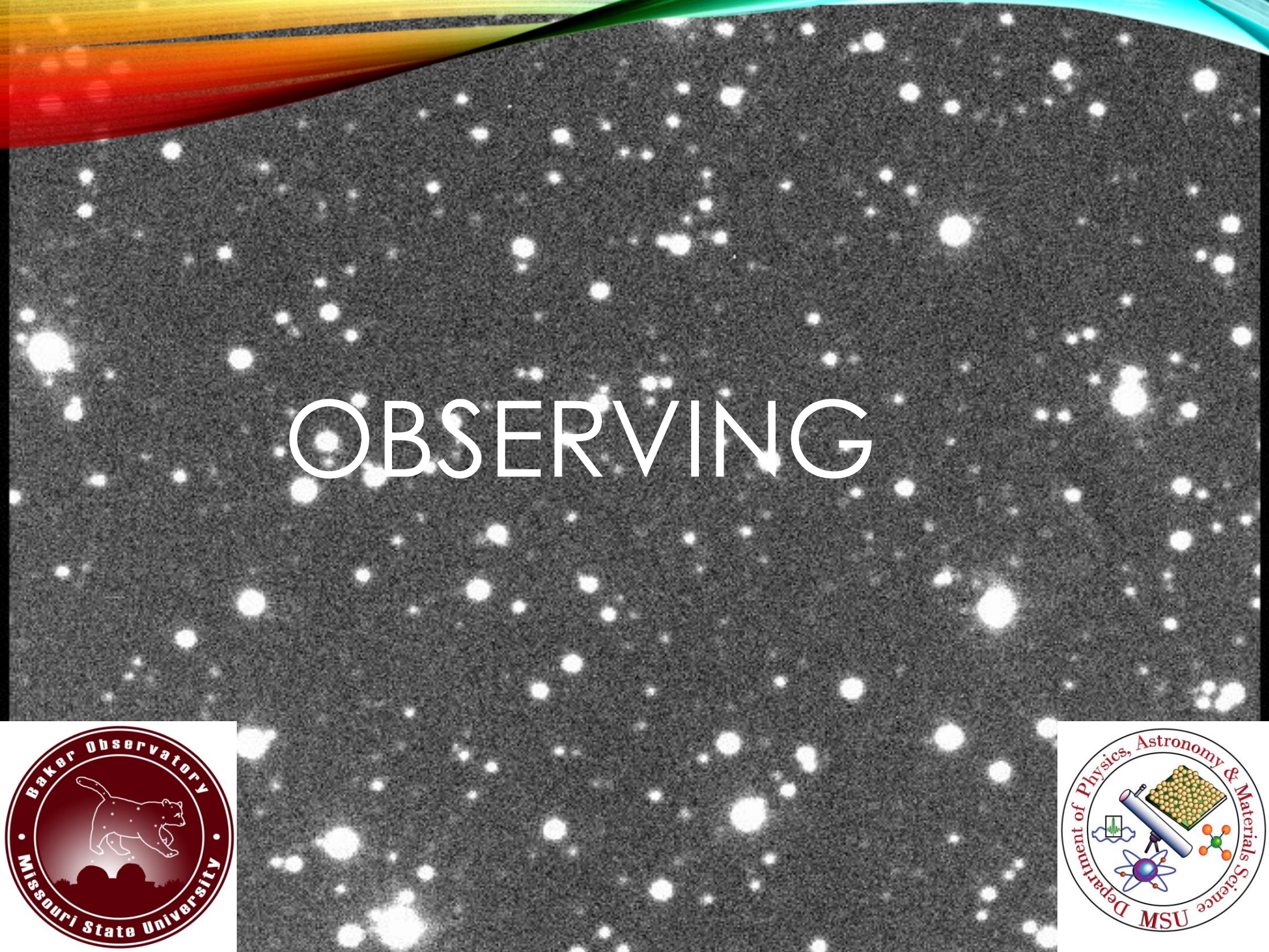
OBSERVING



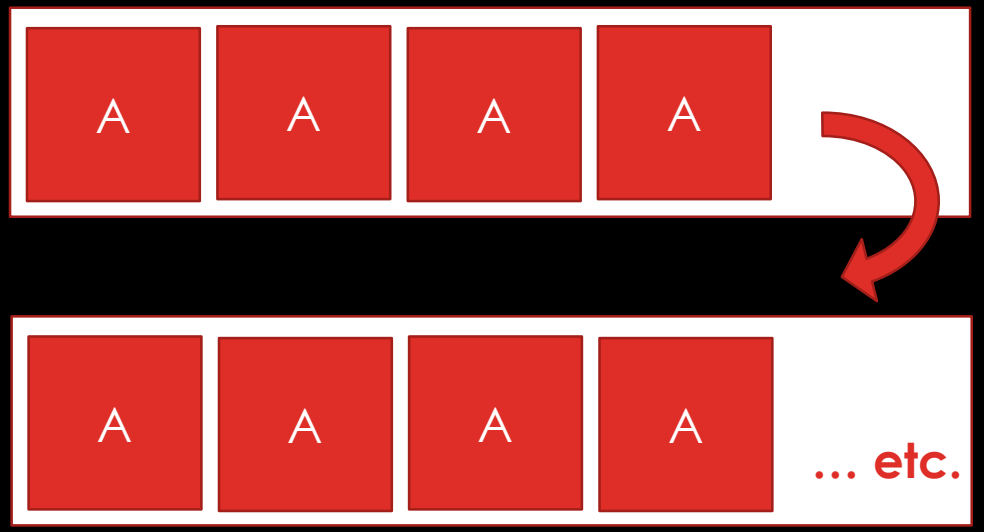
OBSERVING MODES

Series

- multiple targets during a night
- sets of ~10 images per filter

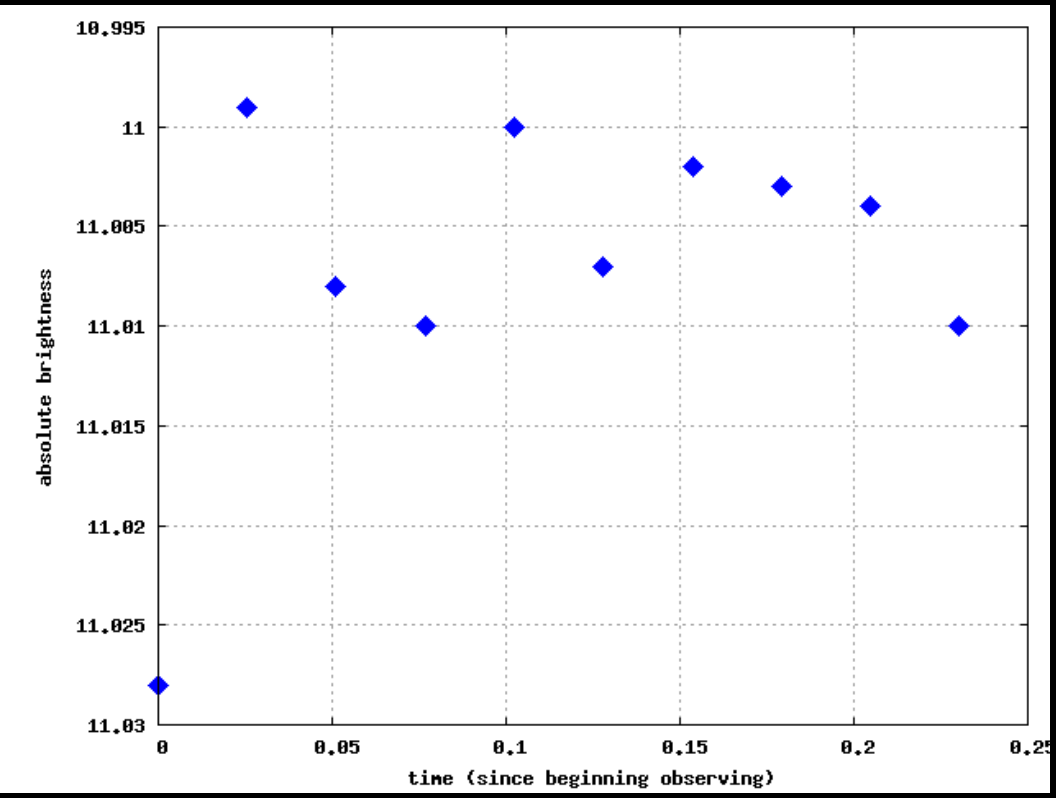
Continuous

- one target during a night
- as many images as possible



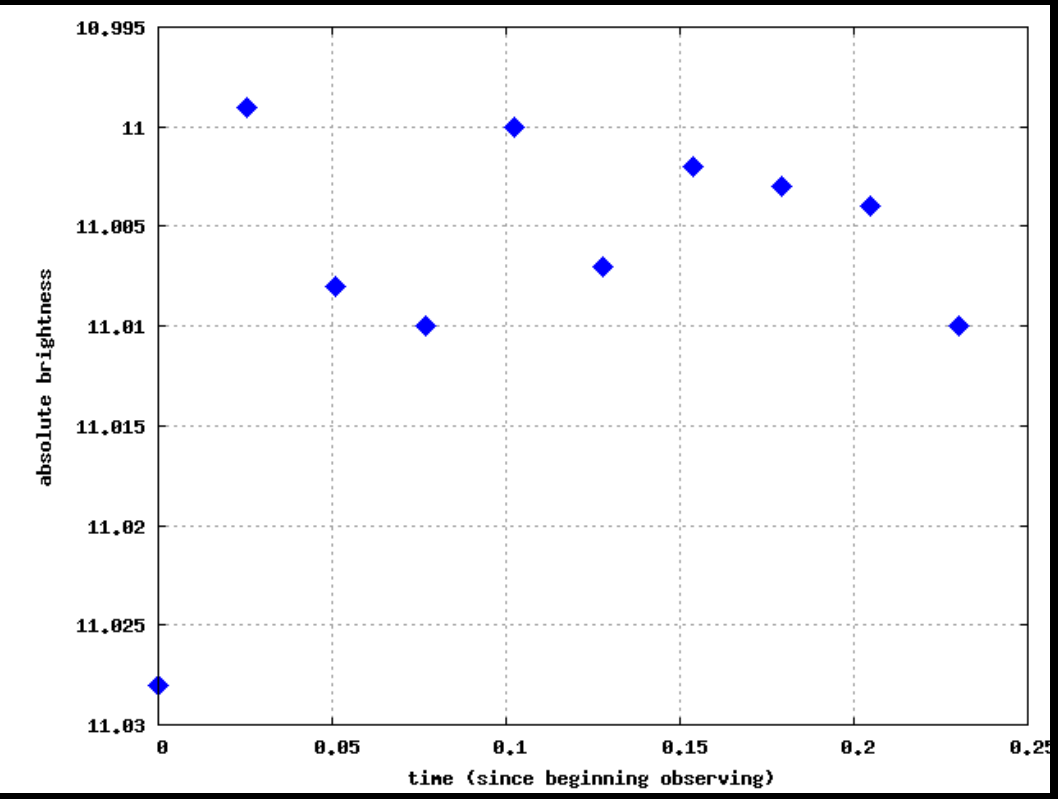
TARGET A: WASP-14 SERIES MODE 01AUG13

unbinned

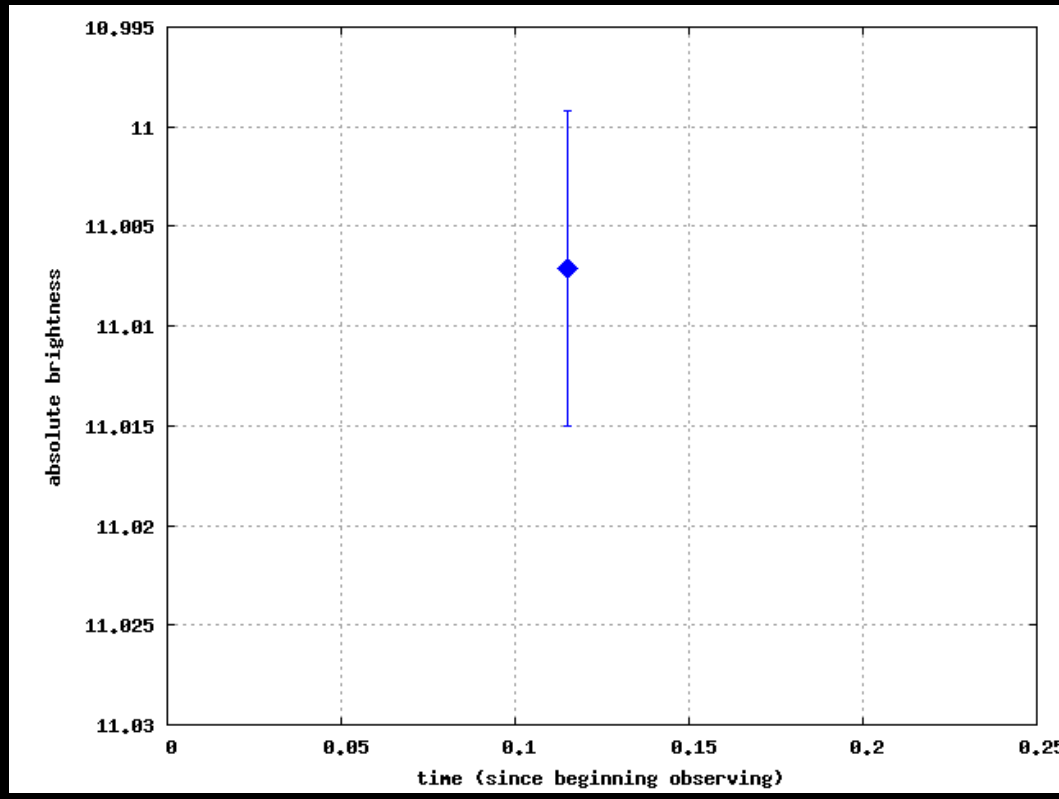


TARGET A: WASP-14 SERIES MODE 01AUG13

unbinned

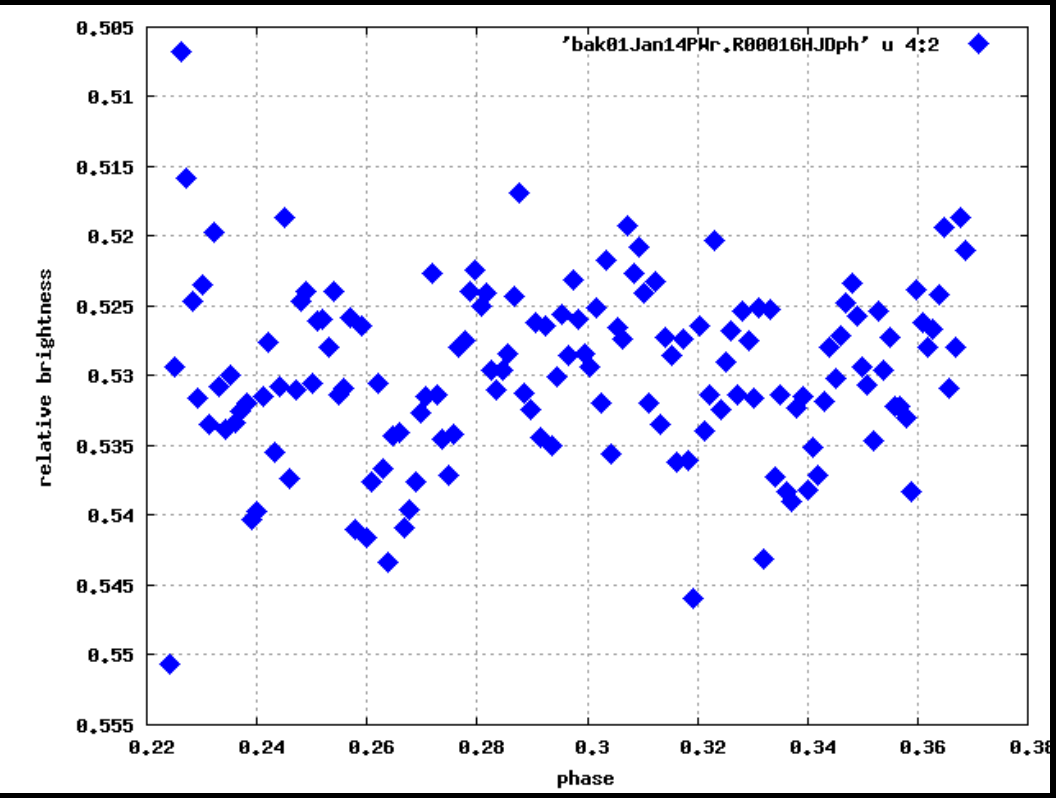


binned



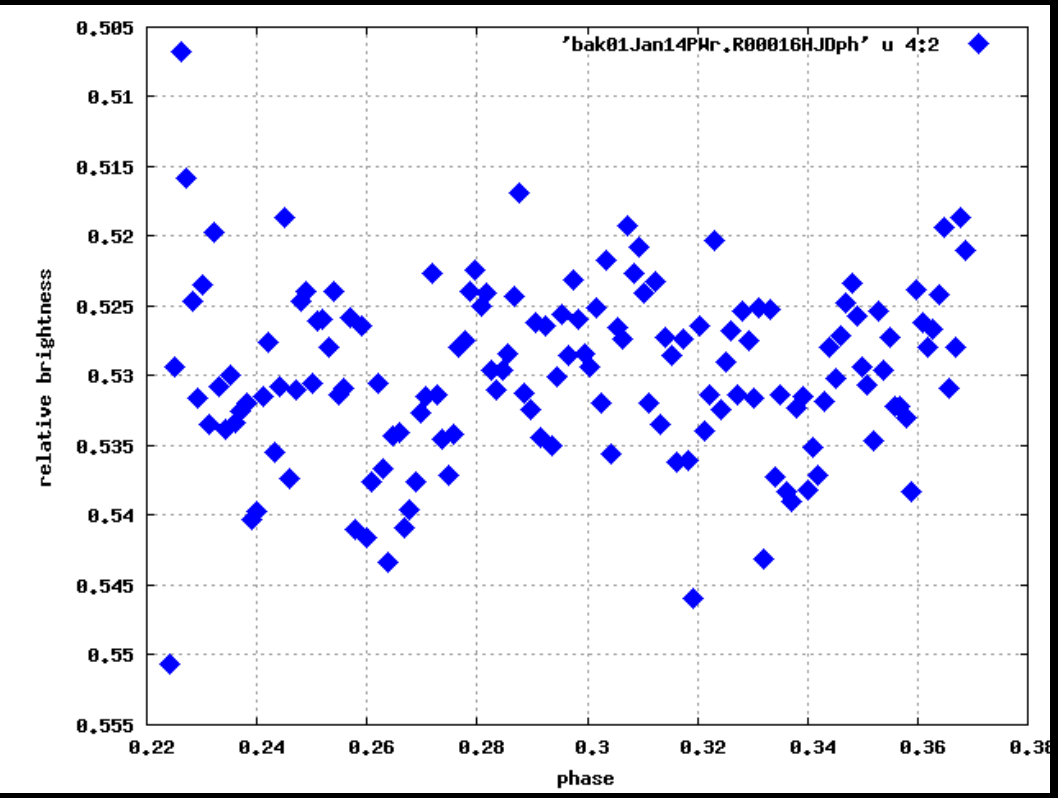
TARGET W: COROT-1 CONTINUOUS MODE 01JAN14

unbinned

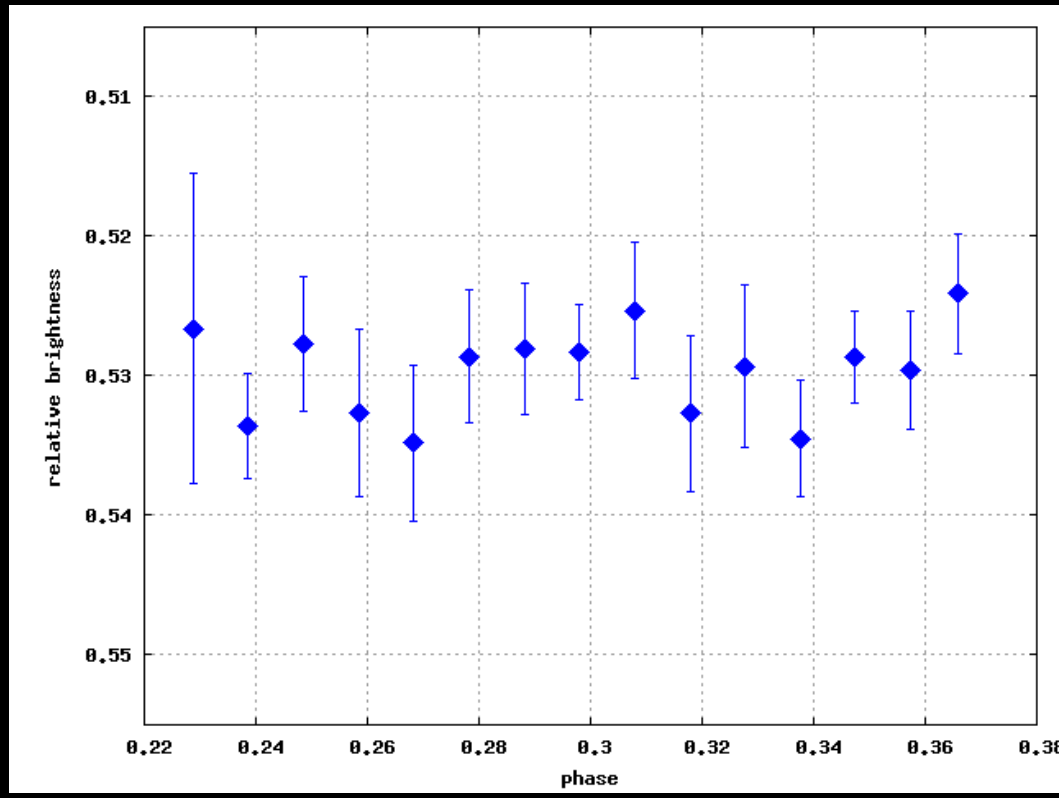


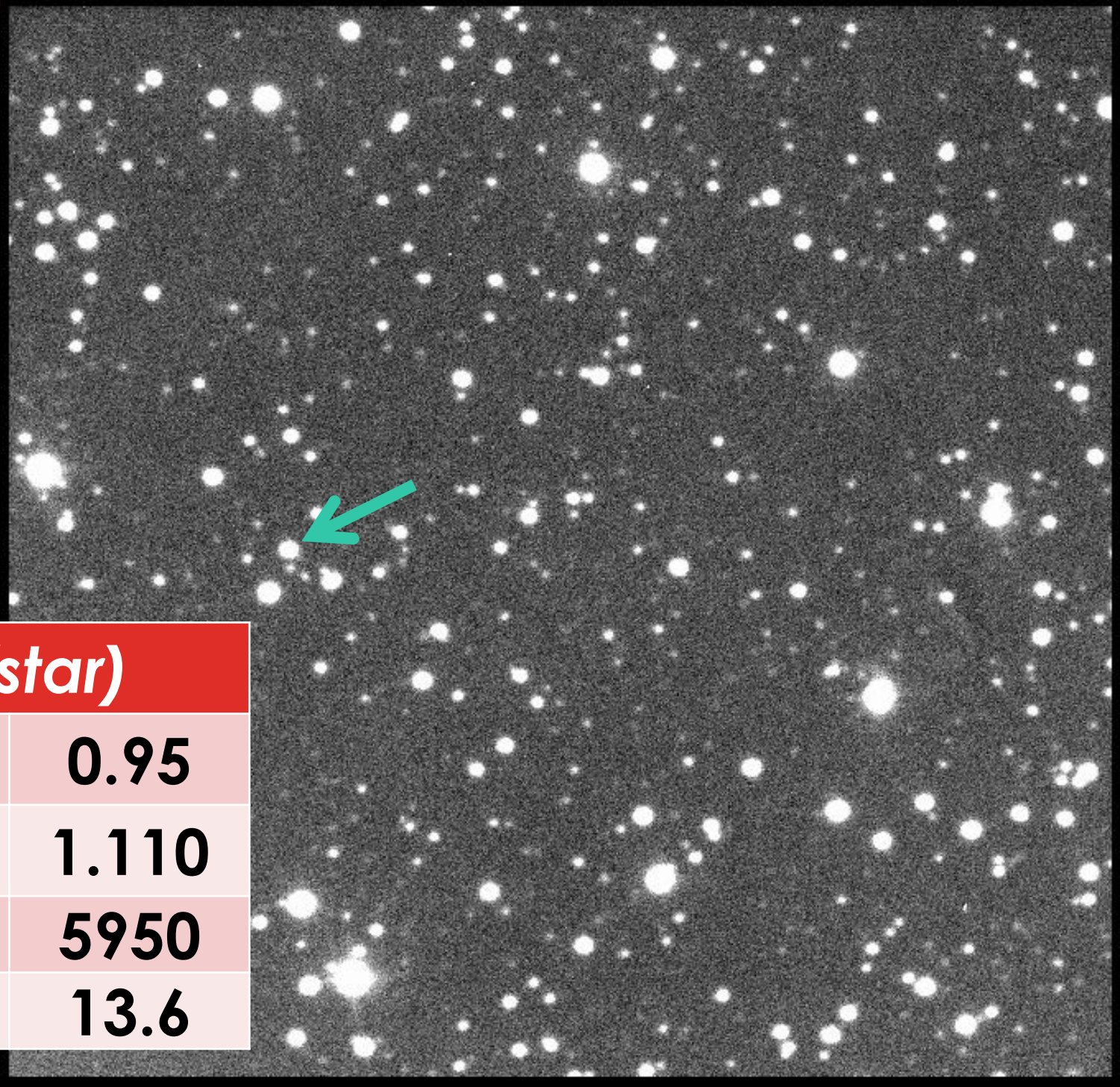
TARGET W: COROT-1 CONTINUOUS MODE 01JAN14

unbinned



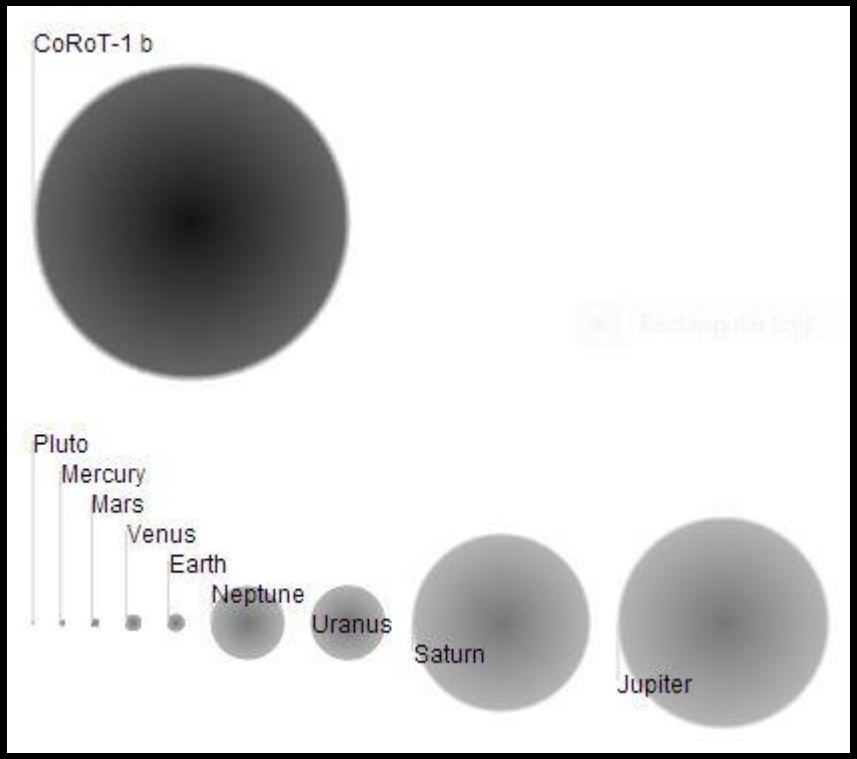
binned





CoRoT-1 (star)	
Mass ($M_\odot$)	0.95
Radius ($R_\odot$)	1.110
T_{eff} (K)	5950
V mag	13.6

CoRoT-1b (planet)	
Midtransit Time (d)	2454159.4532
Transit Duration (h)	2.51
Mass (M_J)	1.03
Radius (R_J)	1.49
Semi-Major Axis (AU)	0.0253
Orbital Period (d)	1.51



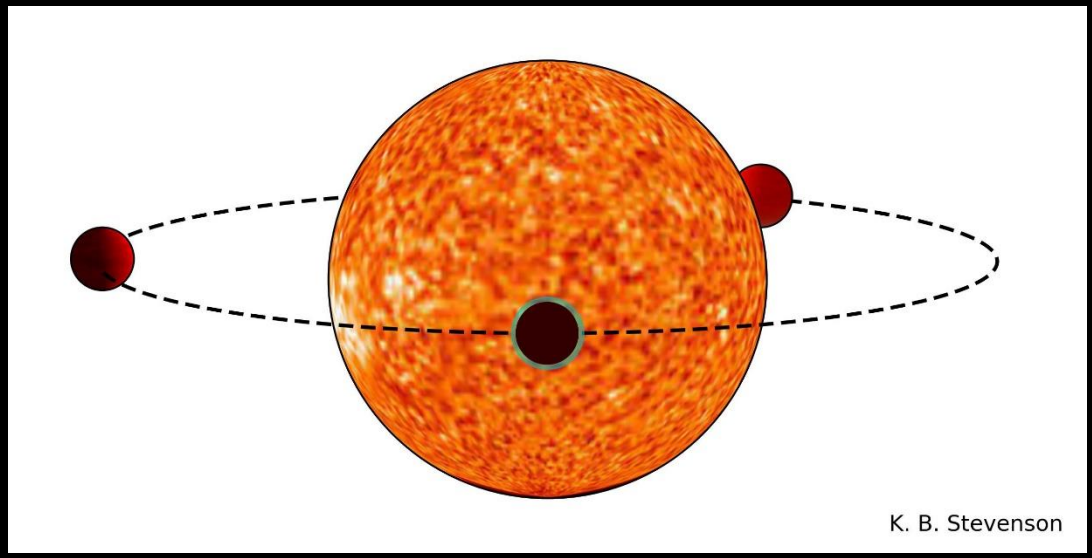
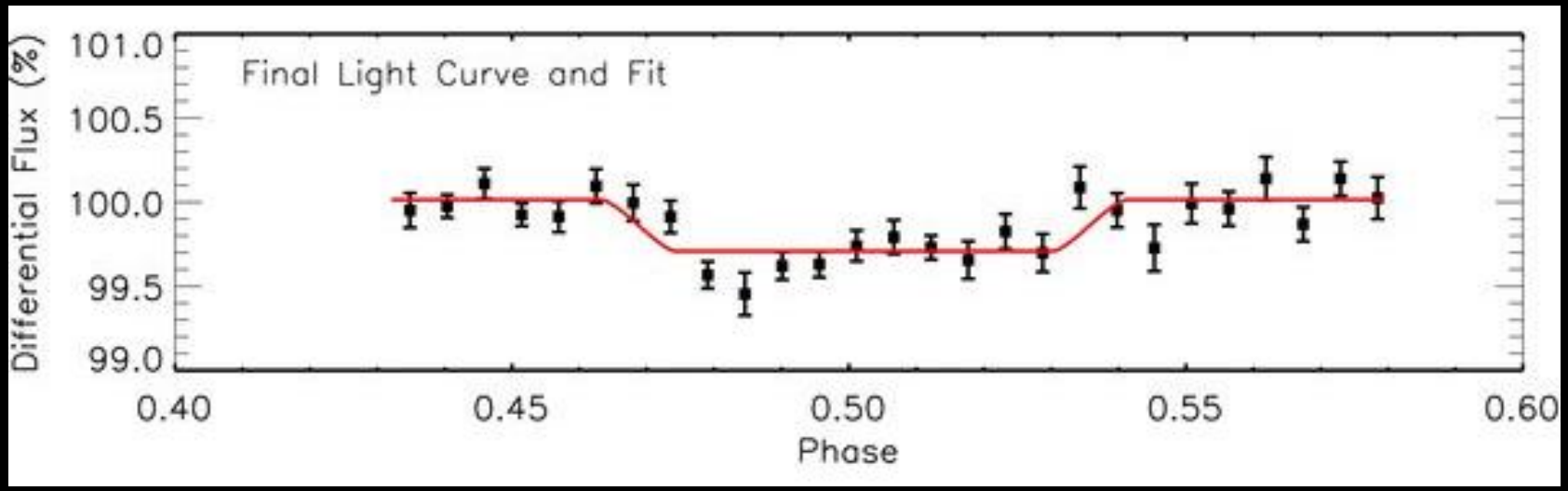


Table info: http://exoplanets.org/detail/CoRoT-1_b
Size diagram: http://www.openexoplanetcatalogue.com/system.html?id=CoRoT-1+b
Transit diagram: http://astro.uchicago.edu/~kbs/research.html

COROT 1B – EXISTING RESULTS

KS-BAND DETECTION OF THERMAL EMISSION AND COLOR CONSTRAINTS TO COROT-1B: … *ROGERS ET AL. 2009, 2010*

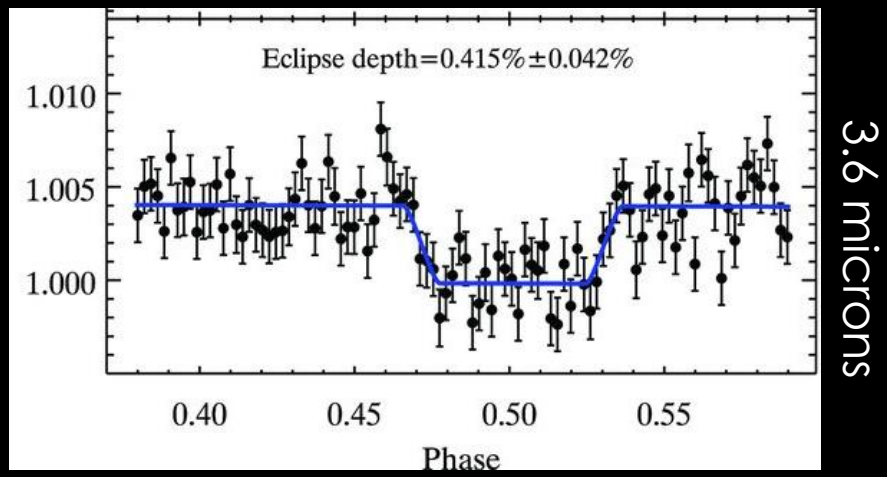
- ARC 3.5m at Apache Point Observatory
- Eclipse depth: 0.336 ± 0.042%
- Bond albedo: $0.050\ ^{+0.093}_{-0.050}$
- Blackbody model temperature: $2310\ ^{+30}_{-60}$

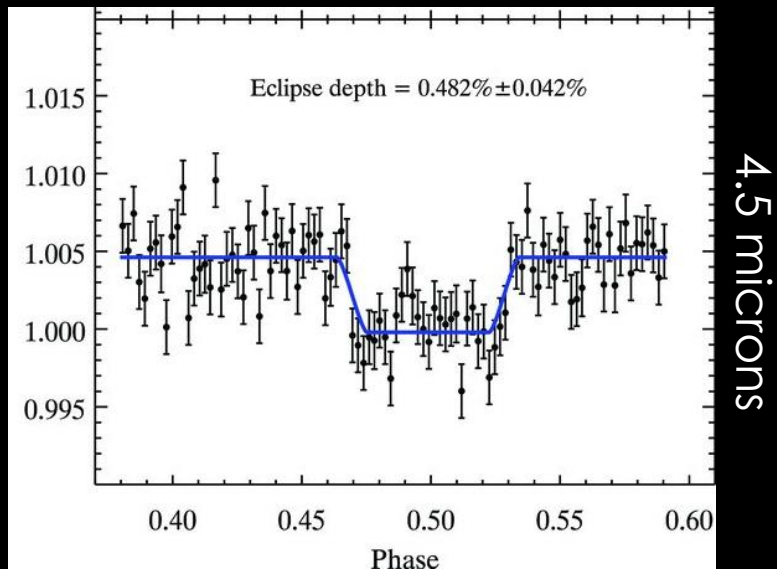


COROT 1B – EXISTING RESULTS

WARM *SPITZER* PHOTOMETRY OF THE TRANSITING EXOPLANETS COROT-1 AND COROT-2 AT SECONDARY ECLIPSE

DEMING ET AL. 2011





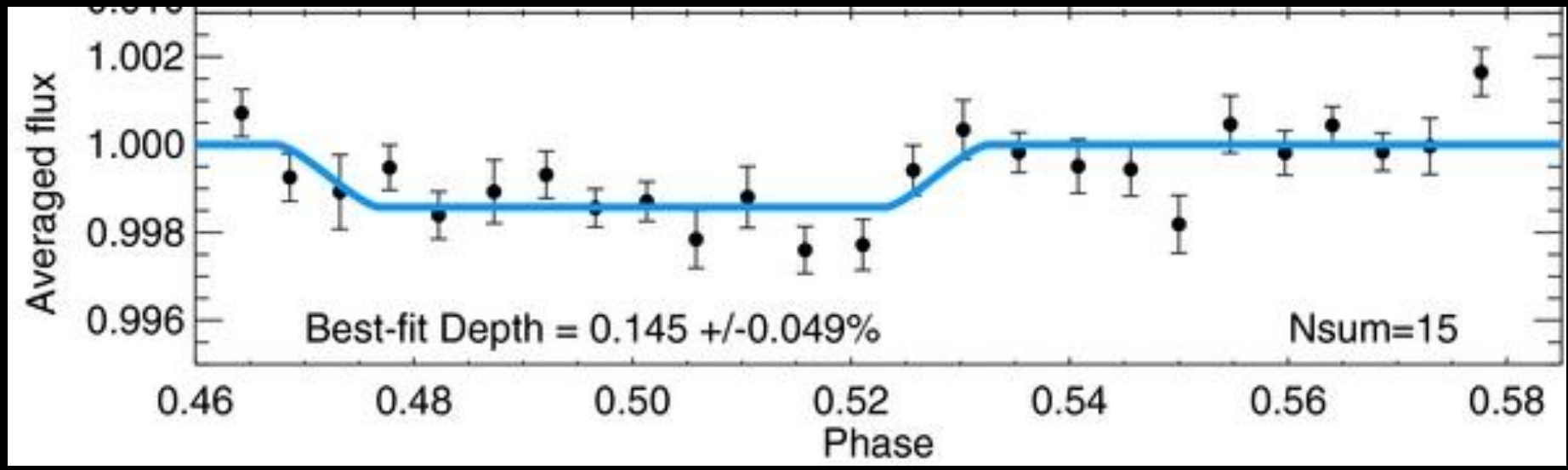
- Orbit close to circular
- Blackbody temperature: 2460 K
- Supports Bond albedo <10%

COROT 1B – EXISTING RESULTS

GROUND-BASED DETECTIONS OF THERMAL EMISSION FROM COROT-1B AND WASP-12B

ZHAO ET AL. 2012

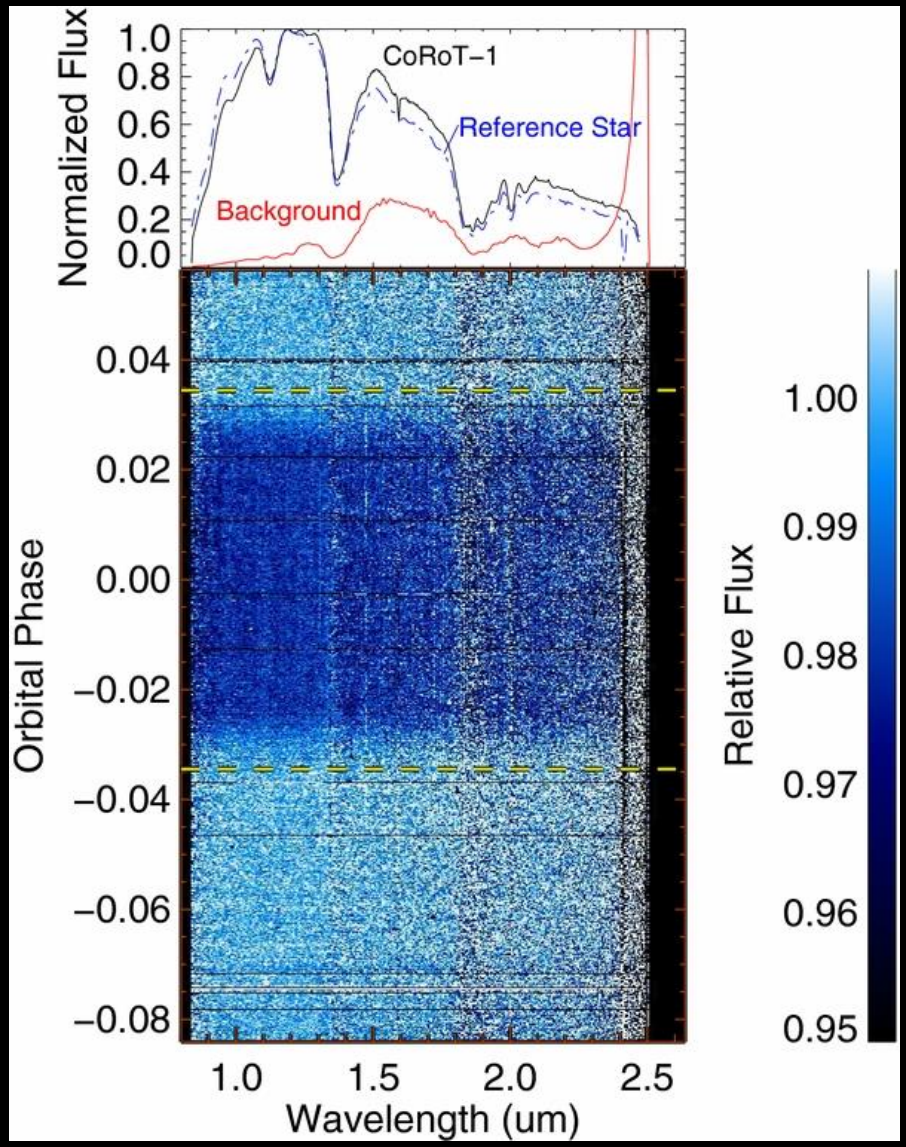
- Thermal emission at secondary eclipse
- Palomar 200 inch
- H-band (1.635 microns)



COROT 1B – EXISTING RESULTS

A 0.8-2.4μm TRANSMISSION SPECTRUM OF THE HOT JUPITER COROT-1B

SCHLAWIN ET AL. 2014



- Disfavors TiO/VO spectrum
- Possibly some other absorber causing a temperature inversion

ALBEDO VS. PLANET BRIGHTNESS

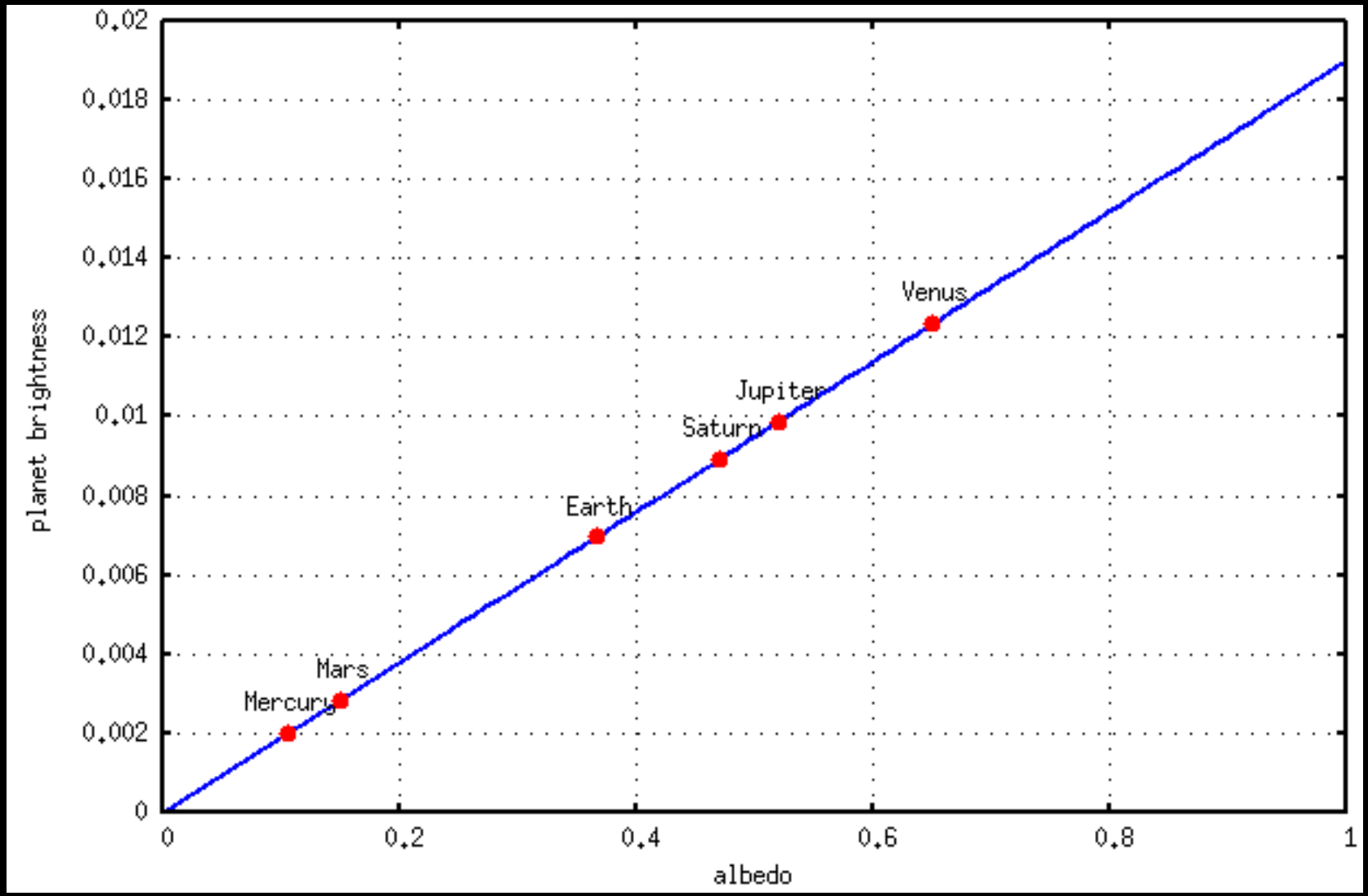


IMAGE PROCESSING – CCD LAYERS

- Sky – stray light evenly spread across the image
- Flats – pixels have varied sensitivities due to pixel itself or specks of dust, bright blank exposures
- Dark current – electronic noise that accumulates over time, long exposures with shutter closed
- Bias level – noise from electricity, zero length exposure

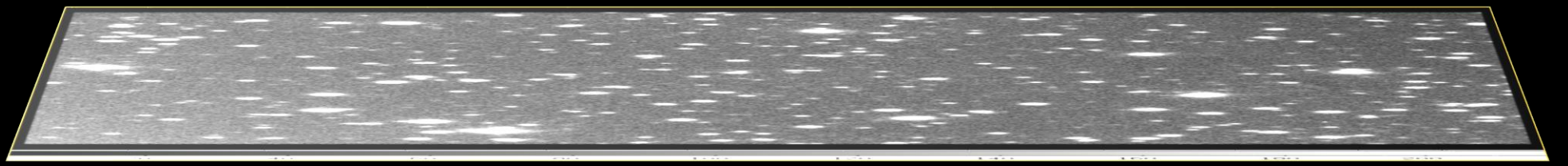
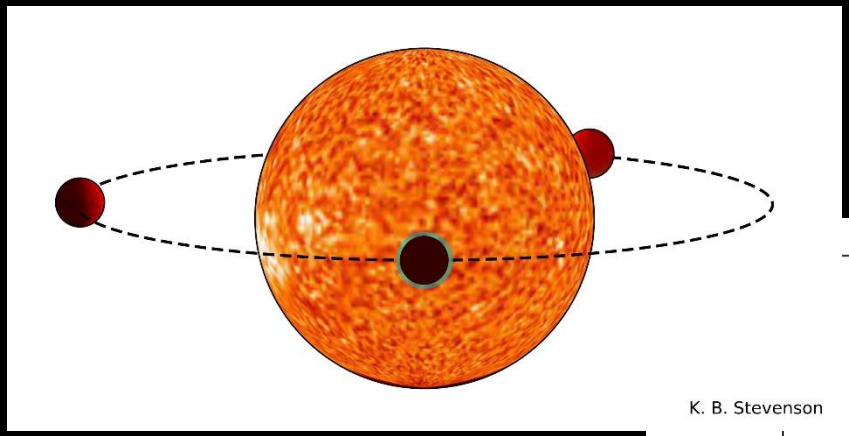
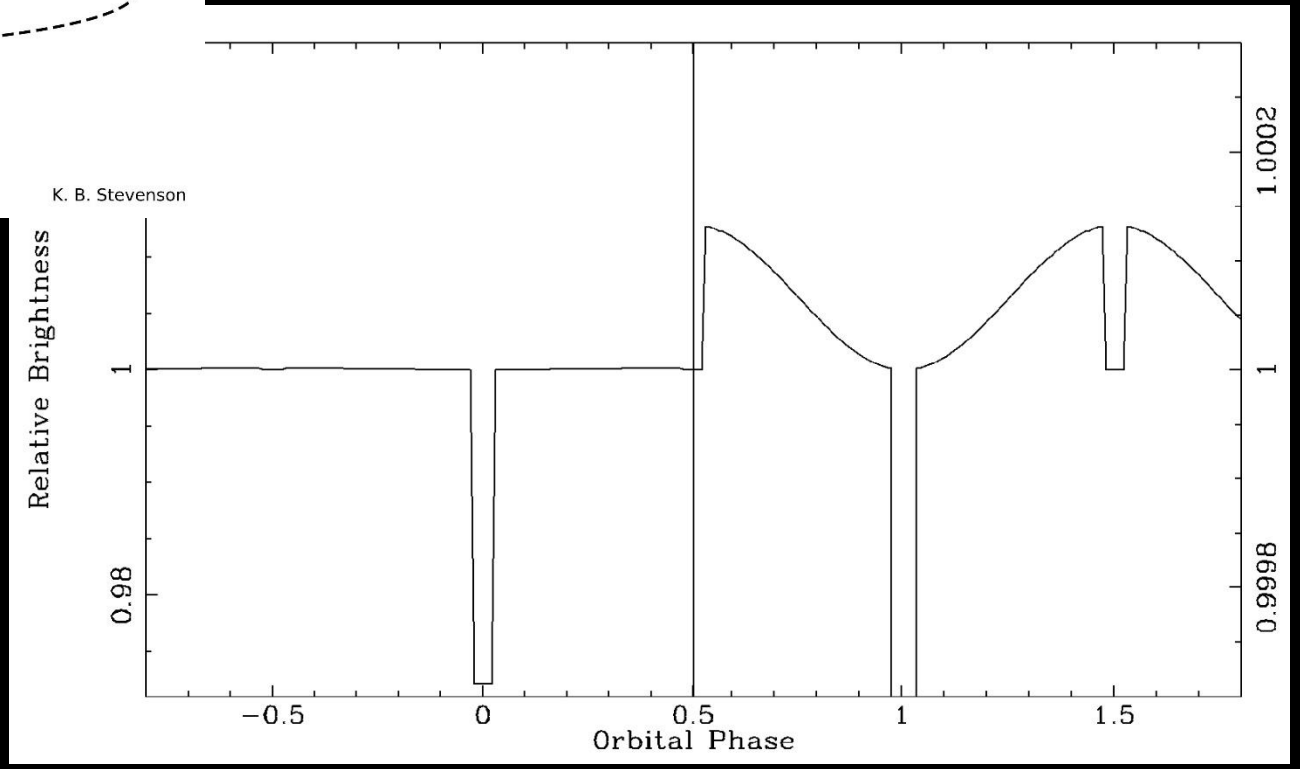


IMAGE PROCESSING - PHOTOMETRY

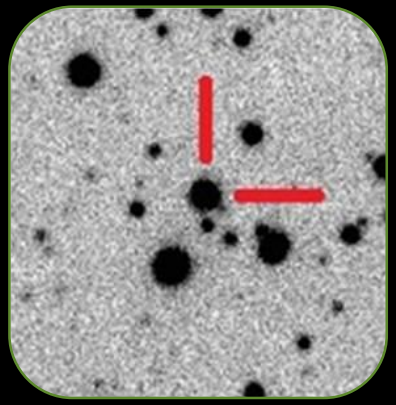
- change in brightness over time





WHAT WE SEE

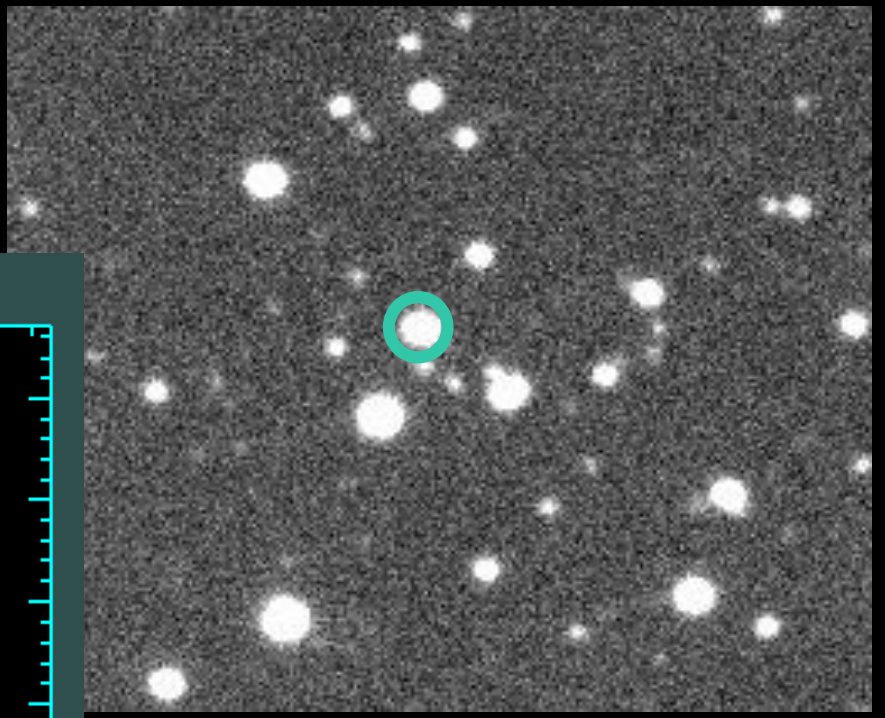
WHAT WE SEE

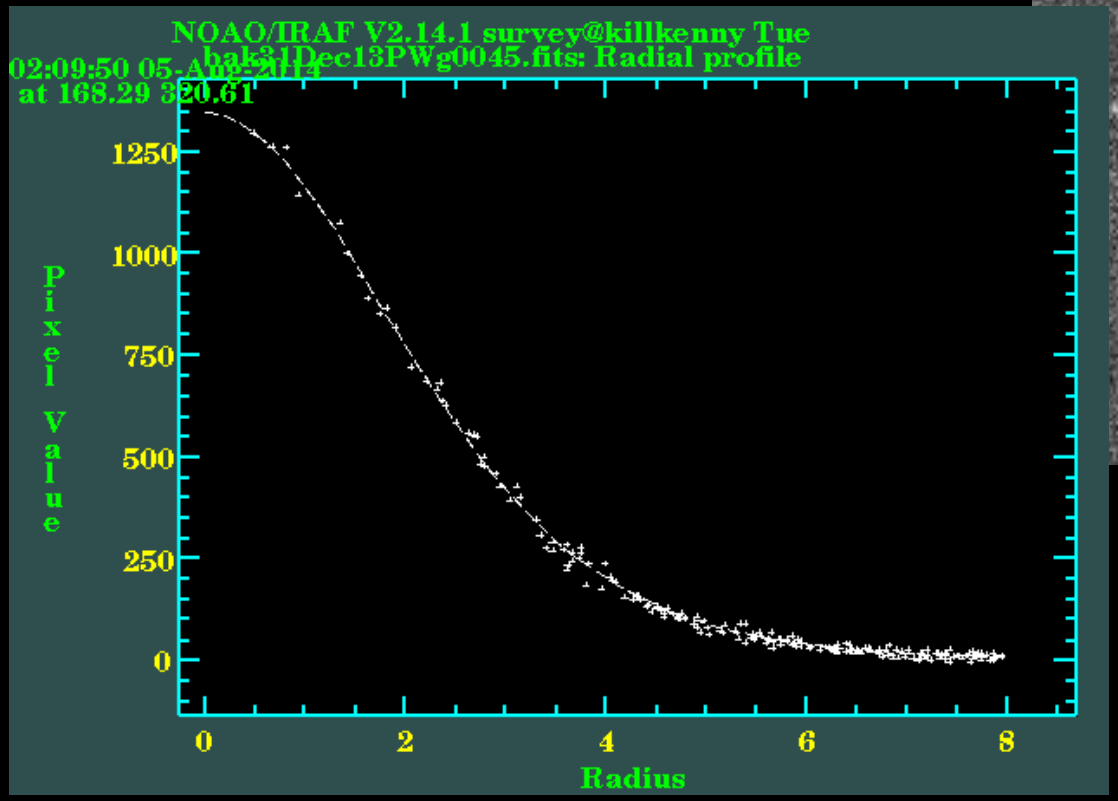


= host star's luminosity + planet's thermal emission + planet's reflected light

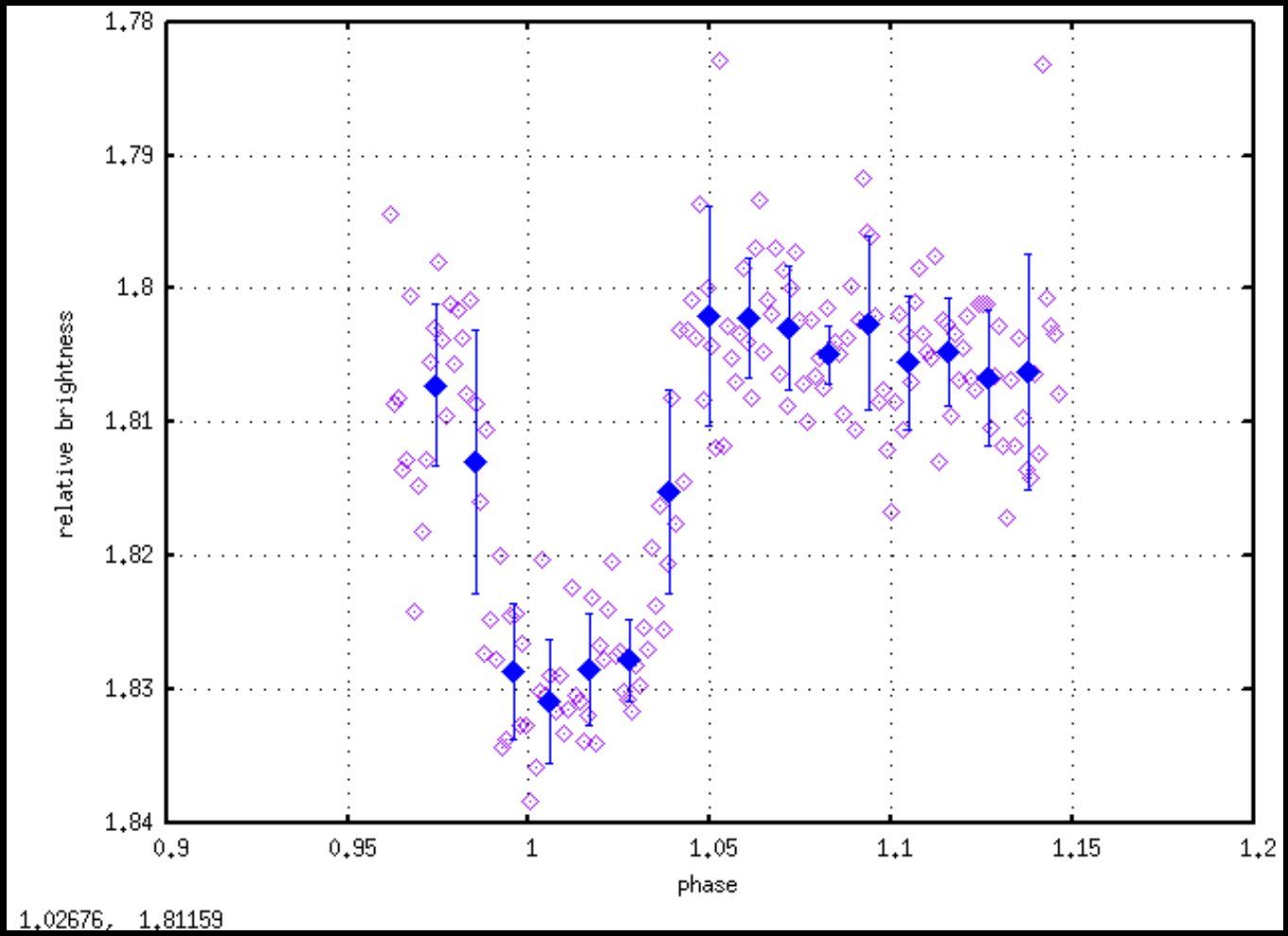
IRAF APERTURE PHOTOMETRY

- puts a circle around the star, sums those pixel counts





IRAF APERTURE PHOTOMETRY

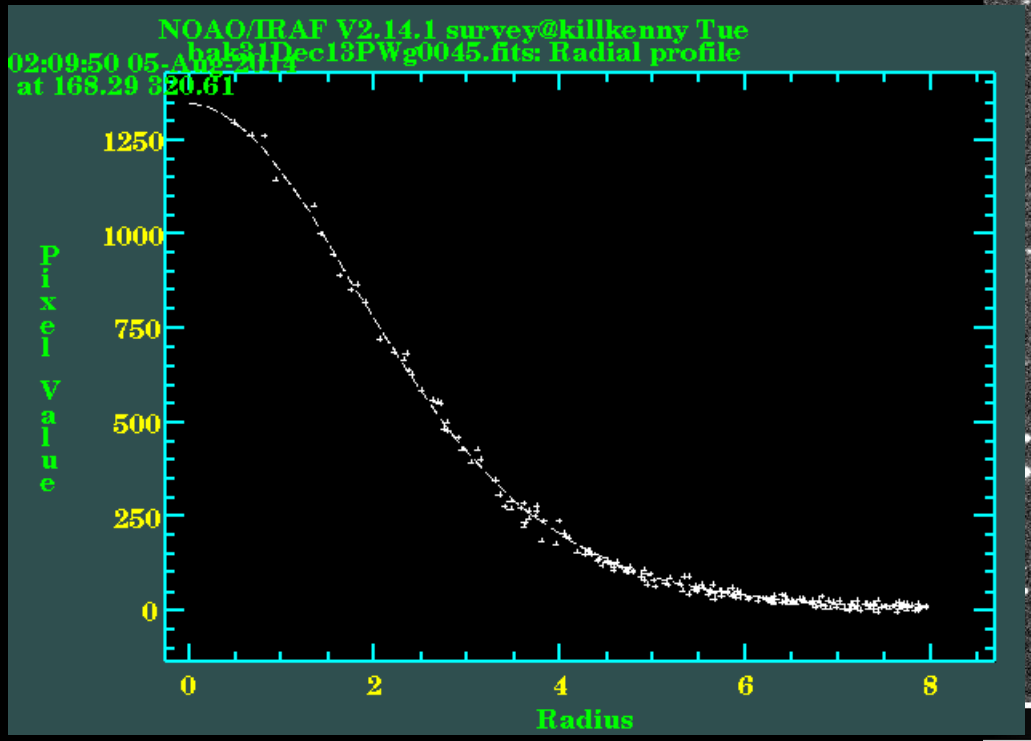


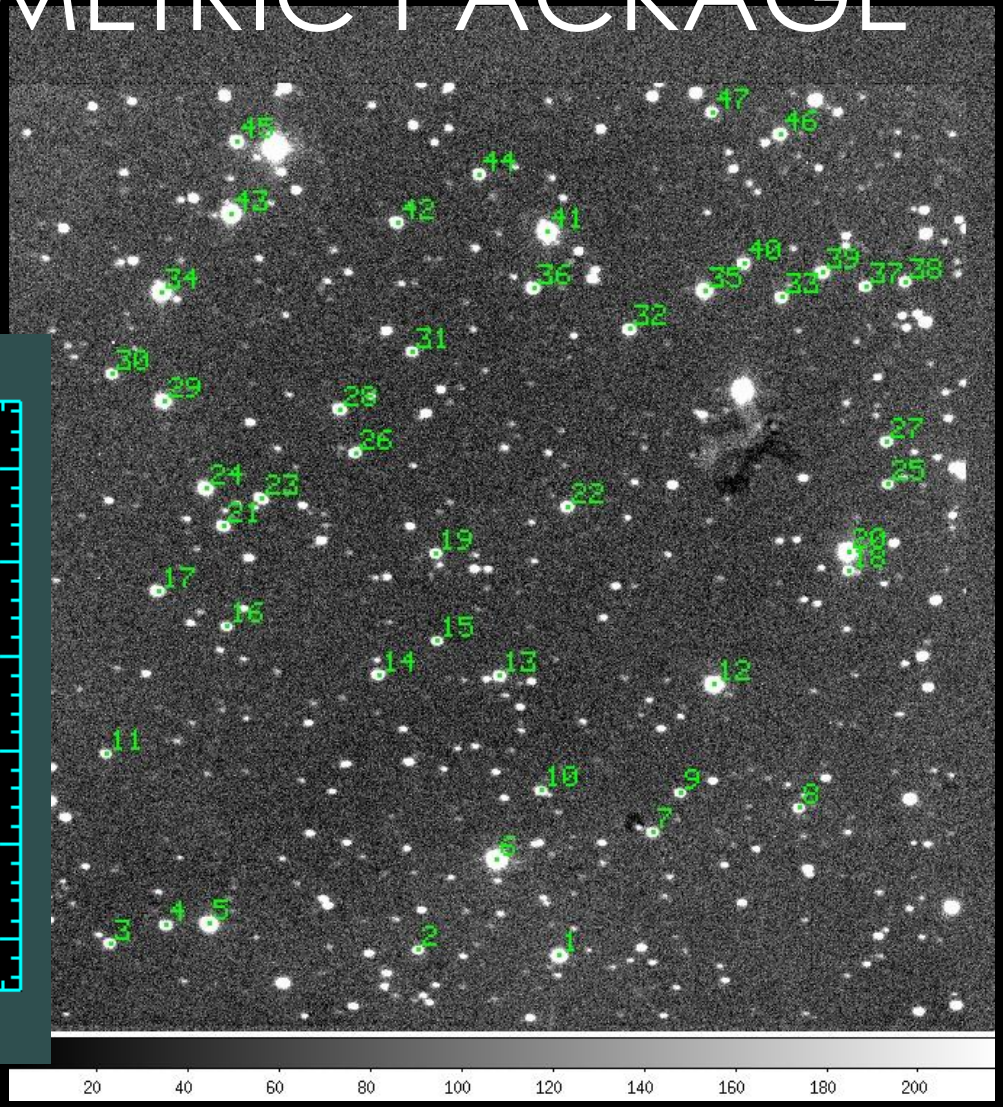
18 Dec 2013

MOMF
MULTI OBJECT MULTI FRAME PHOTOMETRIC PACKAGE

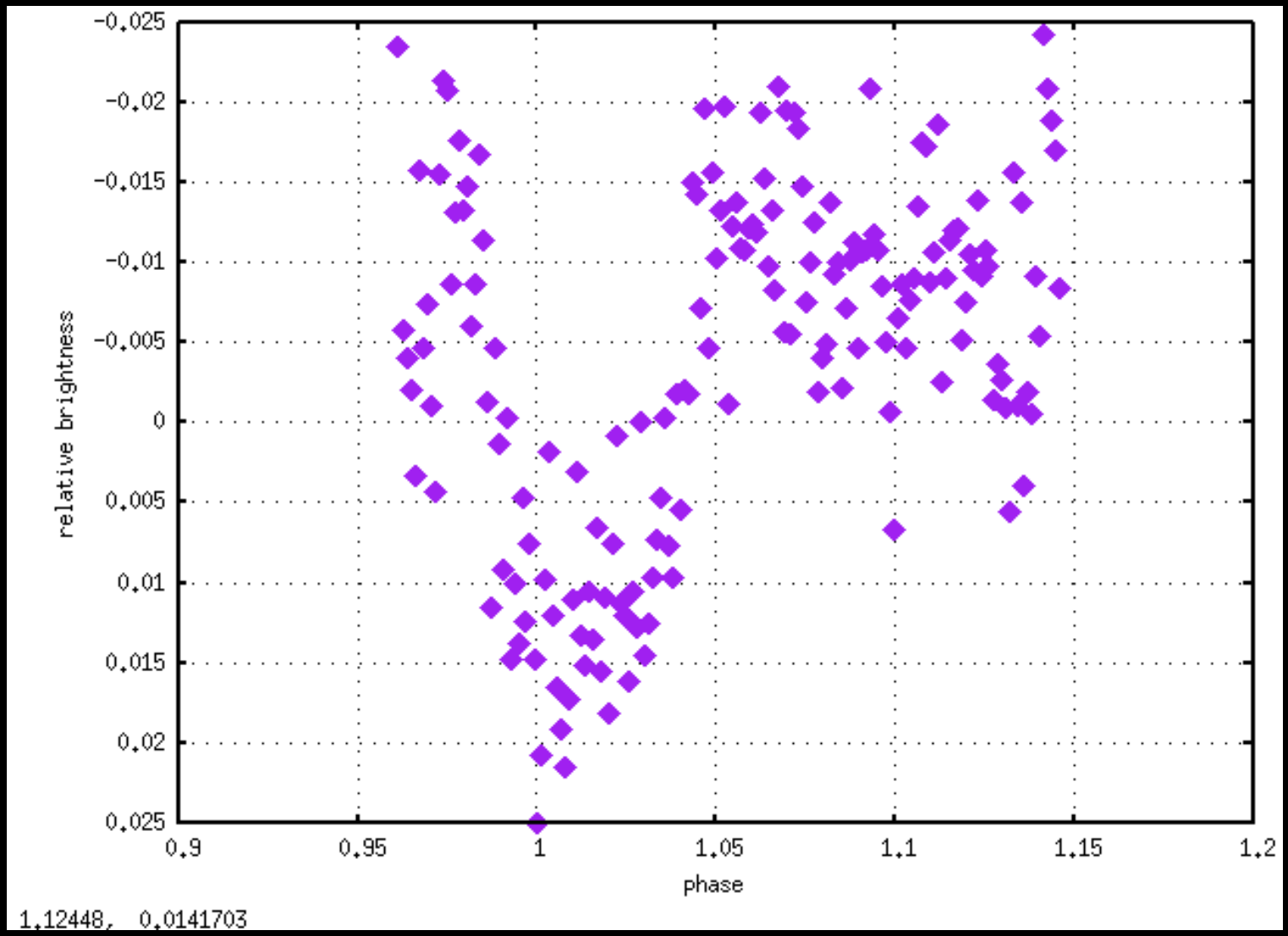
- Point-Spread Fitting

  applies profile to the star



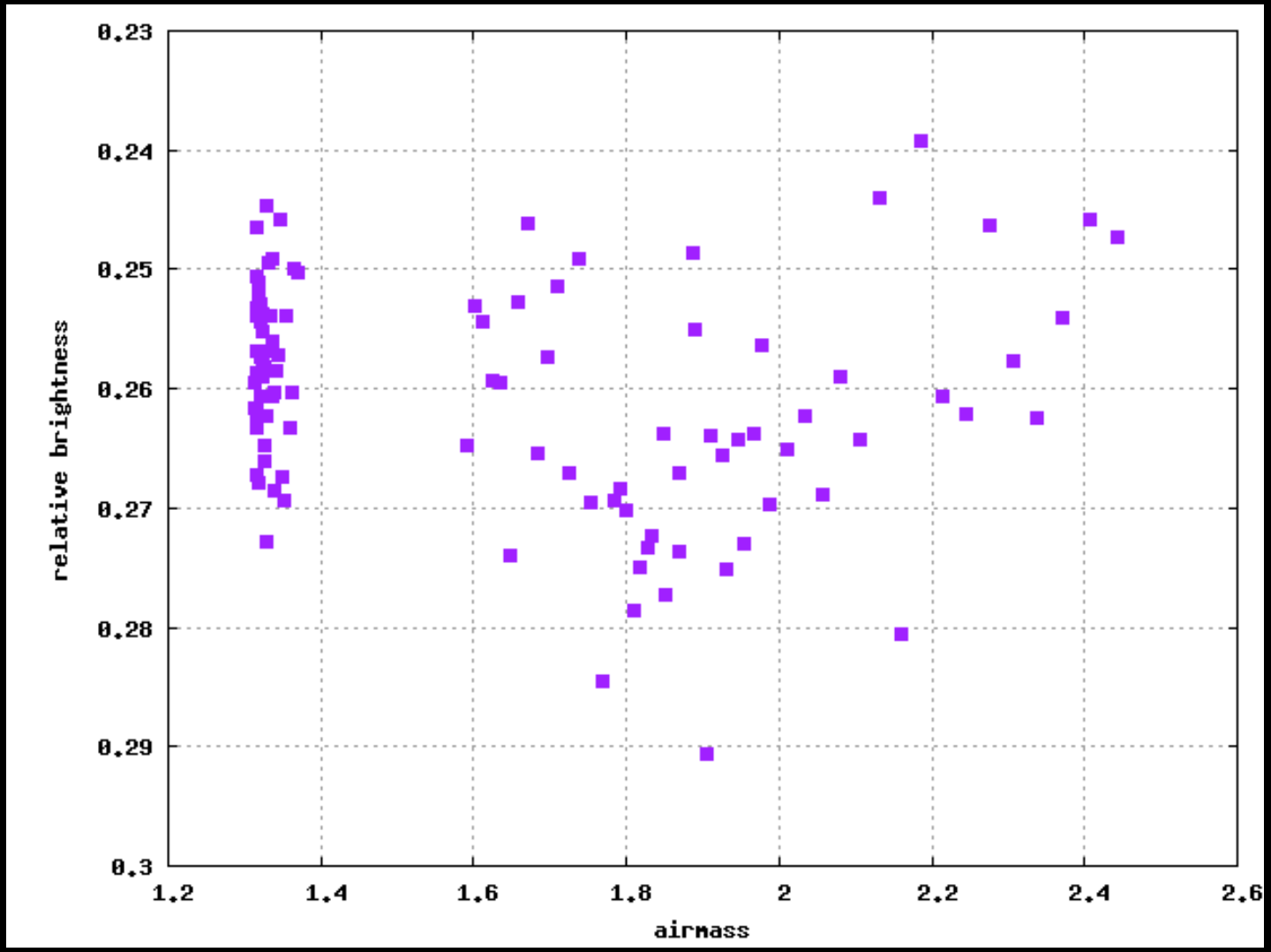


MOMF

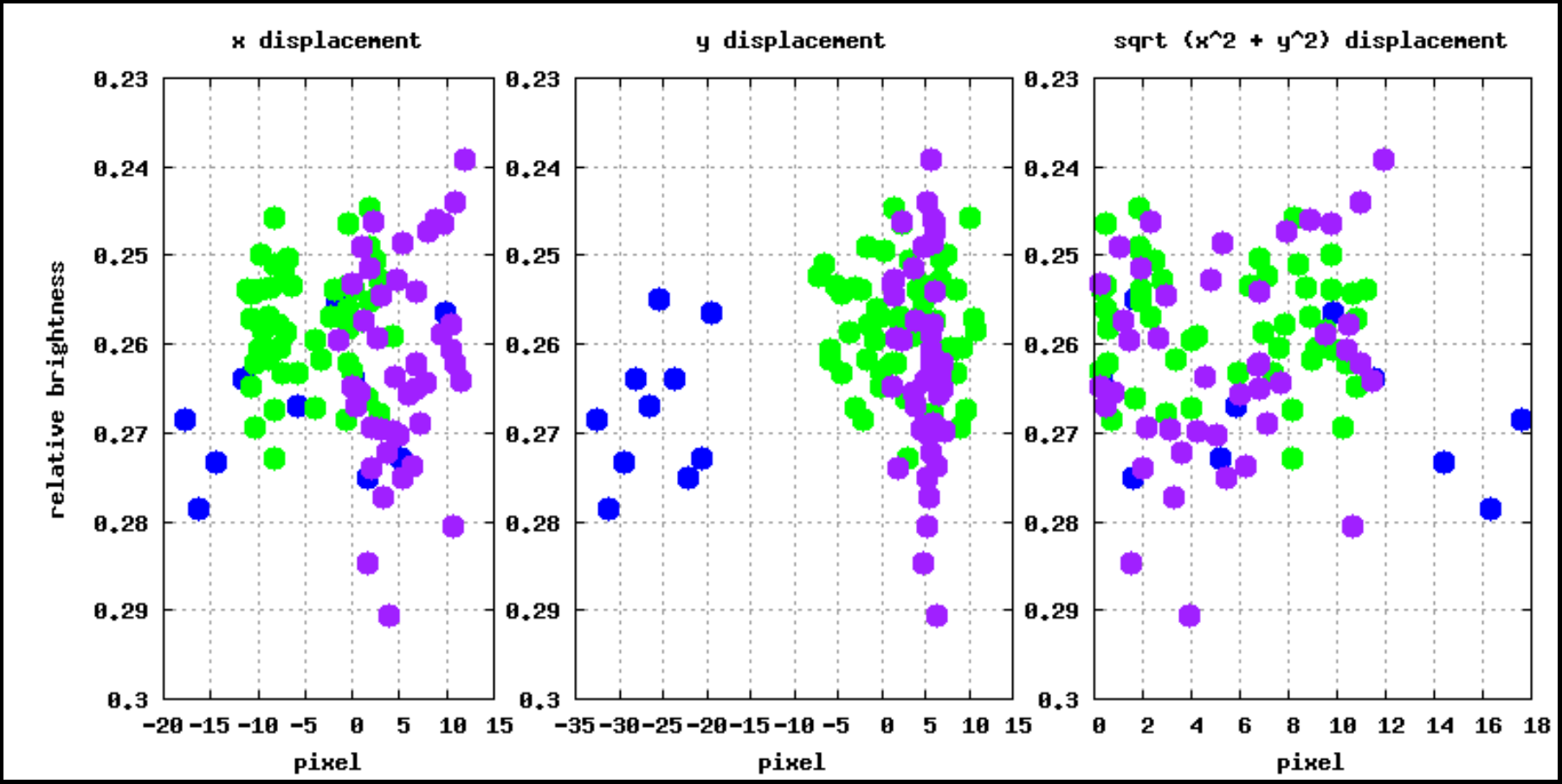

-0.025
-0.02
-0.015
-0.01
-0.005
0
0.005
0.01
0.015
0.02
0.025
relative brightness
0.9
0.95
1
1.05
1.1
1.15
1.2
phase
1.12448, 0.0141703

THINGS WE TRIED TO FIX THE DATA…

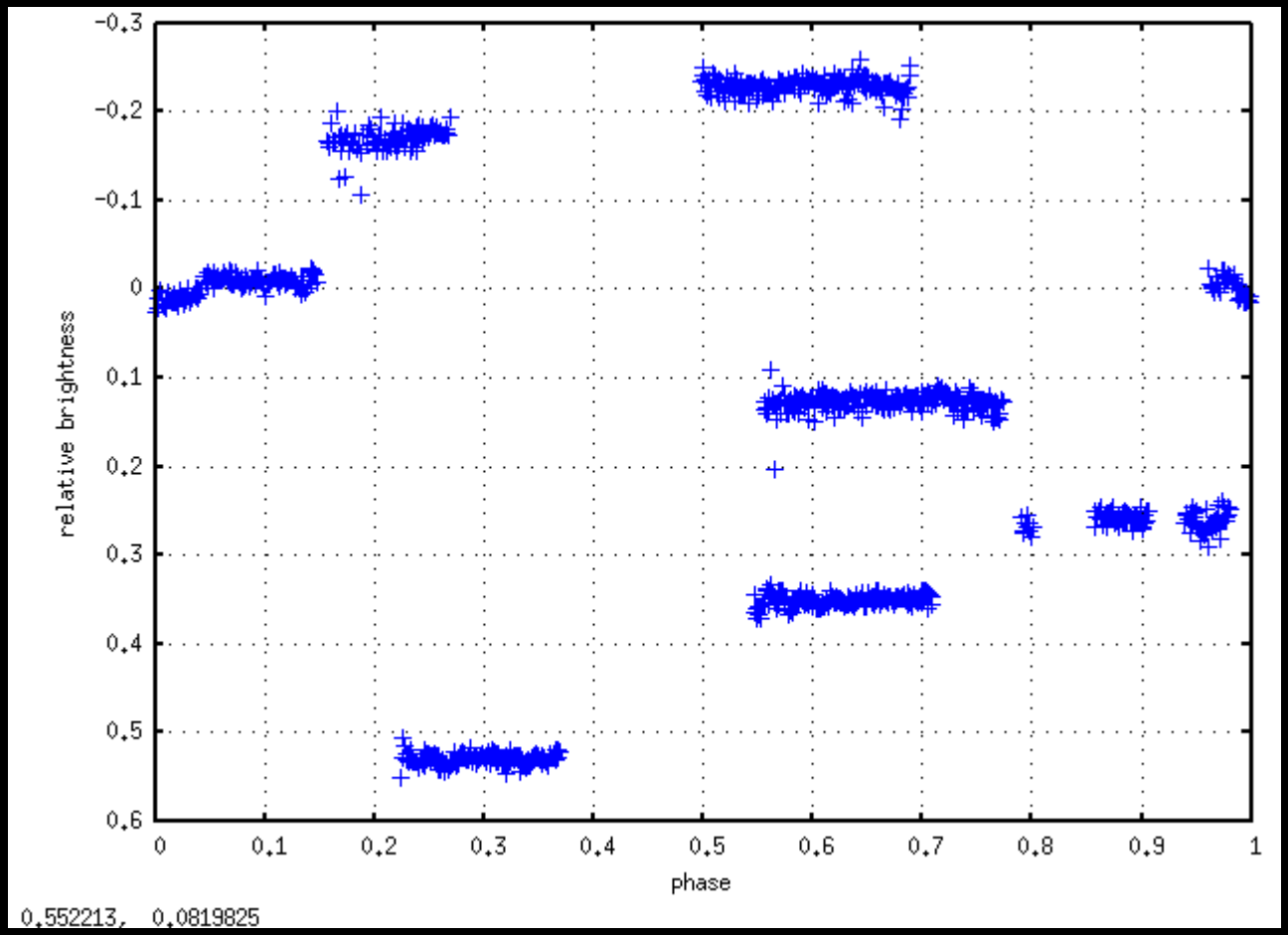
AIRMASS

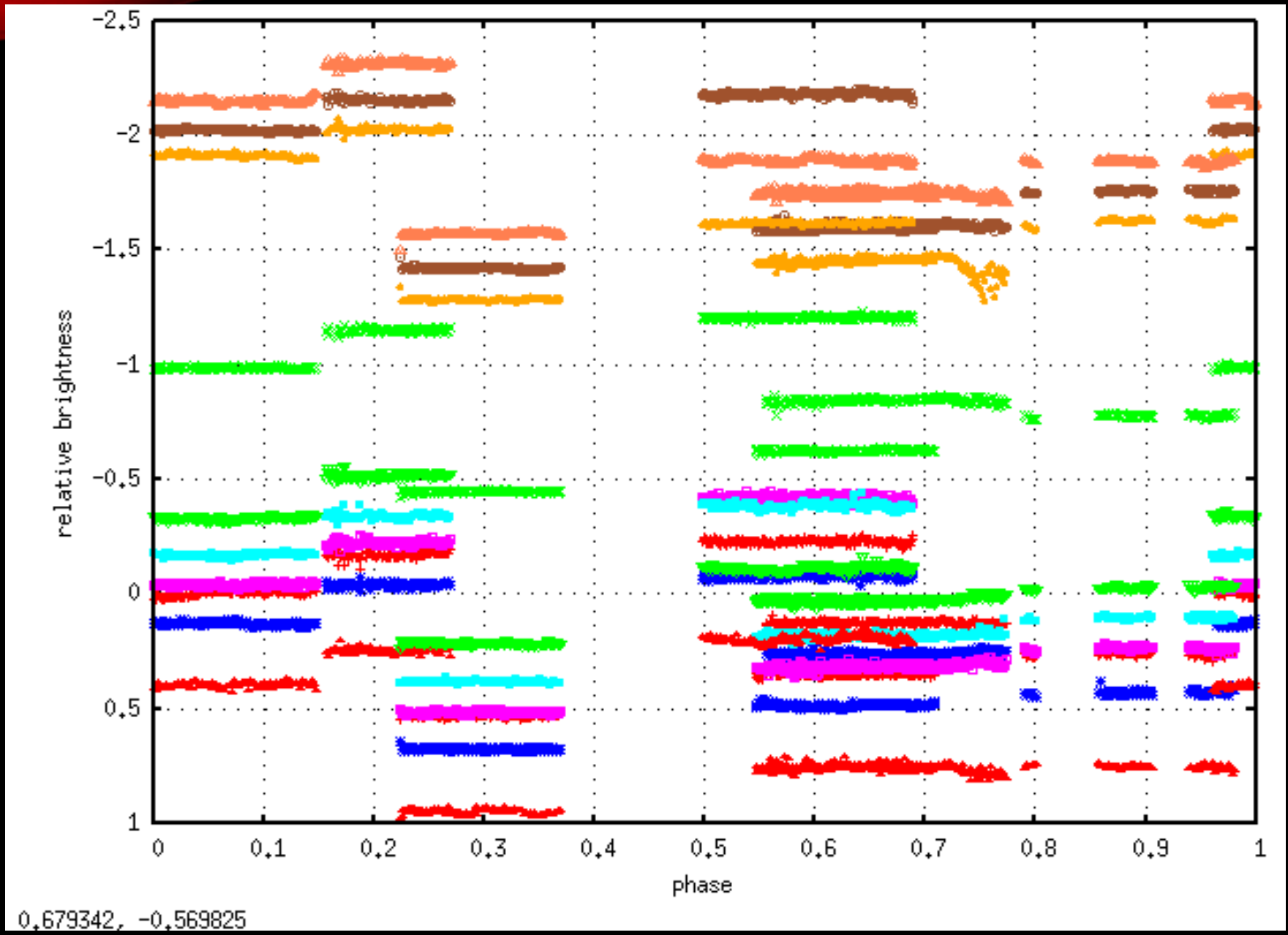

0.23
0.24
0.25
0.26
0.27
0.28
0.29
0.3
relative brightness
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
airmass

PIXEL DEPENDENT BRIGHTNESS

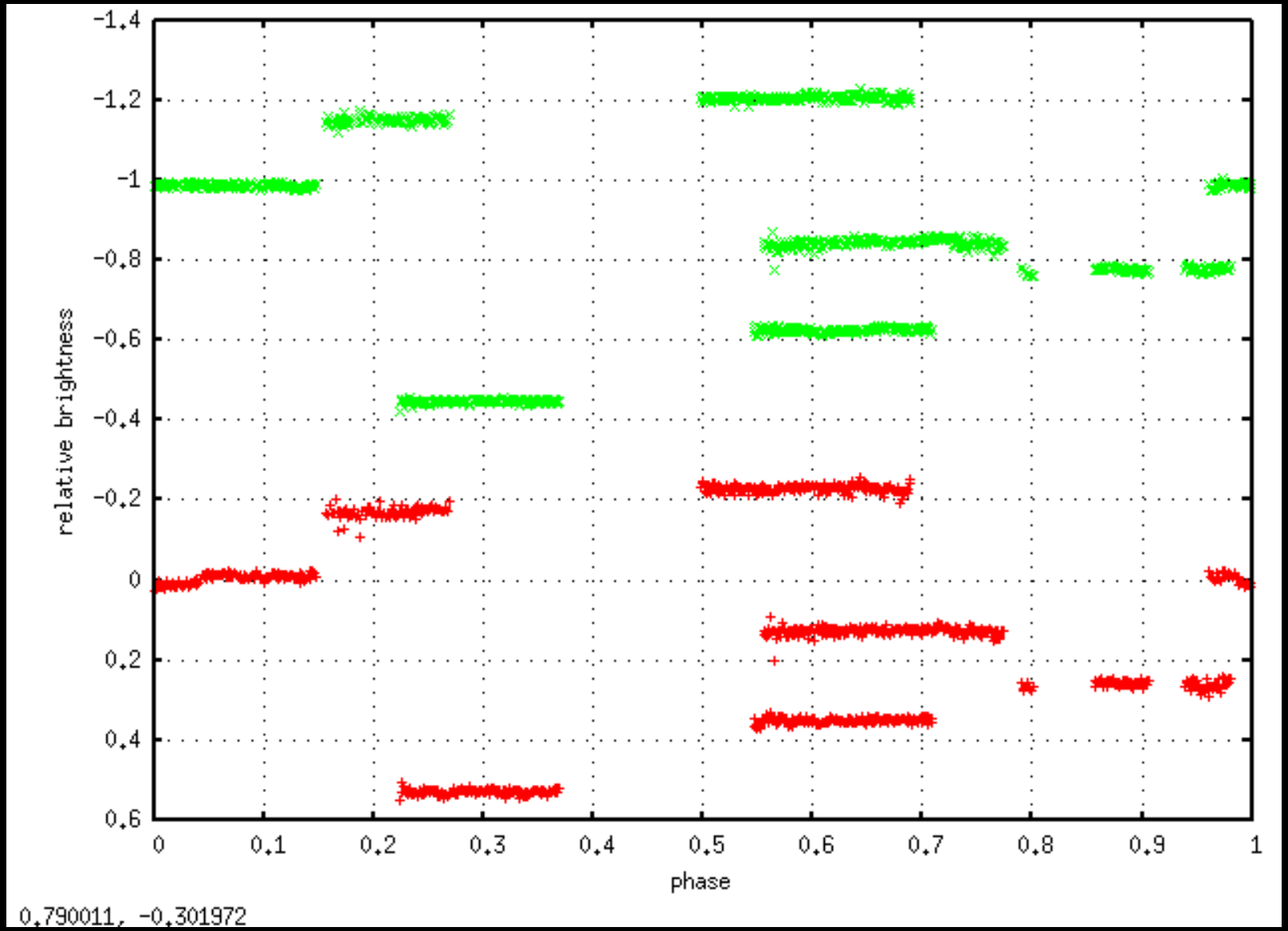


NIGHT-TO-NIGHT DIFFERENCES




relative brightness
phase
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.679342, -0.569825

NIGHT-TO-NIGHT DIFFERENCES

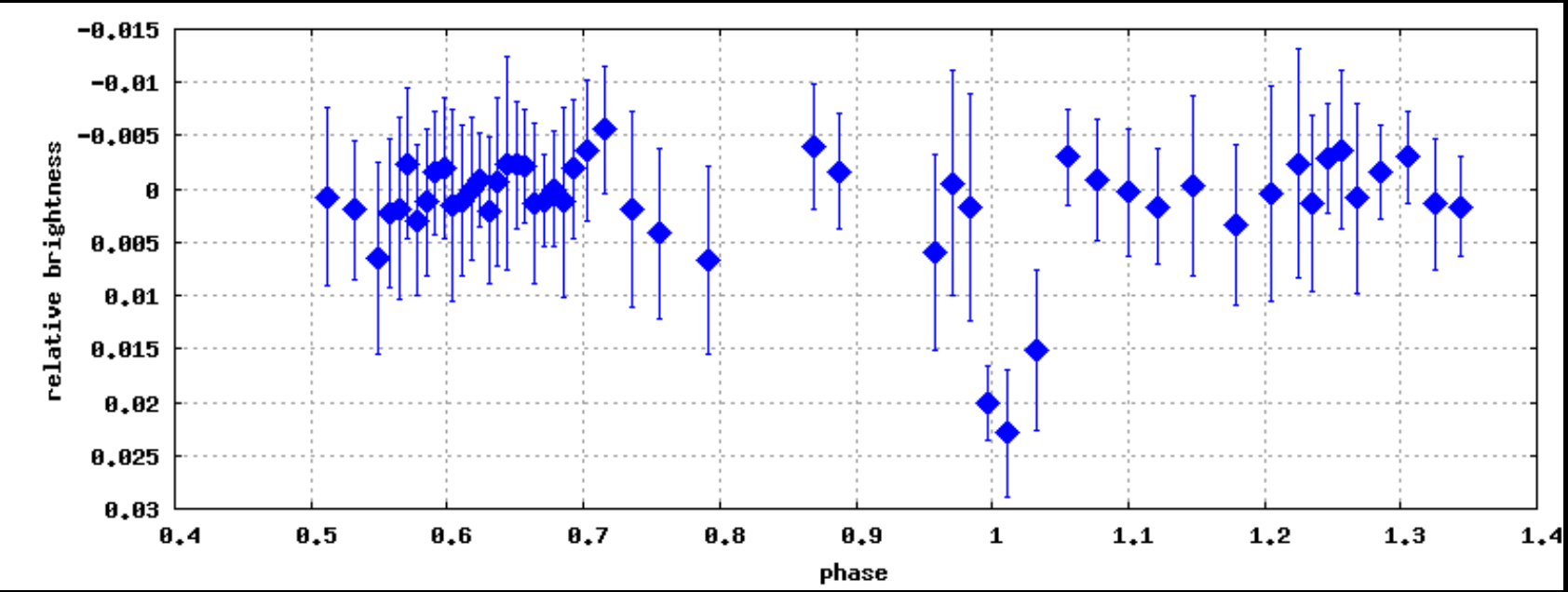


COLORS

- Target star color vs. comparison star color
  - i.e. g – r or r - I
- Differ night-to-night…

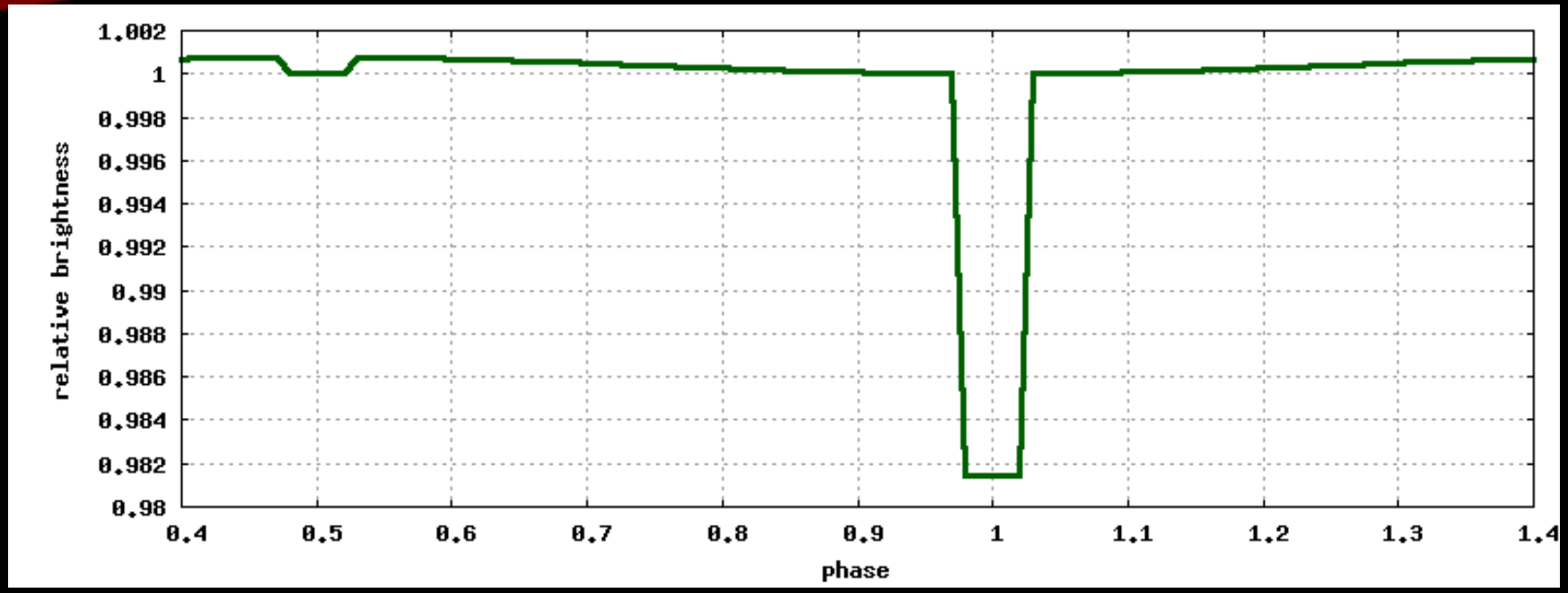
SO THIS IS WHAT WE HAVE:

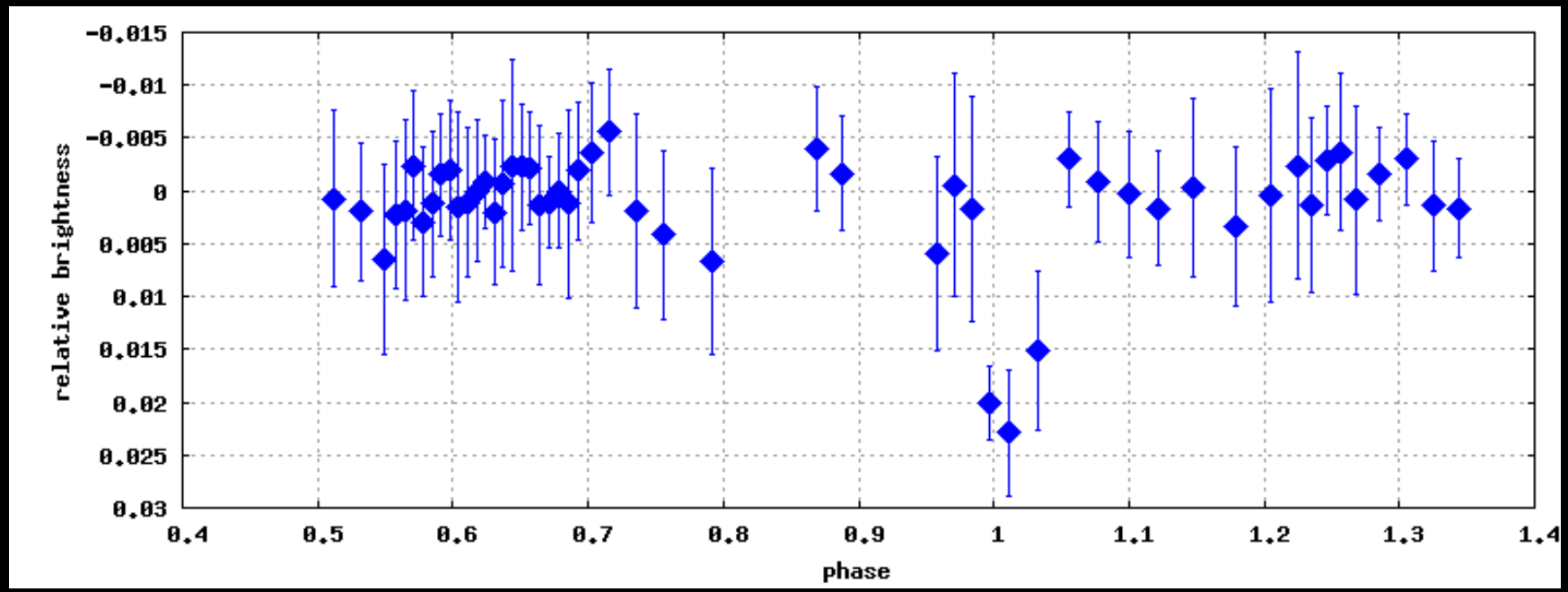
- Photometric measurements
- Determined phases
- Binned by phase



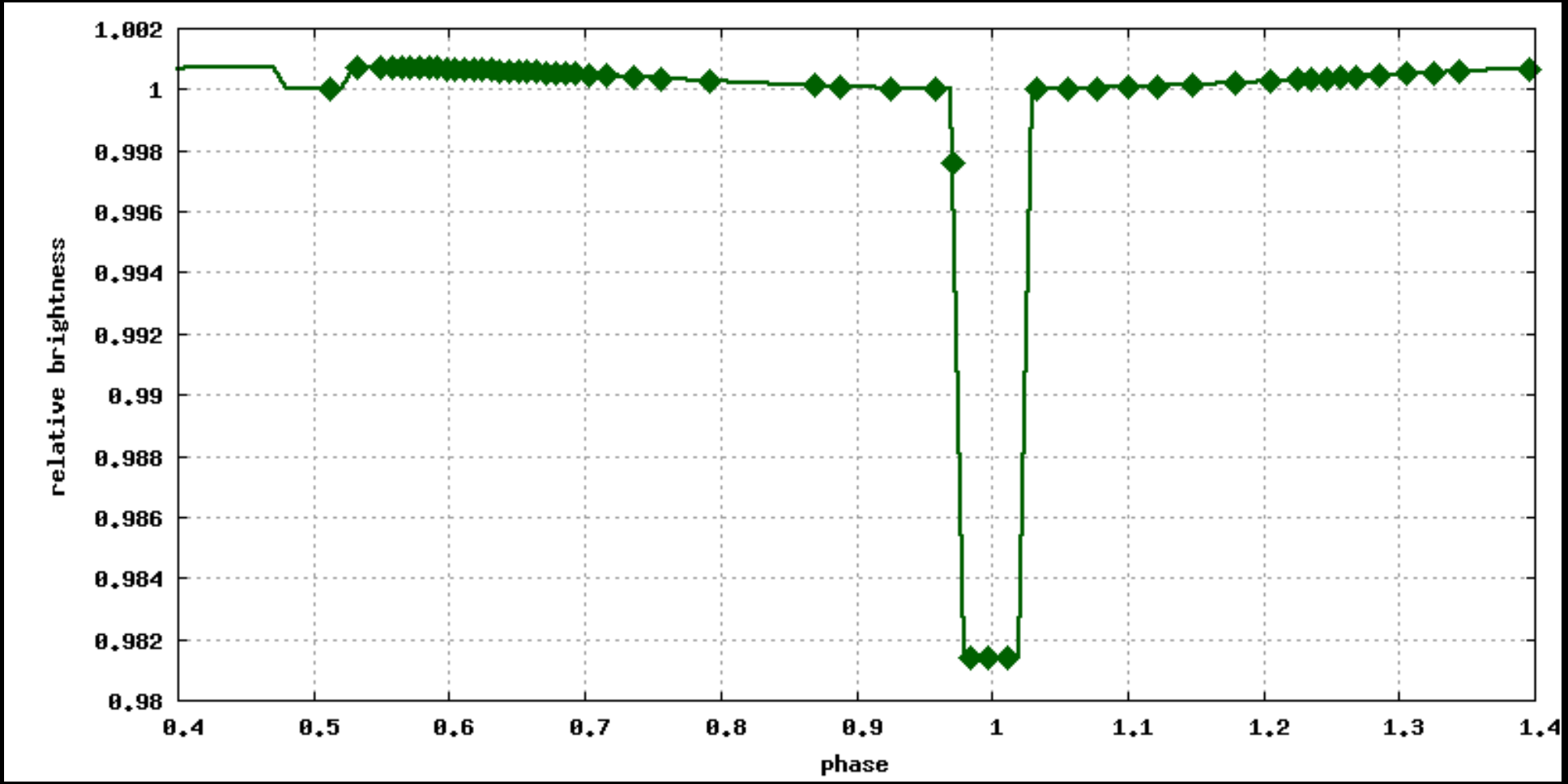
MODEL FITTING - MFIT.C

READ THE MODEL AND DATA

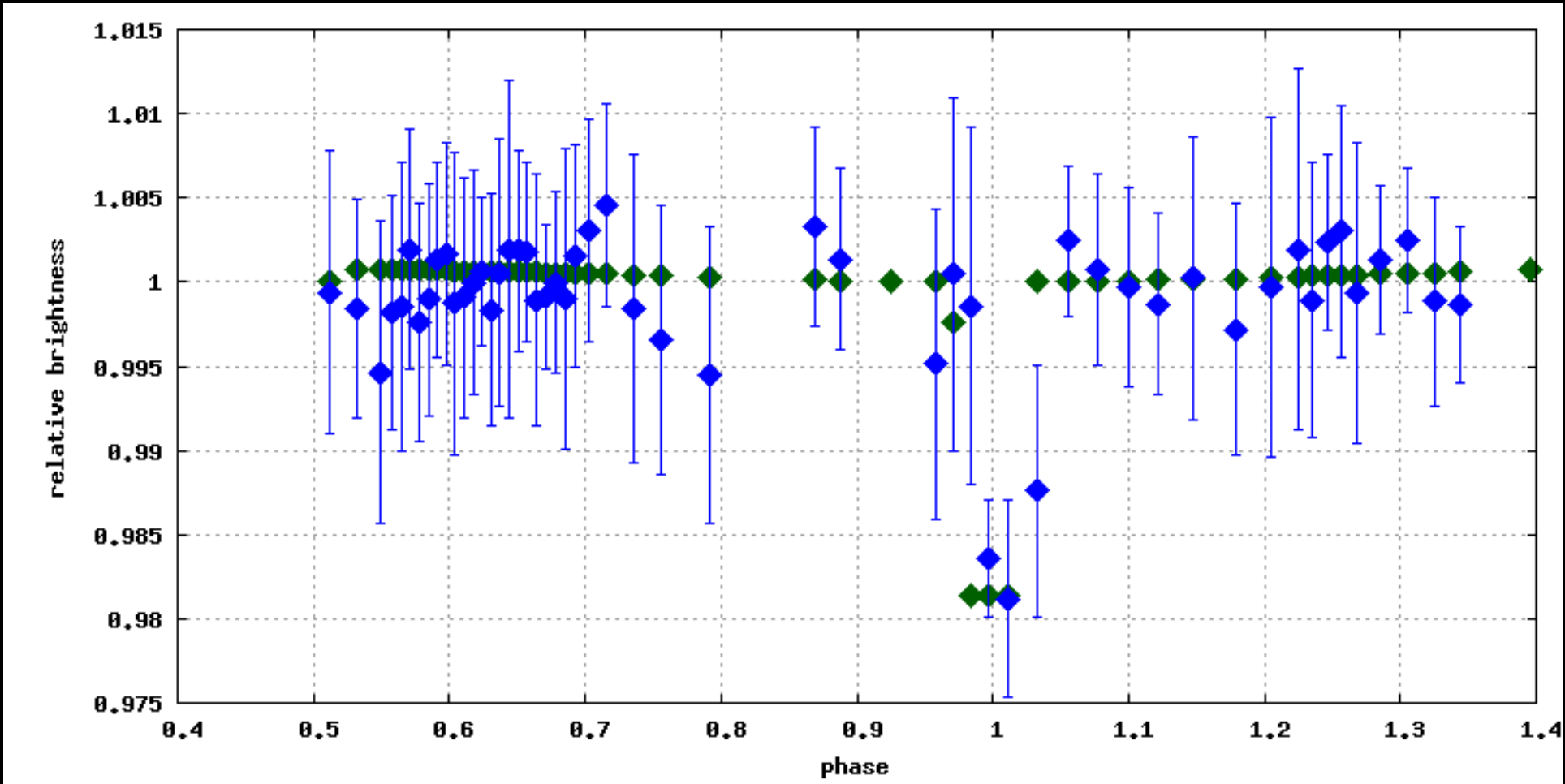




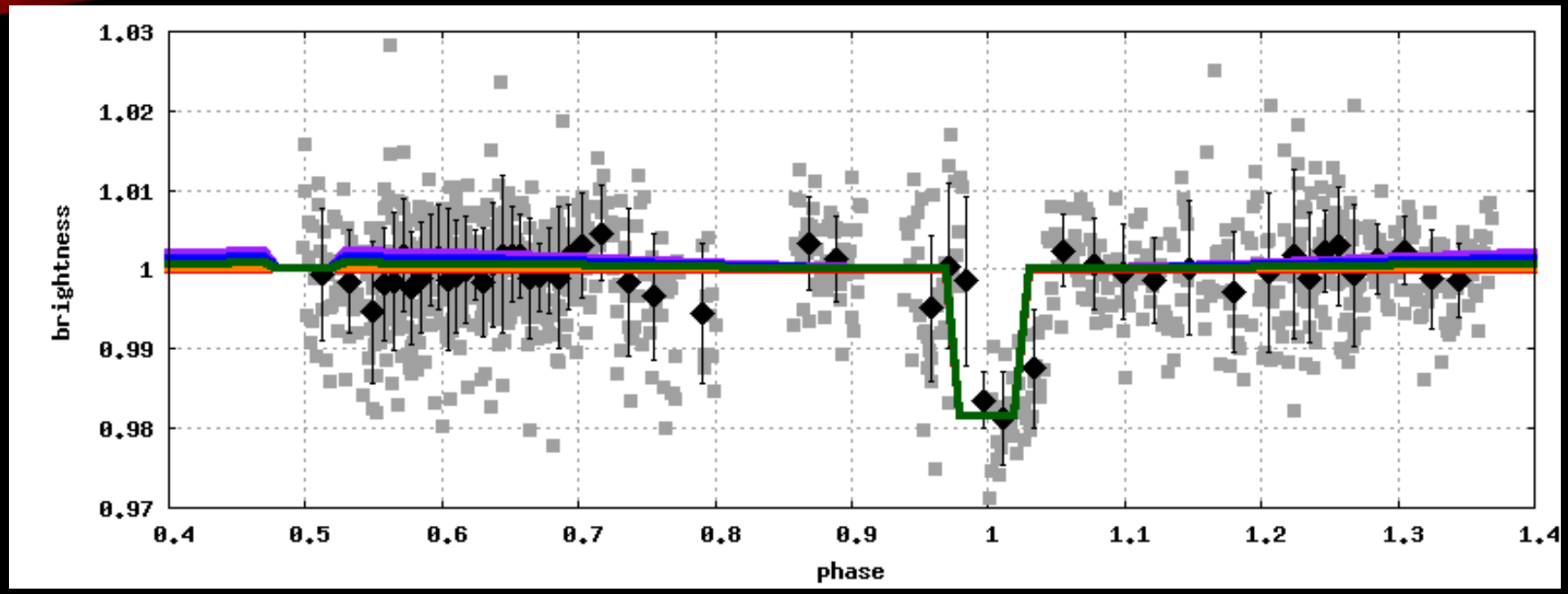
INTERPOLATE THE MODEL

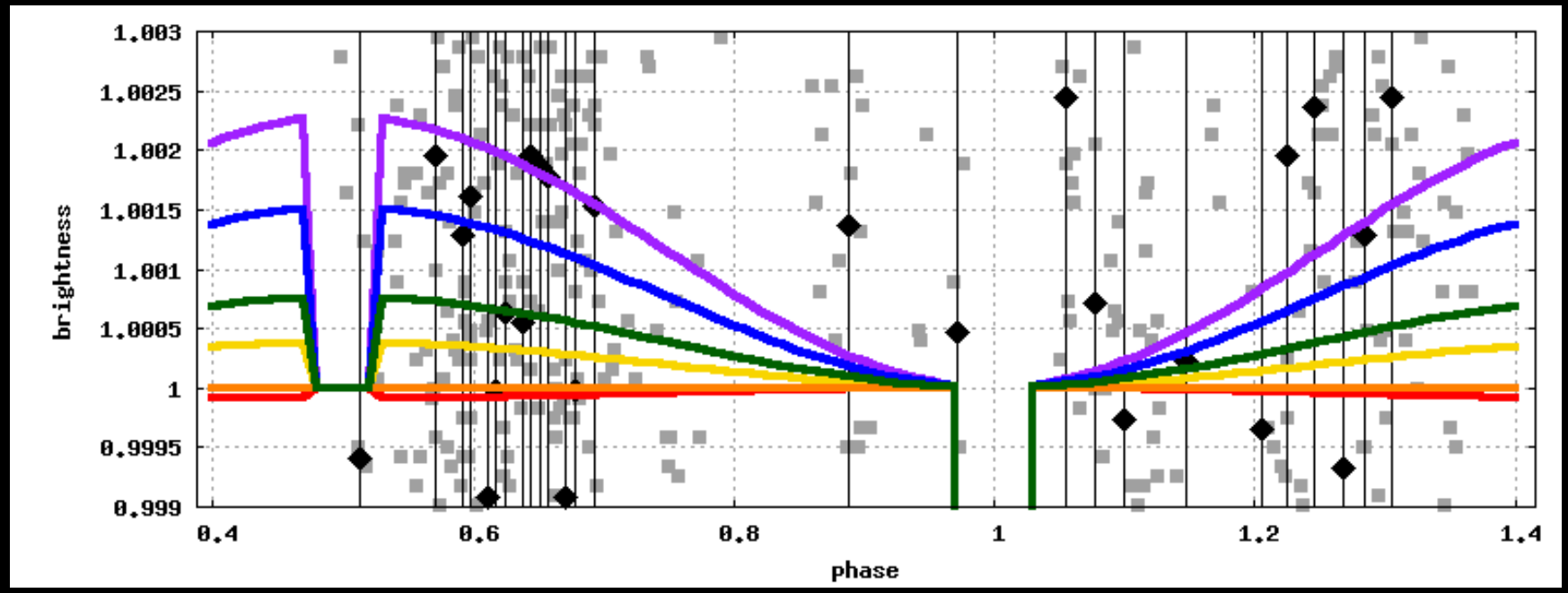


FIND DIFFERENCES

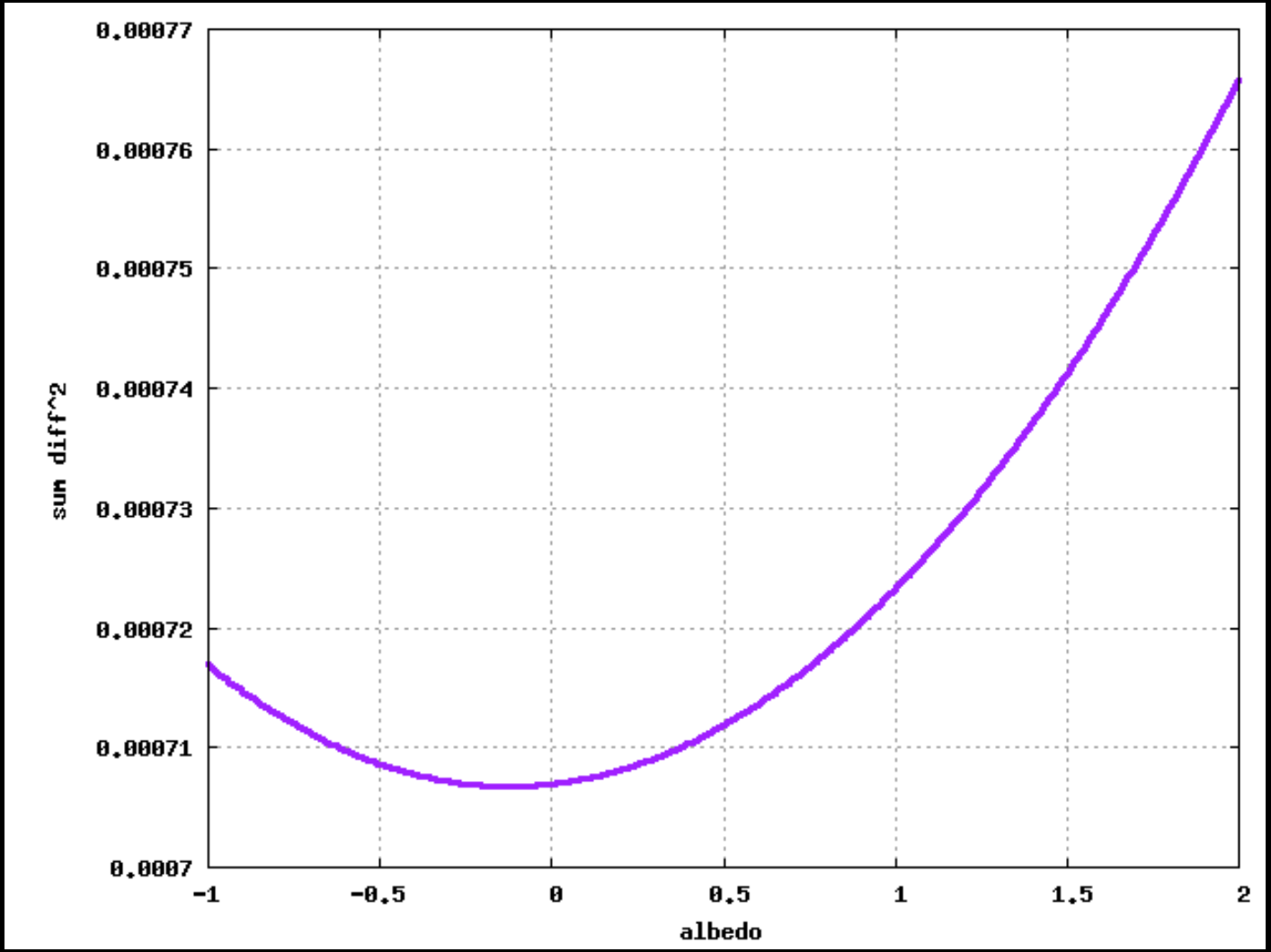


REPEAT FOR MULTIPLE ALBEDOS





OUTPUT



min at albedo = -0.12

THANK YOU!


Baker Observatory
Missouri State University


Department of Physics, Astronomy & Materials Science
MSU