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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Key Facilities for Australia

- **3.9m Anglo-Australian Telescope**
  - Hi-res $l_2$ 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 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

*Veloce Rosso* Fibre-IFU Feed

Sky Object Sky

- ThXe
- Laser Comb

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

- plus all possible M dwarfs to $I \sim 14$.
- 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 $\sim 5$ min - survey of $\sim 1e6$ stars/year feasible.
SWIMS/MOIRCS Astrometry & Spectra

- 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".
- 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
**Extreme Brown Dwarfs with Subaru**

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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.