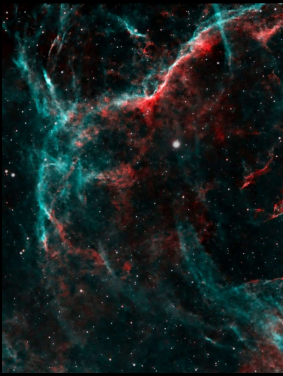


Beginners Astrophotography

Gary Liney

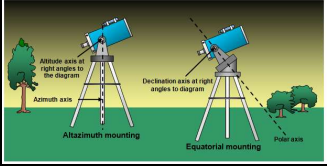
Week 3: Mounts, Star-trackers and Guiding



1

### Mounts

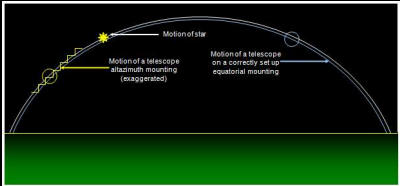
- Altitude-Azimuth (AltAz) mounts
- Equatorial (EQ) Mounts



2


### AltAz Mounts

- ✓ Easy to use
- Cannot match star motion
- Star bloating
- Field rotation



3

### My First Image: AltAz Tripod

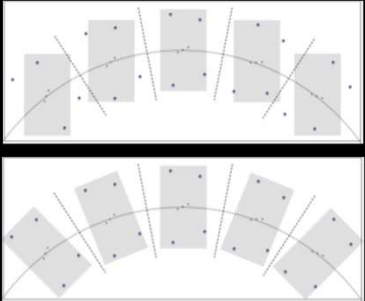


Bloated stars and obvious background noise

4

### Field Rotation


- AltAz can only track a point
- Over time the rest of the frame rotates
- Reduces the stacked image FOV



5

### EQ v AltAz

- Overlay of image taken with EQ and AltAz mode of star tracker
- Stars get bigger and more misaligned further from tracked centre



6

### EQ Mounts

- EQ wedge is used
- Set angle to correct local latitude
- Turns Az into RA, Alt into Dec

7

### Example Mounts

- Star trackers are portable for dark sky sites
- Heavy mounts very stable with more precise guiding
- Can get head and mount combined/seperate
- Payload will dictate the scope that can be used and exposure length

Sky-Watcher Star... \$1,049.00 Bintel	Saxon EQ5 GoTo... \$1,495.00 Astronomy ...	Sky-Watcher EQ6-R Pro... \$3,055.00 Bintel ★★★★★ (72)
Weight (kg) 2.5 Payload (kg) 5	15 11	35 20

8

### Equipment: Star Trackers

➤ Other examples

9

### Equipment Level: Star Tracker

➤ Skywatcher AzGTi  
Intended for AltAz only  
Cost about \$600  
Can now get packages with scopes  
Can be modified to operate in EQ mode

10

### Polar Alignment (PA)

- Need to align the RA (polar) axis to the south or north celestial pole
- Errors in this alignment show themselves up as mis-shapen stars
- Accuracy depends on FL in use
- PA within 1 arc min is good enough for most set-ups

11

### PA Methods

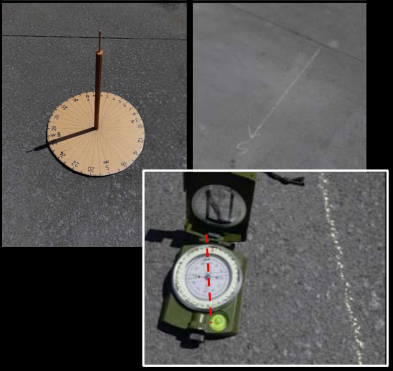
- Rough alignment with compass/sun or some other
- Visual alignment with polarscope
- EAA methods
- Drift alignment
  - ✓ Much longer but very accurate
  - ✓ This method does not require CP to be visible!

↓ Improving accuracy

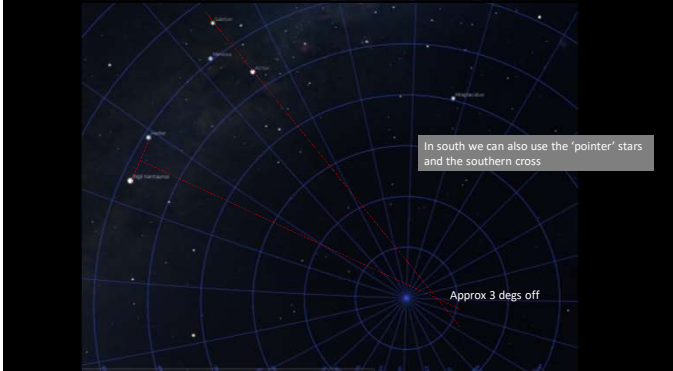
12

### Finding SCP

- Use known position of sun and home made sun dial to find N-S
- And/or use compass
- Phone compass App also works
- This is a good starting point for other methods



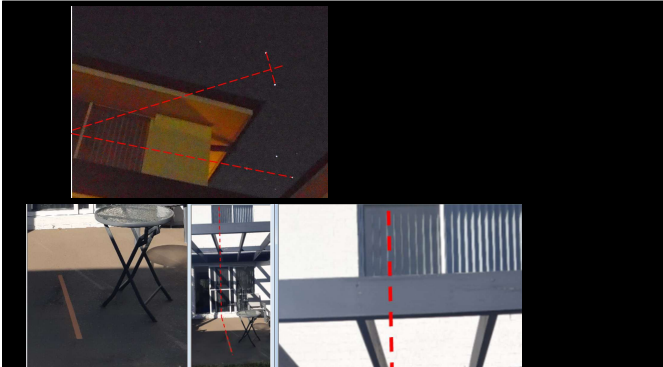
13



In south we can also use the 'pointer' stars and the southern cross

Approx 3 degs off


14



15

### Good enough?

- No view of Mars from usual spot
- Could not see SCP
- PA by phone compass app
  - 50 mm with 10 s exposures for 15 min
  - Two separate days to show planet movement
  - Not best quality (kit lens) but no trails
  - Final result shown in Week 5



Mars 8/1/23

Mars 30/12/22

16

### Polarscope


- More accurate- requires sighting of poles
- Scope that projects star template
- Move mount to align stars
- In south we use the Octans trapezium



Sky Watcher PT6C Polar... \$69.10 AliExpress.c...

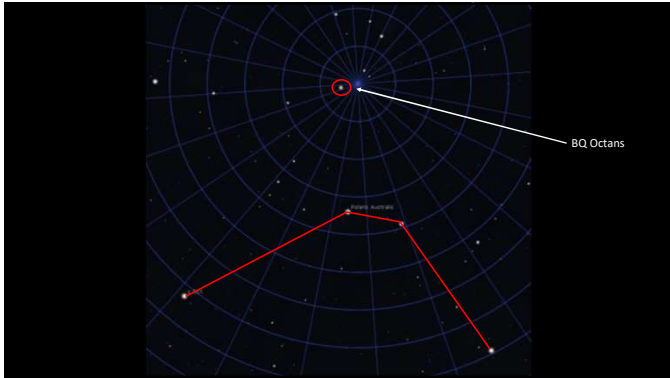
PoleMaster by QHY... \$495.00 Astronomy ...

17



In this Stellarium view we can see Octans

18



19

- This is how I used to do PA
- Take image from my camera (battery!)
- Try and get the circled star as close to centre of FOV
- The image on right has been plat solved to show SCP

A star chart showing a red path connecting stars. One star at the top is circled in red. The chart is overlaid on a dark image of the sky.

20

### EAA Example

- SharpCap Pro upgrade (small annual fee approx. \$20)
- Uses plate solving
- Requires user to rotate mount 90 degrees
- Very quick and accurate
- Need to already be within 5 deg of CP
- Need camera finderscope set-up

21

- Determines whether or not close enough

A software interface showing a star chart with concentric green circles centered on a star labeled 'NCP'. Text on the screen says 'Press the Next button before rotating the RA Axis'. Below the chart is a control panel with various settings.

22

### Adjustments

A photograph of a telescope mount on a tripod against a brick wall. Blue lines point to an 'altitude adjustment knob' and 'Azimuth adjustment screws'. A text box at the bottom left says 'For initial large left-right movements (>1 degree) move the whole tripod'.


23

A software interface showing a star chart with concentric green circles. A red 'X' is placed over the 'NCP' star, and the text 'RA Axis' is written in red. Text on the screen says 'Press the Next button before adjusting Alt/Az!'. Below the chart is a control panel with various settings. Two values are circled in red: '00° 05' 23" (RA)' and 'Up 00000.24'. A text box at the bottom says 'This should be at least 'Good'' and 'Adjust by this amount'.

24

### Guiding

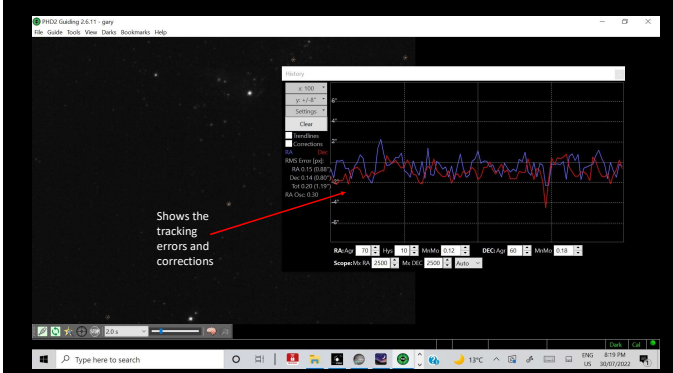
- Even with PA the tracking will have errors
- Use of a separate camera to monitor a star in FOV
- Sends small adjustment to the mount to correct tracking errors
- Popular application is "PHD2"
- Can get subs of many minutes!



Main imaging camera

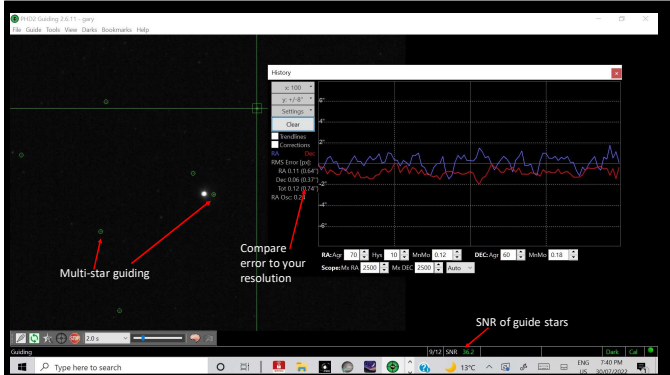
Guidescope & camera

25



Shows the tracking errors and corrections

26

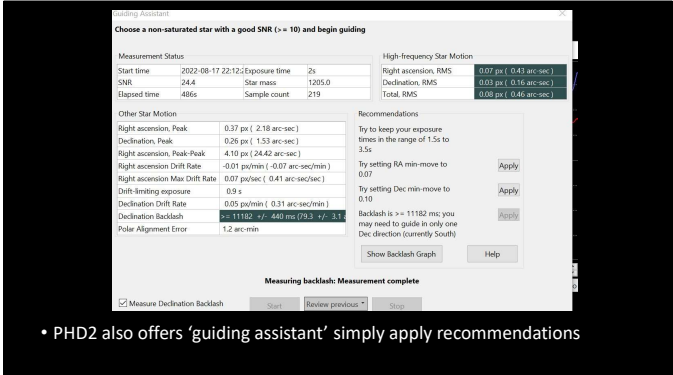


Multi-star guiding

Compare error to your resolution

SNR of guide stars

27



Choose a non-saturated star with a good SNR ( $\geq 10$ ) and begin guiding

Measurement Status		High-frequency Star Motion	
Start time	2022-08-17 22:12:23 Exposure time 2s	Right ascension, RMS	0.07 px ( 0.41 arc-sec )
SNR	24.4 Star mass 1205.0	Declination, RMS	0.03 px ( 0.16 arc-sec )
Elapsed time	486s Sample count 219	Total, RMS	0.08 px ( 0.46 arc-sec )

Other Star Motion

Right ascension, Peak	0.37 px ( 2.18 arc-sec )	Try to keep your exposure times in the range of 1.5s to 3.5s
Declination, Peak	0.26 px ( 1.53 arc-sec )	
Right ascension, Peak-Peak	4.10 px ( 24.42 arc-sec )	By setting RA min-move to 0.07
Right ascension Drift Rate	-0.01 px/min ( -0.07 arc-sec/min )	By setting RA min-move to 0.07
Right ascension Max Drift Rate	0.07 px/sec ( 0.41 arc-sec/sec )	By setting Dec min-move to 0.10
Drift-limiting exposure	0.9 s	Backlash is $\geq 11182$ ms: you may need to guide in only one Dec direction currently Southly
Declination Drift Rate	0.05 px/min ( 0.31 arc-sec/min )	
Declination Backlash	$\geq 11182$ +/- 440 ms (29.3 +/- 3.1)	
Polar Alignment Error	1.2 arc-min	


Measuring backlash: Measurement complete

Measure Declination Backlash

• PHD2 also offers 'guiding assistant' simply apply recommendations

28

### Guided vs Unguided



6 min subs at 135 mm

1 min & 3 min subs at 360 mm

29

### Dithering

- Fixed pattern noise on sensor
- Stacking subs means same pixels on sensor added
- Can be reduced by 'dithering'
- Deliberate movement of sensor every so many frames
- Can be done manually or automatically
- Some use this instead of dark calibration; I tend to use darks only

30

### Goto Mounts (Star Alignment)

- Some star trackers only 'track' earth's rotation
- Others have built in 'Go to' capability like expensive mounts
- Locating invisible targets can become tedious (impossible!) without this
- To get this to work need to perform star alignment

31

### Goto Mounts (Star Alignment)

- Make sure location is set properly (long/Lat)
- Select 1 to 3 bright stars- usually a choice is provided based on best calculation
  - 3 star alignment will give best results and is necessary for targets that cannot be easily located or longer FL
- Centre each one in turn using camera
- This becomes tonight's 'pointing model'
- Can save and restore later if tripod is not moved
- Thereafter any target can be located

32

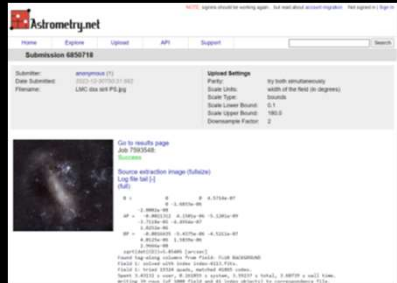
### Plate Solving

- Matches image to known star atlas
- Can be done online (Astrometry.net)
- Can be done on laptop with saved index files at correct FOV
- Can also be done in live acquisition software
- This helps determine accurately where the mount is
  - For some targets you may not 'see' them even when centred so this becomes vital

33

### Plate Solving

- Using Astrometry.net
- Upload any jpg
- No other info needed



34

### Plate Solving

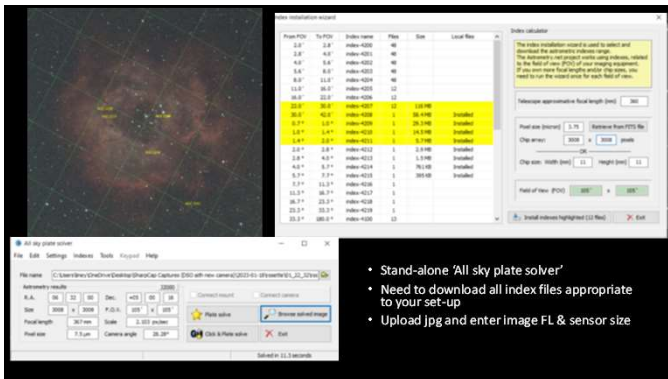
- Produces co-ordinates
- Resolution
- Labels all known DSO



35

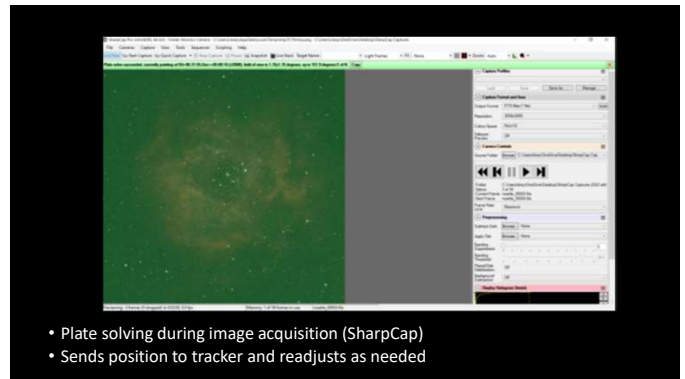


36



- Stand-alone 'All sky plate solver'
- Need to download all index files appropriate to your set-up
- Upload jpg and enter image FL & sensor size

37



- Plate solving during image acquisition (SharpCap)
- Sends position to tracker and readjusts as needed

38

### The Upshot...this is what I use

- 135 mm (fast) lens  
1 min in dark sky or when using NB filter in LP
- 360 mm (slower) scope  
4 min guided when using duoband filter in LP  
20-30s for everything else

39

### Summary

- You can use AltAz tripod and stack lots of short subs- but you will be limited in quality & brightest targets
- Star trackers are most economical per image quality
- Go to functionality is also recommended to make life easier
- Heavier/longer FL imaging will require sturdier mounts with exceptional tracking (\$\$\$\$)

40

The logo for 'Austrophotography' features a stylized kangaroo in grey and white, positioned as if jumping over a large, detailed image of the moon. The text 'Austrophotography' is written in a yellow, sans-serif font across the bottom of the moon. Below the logo is the website address 'www.austrophotography.com'.

Questions?

41