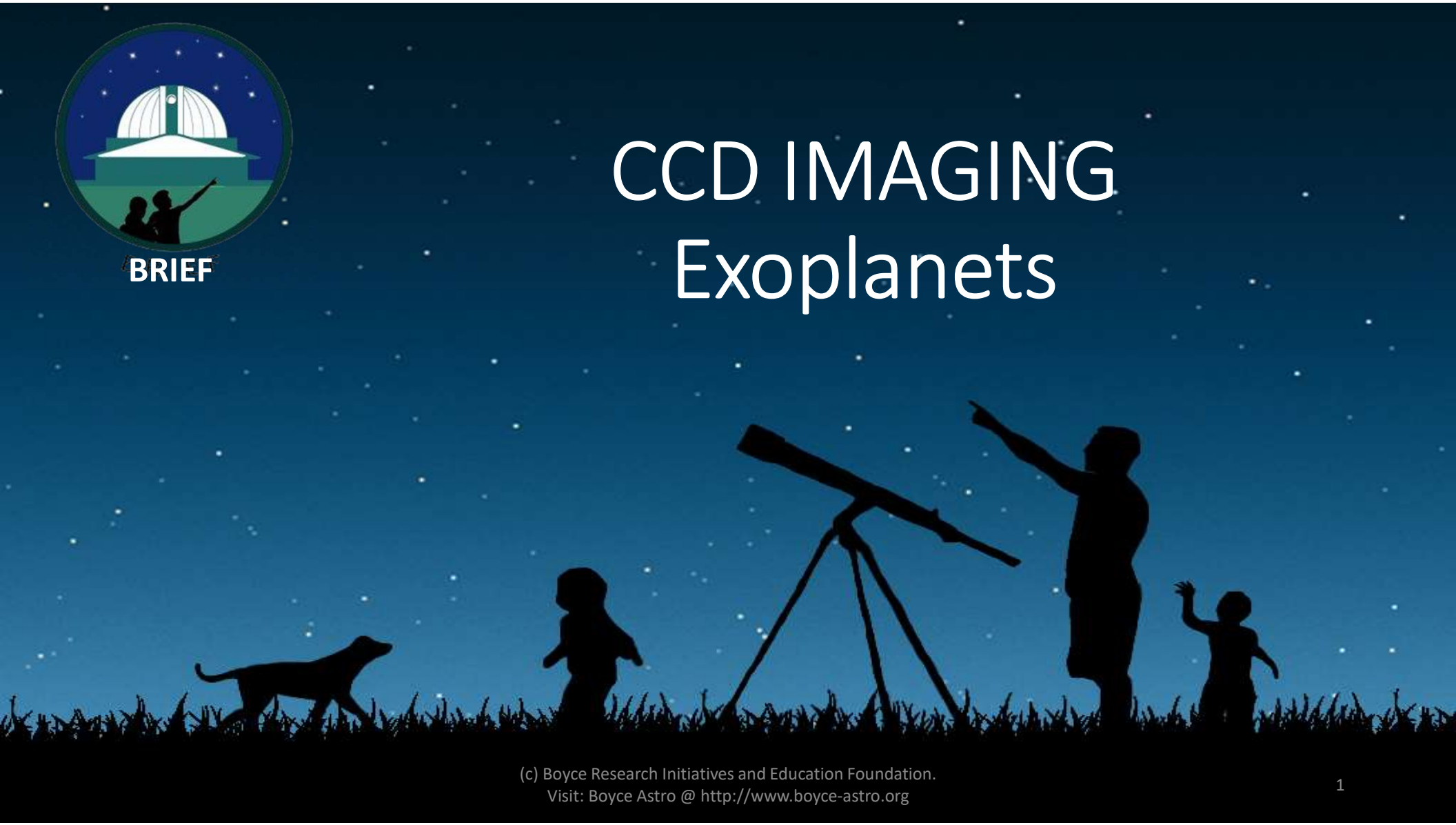
BRIEF

CCD IMAGING
Exoplanets



Overview

This lesson will provide an overview of how to image an exoplanet.

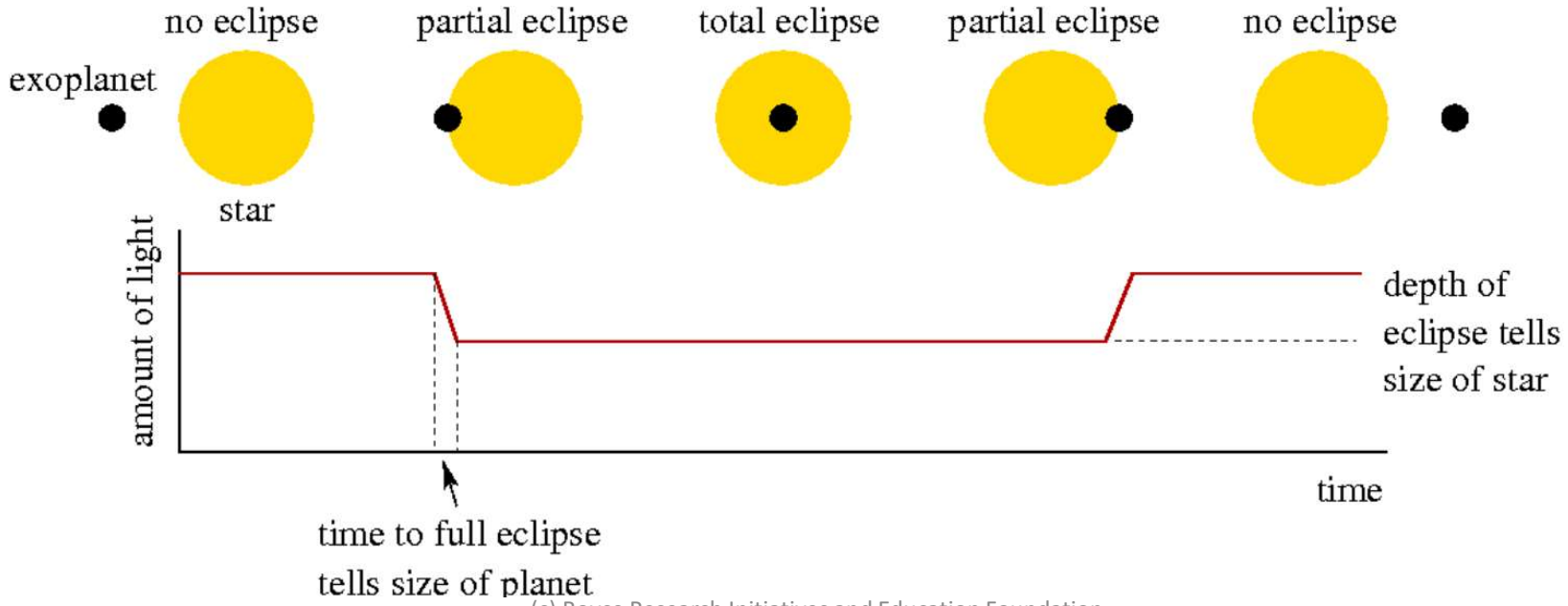
For the most up to date guidance, consult the excellent website: www.astrodennis.com

Dennis Conti has become one of the worlds top amateur exoplanet observers and educators.

This lesson will rely on guidance from his web site.

Transit Method

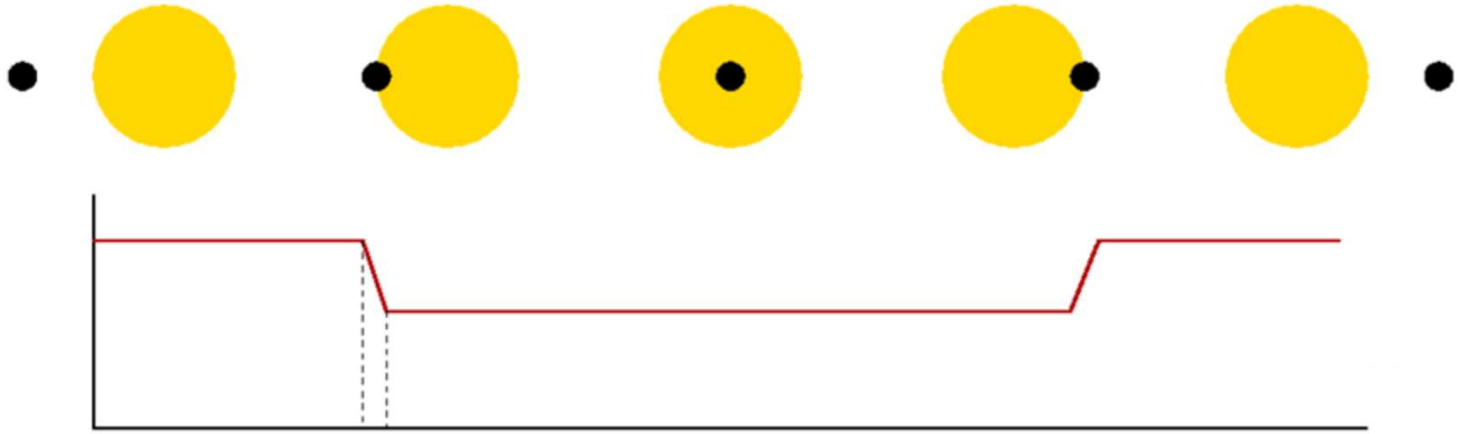
The transit method is the process of measuring the change in flux output of a parent star as the exoplanet moves across the disk surface. Since a exoplanet does not give out its own light, the result is a subtle removal of star light that is measurable.



Transit Method

Technique and Goal:

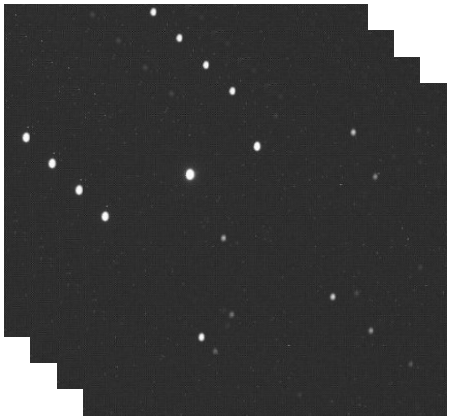
- Research and understand the nature of the exoplanet and its predicted transit
- Begin acquiring images at least 30 min, if not an hour, prior to the beginning of the transit
- Measure through out the transit
- End the imaging run 30 mins, if not an hour, after the transit is concluded
- Keep the stars in the exact location on the CCD chip as possible

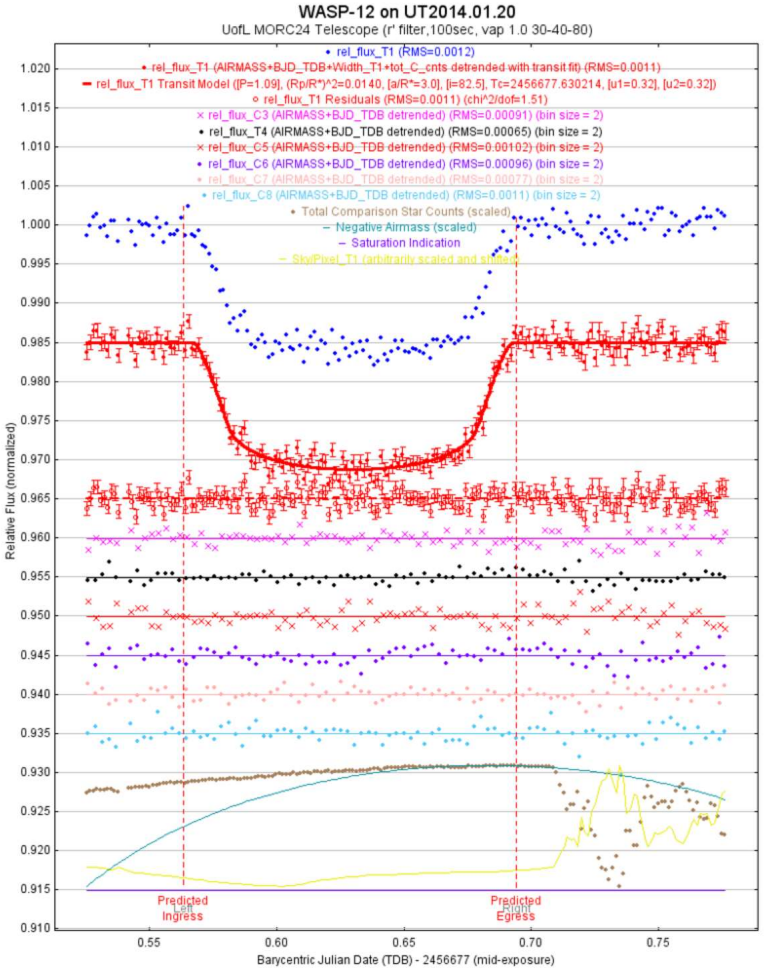


Imaging Result

When the imaging run is complete, you will have multiple, even a couple hundred if CCD images.

From these images, you will determine the target host star and a few comparison stars from which to measure the flux output relative to each other.





Steps to Success

The primary areas of focus to ensure success in imaging Exoplanets are: Accuracy and Precision in determining the number of photons collected in the target field of view.

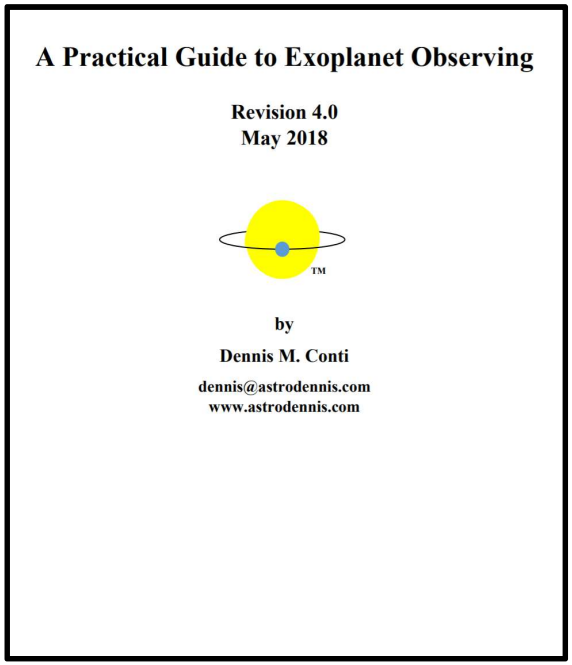
Accuracy: Does the image collection of photons accurately represent the number emanated from the parent star

Factors affecting Accuracy: Interstellar extinction, Sky Glow, Seeing (atmospheric turbulence), local thermal effects, etc.

Precision: Quality of the instrumentation used in the measurement

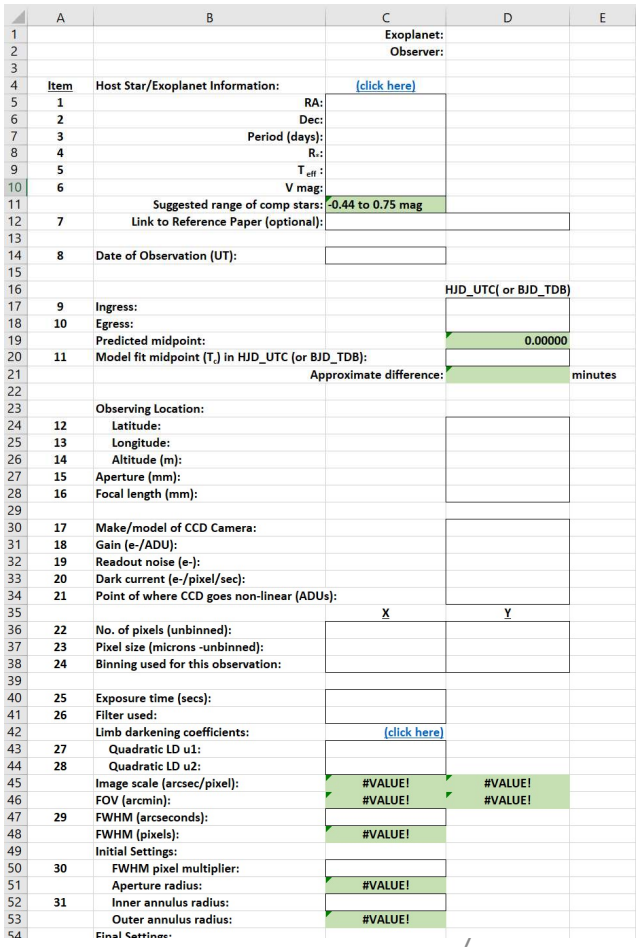
Factors affecting Precision: Size of telescope, Filter selection, efficiency of the CCD, image reduction, etc.

Fortunately, the above impacts both the target and comparison star. Therefore, through Aperture and Differential Photometry, these effects will be accounted for.



Available Tools

- Dennis Conti's Practical Guide to Exoplanet Observing: astrodennis.com
- AAVSO Exoplanet CHOICE Course – Taught by Dennis Conti
- Exoplanet Transit Database (ETD): http://var2.astro.cz/ETD/contribution.php
- Exoplanet Observing Excel Planning Guide: astrodennis.com
- NASA Exoplanet Archive: https://exoplanetarchive.ipac.caltech.edu/cgi-bin/TransitView/nph-visibletbls?dataset=transits



	A	B	C	D	E
1			Exoplanet:		
2			Observer:		
3					
4	Item	Host Star/Exoplanet Information:	(click here)		
5	1	RA:			
6	2	Dec:			
7	3	Period (days):			
8	4	R$_*$:			
9	5	T$_{eff}$:			
10	6	V mag:			
11		Suggested range of comp stars:	-0.44 to 0.75 mag		
12	7	Link to Reference Paper (optional):			
13					
14	8	Date of Observation (UT):			
15					
16				HJD_UTC(or BJD_TDB)	
17	9	Ingress:			
18	10	Egress:			
19		Predicted midpoint:		0.00000	
20	11	Model fit midpoint (T$_c$) in HJD_UTC (or BJD_TDB):			
21		Approximate difference:			minutes
22					
23		Observing Location:			
24	12	Latitude:			
25	13	Longitude:			
26	14	Altitude (m):			
27	15	Aperture (mm):			
28	16	Focal length (mm):			
29					
30	17	Make/model of CCD Camera:			
31	18	Gain (e-/ADU):			
32	19	Readout noise (e-):			
33	20	Dark current (e-/pixel/sec):			
34	21	Point of where CCD goes non-linear (ADUs):			
35			X	Y	
36	22	No. of pixels (unbinned):			
37	23	Pixel size (microns -unbinned):			
38	24	Binning used for this observation:			
39					
40	25	Exposure time (secs):			
41	26	Filter used:			
42		Limb darkening coefficients:	(click here)		
43	27	Quadratic LD u1:			
44	28	Quadratic LD u2:			
45		Image scale (arcsec/pixel):	#VALUE!	#VALUE!	
46		FOV (arcmin):	#VALUE!	#VALUE!	
47	29	FWHM (arcseconds):			
48		FWHM (pixels):	#VALUE!		
49		Initial Settings:			
50	30	FWHM pixel multiplier:			
51		Aperture radius:	#VALUE!		
52	31	Inner annulus radius:			
53		Outer annulus radius:	#VALUE!		
54		Final Settings:			

Summary

Exoplanet observing and subsequent measure can be accomplished by non-PhD, professional, astronomers.

What is required is a methodical process in image planning and execution.

Once the images are acquired, then careful reduction and measurement of the images are essential to producing the final light curve. These areas are covered in other lessons.

Questions?