Exoplanets and Brown Dwarfs

Chris Tinney, UNSW Sydney

Exoplanets & Brown Dwarfs in Australia

- UNSW Sydney, Australian National University, University of Southern Queensland, Swinburne University, University of Sydney, Monash
  - Doppler planet searches
  - Transit confirmation (HAT-S, KELT-S, K2)
  - Transit Follow-up (Rossiter-McLaughlin, Secondary Eclipse)
  - Exoplanetary system dynamics
  - Modelling - atmospheres, disks, debris disks
  - See M.Ireland's talk for Extreme AO imaging/spectroscopy

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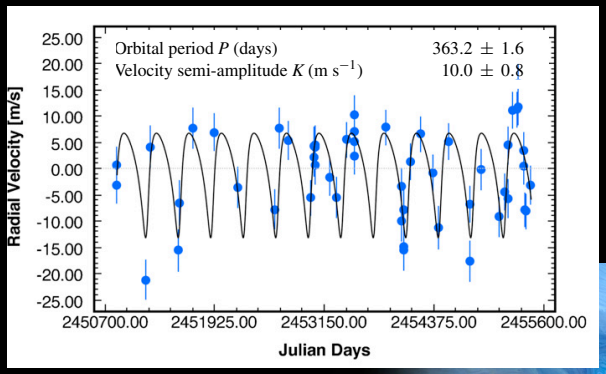

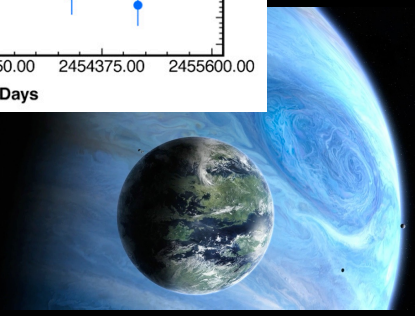

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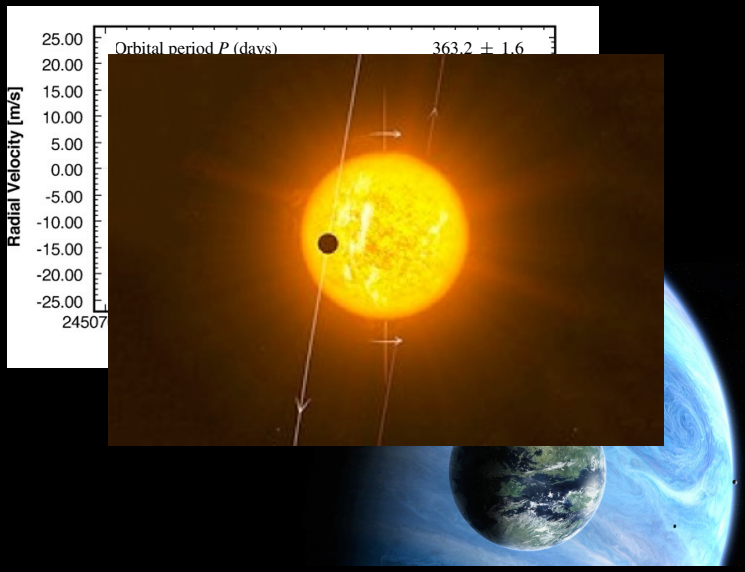

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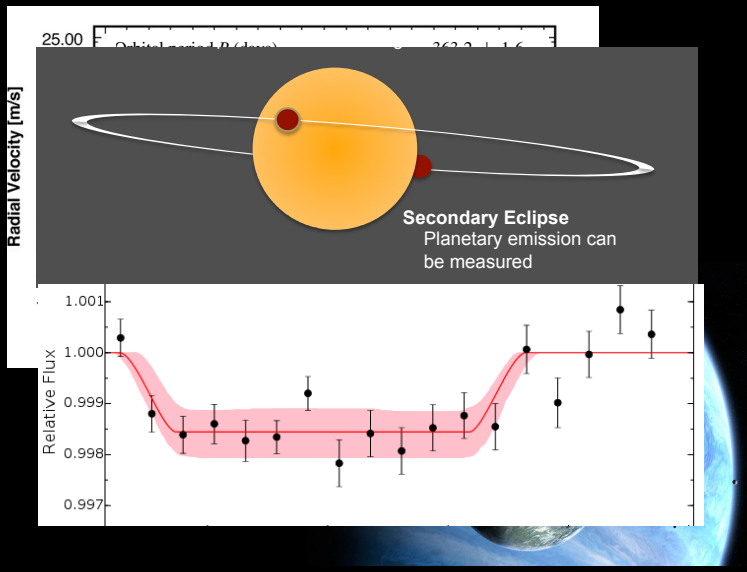


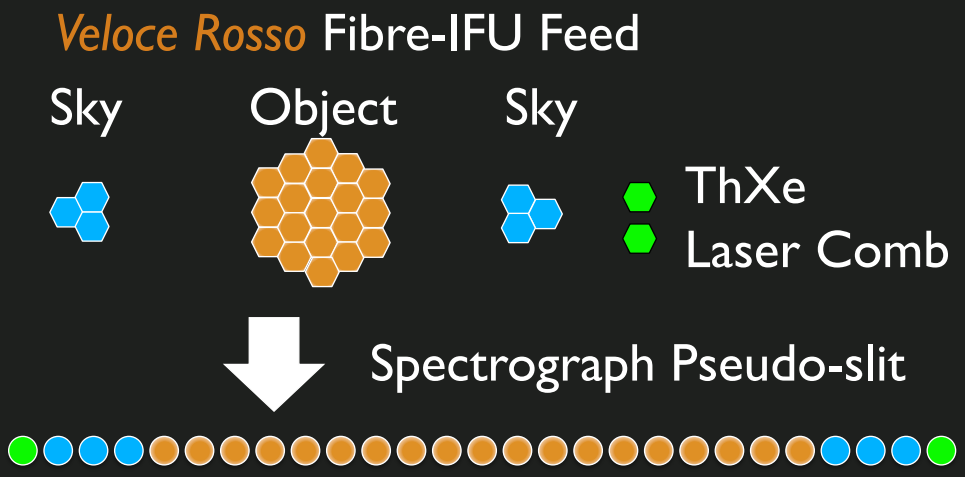
Key Facilities for Australia

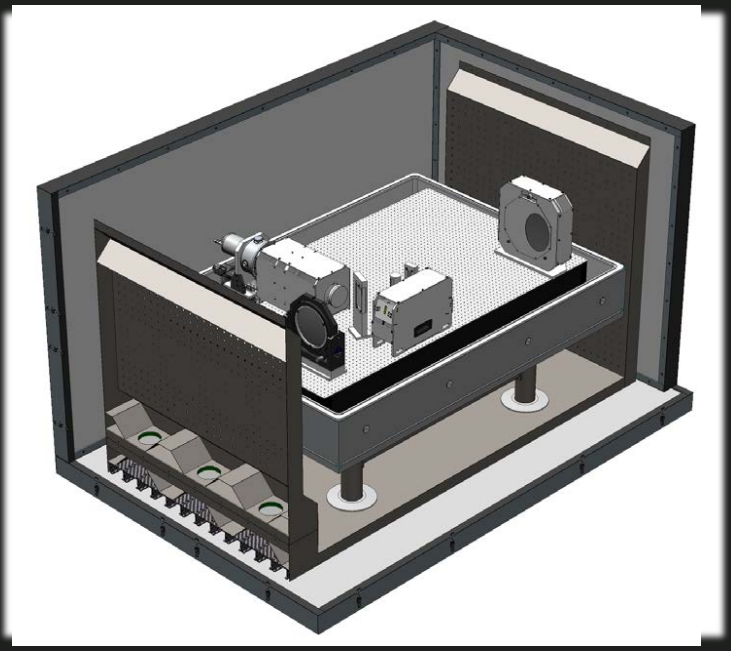
- **3.9m Anglo-Australian Telescope**
  - Hi-res I_2 spectroscopy with UCLES (e.g. AAPS - 50 planets over 20y)
  - Fibre-IFU fed spectroscopy CYLOPS+UCLES for transits …
  - Secondary eclipses with IRIS2
- Access to twin 6.5m Magellan Telescopes
  - FourStar (NIR Y dwarf imaging, astrometry), FIRE (NIR spectra), Planet Finder Spectrograph (PFS)
- New *Veloce* spectrograph coming to AAT in 2018
- New *Minerva Australis* array of dedicated 0.7m coming in 2018

VELOCE

- ***Veloce* Rosso** is a compact, ultra-stabilised and hyper-calibrated spectrograph for 3.9m Anglo-Australian Telescope — funded for 600-930nm at R~80,000 able to obtain Doppler velocities for Sun-like and M-dwarf stars at sub-m/s precision

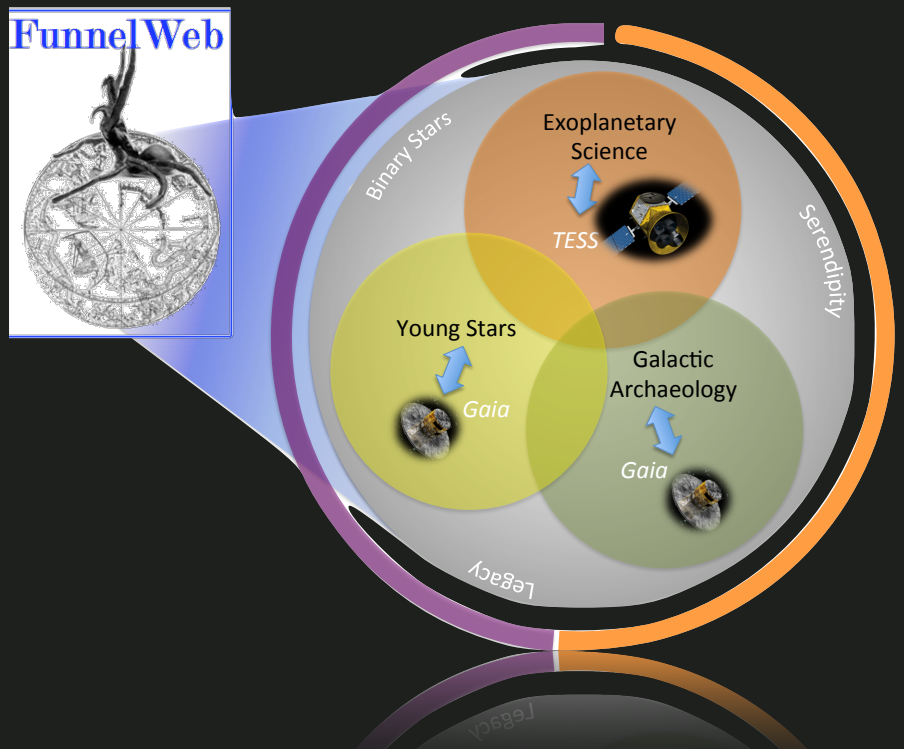
- Spectrograph stabilised to 1m/s and calibrated by laser-comb to ~20cm/s





FunnelWeb

- The FunnelWeb survey will obtain R=2100 spectra for all stars in the southern sky to I<12 (δ<+30, |b|>10), plus targeted science programs



- plus <u>all</u> possible M dwarfs to I~14.
- plus “adolescent star” candidates in Solar Neighbourhood
- Starbug+TAIPAN facility on the 48” UKST delivering 370-870nm twin camera spectra.
- positions 150 fibres in parallel in ~ 5min - survey of ~ 1e6 stars/year feasible

Extreme Brown Dwarfs with Subaru

<u>SWIMS/MOIRCS Astrometry & Spectra</u>

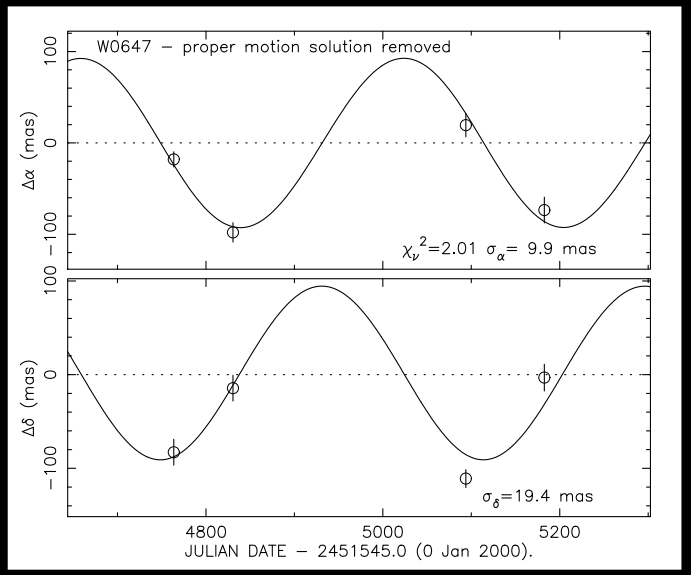
o **T and Y-type brown dwarfs can't be seen by Gaia** - no flux in optical. Parallaxes are critical, and are right at the limit of what can be done with 8m-class telescopes at J=20-24, and need < 0.5".

o **Nasmyth** is the way to go to control flexure

Ultimate Subaru has great potential here for parallaxes at J=24-25 of faintest and coldest Y dwarfs. But

(1) need to be control how GLAO system "modifies" astrometric distortion of field

(2) medium band filters much more efficient



Magellan FourStar J=22

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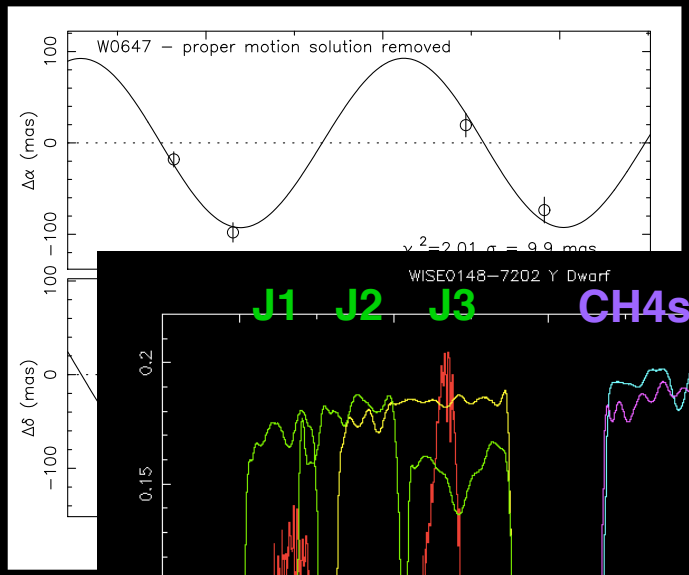
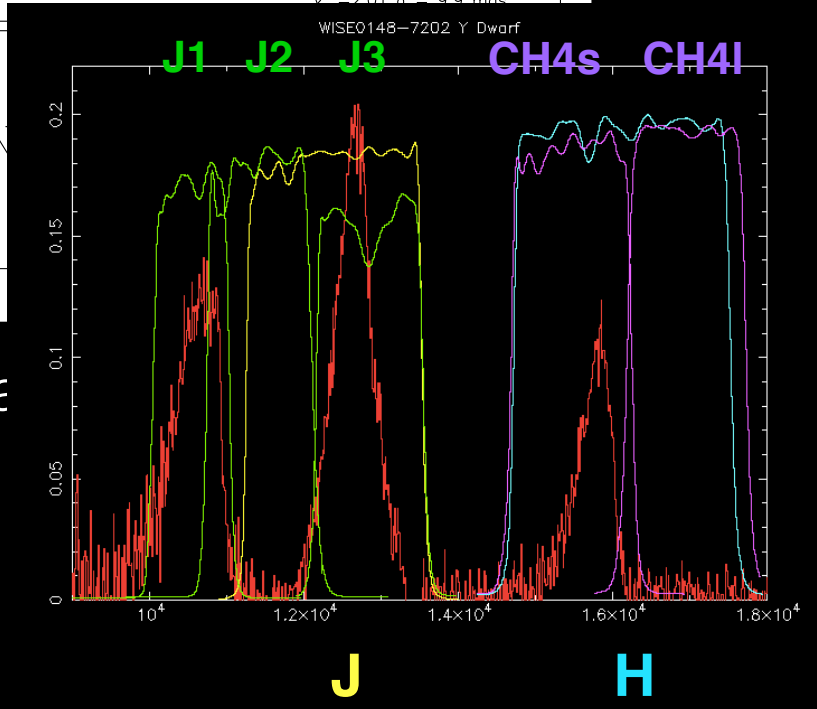
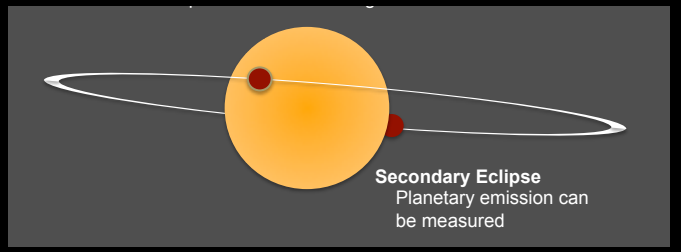
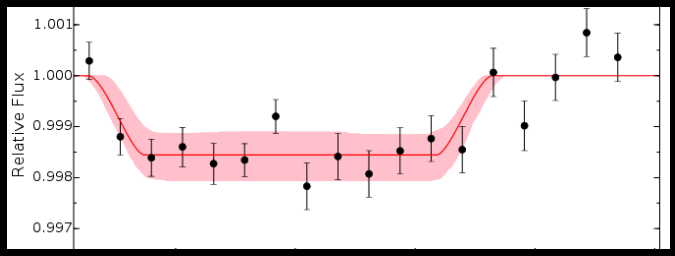




Exoplanets with Subaru

- *Near infrared M-dwarf doppler with IRD - fed by AO!*
  - Australia can contribute M dwarf candidates from FunnelWeb+TESS
- Sadly HDS not strong for this science any more - field has moved on and sub-m/s precision, needs a dedicated stabilised spectrograph
- Secondary eclipses with MOIRCS / SWIMS
  - Growth industry in the age of TESS delivering hundreds of new targets
  - Deliver J,H,K emission fluxes for the planets





Exoplanets with Subaru

ULTIMATE JHK GLAO Imaging of Clusters.

Searches for the coldest, planetary-mass members of young **star** clusters, to probe the form of the bottom of the mass function. Ultimate's ability to see faint objects (because of its excellent image quality) would make it a world leader in this science at levels fainter than J=24.

Wide-field here is critical … these clusters have low contrast on the sky, so you need to survey **large** areas. This would potentially be ULTIMATE's strength in this area over JWST.