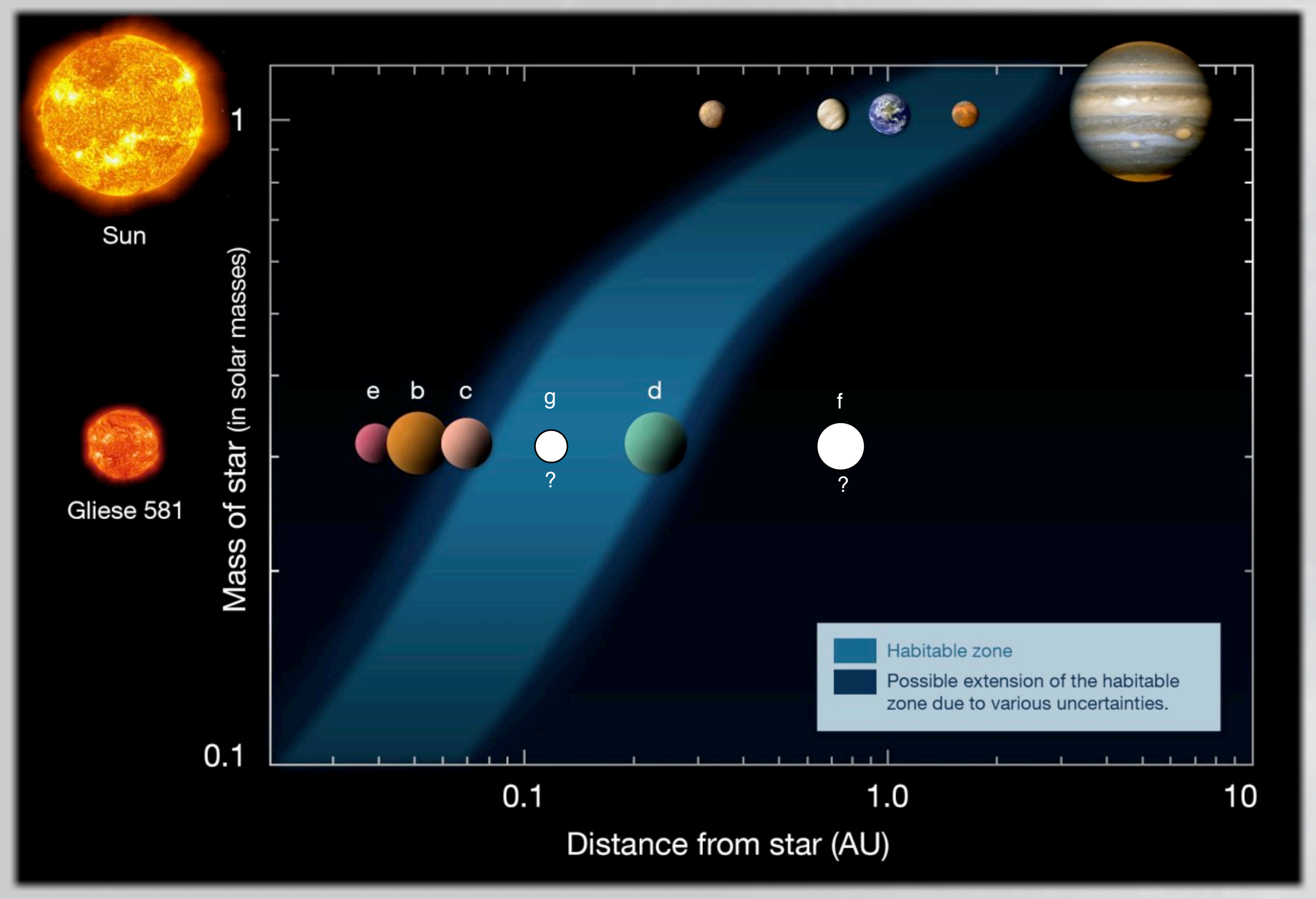
A Search For Transits of GJ581 e Using MOST Space-based Observations

Diana Dragomir *(UBC/IPAC)*, **Jaymie M. Matthews** *(UBC)*, **Jason F. Rowe** *(NASA Ames)*, **HARPS Team**

Introduction

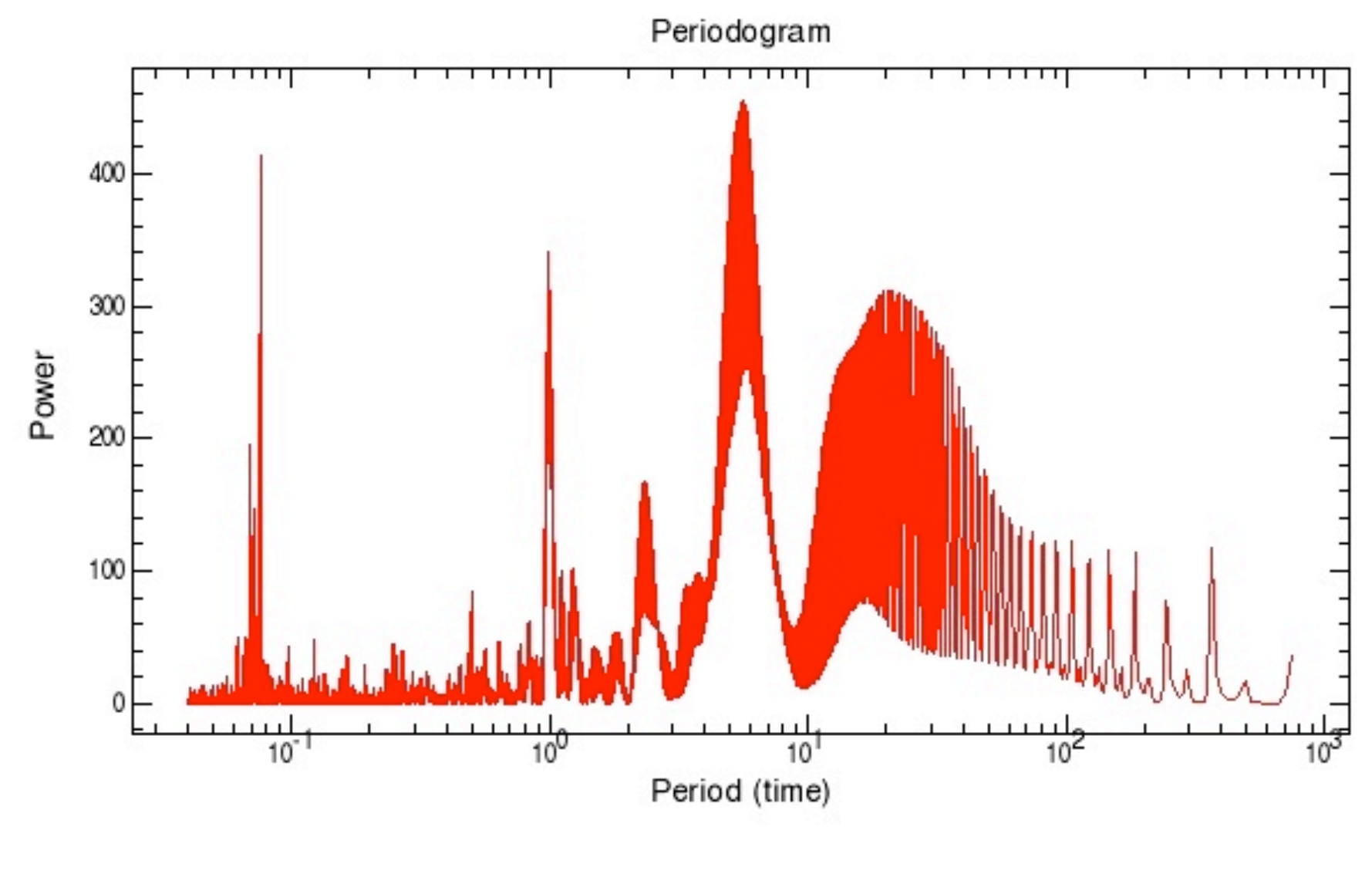
Gliese 581a (M3V, V = 10.56) has a mass of ~0.31 M_{Sun} and a radius of ~0.38 R_{Sun}. This red dwarf hosts at least 4 planets, and possibly at least 6. The innermost companion has an orbital period of 3.15 days and msini = 1.94 $M_\oplus$ *(Mayor et al. 2009)*. If found to transit, GJ581e would become the least massive known exoplanet for which the density can be measured.

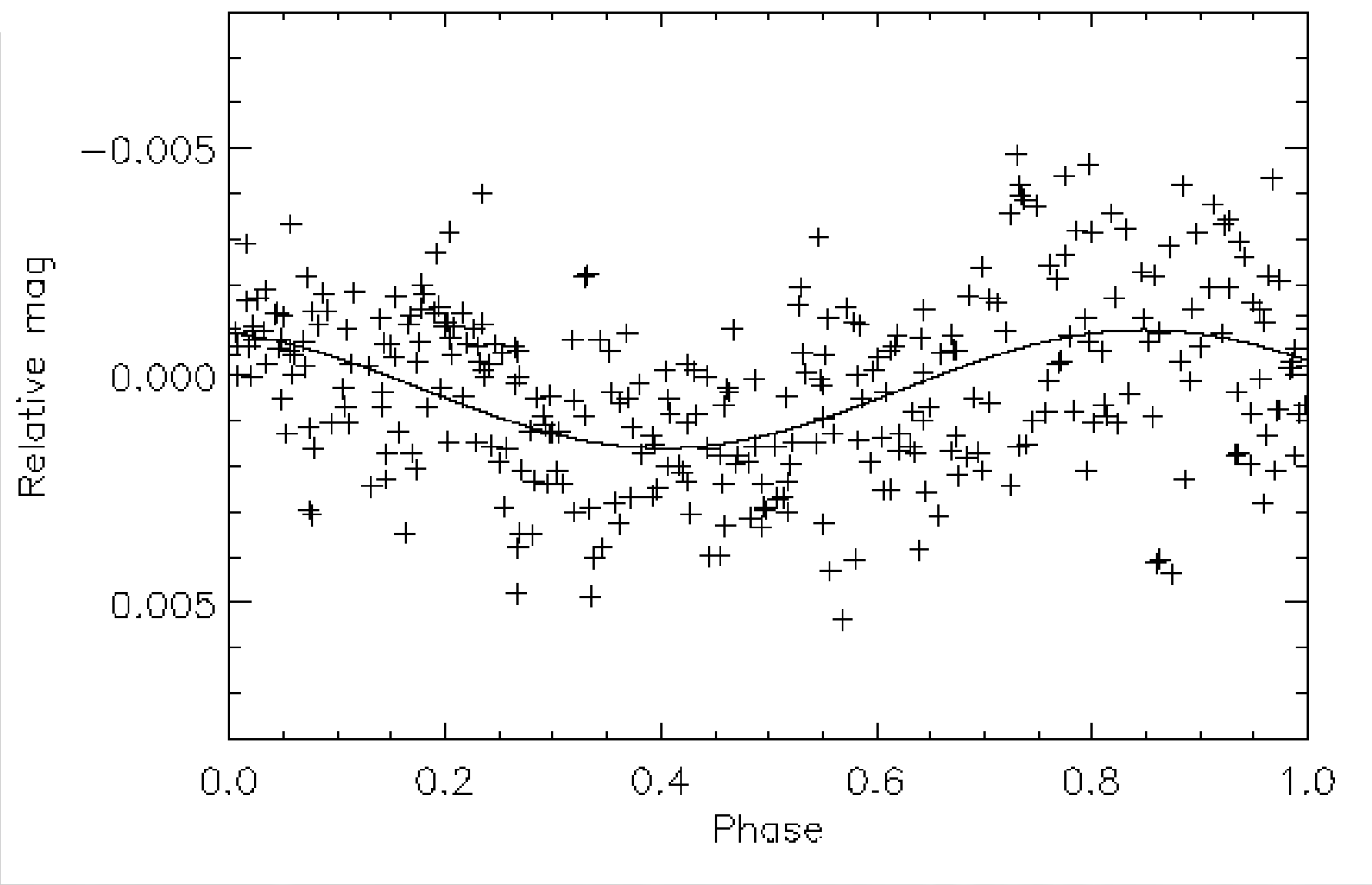


Photometric variability

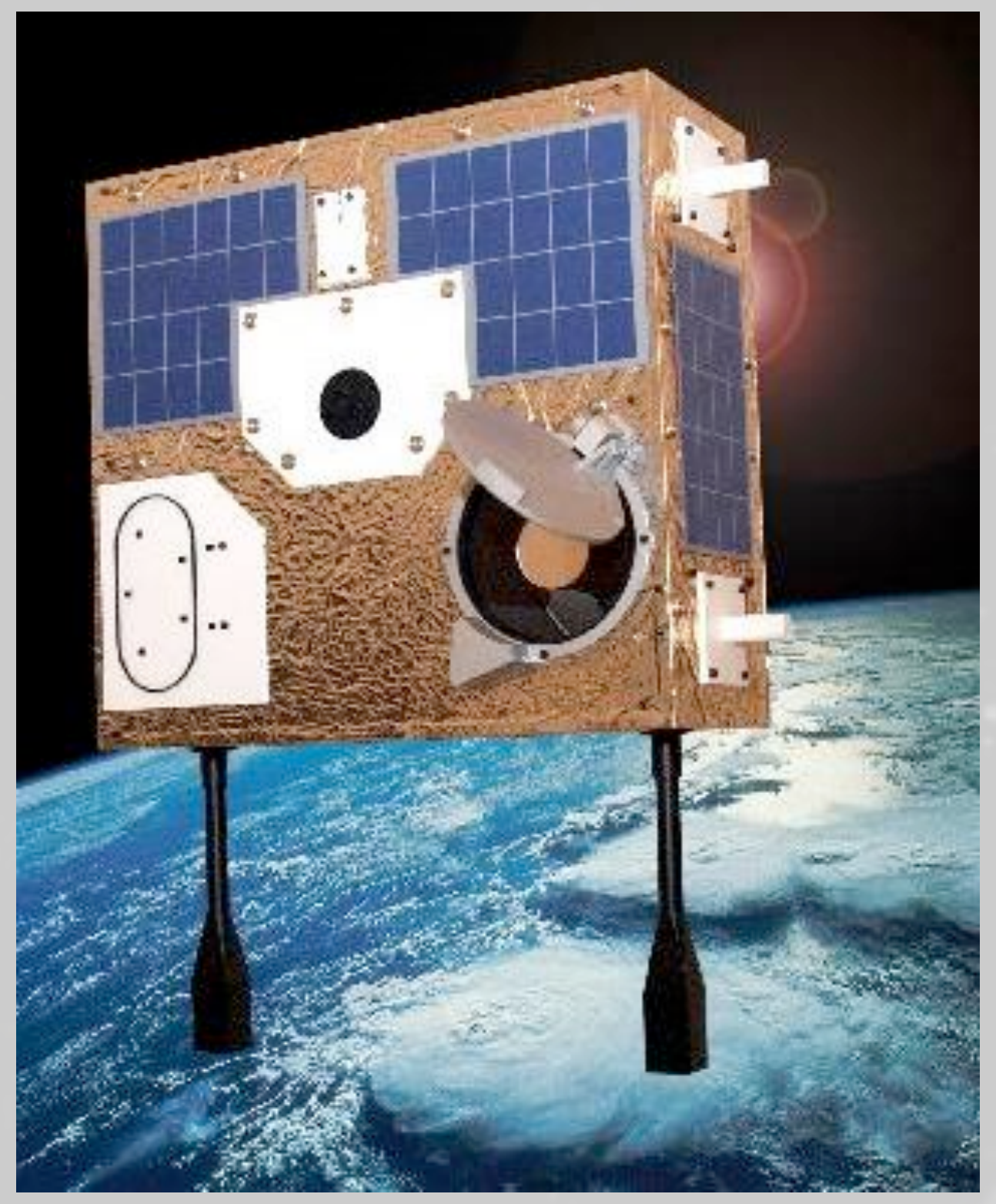
A complete Lomb-Scargle periodogram of all the MOST photometry shows a broad peak at a period of 5.6 days. We note that the orbital period of GJ581b (a hot Neptune and the most massive planet in the system) is 5.37 d. Additional data are required to verify whether this variability is due to star-planet interactions.

A plot of the observations binned and phased at P = 5.6 d is shown. The amplitude of the signal is ~1.3 mmag.





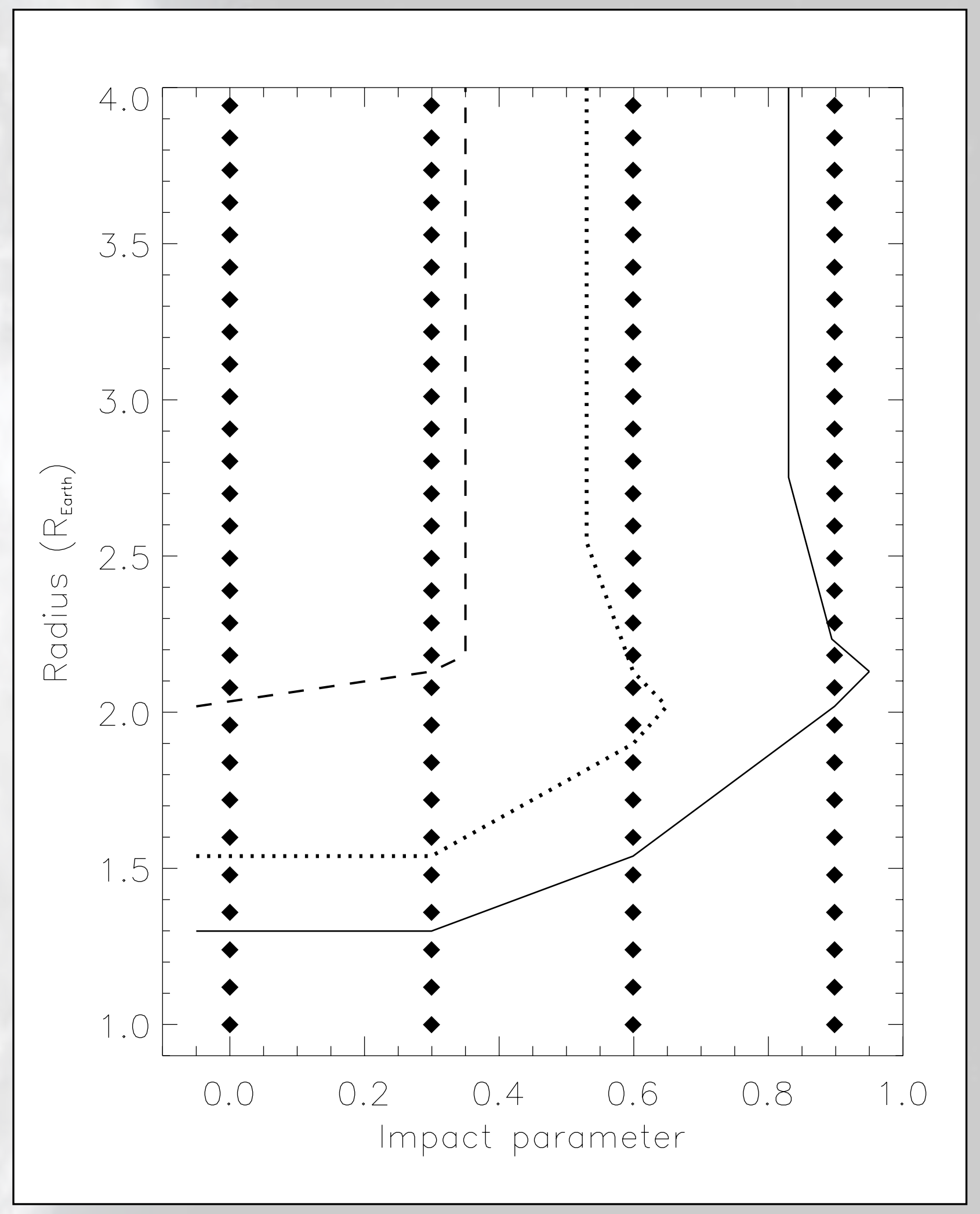
The MOST satellite



MOST (*Microvariability and Oscillations of STars*) is a suitcase-sized microsatellite which houses a 15-cm optical telescope feeding a CCD photometer *(Walker et al. 2003; Matthews et al. 2004)*. From its orbit around the Earth with a period of 101.4 minutes, it can monitor stars continuously for up to 8 weeks. Such long term monitoring is due to a Continuous Viewing Zone (CVZ) which covers a declination range of +36° ≥ δ ≥ -18°.

MOST can achieve a precision of 1 part per million (μmag)

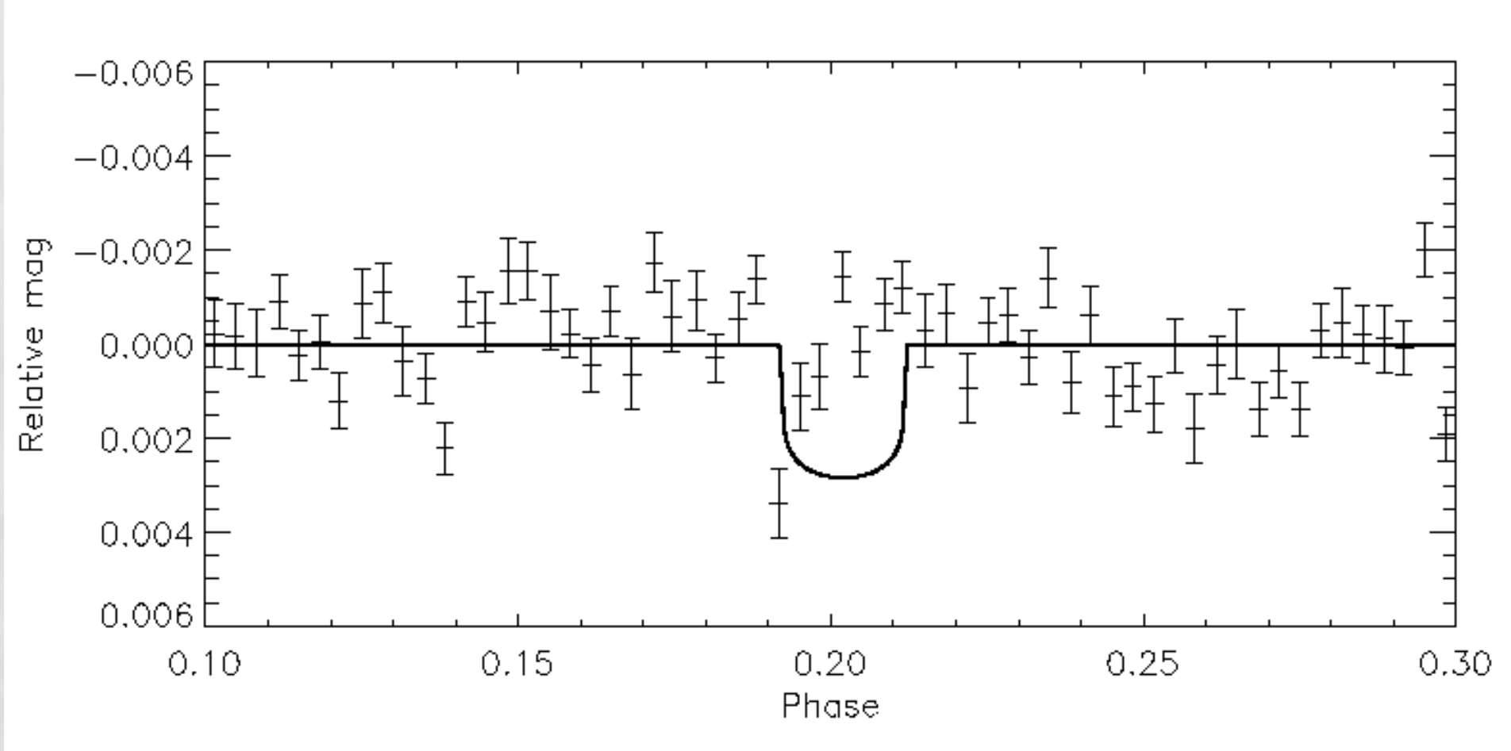
Testing sensitivity to shallow transits



We performed Monte Carlo simulations to quantify our ability to recover transits in the MOST data set phased at the known period of GJ581e. For each of a set of 30 trial planet radii and 4 impact parameters, artificial transits (using the models of Mandel & Agol 2002) were inserted at 100 random phases within the transit time window predicted by the RV ephemeris (Mayor et al. 2009).

A transit was judged to be recovered if $|R/R_{inp} - 1| < 15\%$, and $|\phi - \phi_{inp}| < 0.05$.

Above right is a plot of trial planet radius versus impact parameter. The solid, dotted and dashed lines correspond to the 68%, 95% and 99% confidence contours, respectively.

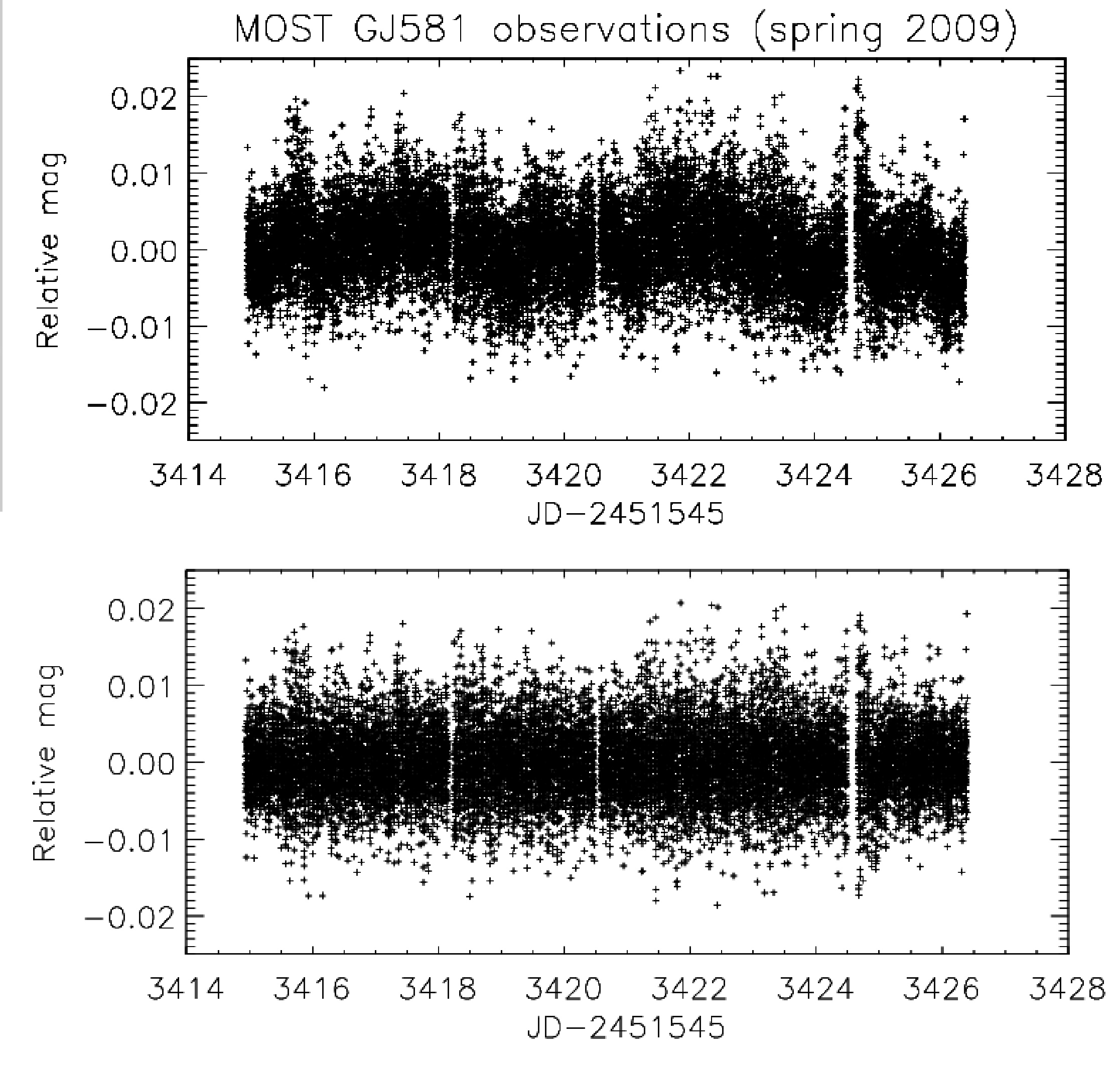


As an example, a transit corresponding to a planet with a 1.55 R_{Earth} radius at the predicted transit time is plotted over the binned and phased observations.

MOST photometry

27 days of MOST photometry of GJ581 were acquired in 2007 (as part of a search for transits of GJ581c), and also 12 days in spring 2009 (spanning 3 orbits of GJ581e). The photometry was reduced and corrected for stray light and flat-fielding effects (see *Rowe et al. 2008*).

Long-term variations were filtered with a cubic spline. Below are the light curves before (*top*) and after (*bottom*) the last step.



Results

Our Monte Carlo simulations demonstrate that the smallest planet we could detect would have a radius of 1.4 R_{Earth} (68% confidence) or 1.5 R_{Earth} (95% confidence). For impact parameter 0, we exclude a planet with density < 2890 kg/m^3 (95% confidence), and < 4280 kg/m^3 (68 % confidence).

References

Mandel, K., & Agol, E. 2002, ApJ, 580, L171
Matthews, J.M. et al., 2004, Nature, 430, 51
Mayor, M. et al., 2009, A&A, 507, 487
Rowe, J.F. et al., 2008, ApJ, 689, 1345
Walker, G. A. H., et al. 2003, PASP, 115, 1023