

A-Team Tutorials

Introduction

Background

The Slooh Research Group (SRG) was set up in 2012 to coordinate the activities of members wishing to use the Slooh.com telescopes for scientific work. From mid-2013, Slooh members Don Cranford Jr. and Tony Evans were guided through a programme of activity developing the skills to submit observations to the Minor Planet Centre (MPC). Experienced member Norm Pritchett was our mentor during this period. In the expectation that others may follow, I prepared some tutorials and made them available to interested Slooh members.

In 2014, when the concept of “Groups” was implemented by Slooh, we christened ourselves the “A-Team” and began to offer assistance to any Slooh members who wished to learn how to measure and report asteroid and comet observations. The current version of the tutorials has been evolved to accommodate A-Team experience and changes in the various websites and tools we use.

There is nothing about observing asteroids and comets that is super-complicated, but there are a lot of small things to think about so I would advise read-a-bit then practice-a-bit until you feel confident.

Principles

There are a couple of principles that we should observe:

1. The Minor Planet Centre (MPC) is a serious scientific organisation with some big responsibilities. When I last looked, it had 323 million observations of over one million objects spanning 215 years. Every day the MPC receives thousands of observations from professional and amateur observers, so strict quality controls must apply. While the MPC welcomes (and needs) amateur observations, they must be of a quality comparable to those from professional observing teams.
2. Slooh.com is a commercial organisation that seeks to provide access to, and education about, astronomy for a wide range of age groups and astronomical experience. Slooh supports members who wish to make observations and submit them to scientific organisations but needs to ensure that these observations are of a high quality that will reflect well on Slooh and its members. To that end, members wishing to submit

measurements to the MPC and other astronomical organisations need to pass through a period of “apprenticeship” to develop and demonstrate the necessary skills.

It is an objective of the A-Team to help Slooh members complete this “apprenticeship” and to achieve the “graduation” that will allow them to submit measurements of asteroids and comets to the MPC.

General Documentation

There are a couple of documents published by the MPC that provide guidance on observing minor bodies and submitting reports. It is strongly advised that the newcomer read these and become familiar with the content. If some of the topics are as yet unfamiliar to you, do not worry. Help will be available each step of the way to becoming an observer.

- [MPC Guide to Minor Body Astrometry](#) is the basic introduction by the MPC.
- [MPEC 2011-E67](#) is an editorial seeking to improve observing and reporting practice.

There are, of course, many books, articles and papers that can be found on the internet, addressing all aspects of asteroid and comet observing. In these notes we will focus on using the Slooh telescopes to report asteroid and comet astrometry and photometry.

Workflow

When asteroid (or comet) chasing I normally follow a “workflow” and for each step in the workflow I have provided some notes. The notes are divided into three Levels that include increasingly complex material: introductory, intermediate and graduate. This is intended to match a beginner’s progress through increasingly challenging observations.

The workflow is described below.

Targets & Priorities

The first thing to do is identify some target asteroids to observe and measure. You can build a “candidates list” of objects that may be worth observing now or in the near future. Initially you may select fairly bright and slow-moving objects to practice on. Later you will advance to more challenging observations including newly discovered Near-Earth-Objects (NEOs), Potentially Hazardous Asteroids (PHAs) and comets.

This activity involves using online resources or planetarium software to determine what objects are currently visible and whether observations are needed.

Visibility & Missions

Here you determine which of your potential targets are currently visible using available mission slots of a suitable Slooh telescope. Eventually you decide on an object, obtain details of its coordinates, and set up the missions. Normally, at least three missions are needed to show the movement of objects clearly. Then sit back and wait for the missions to run and the FITS image files to arrive (weather willing!).

This activity involves using an “ephemeris” (a list showing the position in the sky of an object at different times) and using the Slooh reservation system to set up missions.

Identify & Measure

We normally use [Astrometrica](#) to measure the position and magnitude of objects in an image. FITS images are downloaded from Slooh and loaded into Astrometrica. “Data Reduction” matches the pattern of stars in an image to the stars in a catalogue. Astrometrica will then check for known objects in the field of view (FOV). Hopefully, you will be able to identify your target in the image and you can make astrometric (position) and photometric (magnitude) measurements.

This activity involves installing and configuring Astrometrica and developing the skill to identify and measure targets accurately. You will start with “easy” objects and work towards the more challenging ones.

Quality & Residuals

We use “residuals” to check the quality of our observations. A “residual” is the difference between your measured position and the position predicted by the object’s orbital elements. By calculating residuals, we can assess the quality of our observations and decide whether they should be reported to the MPC.

Find_Orb is the software used to calculate residuals. For your initial objects, it will be enough to upload your observations to the online version of Find_Orb but eventually you will need to install the PC version and use it to generate orbital elements from observations.

Reports & Publications

When your observations and measurements are of a good standard you will be able to report them to the MPC. The report is produced

by Astrometrica and sent using a special “submissions” page on the MPC website.

Once you are qualified to submit observation reports you will want to know that they have been accepted and published. Several types of publication and online databases can be monitored, and your observations will turn up in all of them. Observations of an important NEO will appear in less than 24 hours while those for a well-known main belt asteroid can take a few weeks.

Skills Development

The tutorials are organised in 3 “Levels”.

Level 1 – Introductory

This consists of running through the workflow with relatively easy targets. The main objective is to ensure you can identify targets, set up missions and use Astrometrica to measure the position and magnitude of objects.

Level 2 – Intermediate

This includes finding more scientifically interesting and challenging targets for which the MPC or Spaceguard require observations. Image stacking is used to add multiple images together to show up faint objects.

The program Find_Orb is installed and used to analyse orbits and generate residuals. A basic knowledge of orbits is required to understand why residuals may vary and to make judgements on the quality of observations.

During Level 2 you will submit your first observations to the MPC.

Level 3 – Graduate

Additional types of target are introduced including as-yet-unconfirmed discoveries (Near Earth Object Confirmation Page) and (Potential Comet Confirmation Page) objects. Special techniques are introduced for measuring the position and magnitude of “fuzzy” comets.

Find_Orb is used to show how your observations make a real improvement to an orbit.

The procedures required to report new discoveries are introduced.

Once members have demonstrated the ability to produce quality reports for a range of object types, they “graduate” and are free to

conduct a program of observations individually or as part of a Slooh group.

Level 4 “Post Grad”

Additional skills can be developed, although this part of the programme is less well defined. Topics may include:

- Seeking to find lost objects that are ‘Recovery Opportunities’.
- Predicting probability or location of an impact.
- Analyse the residuals performance of an observatory.
- Optimising Astrometrica configurations.
- Hunting for undiscovered asteroids or comets.

It is hoped that Post Grads will follow their own lines of research and contribute new techniques for the A-Team to use.

Conclusions

Observing asteroids and comets is a fascinating activity and can be of genuine scientific value. It is not particularly difficult but does require time and attention to detail. The Slooh.com A-Team programme can provide support and assistance to develop your skills as an observer.

If you are interested in participating, and have not already done so, contact Paul Cox (paul@slooh.com) and ask to join the A-Team Asteroid Monitoring group. Let him know your level of experience and particular areas of interest and you can soon become a qualified observer.

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