

# Searching for Extra-Solar Planets via the Transit Method

C. L. Griffis and C. H. S. Lacy

Arkansas-Oklahoma Center for Space and Planetary Sciences and  
the Department of Physics, University of Arkansas, Fayetteville,  
Arkansas 72701.



# Overview:

- Introduction
- The Transit Method
- The Transit of HD 209458
- Current Target:
  - HD 130322
  - Results of Observations
- Conclusion

# Introduction: A Brief History

- First extra-solar planet was found in 1995 using precise radial velocity measurements
- Radial velocity data enabled astronomers to analyze the “wobble” of a star due to the orbiting planet
- Made it possible to determine orbital radius, orbital period, and mass limit of planet
- Since 1995, 117 planets have been found in 102 systems [1]
- Recently the transit method has been employed to study the systems known to have planets
- The transit method allows astronomers to find out more about the planet, such as radius, density, and gravity.

# The Transit Method:

## Step 1:

- Observe a star known to have a planet during the predicted time of transit
- Observe the same star again when the planet is not in transit
- Measure the apparent magnitudes of the variable star (HD 130322) and of a control star (SAO 140139) for the afore mentioned observations

## Step 2:

- Compute the difference magnitude by subtracting the apparent magnitude of the control star from the apparent magnitude of the variable star
- This step helps counter atmospheric interference

# The Transit Method: (Cont.)

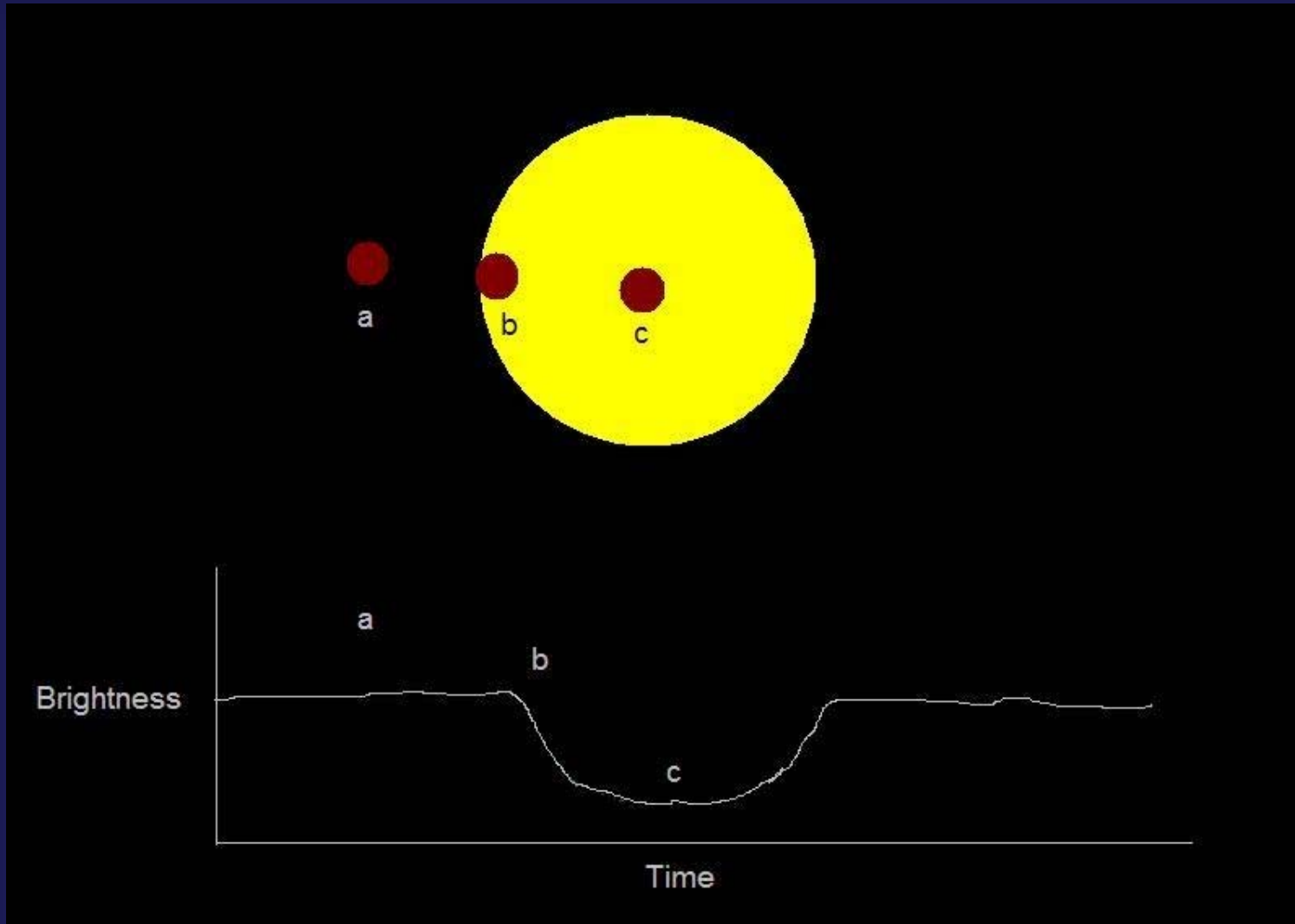
## Step 3:

- Calculate the orbital phase for each image
  - $\text{FRAC}[(t-T_1)/p]$ 
    - $t$  = Date of observation (Heliocentric Julian Date (HJD))
    - $T_1$  = Date of periastron (HJD)
    - $p$  = Orbital period (days)

# The Transit Method: (Cont.)

## Step 4:

- Generate light-curves
  - This consists of plotting the difference magnitudes verses the orbital phases
- If a transit has been captured, there will be a drop in brightness shown on the light-curve
- If no transit was captured, then the light-curve will be a fairly straight line



Example of a planetary transit and the corresponding light-curve

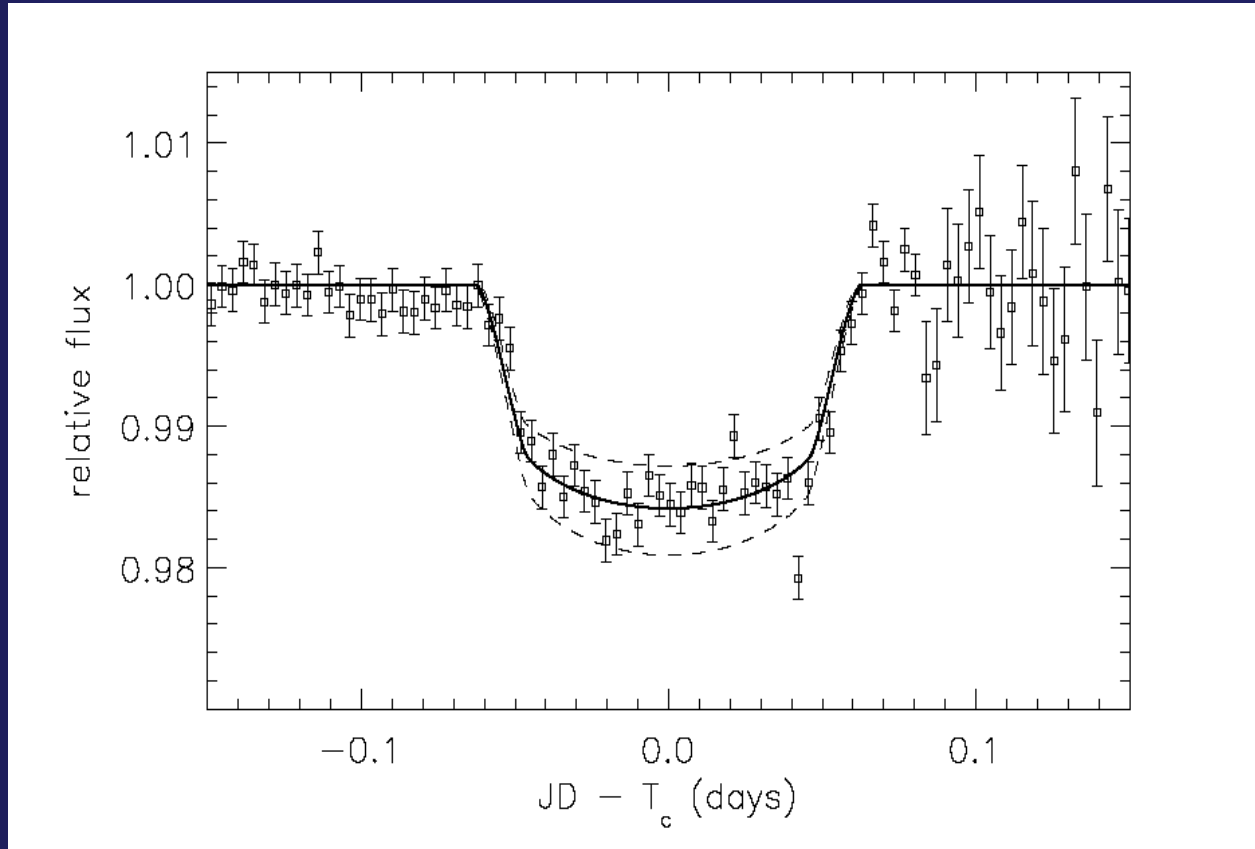
# The Transit of HD 209458:

- The first extra-solar planetary transit was observed in September of 1999
- Allowed astronomers to calculate more detailed physical properties of the planet [2]
  - mass =  $0.63 M_{\text{Jup}}$
  - radius =  $1.27 R_{\text{Jup}}$
  - gravity =  $970 \text{ cm/s}^2$
  - density =  $0.38 \text{ g/cm}^3$



Image of HD 209458

# The Transit of HD 209458: (Cont.)



Superposition of the light-curves from HD 209458 showing the transits observed on September 9 and September 16 of 1999 [2]

# Current Target: HD 130322:

- Why HD 130322?
  - Best candidate visible in our area
  - 4% chance of transit
  - Orbital period of 10.724 days



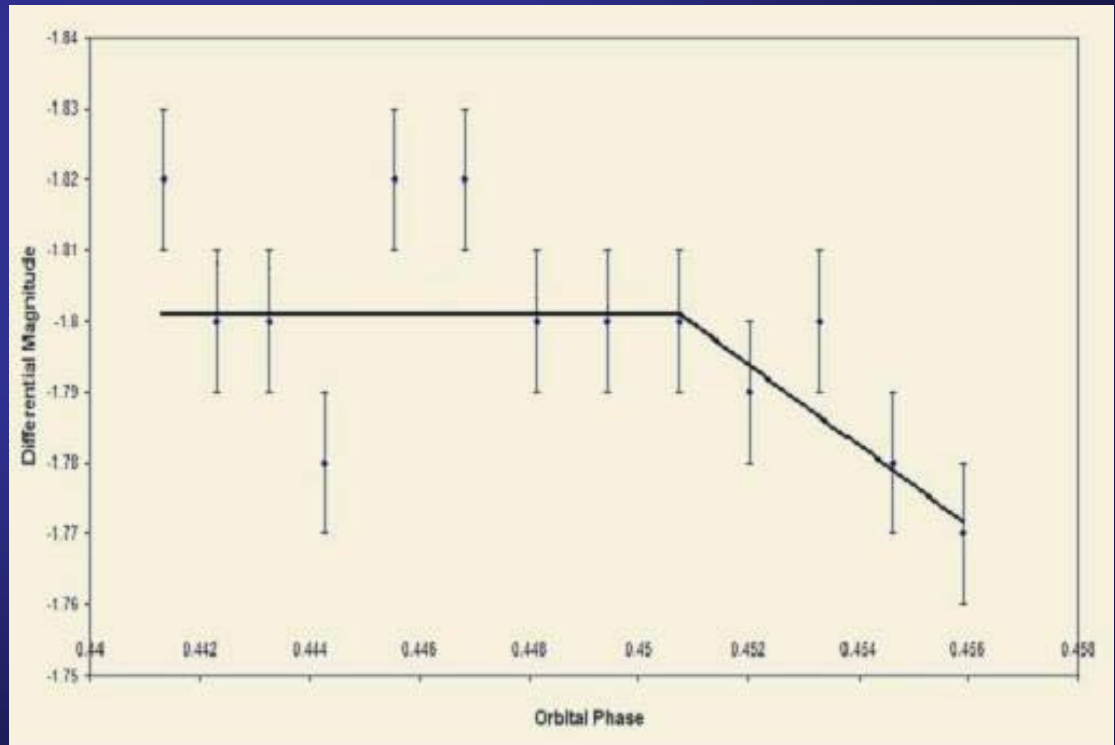
Image of HD 130322 and SAO 140139

- What did we use?
  - Mead LX200 10-inch telescope with attached SBIG camera with UBVRI filters
  - Images processed using SBIG software CCDOPS Version 5 for Windows

# Current Target: Results of Observations:

- What did we find?

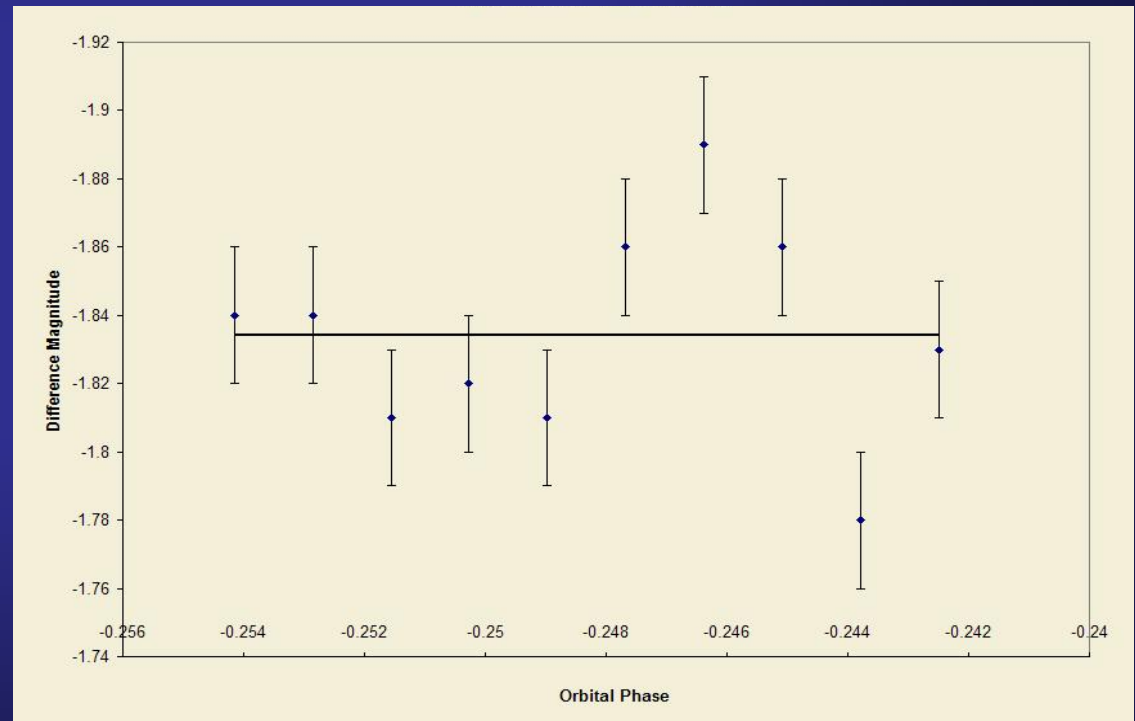
- Light-curve from June 27 UT suggests the possibility that the beginnings of a transit were captured
- Flux is relatively stable in beginning but drops off sharply near the end



Light-curve of HD 130322 from June 27 UT

# Current Target: Results of Observations: (Cont.)

- What did we find? (Cont.)
  - Light-curve from nights when the planet was not predicted to be in transit show little variation in flux.
  - Light-curve from July 11 UT is the best example of this



Light-curve of HD 130322 from July 11 UT

## Conclusion:

- Results are by no means conclusive
- At most, they show that HD 130322 warrants further study
- If a complete transit could be captured, it would be only the second known extra-solar transiting planet



Artist's View of Planet around the Star HD 209458

NASA and G. Bacon (STScI) • STScI-PRC01-38

## References:

- [1] Extrasolar Planets Encyclopedia, [www.obspm.fr/planets](http://www.obspm.fr/planets), maintained by Jean Schneider, © 1996, Observatoire de Paris.
- [2] D. Charbonneau *et al.* (1999) *Detection of Planetary Transits Across a Sun-like Star*, *Astrophysical Journal Letters*.

## Acknowledgements:

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