ASTROPHOTOGRAPHY SEMINAR

INTRODUCTION TO PLATE SOLVING

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WHAT IS PLATE SOLVING

Good question

- Plate solving is the automatic identification of objects in your image

- An advanced computer algorithm, using a reference sky database, analyzes an image and identifies and labels the objects within your image . . . but

- more importantly, it calculates the exact center sky coordinates and rotation of your image

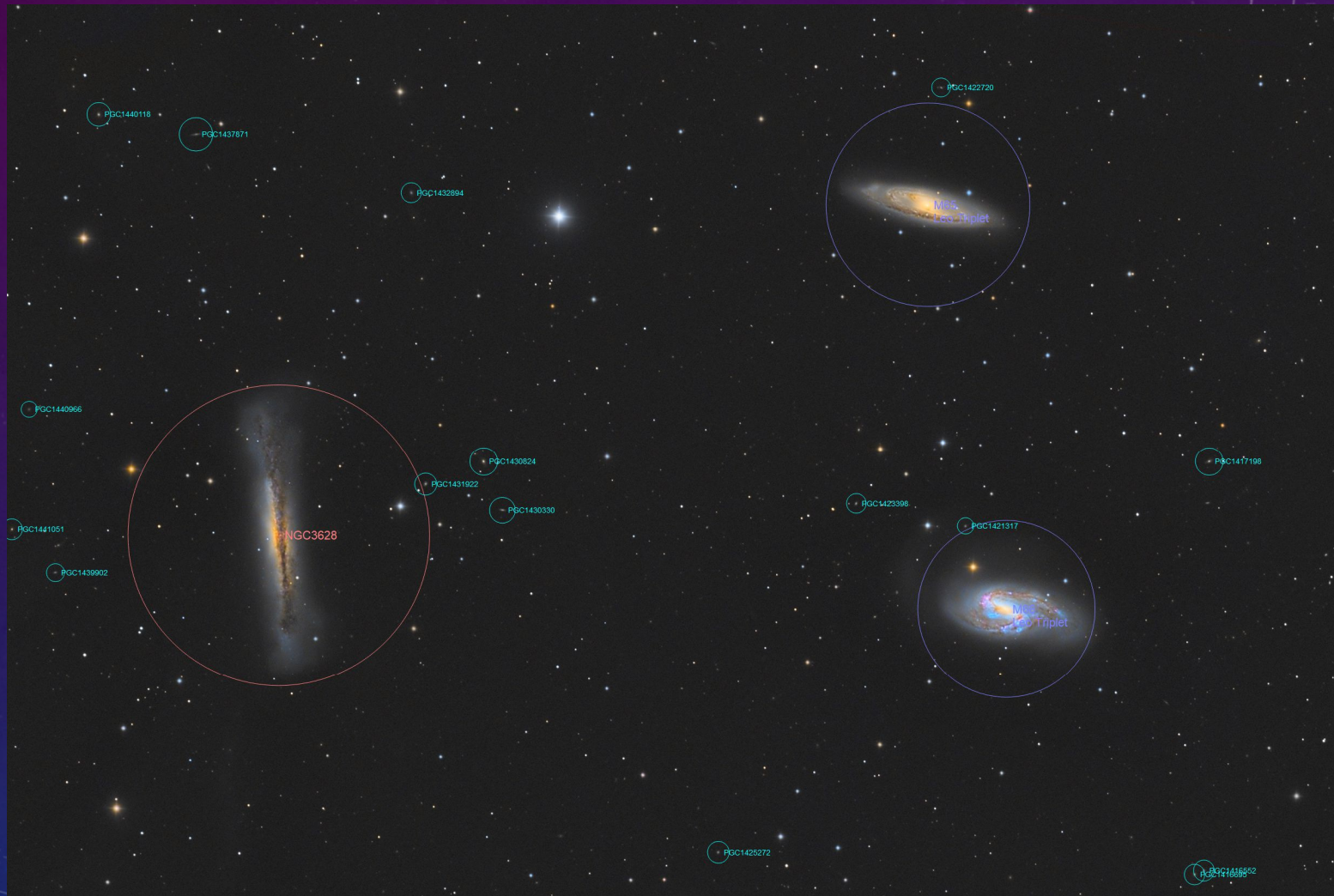- And that is what makes plate solving golden for astrophotography

IMAGE IDENTIFICATION

- A basic image can be "plate solved" and have all objects labeled

IMAGE IDENTIFICATION - PIXINSIGHT

Let's try it out in PixInsight

- Here are the steps:

  1. Open image

  2. Run script "ImageAnalysis" - Choose correct focal length

  3. Run script "AnnotateImage"

IMAGE IDENTIFICATION - PIXINSIGHT

- Here is the plate solved annotated image

PLATE SOLVING FOR ASTROPHOTOGRAPHY

But getting back

- Let's see a few different methods astrophotographers use to find and frame their objects

METHODS OF OBJECT CENTERING

The old school astrophotographer

- Uses a non-GOTO mount, finder scope, and star charts

- Attempts to find an object using star-hopping techniques

- Once the target area is found, the astrophotographer will take numerous test images and finely move their mount until the object is properly framed.

- This is an iterative process – can be very time consuming

- Also, terrible for your neck and back

- Generally, the goal here is to simply have the object centered

- The process is time consuming so fine tuning to get a "creative" framing is generally avoided

- Also nearly impossible to get identical framing over several nights

- And Imaging an object is generally limited to what is captured during a single night

METHODS OF OBJECT CENTERING (CONT)

Next - The laptop astrophotographer

- Uses a GOTO mount and laptop

- Uses a hand controller or laptop to move the mount to the desired object

- Will then use an iterative process to frame the object

- This again can be time consuming and usually requires luck to get a good framing

- Identical framing over multiple nights is very difficult

- Multi-image mosaics are nearly impossible and mosaic "efficiency" is very low due to mismatches in framing

METHODS OF OBJECT CENTERING (CONT)

Finally - The plate solving astrophotographer

- Uses a GOTO mount, laptop, and plate solver software

- With a couple mouse clicks, the object is perfectly framed and ready to go

- Yes! It is that simple

- It takes about five minutes at most

- It can be repeated within a few pixels on multiple nights

- And it can be done <u>before it becomes fully dark out</u> – BIG PLUS!

WHEN NOT USING PLATE SOLVING

- Iterative process of framing an object can take a very long time (up to 1 hr)

- Must be done after astronomical twilight, especially with faint objects

- Nearly impossible to frame an object exactly over multiple nights

- An imaging session can be ruined if the auto guiding or mount goes squirrely. Takes too much time to re-frame the object

- "Creative" framing is difficult

- And the numb[er] can frame and rot[ation] [t]o do manually if y[ou] your imaging came[ra]

What is "creative" framing
- Frame objects in an artistic manner – exactly how you want them – Rule of thirds – multiple object placement
- Maximize the number of objects in your FOV by choosing the best rotation and framing – Difficult to do especially when objects are at the edges of camera FOV.

BENEFITS OF PLATE SOLVING

- An object can be framed exactly how you want it ("creative framing")

- Takes less than a minute to frame an object within a few pixels

- An object can be framed before its fully dark saving valuable imaging time

- If guiding or tracking is lost, the image can be framed again in seconds

- Framing can be repeated within a couple of pixels on multiple nights

- Save your knees, back, and neck

- A GOTO mount is not required, although it helps with initial pointing

- A star aligned GOTO mount is not required. With blind plate solving, you can point your camera anywhere in the sky and the plate solver algorithm will find where its pointing and move your mount to your object!

- Automated meridian flips – Yes the dreaded meridian flip!

- Finally, large mosaics can be created very easily. Very difficult if not using plate solving.

HOW PLATE SOLVER WORKS

- Plate solvers work by comparing your image with a large database of known star maps

- Two types – "hint" based plate solver (most common) and "blind" plate solver

Hint based plate solver

- Requires initial hint of RA/DEC coordinates to allow the plate solver to choose the correct database catalog

- Fastest! Usually takes a few seconds at most

- Most convenient – requires local database files only

HOW A PLATE SOLVER WORKS (CONT)

Blind plate solver

- Algorithm will compare your image to the entire sky database

- Does not require an initial hint. Point your scope anywhere and the plate solver will usually find a match – but not always.

- Can take a very long time – lots of searching

- Requires an internet connection for online database or requires you to set up a special local server to emulate an online server

- Not very practical for field use – takes too long and can be unreliable

PLATE SOLVING WORKFLOW

General workflow for image capture with plate solving

- Choose your object – Do this at home

- Frame your object in SGP and save as a "target" – Do this at home

- Set-up and polar align your mount

- Perform a single star mount alignment - very rough alignment required

- Load up "target" in SGP or similar program

- Perform a rough slew to the target

- Center and rotate object command (SGP)

- If using a manual rotator, rotate the number of degrees as requested by SGP.

PLATE SOLVING WORKFLOW (CONT)

Choose your object

- Choose your imaging object based on time of year, position in sky, etc…

PLATE SOLVING WORKFLOW (CONT)

Frame your object using SGP Framing Wizard

- Open Sequence Generator Pro

- Run the Framing and Mosaic Wizard

- Enter your object designation (M54, NGC819, etc…)

- Frame and rotate your image exactly how you want to the camera to capture it

- Save this framed image as a SGP Target file

PLATE SOLVING WORKFLOW (CONT)

Set-up mount

- Unpack and set-up mount

- Polar align as required

PLATE SOLVING WORKFLOW (CONT)

Calibrate your GOTO mount using star alignment

- Perform a very rough star alignment with your mount
- A single star is sufficient

PLATE SOLVING WORKFLOW (CONT)

Rough slew

- Open up SGP and load your SGP Target file

- Perform a "rough" slew

- This will get the mount in the general location – all that is needed!

PLATE SOLVING WORKFLOW (CONT)

Plate solve and centering

- In SGP, click on Center and Rotate Target

- This begins the plate solving process

    1. SGP will take a reference image of where the scope is pointing

    2. SGP will then plate solve this image and determine its coordinates

    3. SGP will then compare these coordinates with your SGP Target file coordinates

    4. SGP will then calculate the corrections and send them to the mount

    5. The mount will move a small amount to perfectly center the object and match your SGP target file image.

    6. If rotation is needed, it will tell you exactly how many degrees to rotate your camera

PLATE SOLVING WORKFLOW (CONT)

7. SGP will now take a new reference image and repeat the process

8. The process will repeat until the error is close to zero. The default error is within 10 pixels and ½ degree rotation. These can be changed by the user in SGP.

- Generally, this process takes less than a couple of minutes

- And yes, this process can begin as soon as the brightest stars are visible in the sky. No need to wait until dark!

- At this point you can begin imaging!

PLATE SOLVING WORKFLOW (CONT)

Start imaging

- At this point, you may start imaging

- For me, this is usually at least 15 minutes before astronomical twilight.

- I will start taking images, even though they are throw-aways because its still relatively light out, to check my guiding and framing

FINAL COMPARISON

Event	No Plate Solving	Plate solving
Initial object targeting and framing	30 to 60 minutes	2 minutes
Meridian flips	15 to 30 minutes	1 minute
Loss of guide star and tracking (Require object to be re-framed)	15 to 30 minutes	1 minute
Major mount malfunction / power loss	15 to 30 minutes	1 minute
Automated and remote imaging	No	Yes! I control and perfectly frame my objects from the comfort of my home and car – Great when its cold
Multi-image mosaics	Very Difficult	Easy
Image same objects on multiple nights (eg. Narrowband imaging)	Difficult	Easy
Imaging in light polluted skies (eg Narrowband imaging)	Difficult	Easy