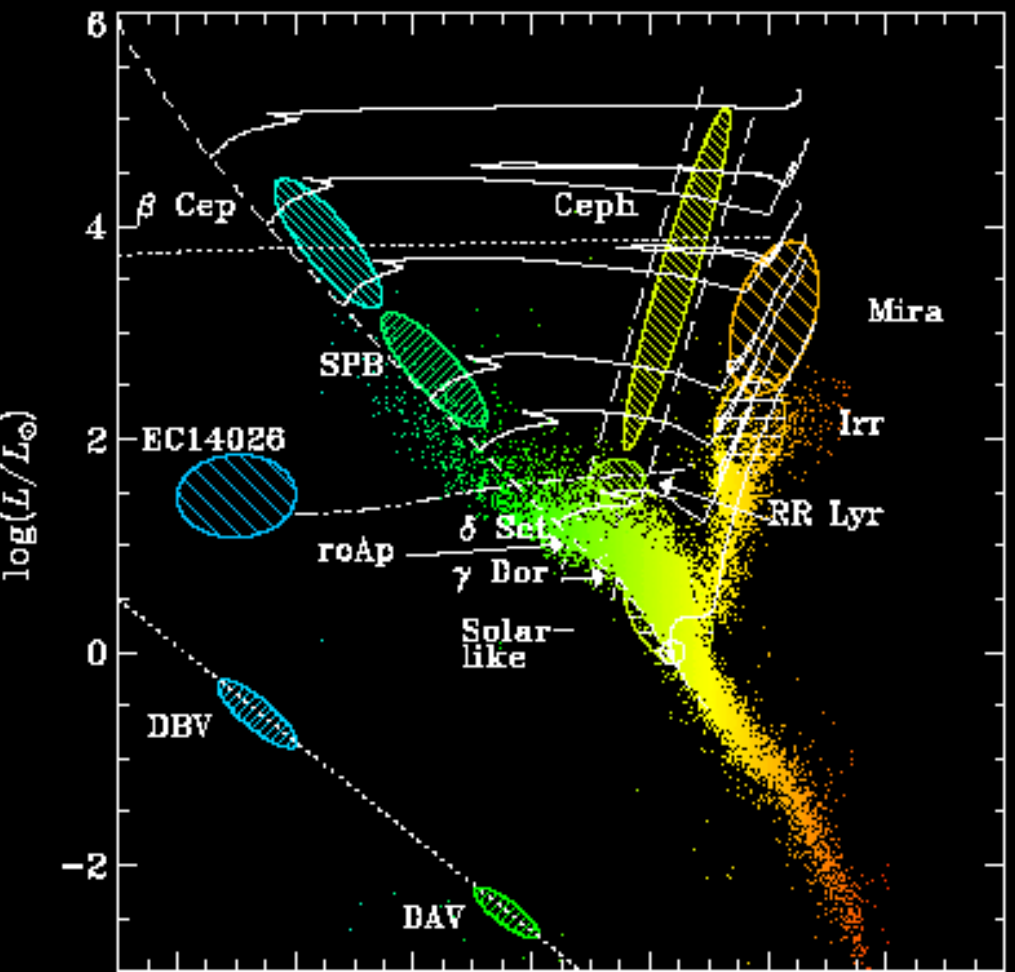
Vega-like

xcess

If the star is older than about 300 Myr the companions would be brown dwarfs *not* planets

based on the IR flux contrast fits to the star

Writing stellar biographies



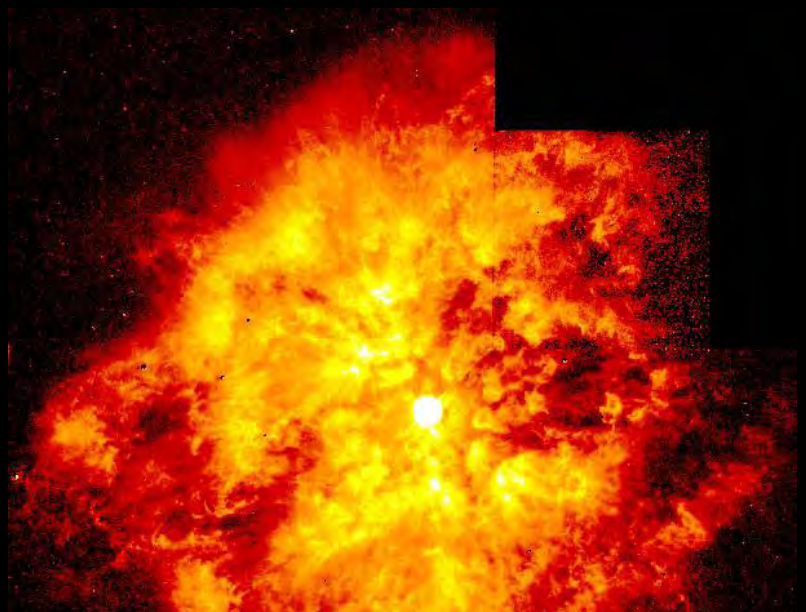
CoRoT and MOST cover a wide range of stellar parameter space – mass, age, temperature, magnetic field

Precursors to supernovae

f-Rayet stars are hot, massive stars with strong winds

y are key contributors to the “ecology” of the Universe

Do pulsations of the stars drive the winds?
Can we understand their structure via seismology?



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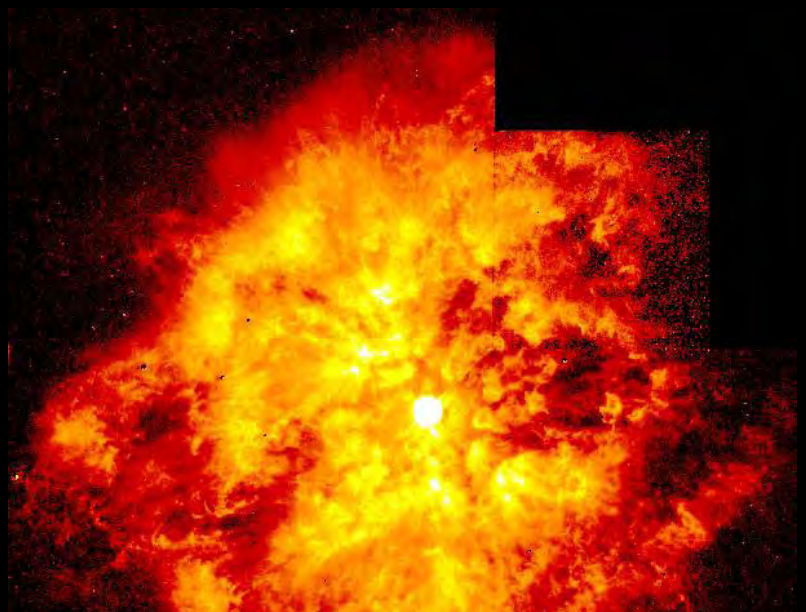


Momentum problem

$[dM/dt\ v_\infty] / [L/c] < 1$

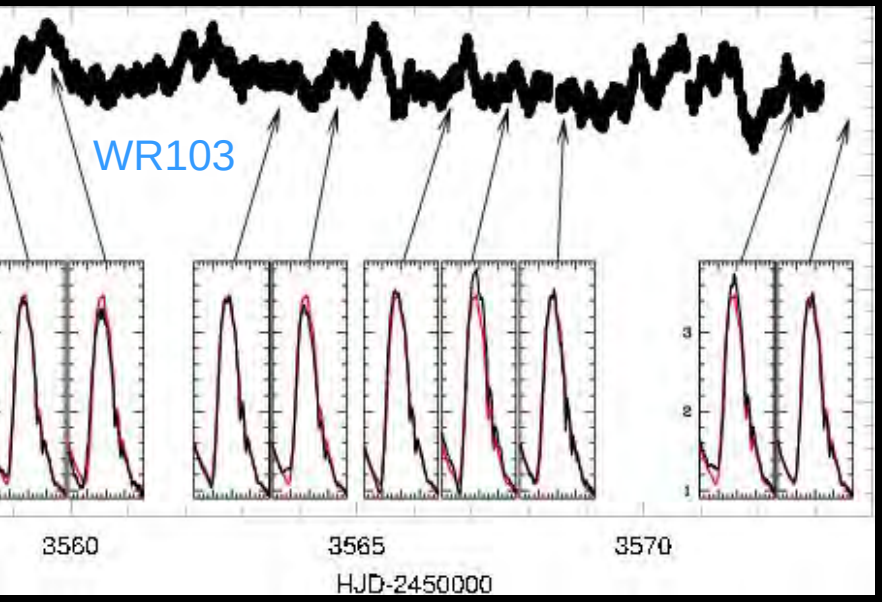
for O stars

WR stars observed by MOST

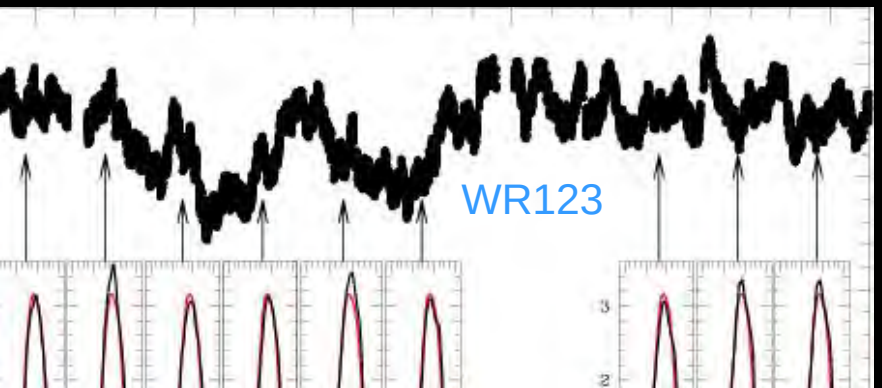
	spectral type	*V*	
R123	WN8	11.6	2004 (*Lefevre* et al. 2005)
R103	WC9d	9.0	2005 (Moffat et al. 2006)
R111	WC5	8.0	2006 (Moffat et al. 2007)
R110	WN5-6	10.0	2007 (in preparation)
R124	WN8h	11.6	2008 (in preparation)

MOST photometry supported by
simultaneous groundbased spectroscopy

multaneous groundbased OMM spectroscopy (He I 5876)



Red lines = mean



Lines ~ 10% of broadband flux & vary relatively little

➢ observed light variability must be related to pulsations of the stellar core!

➢ delayed reaction of wind (lines) triggered by

What drives WR winds?

velation for the first time:

s very likely that pulsations do play a role accelerating the winds of cool WR stars!

This is entirely compatible with recent spectral alyses of Graefener & Hamann, who propose that

winds driven by radiation pressure alone cannot explain the high mass loss rates of WN8 stars

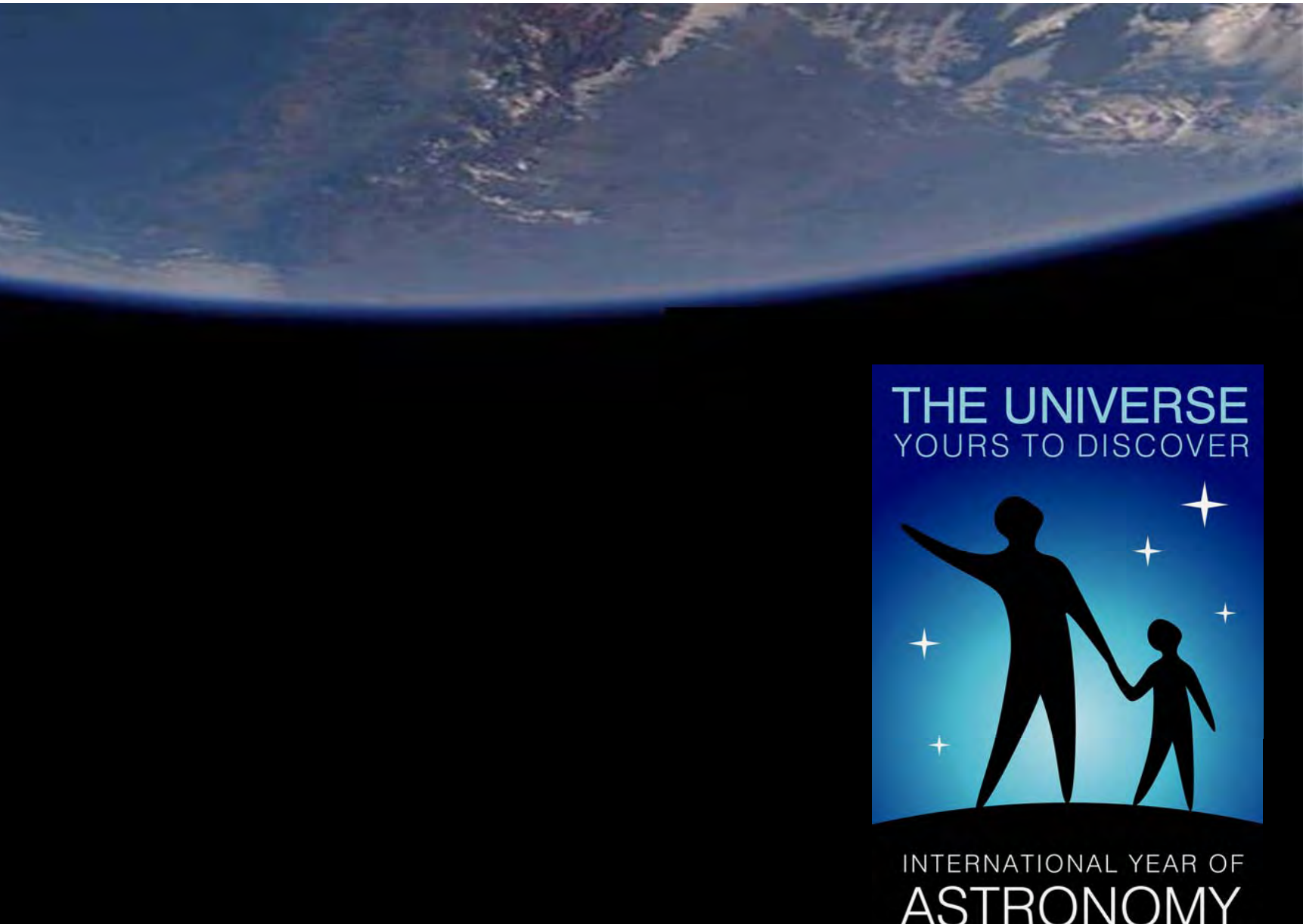
Superstars

a Moldovan
C

P – III – 33

Michael Gruberbauer
IfA Vienna

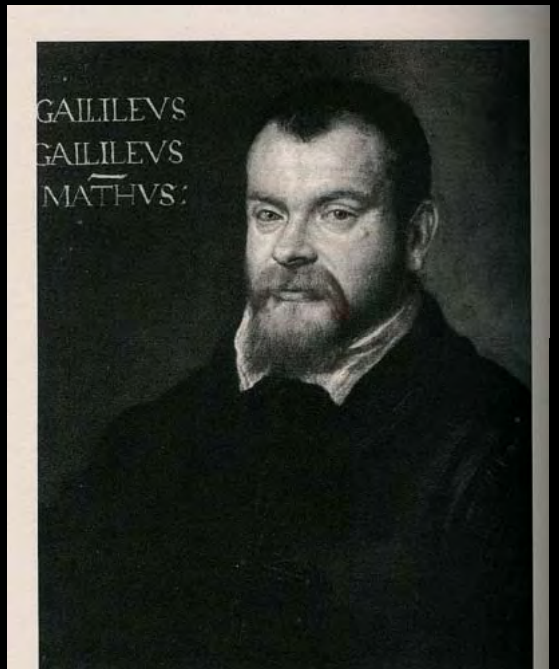
Superstars

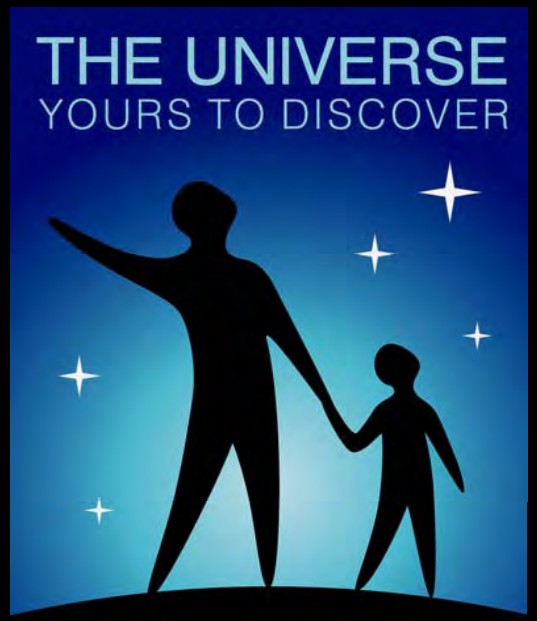


THE UNIVERSE
YOURS TO DISCOVER

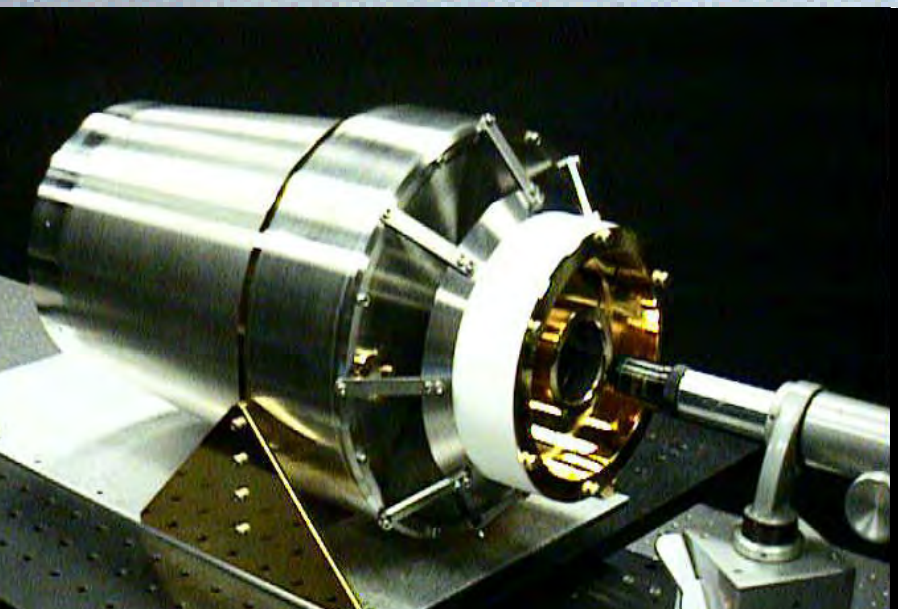
INTERNATIONAL YEAR OF
ASTRONOMY

What if Galileo had a space telescope?





INTERNATIONAL YEAR OF
ASTRONOMY



same scale

What if Cassini had a space telescope?


CoRoT

MOST in the CoRoT era

MOST can operate until 2014

The MOST team will continue to cooperate with the CoRoT team to help fill in niches in location in space and in parameter space to maximise the scientific returns

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