White Dwarfs in the WTS:

White Dwarf + Brown Dwarf Eclipsing Binaries

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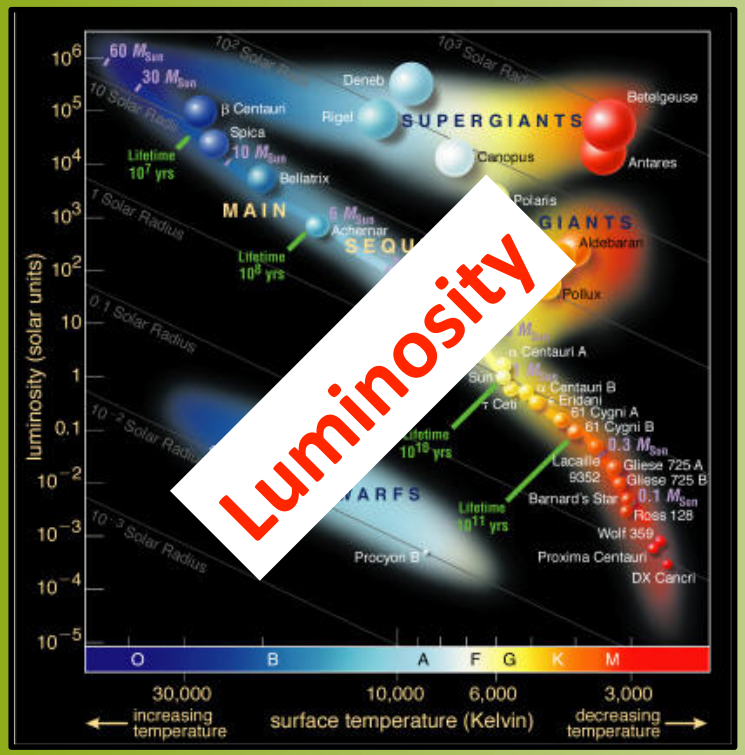
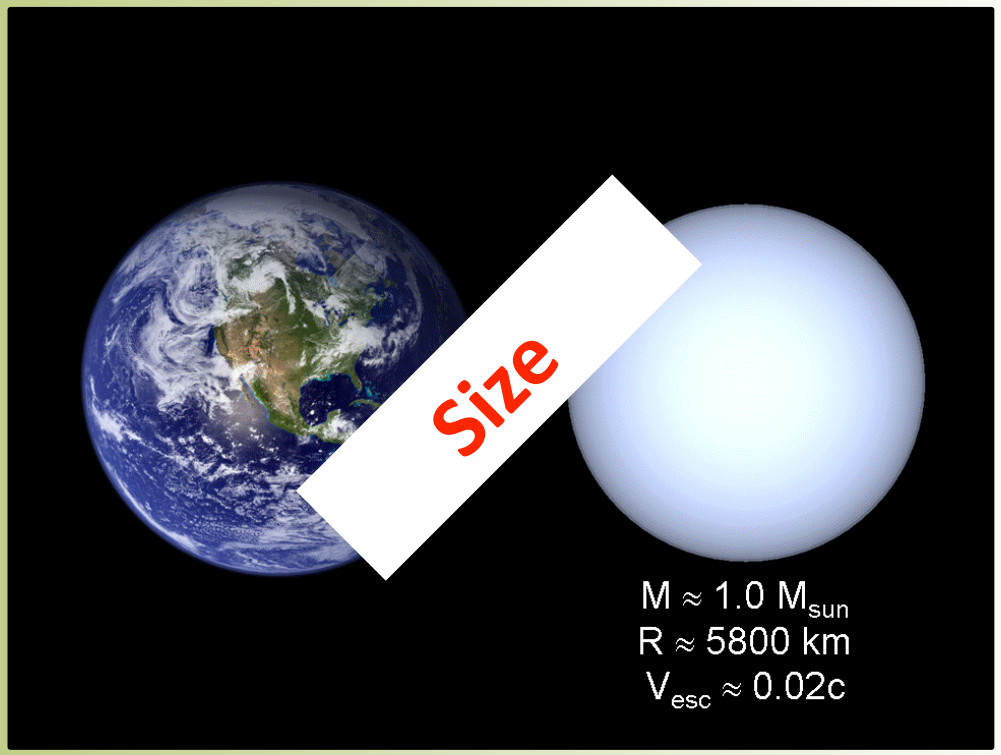
Introduction

Why White Dwarfs?





- Fantastic age calibrators.

White Dwarfs + Brown Dwarfs

- Photometric/Proper motion searches ongoing for WD+BD systems.
- Examples of Confirmed systems
  - GD165 (Becklin & Zuckerman 1988)
  - PHL5038 (Steele et al. 2009)
  - LSPM1459+0857 (Day-Jones et al. 2010)
  - WD0137-349 (Maxted et al. 2006)
  - GD1400 (Farihi & Christopher 2004)

Wide

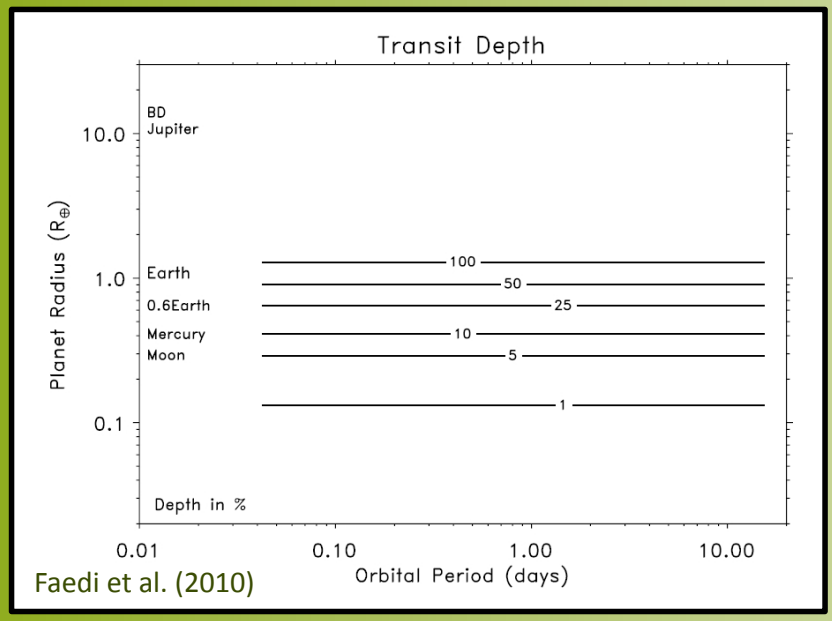
Close

- WD+BD binaries are rare (**~0.5%**, Steele et al. 2011)

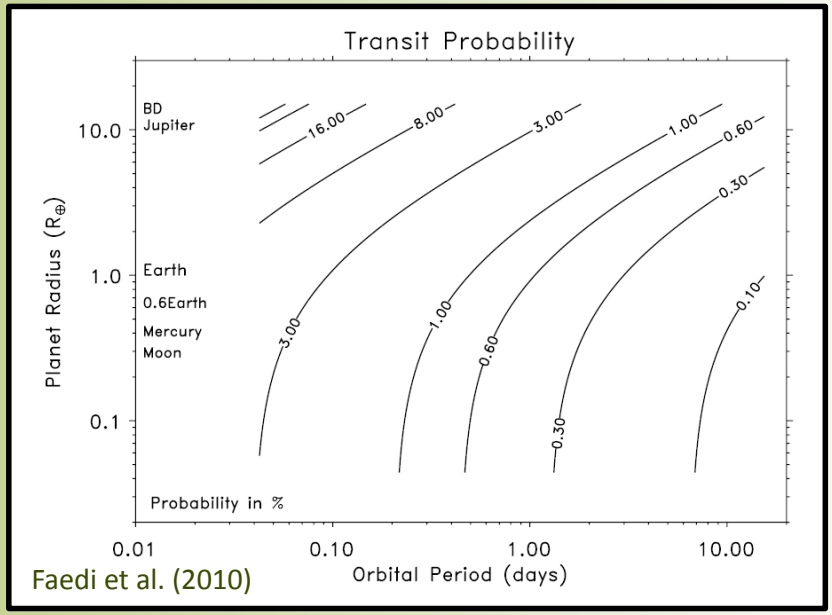
White Dwarfs + Planets

- Can we use WTS to search for planets around WDs?
- Don't need high precision photometry so can probe to much fainter magnitudes.
- Can extend to other surveys e.g. PanPlanets.
- Detections will yield very accurate planet properties (Age, Radius) due to well know WD physics.
- The evolution and fate of planetary systems.

White Dwarfs + Planets



Faedi et al. (2010)



Faedi et al. (2010)

$$\delta_{tr} = \frac{\Delta F}{F} = \begin{cases} R_p^2 / R_*^2 & for\ R_p \le R_* \\ 1 & for\ R_p > R_* \end{cases}$$

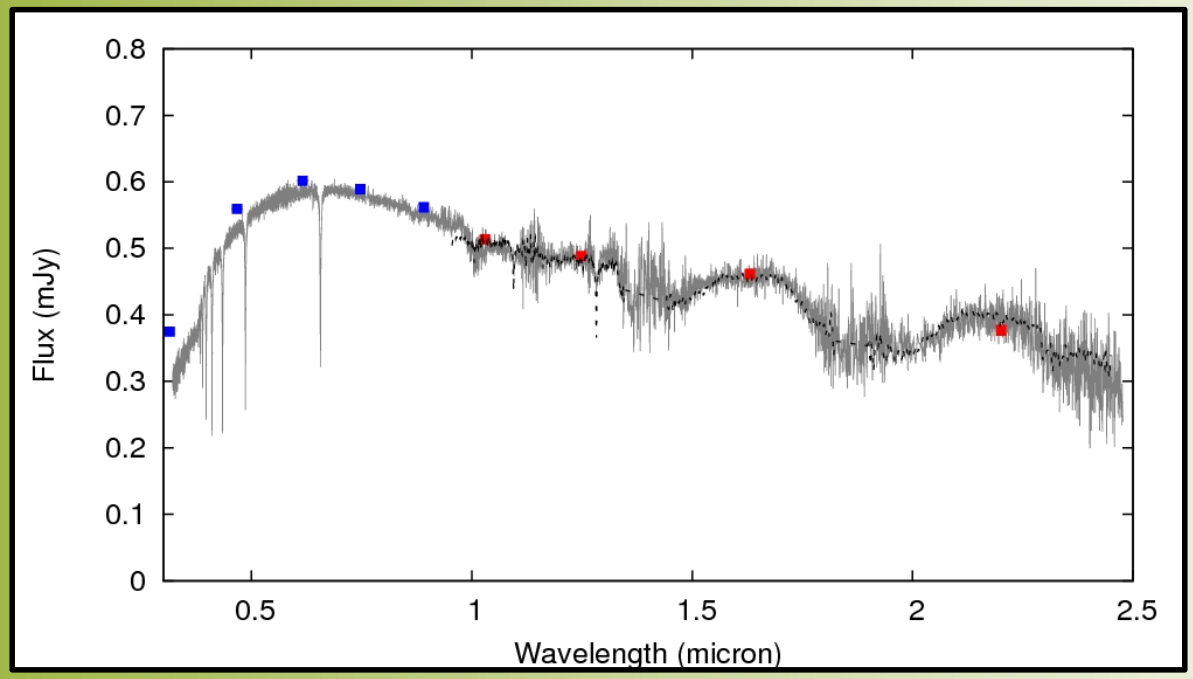
$$p_{tr} \approx \left(\frac{4\pi^2}{G M_*} \right)^{1/3} \frac{R_p + R_*}{P^{2/3}}$$

- So need a large sample of stars…
- Faedi et al. (2010) - 194, Drake et al. (2010) – 12k

I: NLTT 5306

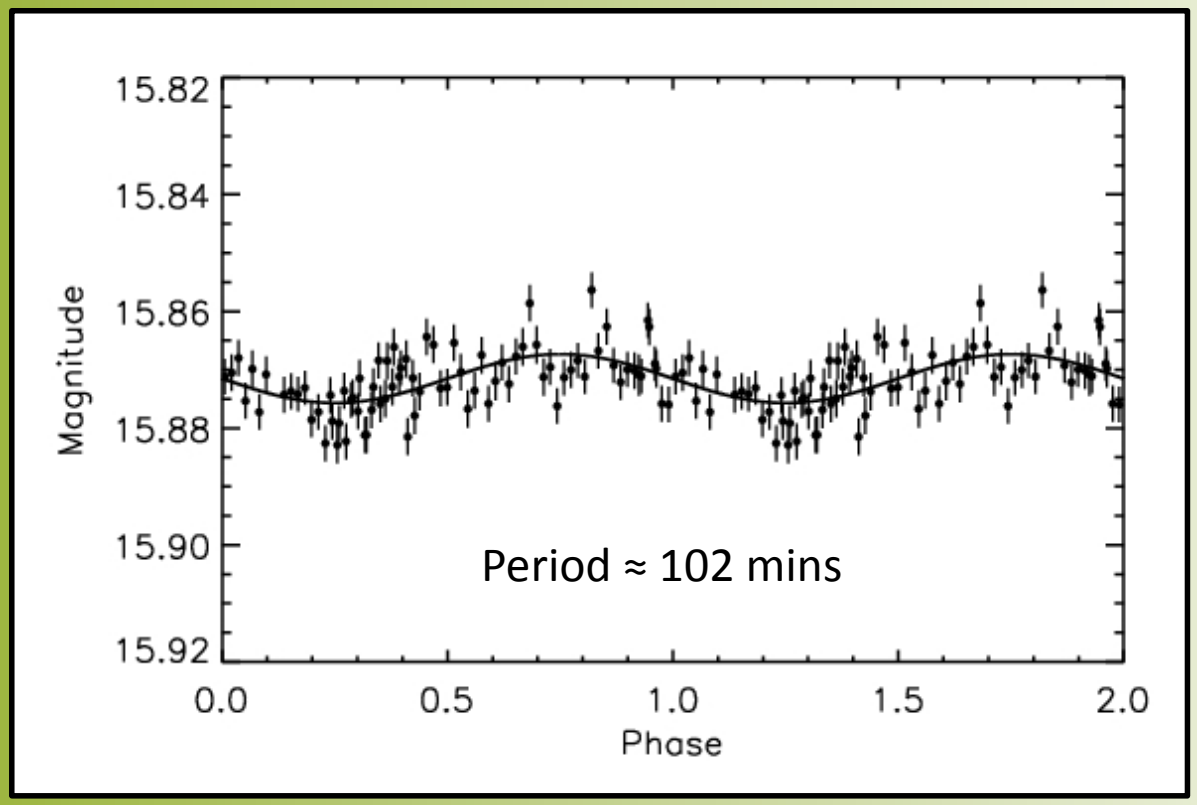
NLTT 5306

- Identified as a WD in SDSS DR4 spectroscopic catalogue of WDs (Eisenstein et al. 2006)
- X-Correlated with UKIDSS (Steele et al. 2011) where near-infrared excess was discovered consistent with a WD+dL5 brown dwarf.
- Confirmed with X-SHOOTER:



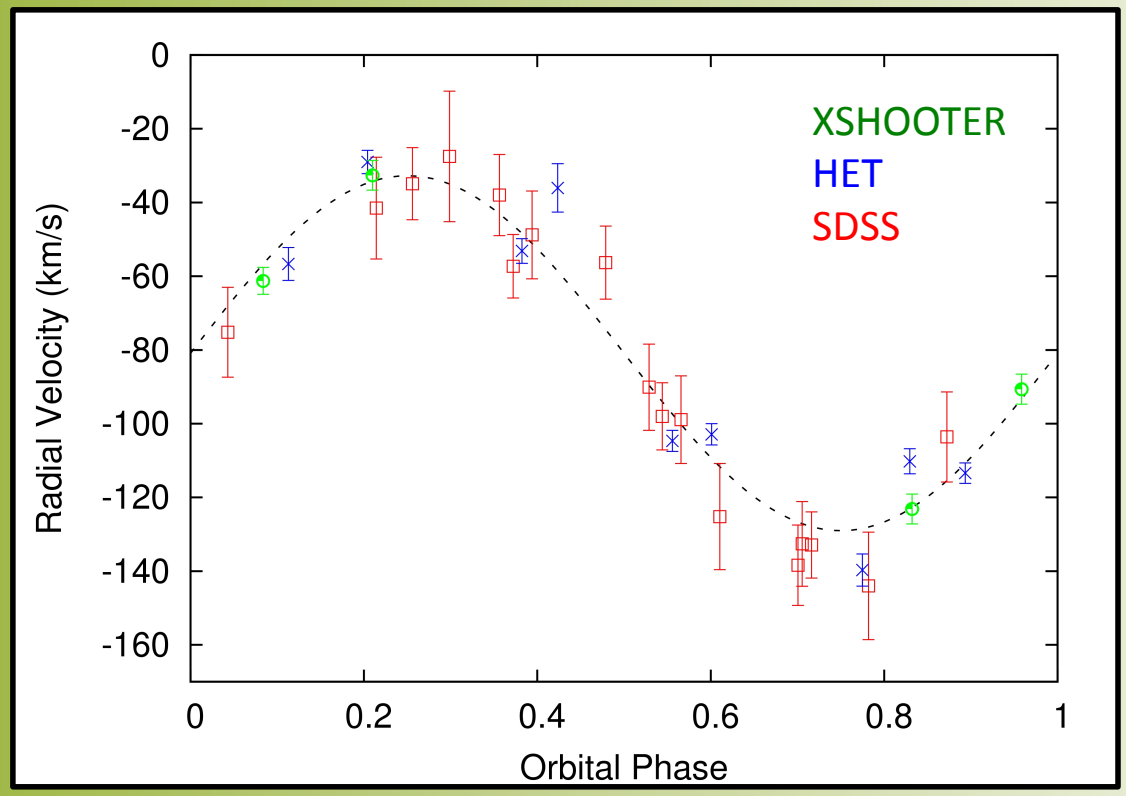
NLTT 5306

- Close (P = Hours) or wide binary?
- Brightest in UKIDSS sample so we took 6 random HET observations.
- Shortly after i-band date from INT showed variability of order 1%:



NLTT 5306

- Contacted by team at Warwick who observed radial velocity variation in SDSS data and recognised WD from Steele et al (2011).
- Combined observations confirming period = 0.0707354±9.92452e-6 days (≈102mins), and Mass > 54-56Mj consistent with previous spectral typing:



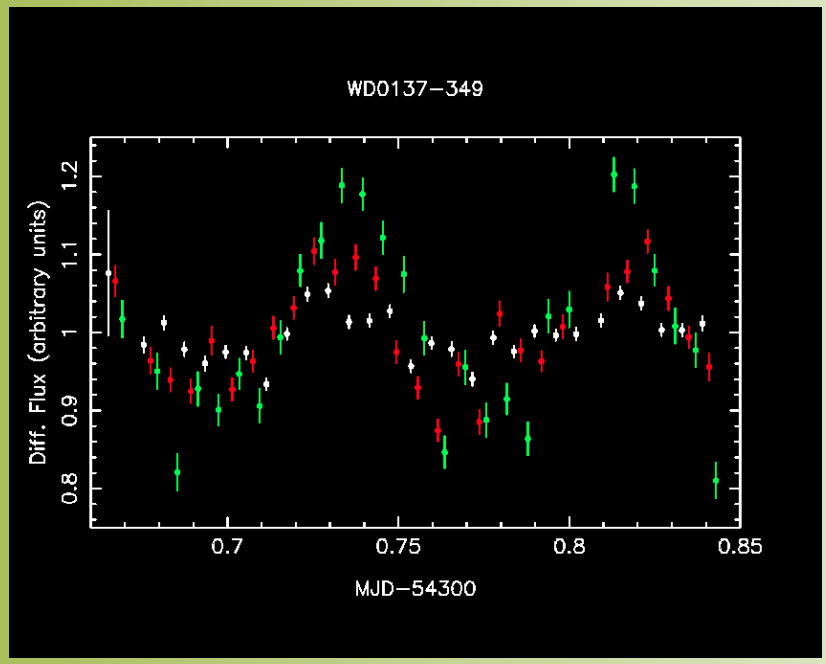
NLTT 5306

- Shortest period spectroscopically identified detached WD+BD binary.
- Period = 102 mins giving Orbital radius = 396,000 km,
- Distance to system = 60±10 pc.
- Likely to have survived a stage of common envelope evolution like its counterpart WD0137-349 (Maxted et al. 2006).
- Evidence for low level accretion via a stellar wind.
- Paper submitted to MNRAS.

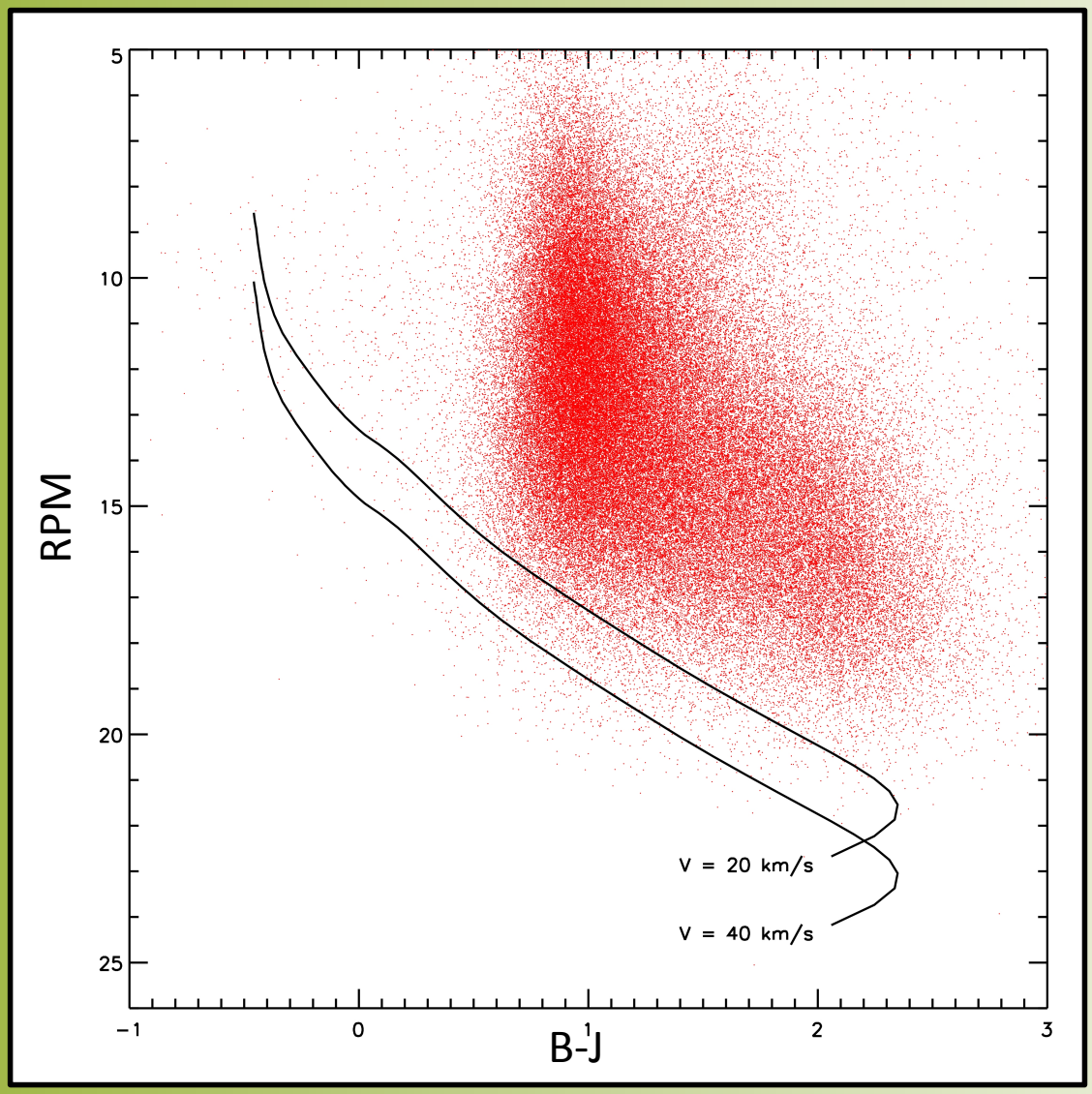
II: White Dwarfs in the WTS

White Dwarfs in the WTS?

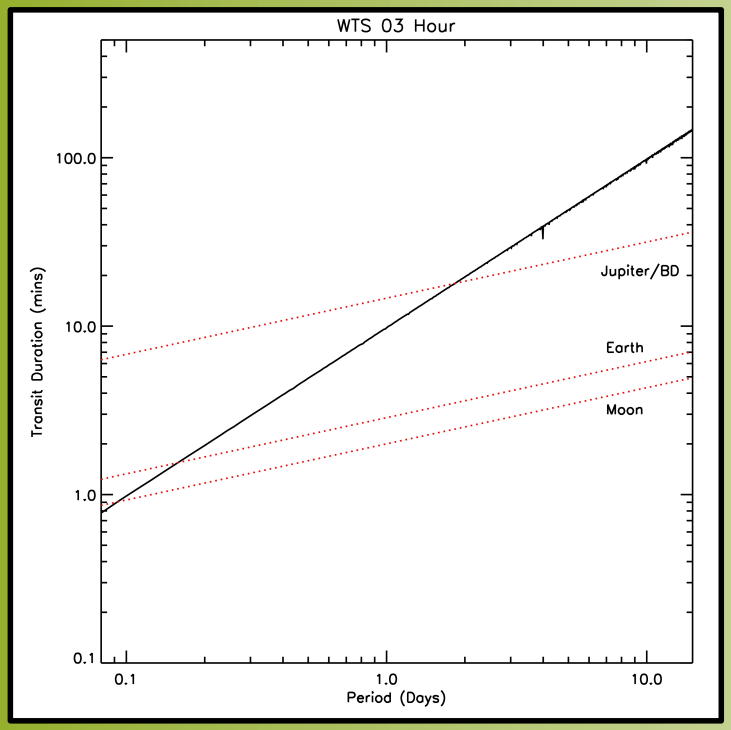
- Candidate white dwarfs selected using a colour vs. reduced proper motion diagram. Sample likely to include a large number of sub-dwarfs.
- Candidates run through Johannes' analysis programs to look for eclipses/ transits/variability.

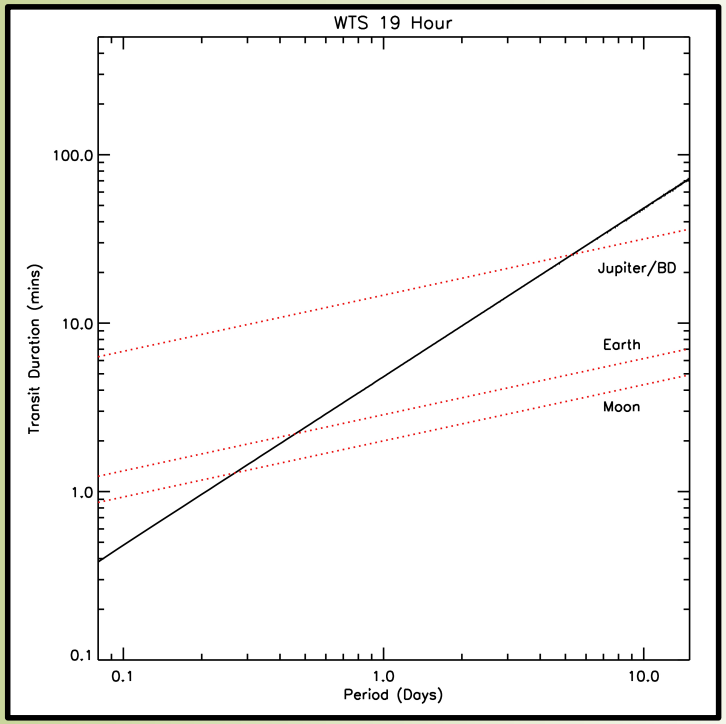


Reduced Proper Motion



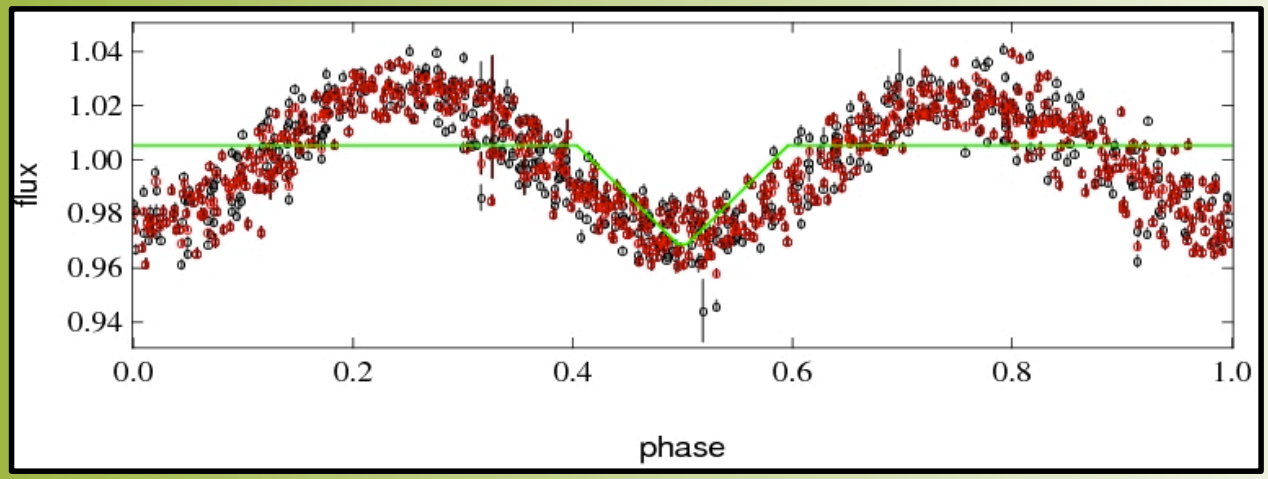
Survey Sensitivity

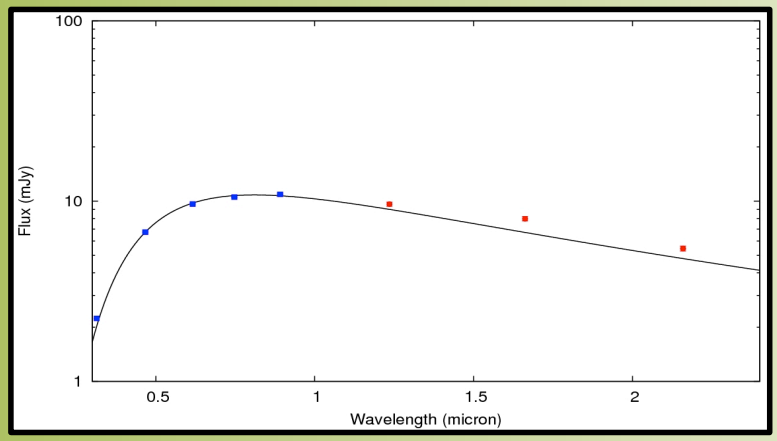




	03 Hour	07 Hour	17 Hour	19 Hour
Moon	< 0.10	< 0.14	< 0.17	< 0.27
Earth	< 0.17	< 0.24	< 0.27	< 0.47
Jupiter/BD	< 1.84	< 2.69	< 3.09	< 5.36

Irradiated Secondary?





Summary

- Increasing the sample size is key to understanding the population and improving on statistics.
- WD (and Sub-Dwarf) candidates in surveys (such as the WTS) can be identified through reduced proper motion diagrams.
- Analysis of light curves can reveal further brown dwarfs through both variability and looking for eclipses/grazing transits.
- Potential to find rocky planets through eclipse/grazing transits