

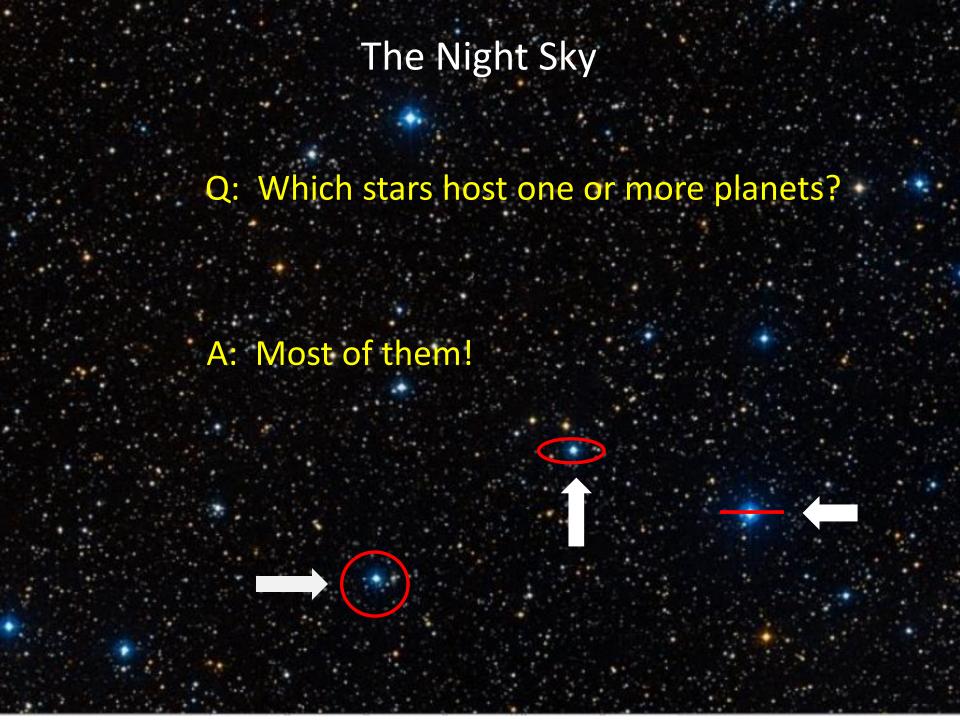
# The Role of Amateur Astronomers in Exoplanet Research

Dennis M. Conti Chair, AAVSO Exoplanet Section June 17, 2016

## Overview

- What roles do amateur astronomers play in exoplanet research?
- How do we do exoplanet observations?
- What does the future hold?

(See paper in the SAS Proceedings for details on background, best practices, techniques, etc.)



## Roles of Amateur Astronomers

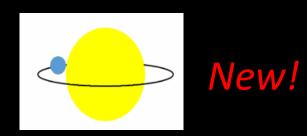
1. Confirm

Exoplanet Candidates

2. Refine

**Exoplanet Ephemeris** 

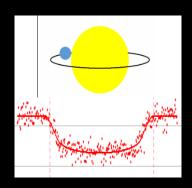
3. Discover



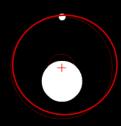
4. Help characterize other "Exo-Objects"

# **Exoplanet Detection Methods**

- Transit Method:
  - the dominant method used by amateur astronomers



Radial Velocity Method



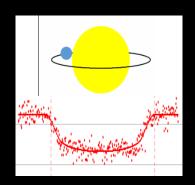
Microlensing



Direct Imaging

# **Exoplanet Detection Methods**

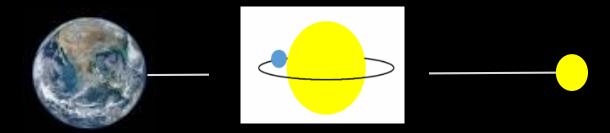
- Transit Method:
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Radial Velocity Method



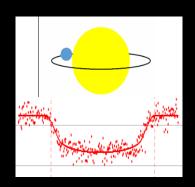
Microlensing



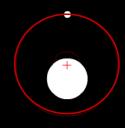
Direct Imaging

# **Exoplanet Detection Methods**

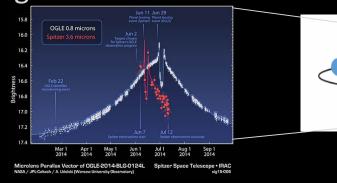
- Transit Method:
  - the dominant method used by amateur astronomers



Radial Velocity Method



Microlensing



Direct Imaging

# Examples of Pro/Am Collaborations

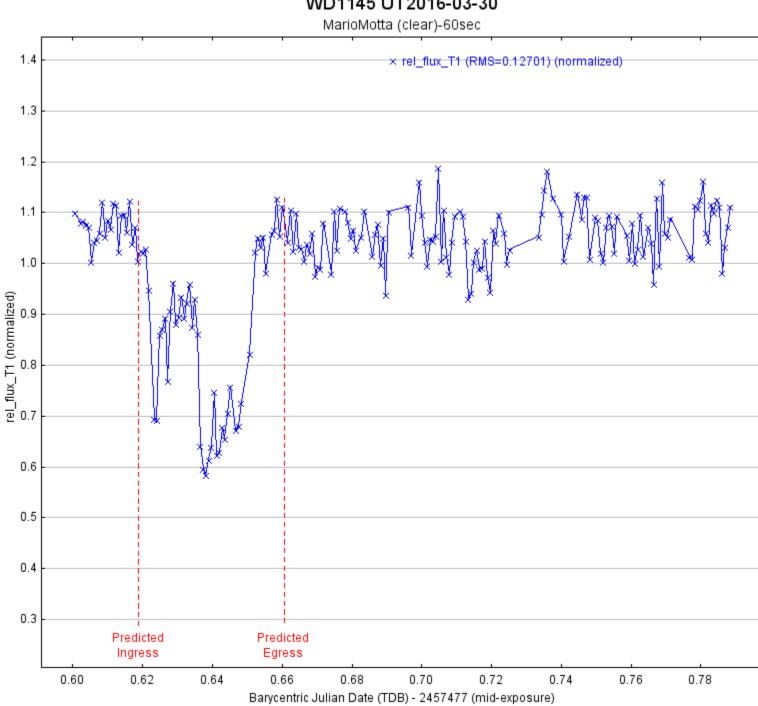
- KELT Follow-up Network
- Hubble Near-Infrared Study of 15 Exoplanet Atmospheres
- Study of WD1145+017

Sample Observations

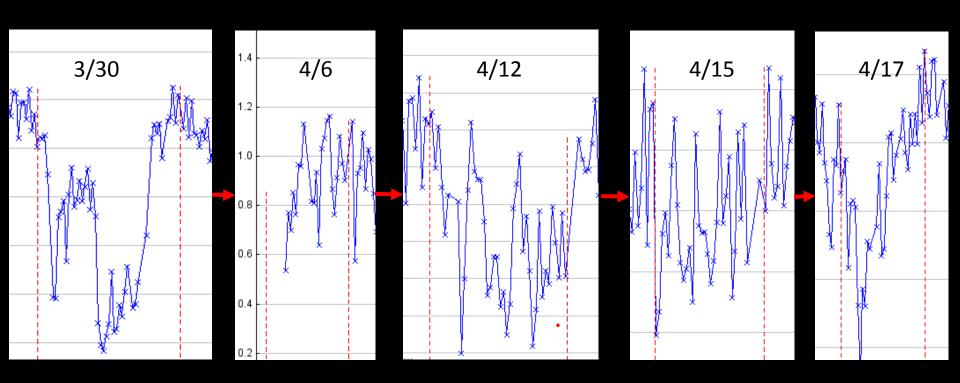
#### WASP-12b on UT2016-01-06

Conti (V, 45 sec) rel flux T1 (normalized) rel\_flux\_T1 (AIRMASS detrended with transit fit) (RMS=0.00397) (normalized) 1.06 rel\_flux\_T1 Transit Model ([P=1.09], (Rp/R\*)^2=0.0127, a/R\*=3.2, i=90.0, Tc=2457393.601228, [u1=0.39], [u2=0.3]) o rel\_flux\_T1 Residuals (RMS=0.00397) (chi^2/dof=2.09) • rel\_flux\_C2 (AIRMASS detrended) (RMS=0.00366) (normalized) x(0.5) (bin size = 2) 1.04 • rel\_flux\_C3 (AIRMASS detrended) (RMS=0.00343) (normalized) x(0.5) (bin size = 2) rel\_flux\_C4 (AIRMASS detrended) (RMS=0.00428) (normalized) x(0.5) (bin size = 2) - AIRMASS (arbitrarily scaled and shifted) 1.02 · tot\_C\_cnts (arbitrarily scaled and shifted) 1.00 0.98 0.96 nel\_flux\_T1 (normalized) 0.90 0.90 0.88 0.86 0.84 promise and the second of the 0.82 0.80 Predicted Ingress 0.78 0.52 0.62 0.50 0.54 0.56 0.58 0.60 0.64 0.66 0.68 0.70 Barycentric Julian Date (TDB) - 2457393 (mid-exposure)

#### WD1145 UT2016-03-30



# WD-1145+017 Observations



Courtesy of Mario Motta

## **Observational Considerations**

Use virtually the same equipment as for deep sky imaging

### However:

- Need accurate timing
- Want minimal image movement on the CCD detector
- Need to stay within the linearity of the CCD detector
- Need FWHM to span multiple pixels



## Summary

- Amateur astronomers are able to conduct exoplanet transit observations with amazing accuracy
- Their contribution to exoplanet research continues to be of value to professional astronomers
- The need for such observations in the near future will continue to grow
- Amateur astronomers' contribution to exoplanet research beyond just the transit method is promising

## Resources

- www.aavso.org/exoplanet-section
- www.astrodennis.com
  - "A Practical Guide to Exoplanet Observing"
  - Worksheets
  - Other presentations, tutorials