The HATSouth survey

THE AUSTRALIAN NATIONAL UNIVERSITY

PRINCETON UNIVERSITY

WHY?

Goal

The primary scientific goal of the HATSouth network is to discover and characterize a large number extra-solar planets transiting nearby bright stars, and to explore their diversity.

In particular, we want to detect planets with long periods (>10 days), and reach out to small planetary radii of the order of Neptune-Super Earth size.

HOW?

The survey

HAT-South is a network of six identical, fully automated wide field telescopes, capable of 24h coverage thanks to the location of its facilities in different sites of the Southern hemisphere:

- Australia: Siding Springs Observatory
- Chile: Las Campanas Observatory
- Namibia: HESS site

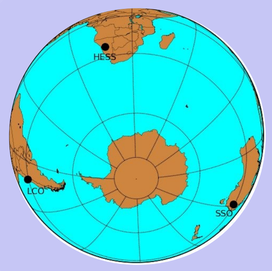


Photo credit: Gaspar Bakos

Each site has two units composed by four telescopes fixed on the same heavy mount:

- 18 cm hyperbolic Takahashi astrograph
- Apogee 4k x 4k ccd detector
- FOV 4° x 4° → a total of 8° x 8° per unit
- Resolution of 3.7 arsec per pixel

Characteristics:

- Cadence of 4 minute
- Mag range: 8 < Mv < 17
- Average of 10 hours per day of observation
- Sloan *r* filter

Bakos et al. 2013, PASP 125, 154

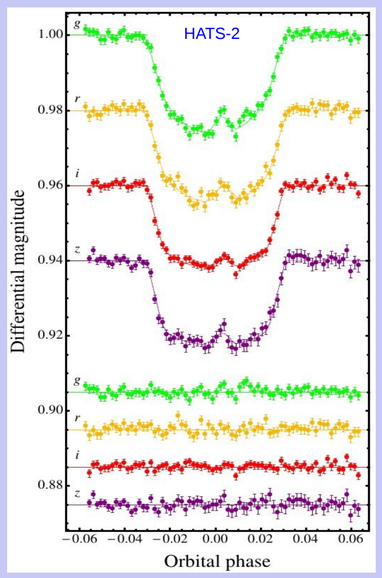
HOW?

Follow-ups

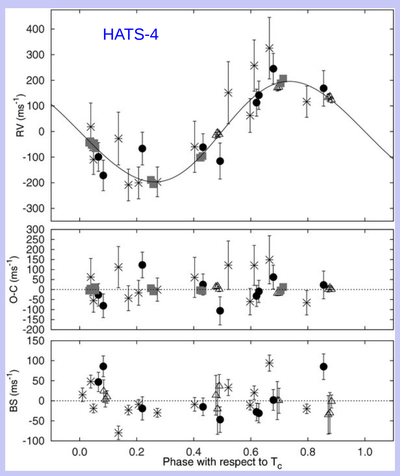
To confirm our candidates we carry out extensive photometric and spectroscopic follow-up observations in order to determine if the mass and radius of the observed object is in the planetary regime.

Photometry

- Obtain high precision photometry to determine precise orbital parameters and planetary dimensions
- Instruments:
  - Multiband photometry: GROND
  - e.g. FTS, Swope, LCOGT, PEST
  - Amateur telescope :TG Tan



Mohler-Fischer et al. 2013, A&A, 558, A55



Jordan et al. 2013, AJ, 148, 29

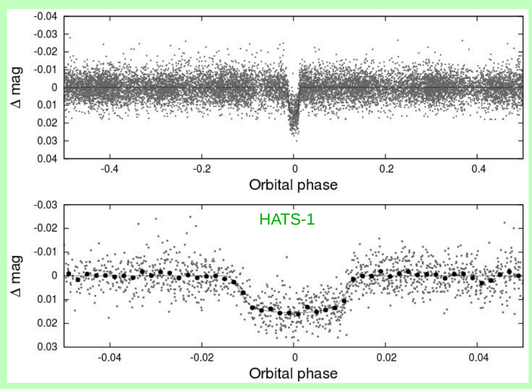
Spectroscopy

- Reconnaissance: low resolution observations
  - Rule out false positive scenario
  - Provide a first spectral classification
  - WiFeS, du Pont
- High resolution RV observations
  - Measure system's property e.g. M_P, *ecc*, *a*, ...
  - e.g. FEROS, Coralie, PFS, HARPS, HIRES

WHAT?

Achievements

The survey is more sensitive to mag around 14 region, a region which is not really explored from the other ground-based surveys



Penev et al. 2013, AJ, 145, 5

The light curves obtained have a good photometric precision: e.g. for a Mv = 12 target the rms <1%

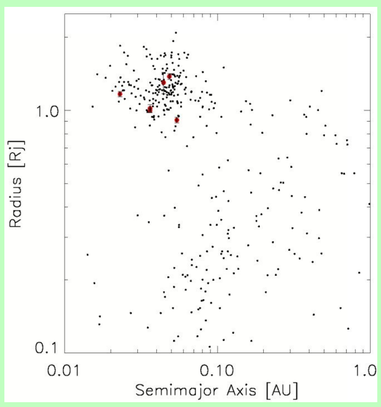
- Year by year the rate of candidate production is increasing, and thanks to several improvements of the control software, is becoming more efficient
- From the beginning of the operation 37 fields have been continuously observed for a period of 3 to 6 months

WHAT?

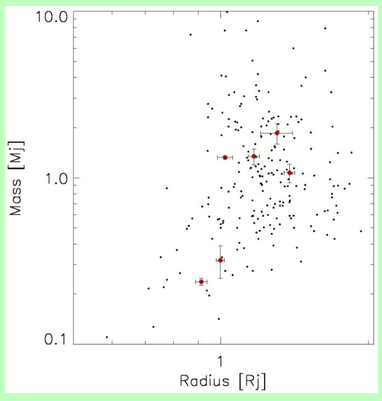
HATS planets

The survey has discovered 6 planets up to now, but many other will be announced in the next months

Planet	Mass [M_J]	Radius [R_J]	Period [days]	Host spectral class
HATS-1b	1.855	1.302	3.44646	G
HATS-2b	1.345	1.168	1.35413	K
HATS-3b	1.071	1.381	3.54785	F
HATS-4b	1.32	1.02	2.5167	G
HATS-5b	0.24	0.91	4.7634	F
HATS-6b	0.319	0.998	3.3252725	M



The six HATS planets compared to the other transiting planets so far discovered with 0.1 MJ > MP >10 MJ

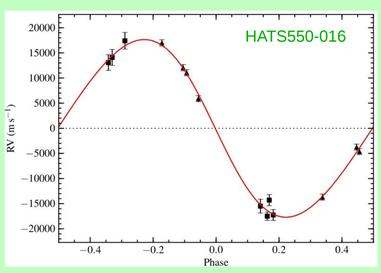


Penev et al. 2013, AJ 145, 5
Mohler-Fischer et al. 2013, A&A 558, A55
Bayliss et al. 2013, AJ 146, 113
Jordan et al. 2014, AJ 148, 29
Zhou et al. 2014, AJ 147, 144
Hartman et al. 2014, Submitted to ApJ, arXiv:1408.1758

WHAT?

M dwarfs

Thanks to our good sensitivity at the fainter regime with respect to other ground-based surveys, we detected several candidates around M dwarf stars

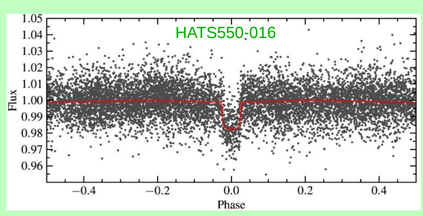


Zhou et al. 2014, MNRAS, 437, 2831

The discovery of 4 F-M eclipsing binary systems, with companions between 0.1 and 0.2 M_{sun}, allowed to better study the Mass-Radius relationship for low mass stars

HATS550-016 parameters

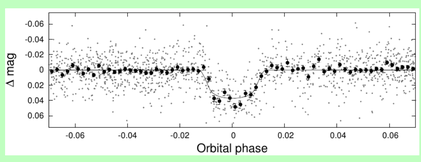
$M_1 = 0.97 \pm 0.05\ M_{sun}$
$R_1 = 1.22 \pm 0.03\ R_{sun}$
$M_2 = 0.11 \pm 0.05\ M_{sun}$
$R_2 = 0.15 \pm 0.04\ R_{sun}$



WHAT?

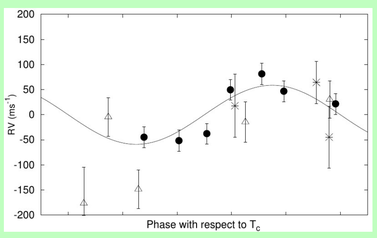
M dwarfs

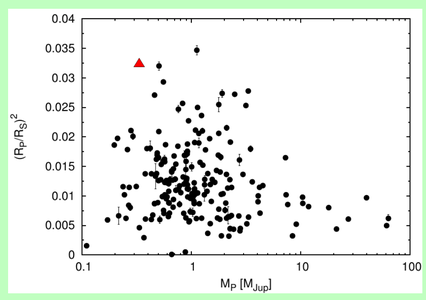
HATS-6 is a warm Saturn-like planet orbiting a M1V star



Given the high radii ratio this planet, is a very good candidate for further photometric follow up during transit or eclipse to study the planetary atmosphere

→ with new instrument e.g. MIRI @ JWST





Hartman et al. 2014, submitted to ApJ

WHO?

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