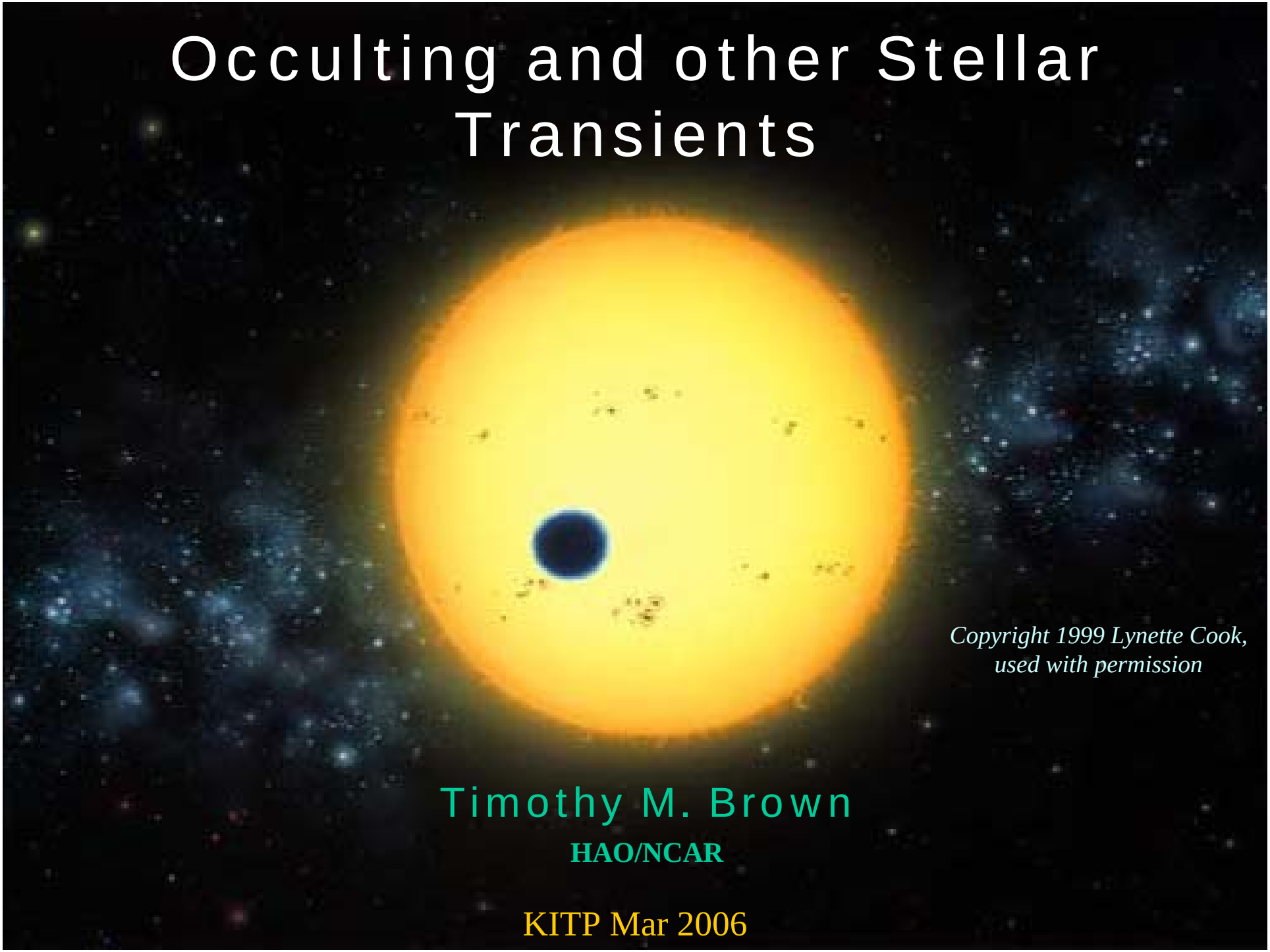
Occulting and other Stellar Transients



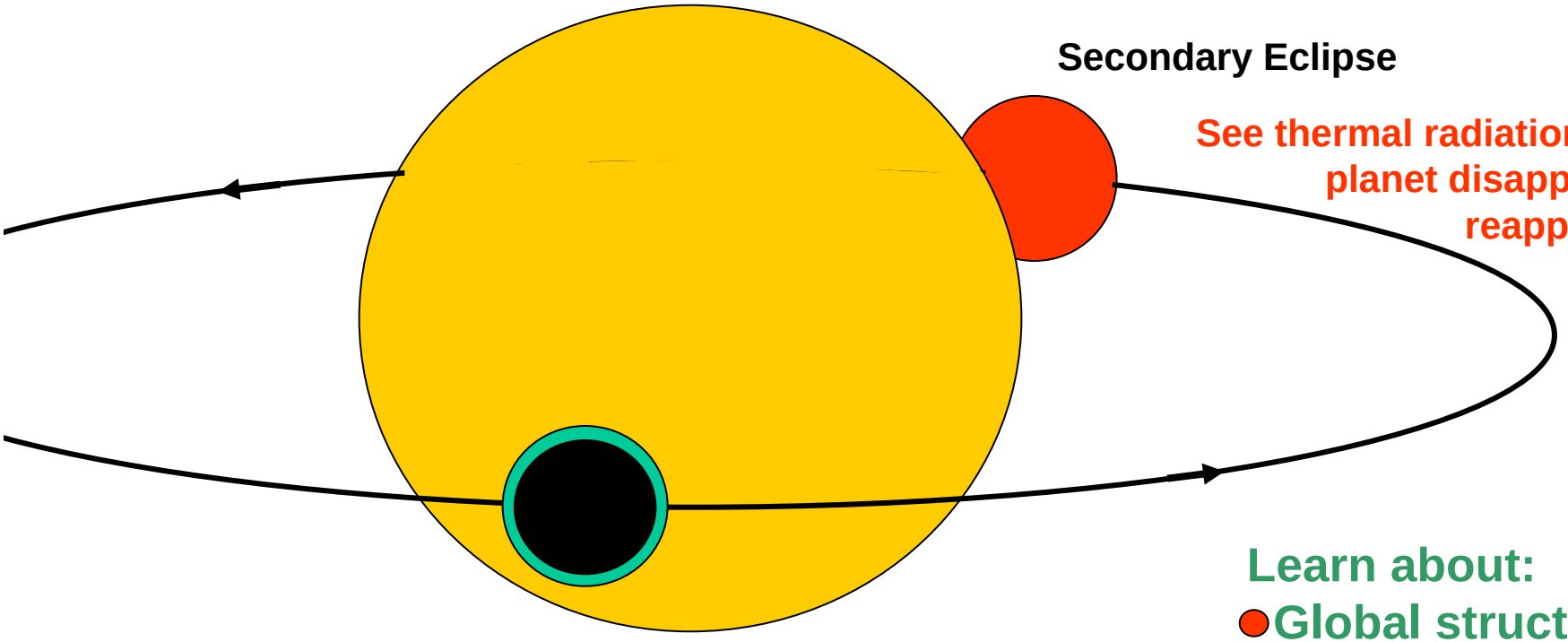
Copyright 1999 Lynette Cook, used with permission

Timothy M. Brown

HAO/NCAR

KITP Mar 2006

Transits allow measurements that are not possible for non-transiting planets.



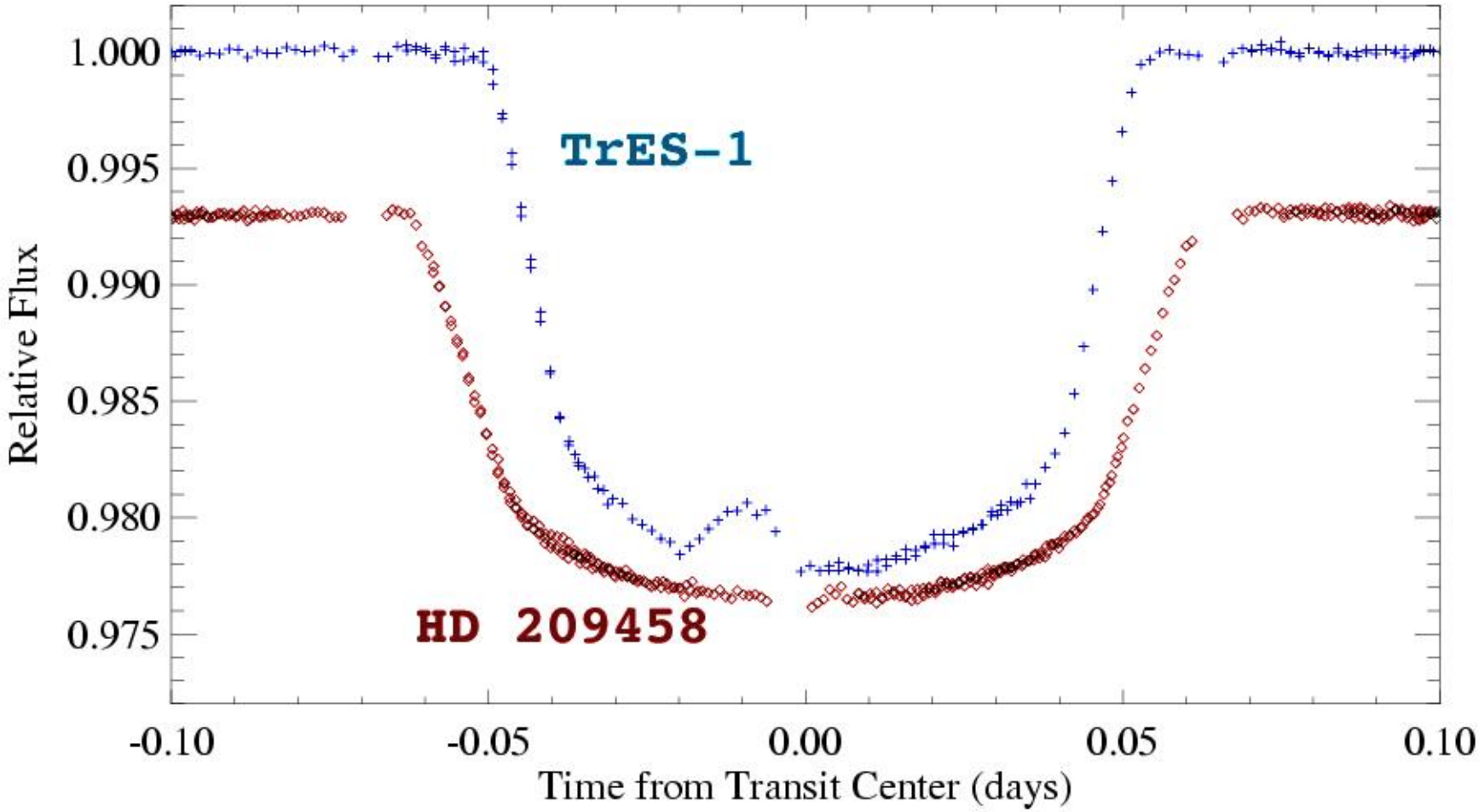
See thermal radiation from planet disappear and reappear

Measure size of transiting planet, see radiation from star transmitted through the planet's atmosphere

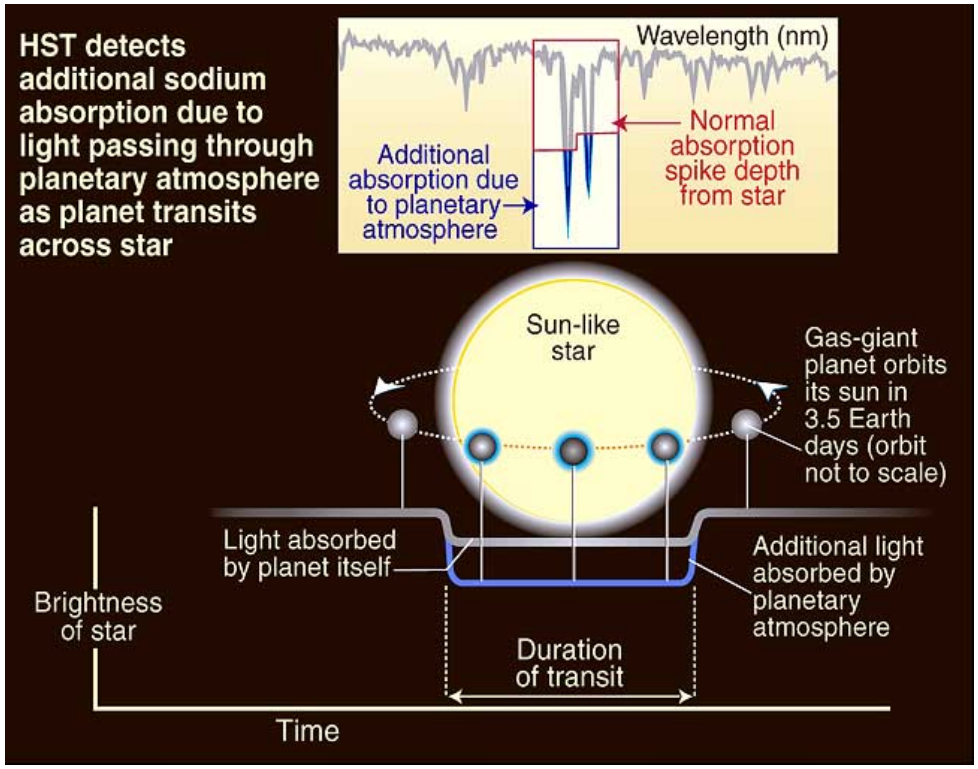
Learn about:

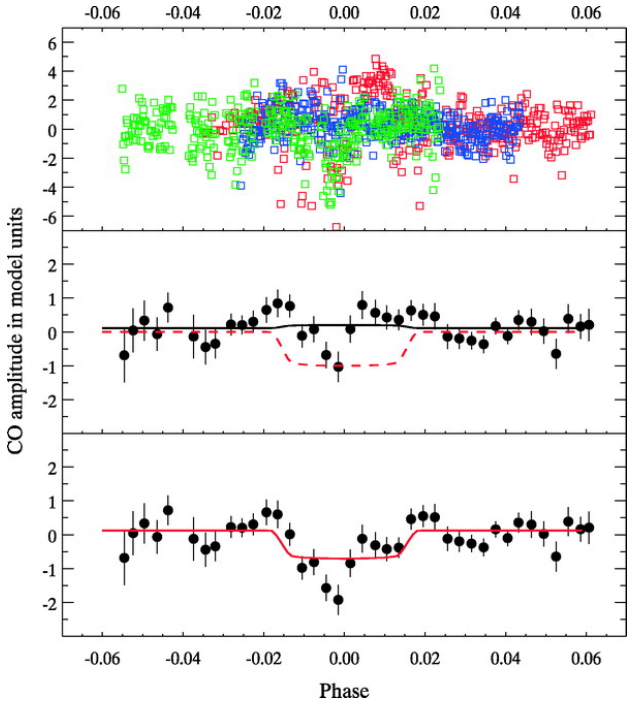
- Global structure
- Atmospheres
- Eccentricity & Obliquity

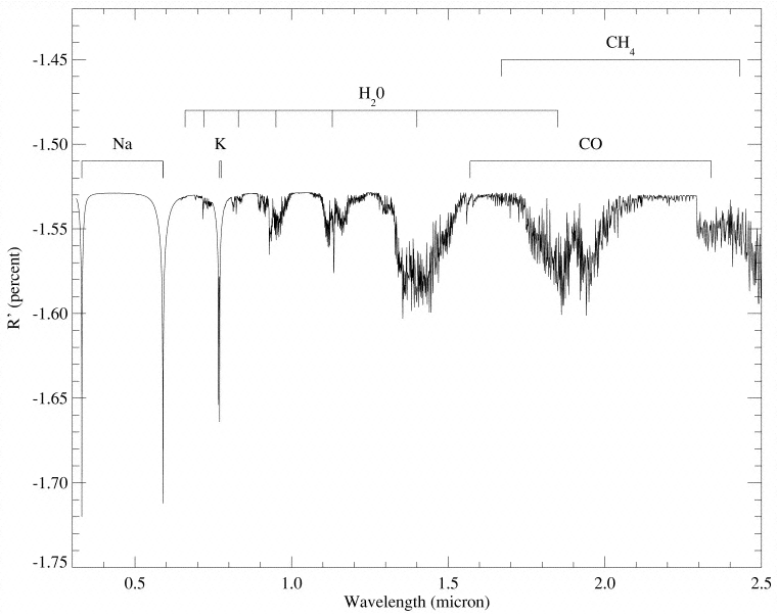
HST Light Curves



Transmission Spectroscopy of Extrasolar Planet Atmospheres







General suppression of depth of absorption features at variety of wavelengths

Spitzer IR Photometry of TrES-1, HD 209458b

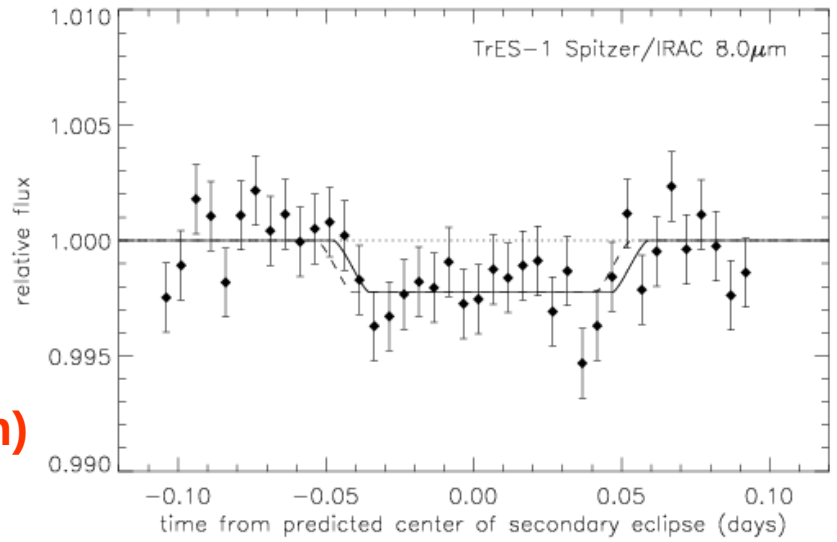
During secondary transit, one can observe the disappearance and reappearance of the thermal emission from the planet. The short time scale of the event facilitates this observation.

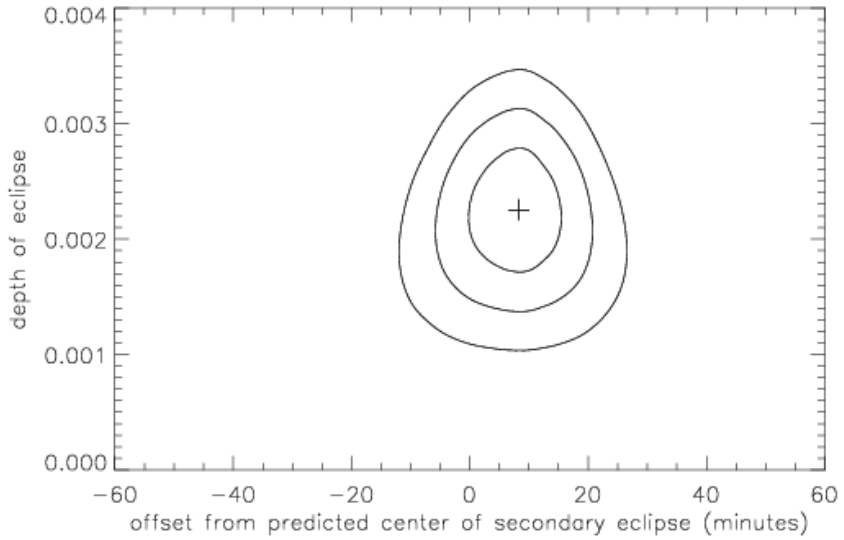
Spitzer IRAC (4 micron and 8 micron) observations of TrES-1

Charbonneau et al. 2005

MIPS (24 micron) of HD 209458

Deming et al. 2005





Aug 2005

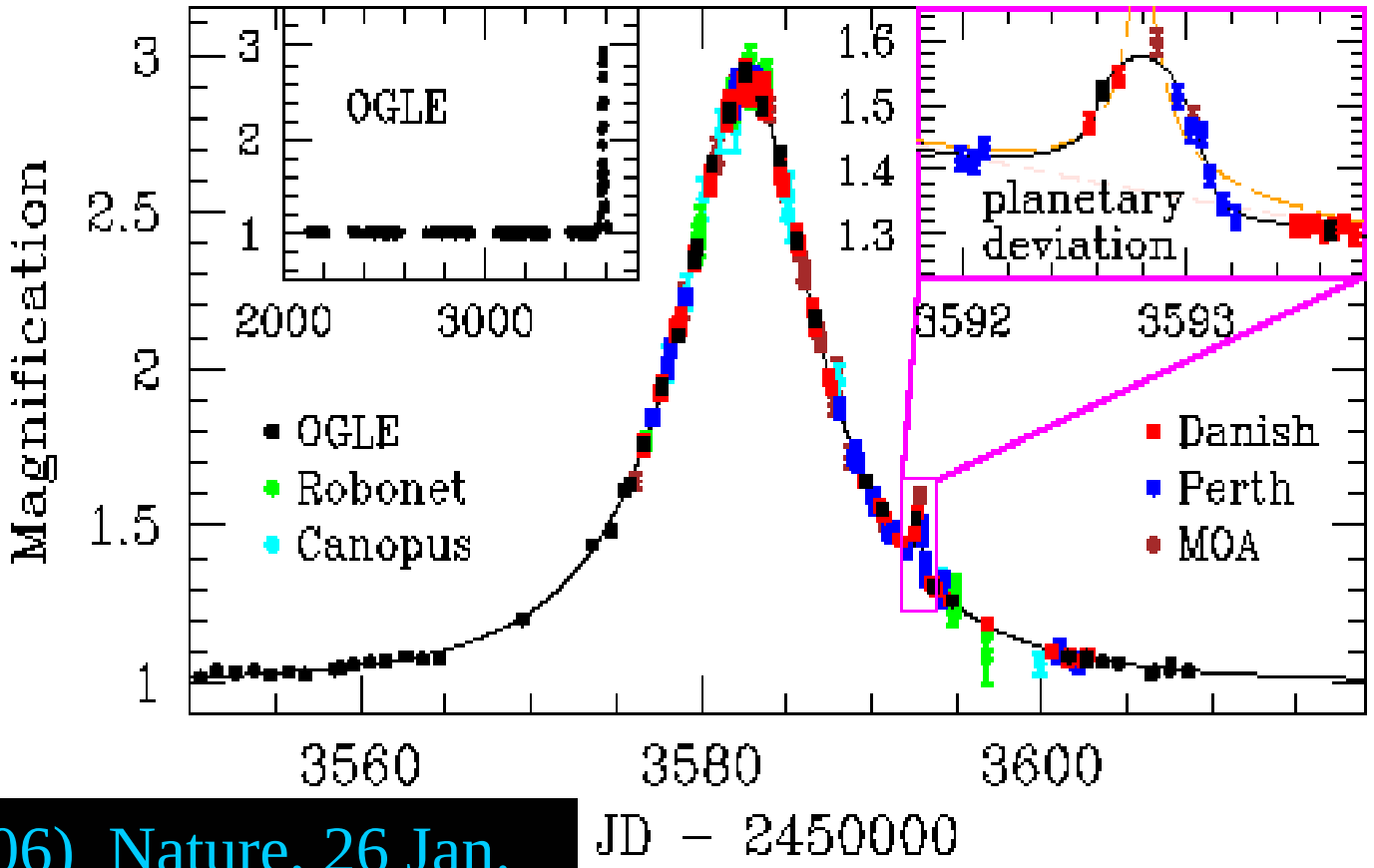
OB-05-390

smallest cool planet

$m \sim 6\, m_{\oplus}$

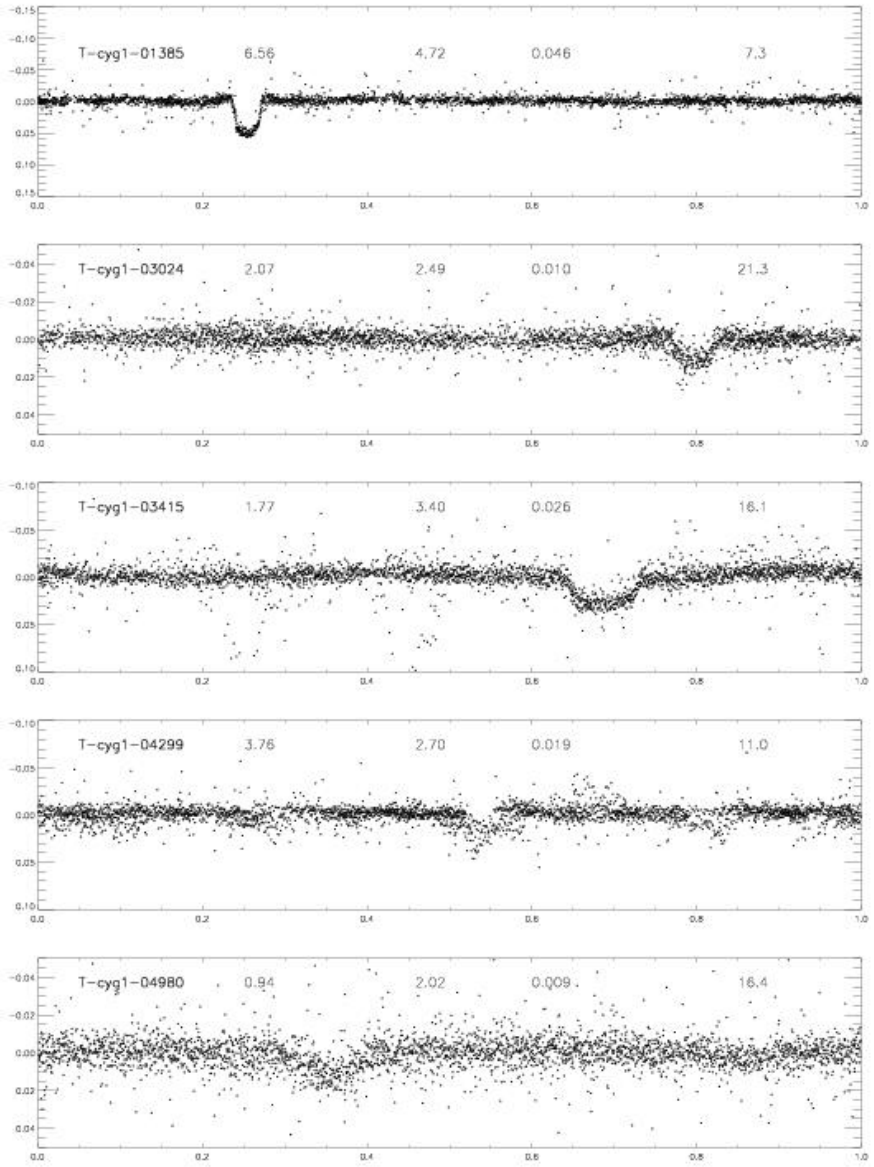
$a \sim 2.9$ AU

PLANET/RoboNet
OGLE
MOA



Beaulieu et al. (2006) Nature, 26 Jan.

False Alarms Abound, but….



Probably:

F + M star

F + M star

F + M star

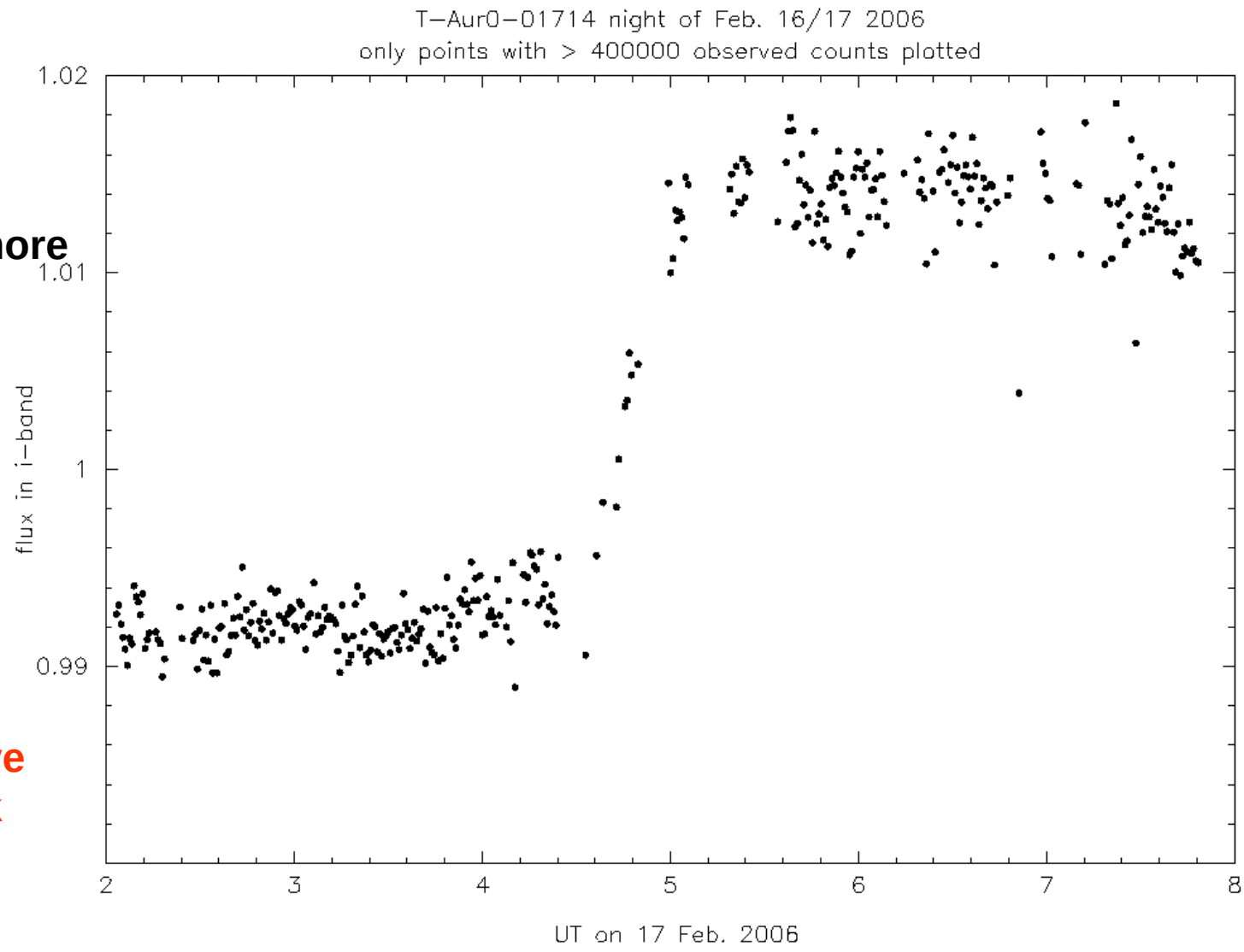
Triple w/ Giant

Grazing early/late F binary

Light Curve Data from Mt. Hopkins 1.2m

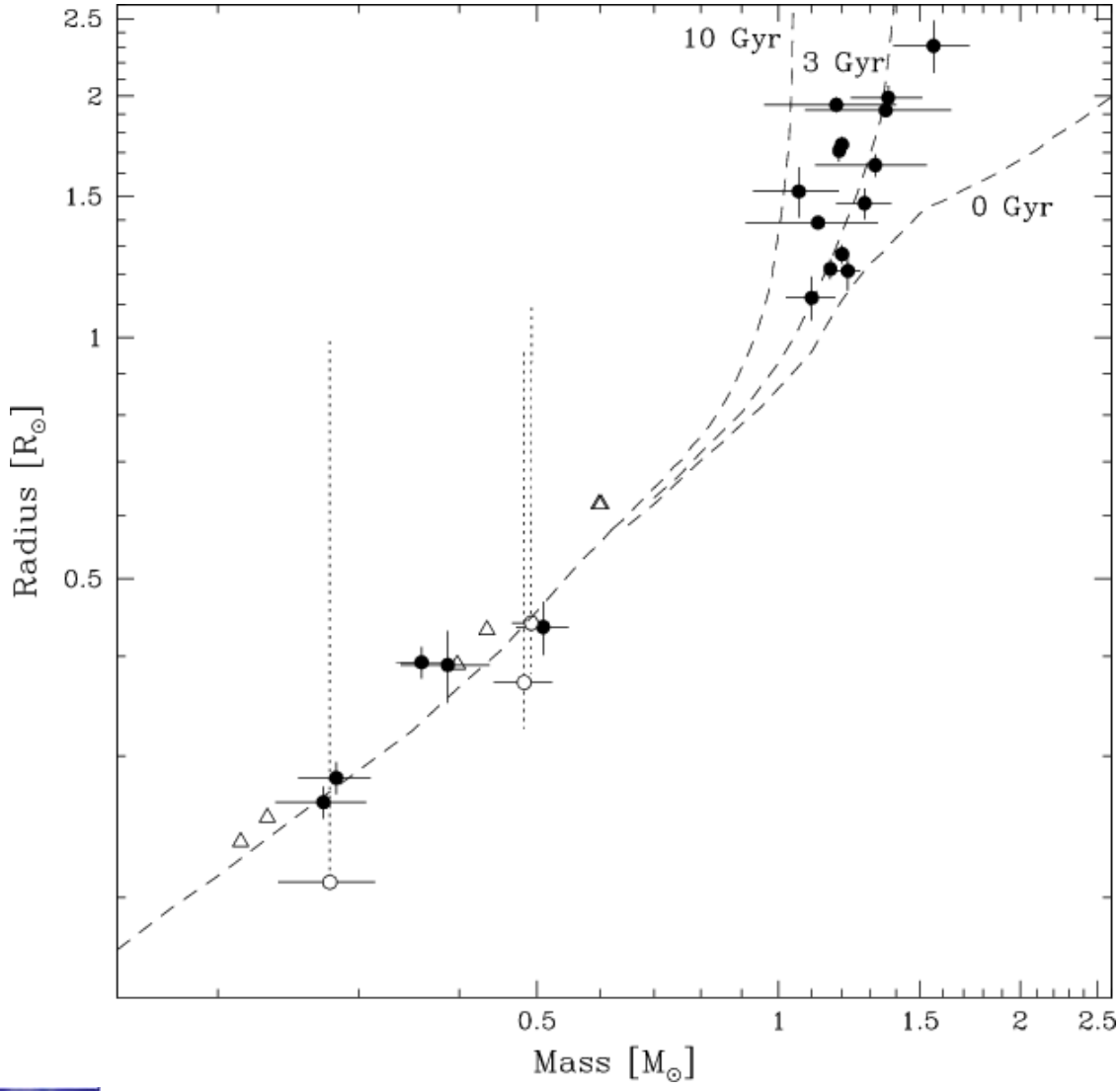
This one has R <~ 0.2 R_{sun}

There are lots more of these in the existing data.



(Thanks to Dave Latham & Mark Everett)

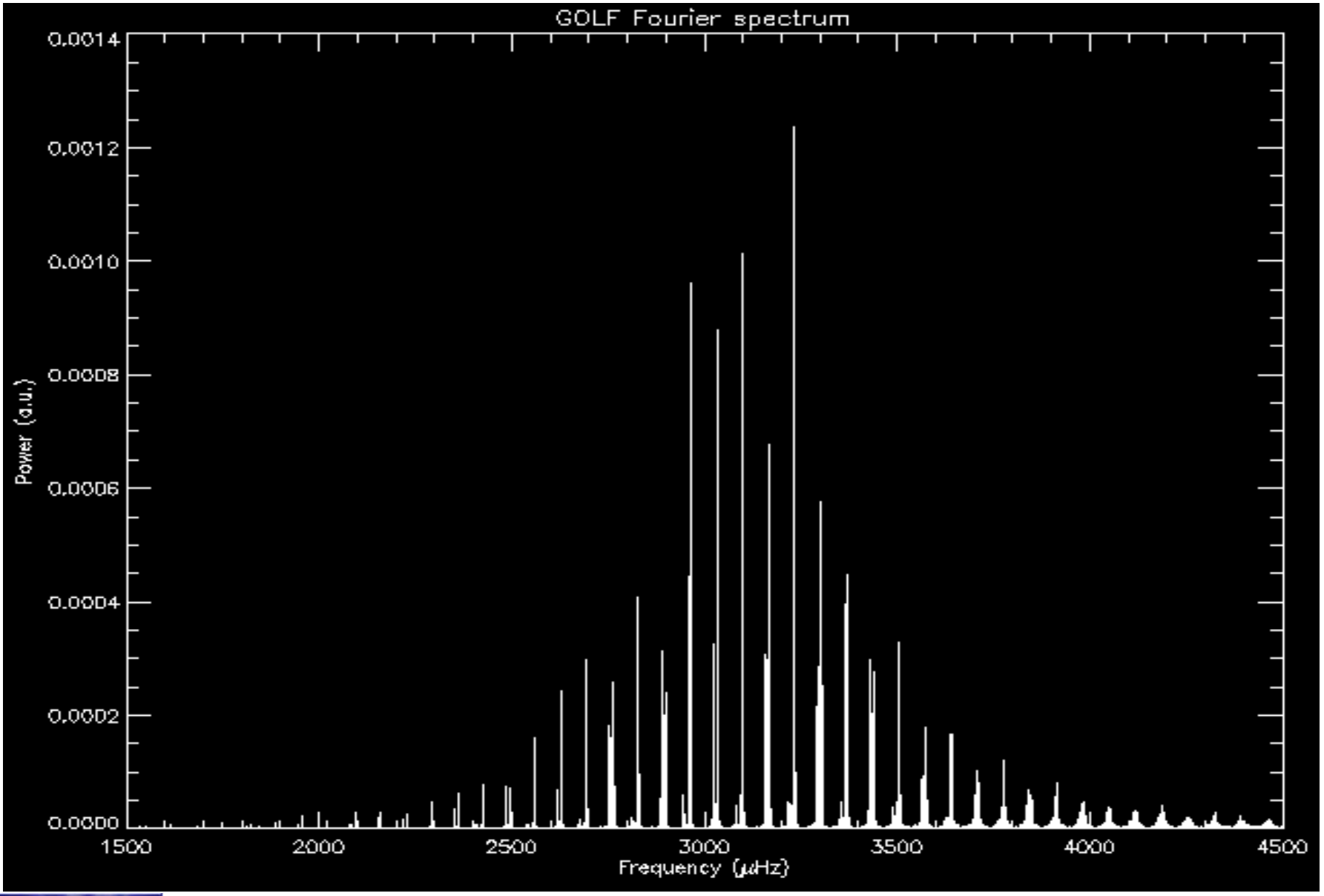
Lower Main-Sequence Mass-Radius Relation



Bouchy et al., A&A 431, 1105 (2005)

(Mostly from follow-up of OGLE transiting planet candidates)

Solar p-mode Spectrum



Asteroseismic HR Diagram

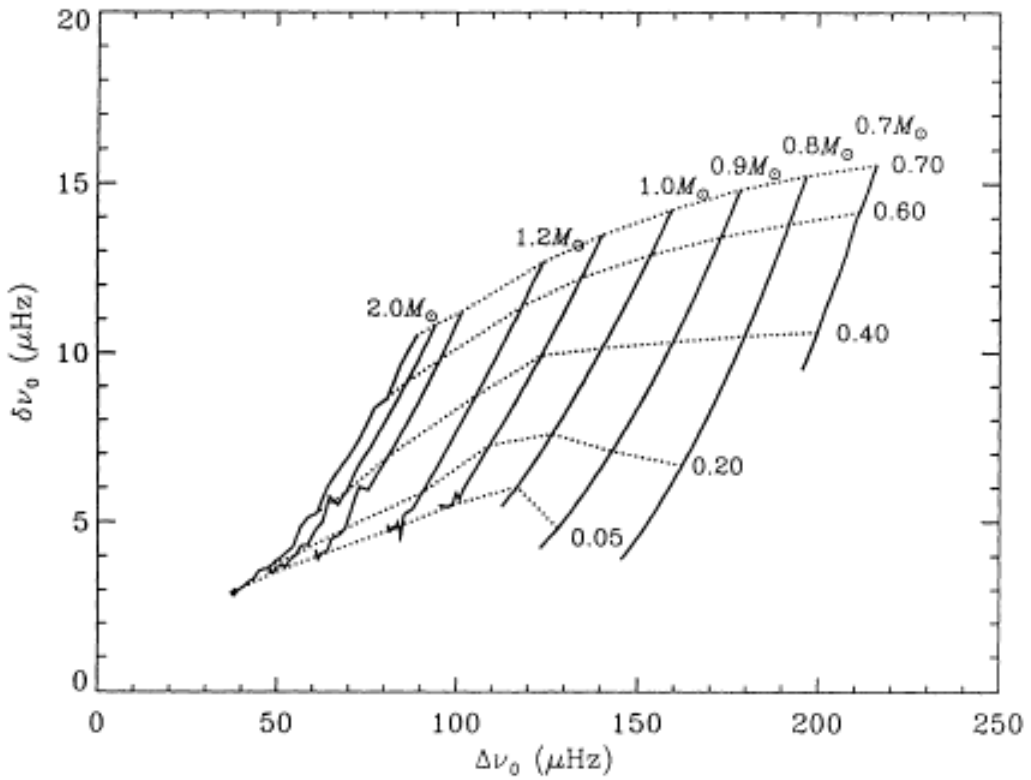


Figure 2 The "asteroseismic H-R diagram" of Christensen-Dalsgaard (1993), showing the variation in large ($\Delta\nu_0$) and small ($\delta\nu_0$) frequency separation with stellar mass and age. Mass is constant along solid lines; age (parameterized by the central hydrogen abundance) is constant along dotted lines.

KEPLER MISSION

A wide FOV telescope monitors ~200,000 stars for 4 years to detect Earth-size planets

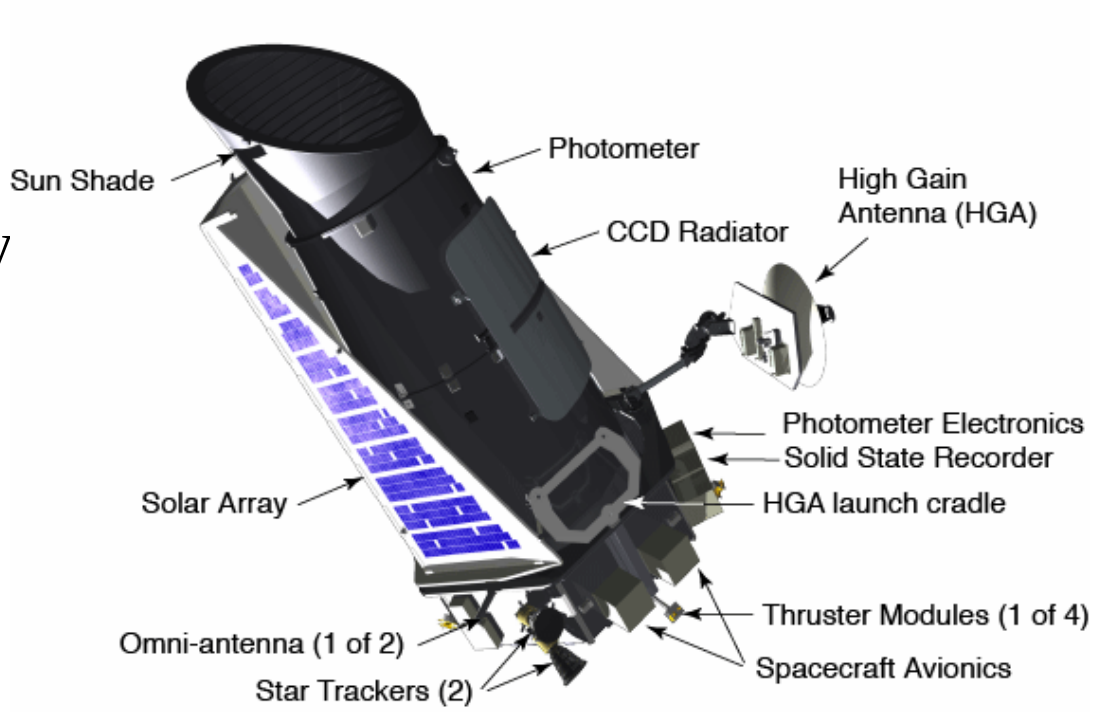
Launch in June, 2008

Transit Photometry

- 0.95 meter aperture
- Observe for several years
- Monitor stars continuously
- Heliocentric orbit

Statistically valid results

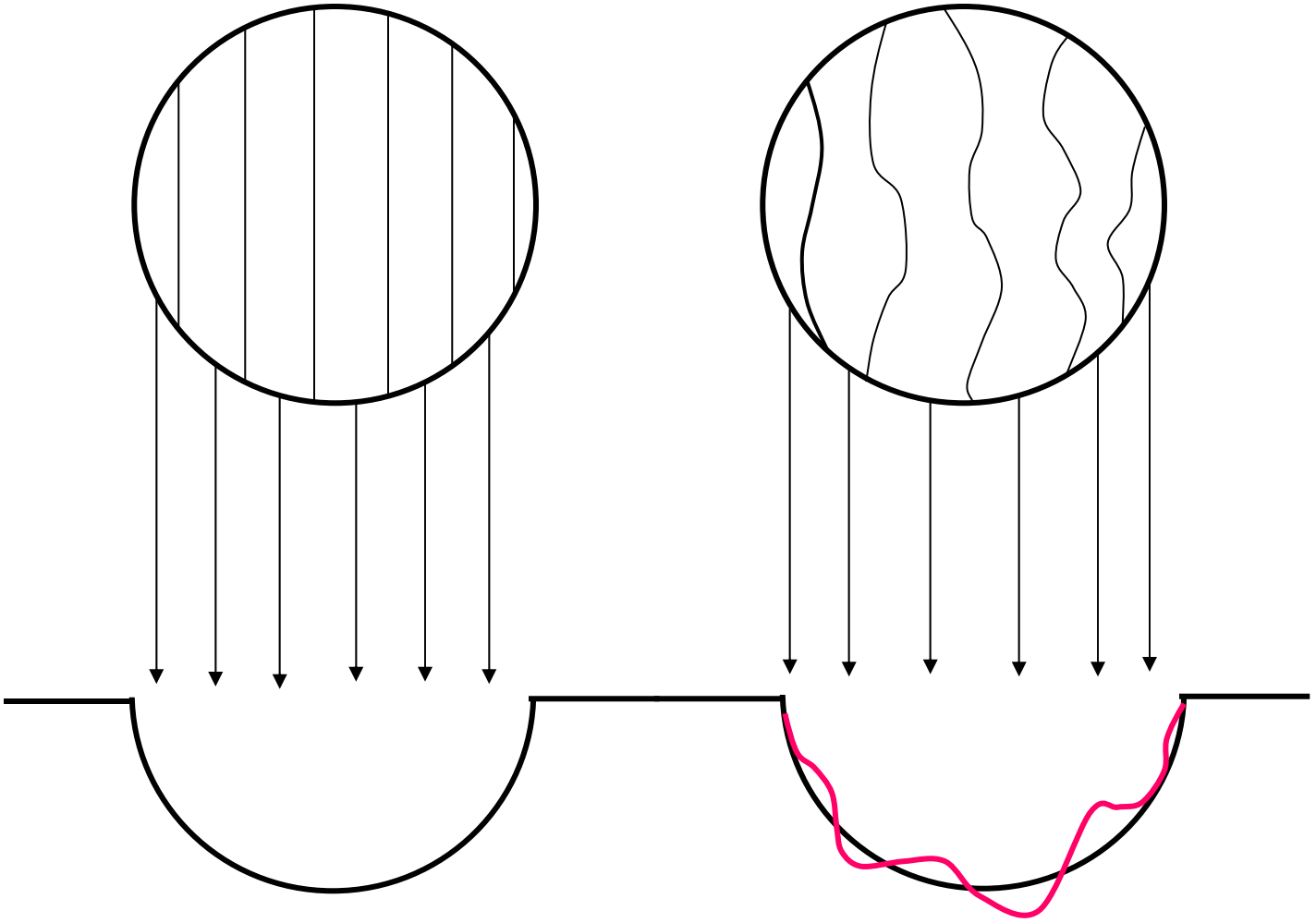
- 200,000 stars
- Wide field of view telescope
- Array of CCD detectors



Pulsations -> Line Profile Variations

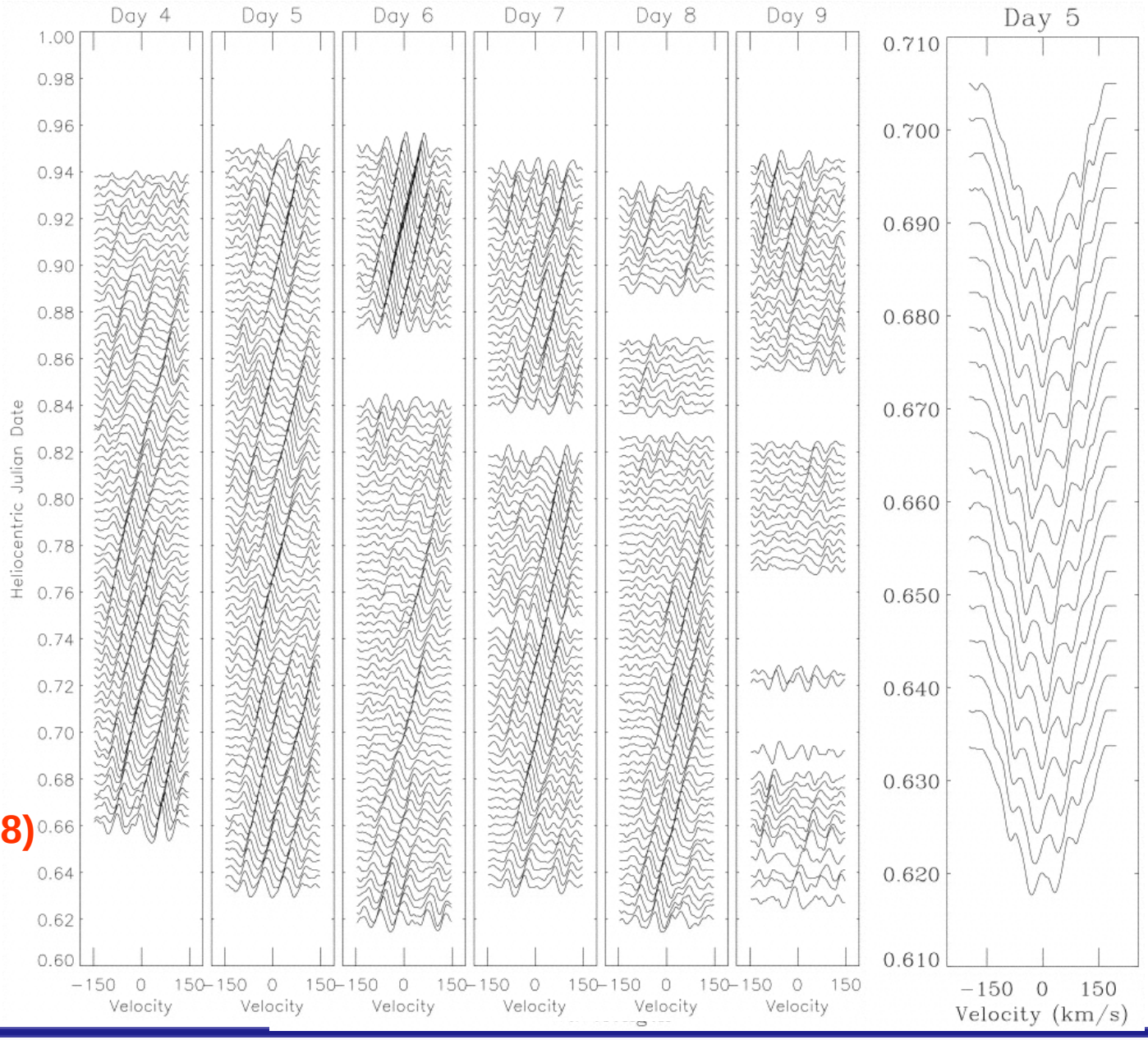
Star rotating as solid body

plus oscillations



Line-Profile Oscillations in tau Peg

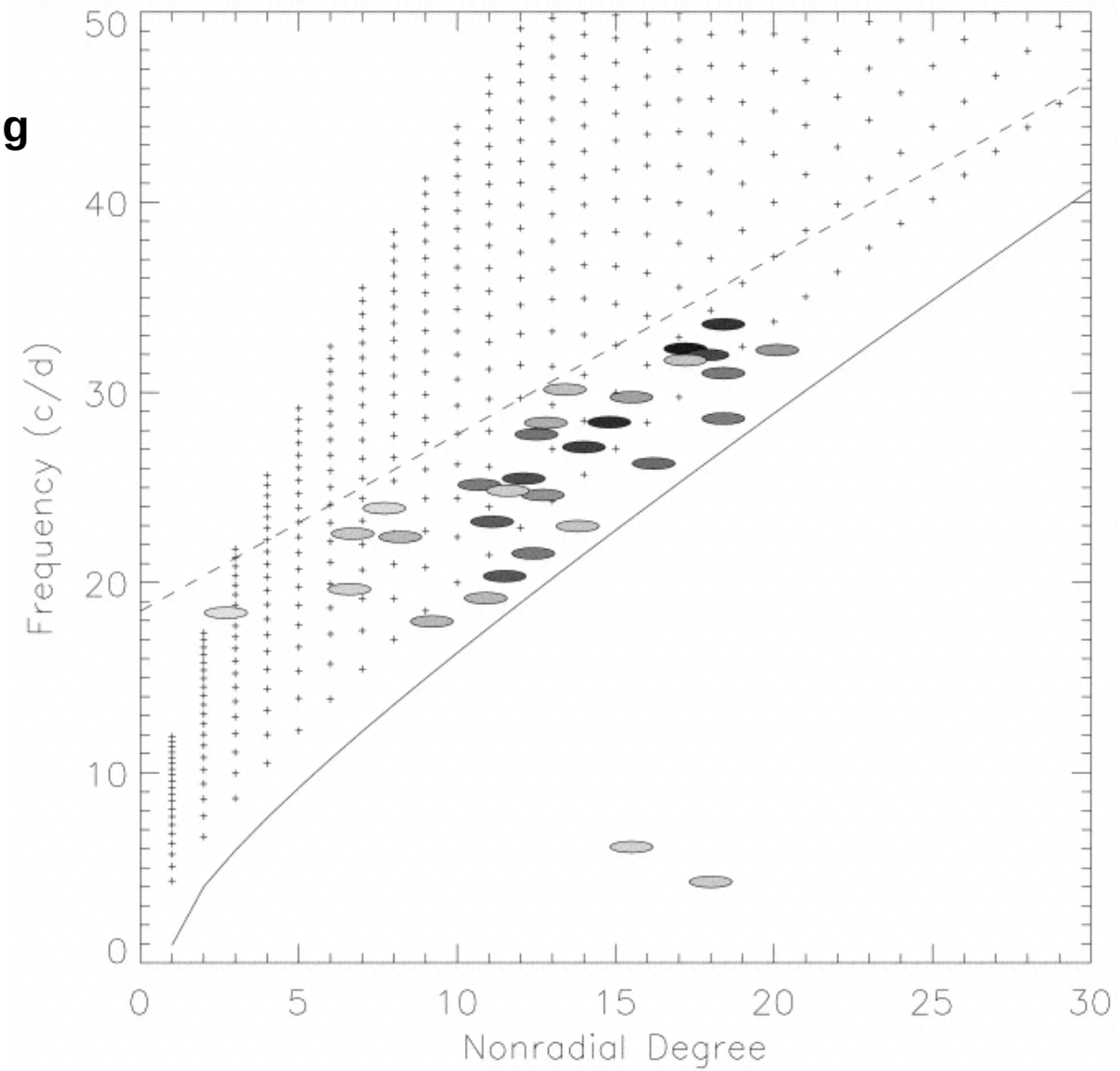
Rapidly-rotating delta Scuti stars oscillate in a lot of modes simultaneously. This one has only 1 photometric (low-l) mode, but > 20 high-degree modes.



Kennelly et al.
ApJ 495, 440 (1998)

The Modes are All Prograde!

Also observed in pulsating B stars.
What's the physics here?
What is it telling us about rotation in these stars?



Kennelly et al.
ApJ 495, 440 (1998)

Las Cumbres Observatory / Global Telescope

- New, privately funded observatory based in Santa Barbara, with connection to UCSB. Director is Wayne Rosing.
- Will soon operate a global network of 2m telescopes, plus a significant number of smaller ones.
- Will concentrate on time-varying phenomena.
- Is in the process of defining initial science program, hence initial suite of instruments.
- Please talk to Wayne Rosing, Stuart Taylor, John Farrell, or me.