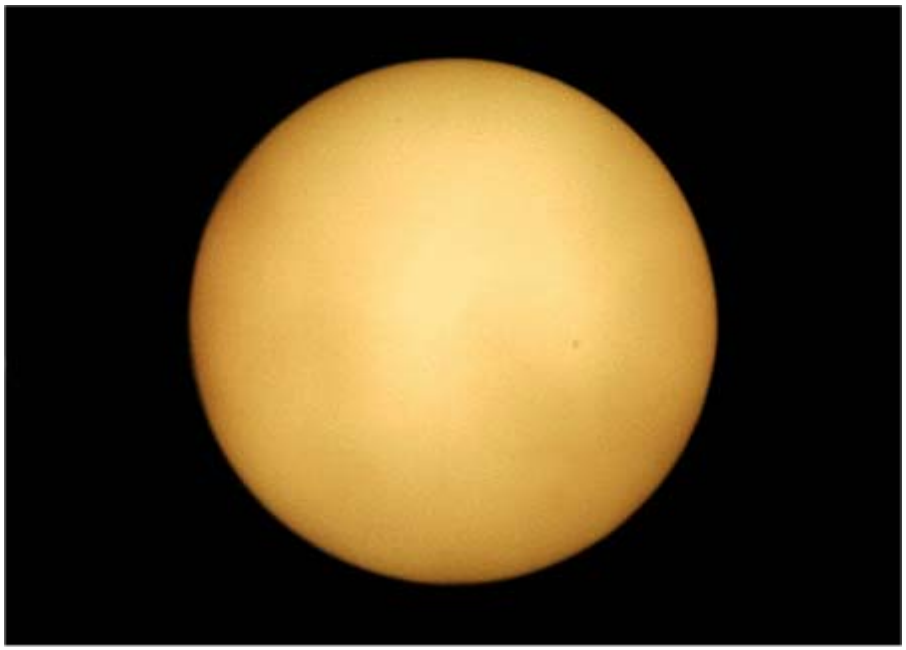
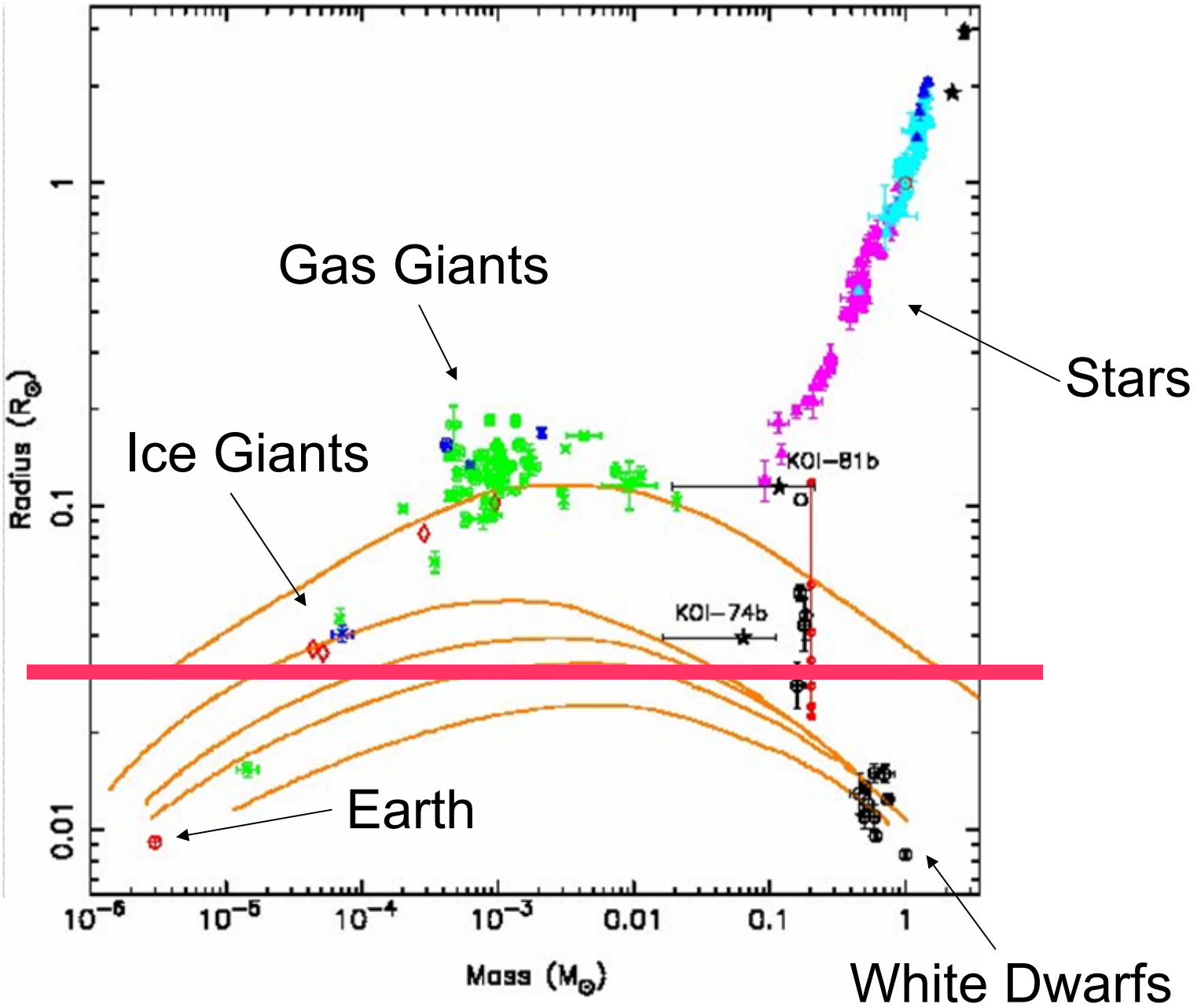
BRITE Planetary Transits

Jason Rowe
jasonfrowe@gmail.com
NASA Postdoctoral Program

I. Frequency of Planets
II. Photometric Quality
III. False Positives

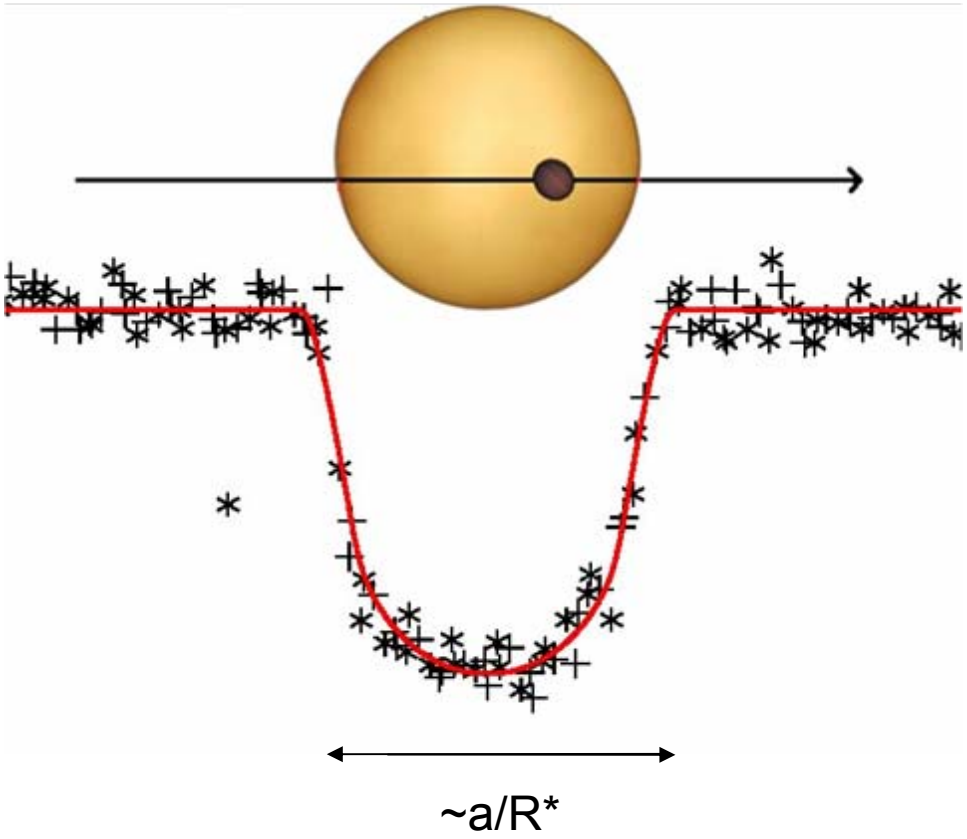


A Survey of Spheres



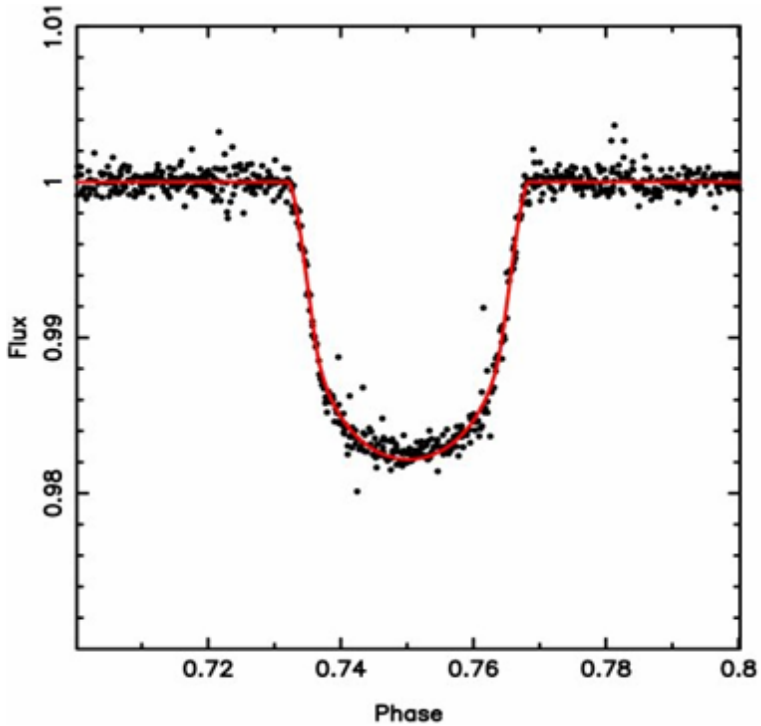
Synergy = Planets + Stars

- Planets help us learn about Stars
  - Transits give a geometrical measurement of stellar density
  - Combined with the effective temperature one can determine fundamental stellar parameters such as mass and radius.



Frequency of Planets

- Transit occurs if $\cos i < (R_* + R_p)/a$
  - Currently 79 transiting planets known
- Probability ~ R_*/a
  - Jupiter-Sun ~ 0.001
  - Earth-Sun ~ 0.005
  - Hot Jupiter ~ 0.1
- Transit duration
  - Timescale of hours to a day



MOST Photometry of HD 209458

Frequency of Hot-Jupiters

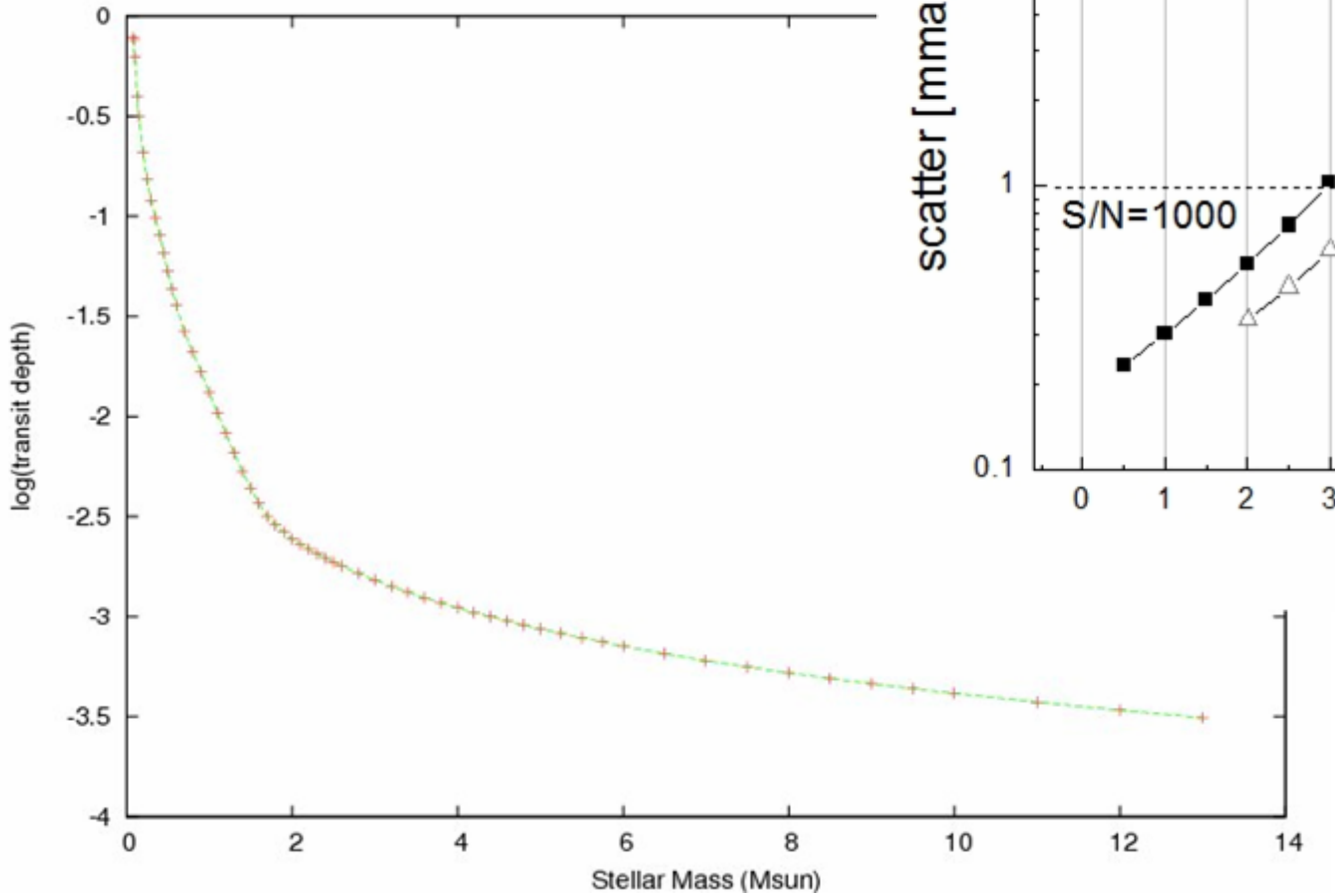
- Frequency of Hot-Jupiters
  - Radial velocity survey (KECK): 1 / 250
  - Photometric survey (OGLE): 1 / 450
  - Expect ~80 large, transiting planets for V<12
- CoRoT
  - 5.9+/- 1.2% of FGK stars host a giant planet
    - 0.3 to 15 M_J with 4 AU
  - 9.1+/- 1.8%
    - 1 < P < 5 days
  - 1 transiting planet for 1350 +/- 250 stars (F,G,K dwarfs)
    - Statistics restricted to gas-giant planets

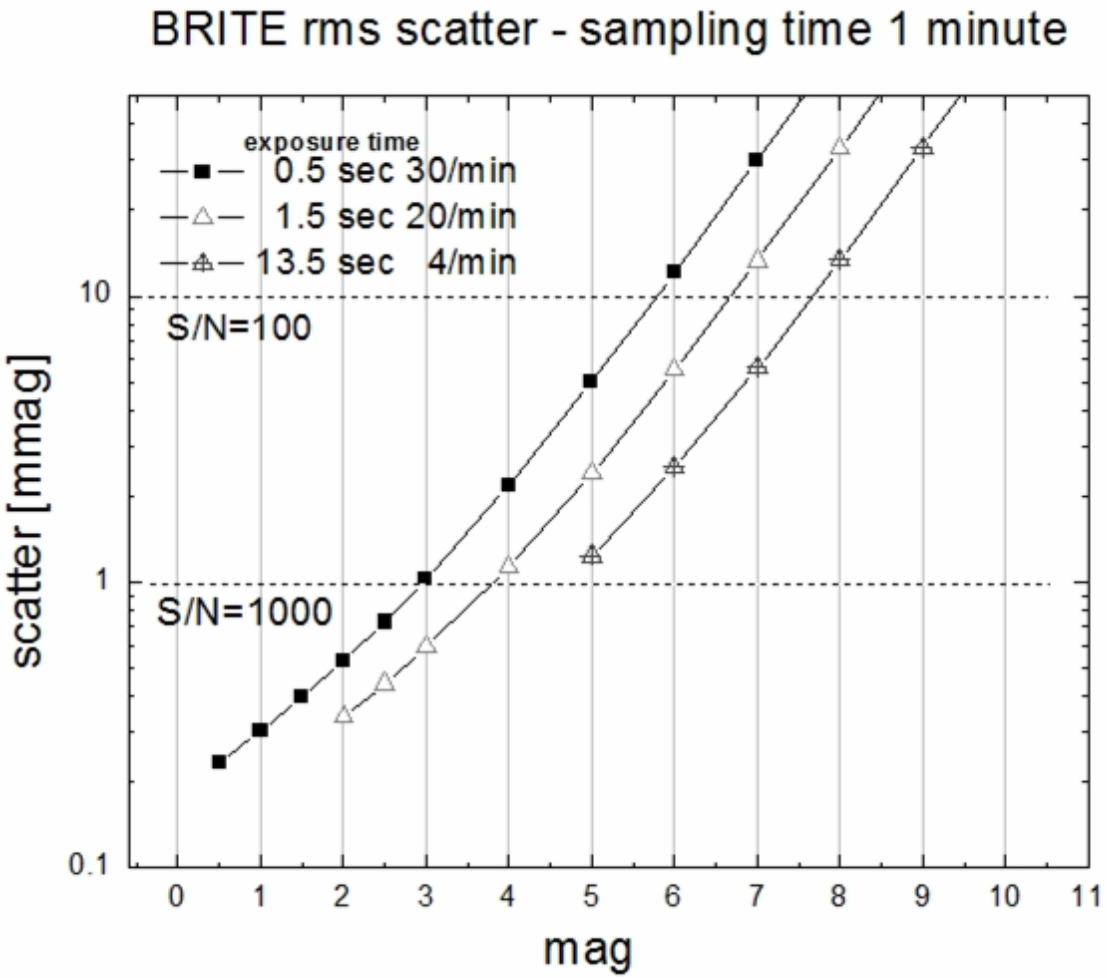
Groundbased Transit Surveys

- Wasp N : 1 500 000 : 26 planets
- XO : 250 000 : 5 planets
- Hat : 500 000 : 14 planets
- TrES : 50 000 : 4 planets
  - Poor duty cycle hurts detection efficiency for outer planets.
  - Handling Red noise

Photometric Requirements

- $dI/I \sim (R_p/R_*)^2$
  - Earth-Sun : 0.0001
  - Jupiter-Sun : 0.01





Monetary Value?

$$C = 5.75 \times 10^8 \exp^{-(t_y - 2000)/5\mathrm{yr}} \sqrt{\frac{P}{3.5\mathrm{d}}} \sqrt{2.5^{(7-V)}} \left(\frac{M_{\mathrm{Jup}}}{M_{\mathrm{Pl}}}\right) \left(\sqrt{\frac{1+e}{1-e}}\right) \left(\frac{R_{\mathrm{Pl}}}{R_*}\right)^2 (N_{\mathrm{Pl}}^2)$$

Greg Laughlin (UCSC)

- Bright
  - More photons
- Eccentric
  - Tides
  - Strong stellar heating gradient
- Large radius
  - More photons from planet

HAT-P-1 b $969,483

HAT-P-2 b $85,507

HAT-P-3 b $285,768

HAT-P-4 b $189,636

HAT-P-5 b $146,178

HAT-P-6 b $245,873

HD 149026 b $792,760

HD 17156 b $953,665

HD 189733 b $2,665,371

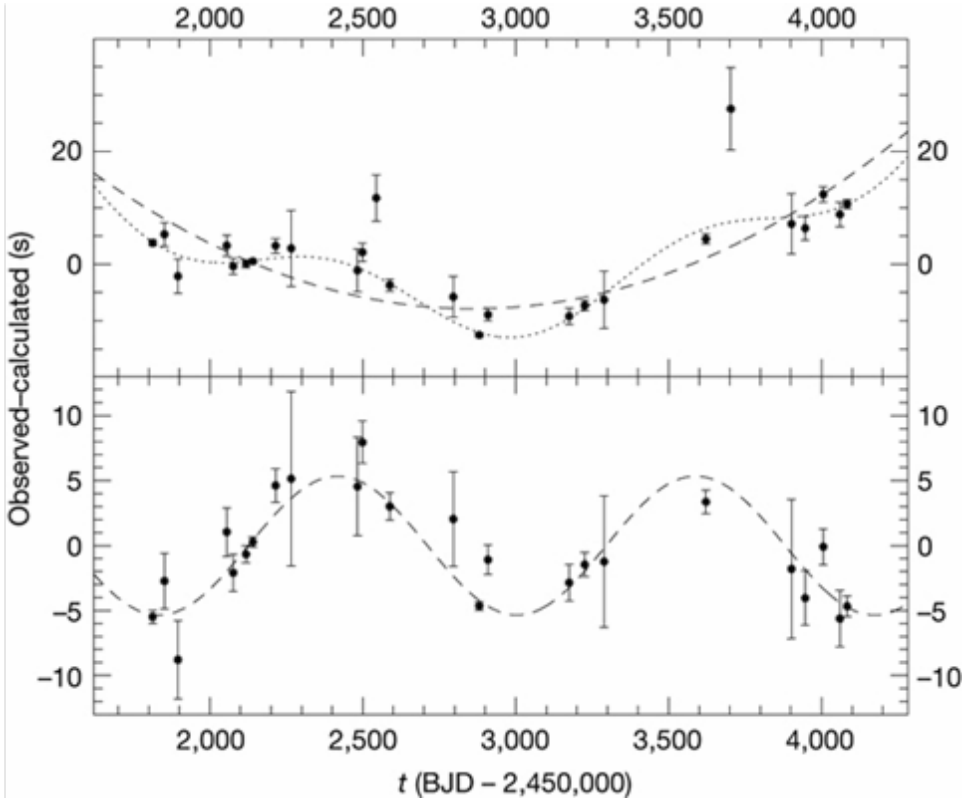
HD 209458 b $11,084,661

False Positives

- F-M binaries, grazing eclipsing binaries
  - RV spectra
  - Colour changes during transit
- Background binaries
  - high resolution imaging
  - Centroid analysis
- All Candidates will ultimately require radial velocity followup

Asteroseismology

- O-C timings
  - Silvotti, Schuh, Janulis et al. 2007
    - V391 Peg, O-C ~ 5 sec
  - Confusion with stellar evolution
    - d/dt (dR/r) < 10^{-9} Hz/year
  - Mass: 3.2 M_J
  - Period: 3.2 years



Conclusions

- Stellar and Planetary astrophysics go hand-in-hand
- Hot Jupiters : 1 in 1350
  - Probably more 'hot Neptunes'
  - Current discoveries indicate that smaller planets are more plentiful
- Transit depth favourable for low-mass stars
- Hot Stars are typically ignored by 'classical' planet surveys
  - RV followup can be difficult
- A bright star with a transiting planet
  - Extremely valuable to community