Exoplanet Transits Update

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Last Time We Discussed:

- Equipment required to detect a transit
- Using Exoplanet Transit Database for transit predictions
- Differential aperture photometry concepts
- Rev 0 Workflow
- Noise calculations
- Picking photometric aperture for best SNR
This Time We Discuss:

- Workflow in a nutshell
- Progress since last time
- Calculating orbital parameters from transit data
- Key learnings from last year

![Graph showing Relative Flux of HD189733 b with a 0.005 mag change]
My Observatory

- Paramount ME
- RCOS 12.5"
- QSI 516 wsg
- ST-402 guider
Workflow Rev 1

- Pick a star from ETD that will have a transiting planet on a given night
- Take exposures continuously during the transit and one hour on either side
- Calibrate your images—good flats are important
- Use AIP4WIN to extract differential magnitudes
- Plot in EXCEL to evaluate data
- Upload to ETD (JD, differential mag, 1-sigma)
- Get curve fit, midpoint, depth, and duration
Variable Star and Exoplanet Section
of Czech Astronomical Society

ETD - Exoplanet Transit Database

known transits:
CarT-1 b
CarT-10 b
CarT-11 b
CarT-12 b
CarT-13 b
CarT-2 b
CarT-3 b
CarT-4 b
CarT-5 b
CarT-6 b
CarT-7 b
CarT-8 b
CarT-9 b
GJ1214 b
HAT-P-1 b
HAT-P-10/WASP-11 b
HAT-P-11 b
HAT-P-12 b
HAT-P-13 b
HAT-P-14 b
HAT-P-15 b
HAT-P-16 b
HAT-P-2 b
HAT-P-3 b
HAT-P-4 b
HAT-P-5 b
HAT-P-7 b
HAT-P-8 b
HAT-P-9 b
HD149026 b
HD17165 b
HD189733 b
HD209458 b
HD99066 b
Kepler-4 b
Kepler-5 b
Kepler-6 b
Kepler-7 b
Kepler-8 b
LUPUS.TR-3 b
OGLE-TR-10 b
OGLE-TR-11 b
OGLE-TR-113 b
OGLE-TR-121 b
OGLE-TR-181 b
OGLE-TR-211 b

ETD - Exoplanet Transit Database

Announce us paper with transits | How to contribute to ETD | Model-fit your data | transit predictions

Available predictions: (UT evening date)
2010-07: 25, 26, 27, 28, 29, 30, 31,
2010-08: 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,

User defined time span: From: YYYY-MM-DD Till: YYYY-MM-DD Show

Transits predictions for ELONGITUDE: -122° and LATITUDE: 45°

Object: Kepler-4 b
Elong: 73° W
Mag: 8.3

Object: WASP-2 b
Elong: 52° S
Mag: 8.8

Object: WASP-33 b
Elong: 52° S
Mag: 9.3


OMSI Astrophotography Conference
2011
Light Curves Page 1

- WASP-10 b
- TrES-3 b
- TrES-2 b
- HD189733 b
- TrES-4 b
- HAT-P-14 b
Light Curves Page 2

- CoRoT-2 b
- WASP-33 b
- WASP-1 b
- HAT-P-8 b
- HAT-P-1 b
- HAT-P-6 b
Orbital Parameters

• Using the transit data and some assumptions you can calculate several orbital parameters:
  – Orbital inclination (i)
  – Radius of the planet (Rp)
  – Orbital radius or semi-major axis (a)

• You can also estimate:
  – Mass and radius of the host star

• The main assumption uses a stellar mass-radius relation for main sequence stars
Orbital Parameters

\[ i = \text{orbital inclination} \]

\[ a \]

\[ Rp \]

\[ \text{eye} \]

\[ i = 83.6^\circ \quad \text{TrES-3 b} \]

\[ i = 88.7^\circ \quad \text{WASP-1 b} \]
Transit Geometry

\[ \Delta F = \frac{F_0 - F_1}{F_0} = \left( \frac{R_p}{R^*} \right)^2 \]

\[ V = \frac{2\pi a}{P} \]

\[ P^2 = \frac{4\pi^2 a^3}{G(M^* + M_p)} \]

\[ \frac{R_p}{R_s} = \left( \frac{\rho^*}{\rho_s} \right)^{-0.57} \sqrt{\Delta F} \]

See Seager et al. (12)
Planet Radius vs. Semi-Major Axis—Calculated vs. Catalog

See http://exoplanet.eu/catalog.php for catalog values
Effects of Air Mass (Altitude)

WASP-1 b Residuals & Airmass vs. Time

- Residuals (mag)
- Air Mass

- 17°
- 22°
- 34°
- 46°
- 58°
- 69°
- 77°

Time (JD +2455406)
Key Learnings

- Good light curves are surprisingly easy to get
- Seeing seems to be the main variable in data quality
- Try to image above 45° to minimize data spread
- If your data points don’t line up after a meridian flip, you need new flats
References

2. Castellano et al. Detection of Extrasolar Giant Planets With Inexpensive Telescopes and CCDs. J. AAVSO Volume 33, 2004
6. Buchheim, Robert. The Sky is Your Laboratory.

This research has made use of NASA's Astrophysics Data System
References (cont.)


This research has made use of NASA’s Astrophysics Data System
Backup Slides
### Transit Data

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