



Target Asteroids! Frequently Asked Questions



1. What are *Target Asteroids!* and *Target NEOs!* ?

Target Asteroids! and *Target NEOs!* are citizen science projects of the NASA OSIRIS-REx asteroid sample return mission that provide data for continued study of near-Earth asteroids. *Target Asteroids!* is an education and public outreach project of the OSIRIS-REx mission and *Target NEOs!* is a parallel observing program through the Astronomical League. Observations from both projects benefit the OSIRIS-REx Science Team and other researchers.

2. Why are amateur astronomers important?

Many advanced amateur astronomers are highly skilled, possess large aperture telescopes equipped with research quality instrumentation, and are eager to engage in research-oriented activities. Their observations can complement professional observations, provide greater geographic distribution, and create larger data sets through more frequent observing.

3. What are NEOs?

NEOs (near-Earth objects) are asteroids and comets that approach to within 1.3 AU of the Sun. Near-Earth asteroids (NEAs) are a subset of this population limited to objects scientists believe to be asteroids.

4. How was the *Target Asteroids!* list compiled?

Carl Hergenrother, OSIRIS-REx Asteroid Astronomy Lead and *Target Asteroids!* Co-lead, compiles the list by selecting near-Earth objects that are greater than 200 meters in size and are relatively easy to access for sample return spacecraft missions. Additional brighter, Main-belt asteroids that are analogues to (101955) Bennu have been added too. This list is dynamic and will change over the course of the mission as we learn more about these objects and astronomers discover new objects.

5. Where can I find the *Target Asteroids!* list?

http://www.asteroidmission.org/?q=target_asteroids lists the current target asteroids. Also, co-lead Carl Hergenrother sends email updates to registered *Target Asteroids!* Observers.

6. How often is the *Target Asteroids!* list updated?

The *Target Asteroids!* team will update the list as needed. If new asteroids that meet the criteria for our program are discovered, they will be added to the *Target Asteroids!* list. No objects will be deleted from the list though some may be downgraded in priority as we learn more about them. When updates occur, we will send out a notification to the *Target Asteroids!* listserv (members include those participating in the Astronomical League's *Target NEOs!*).

7. Is the *Target NEOs!* list the same as the *Target Asteroids!* list?

Yes.

8. What can my observations tell us about NEOs?



Participants in *Target Asteroids!* and Target NEOs! can produce three different types of data; 1) photometry, 2) astrometry and 3) spectroscopy. Photometry is the measurement of the brightness of an asteroid relative to standard reference stars. When photometric observations are taken over time, astronomers are able to measure an asteroid's rotation (or spin) rate, get a rough idea of its shape, derive its color, and by measuring how an object changes brightness at different phase angles (the Sun-asteroid-observer angle) even estimate its albedo or amount of light being reflected back at us. Astrometry is the measurement of an asteroid's position relative to the background stars. When an observer's astrometry is combined with the astrometry of other observers the orbit of the asteroid can be computed. Knowing the orbit is required for predicting the motion of an asteroid into the future. These not only allow the object to be studied in the future but may even help determine its probability of impacting the Earth. Spectroscopy is the measurement of the amount of light being reflected by the surface of an asteroid at different wavelengths. Similar but better than filter photometry, spectroscopy can tell us the color and taxonomic type of an asteroid and, in some cases, reveal minerals on the surface of an object.

9. How do I get started?

See the Instructions webpage on the OSIRIS-REx website. The first step is to complete the *Target Asteroids!* Registration Form on the website and submit it if you are interested in participating. This action registers your interest in the project, allows you to receive updated information, and provides access to communication with other observers via the *Target Asteroids!* listserv.

10. What kind of instrumentation do I need?

- Telescope 8" or larger (the larger the better!)
- CCD Camera (preferably one that is color calibrated)
- Computer with internet connection
- Free astrometry software

OR

- Obtain observing time from a remote telescope vendor such as Sierra Stars Observatory Network, iTelescope.net or LightBuckets. (Note: *Target Asteroids!* does not endorse any specific vendor)

11. Does *Target Asteroids!* provide instrumentation or software?

No. *Target Asteroids!* does not provide telescopes, cameras or computers to observers. We can provide site license access to Astrometrica asteroid measuring software courtesy of Herbert Raab. Contact us for more information. See other FAQs and partners for help obtaining these items or accessing remote telescopes.

12. I don't have a telescope. How can I participate?

There are several ways in which you can participate. You may team up and use a telescope owned by a friend, astronomy club, local college or planetarium observatory. There are several private telescope vendors at observing locations all over the world from which interested observers may purchase telescope time such as Sierra Stars Observatory Network, iTelescope.net or LightBuckets. (Note: *Target Asteroids!* does not endorse



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any specific vendor.) In addition, *Target Asteroids!* partners with the International Astronomical Search Collaboration (IASC) for annual asteroid measuring campaigns. IASC partners with large private and public observatories to provide images for schools and students. Then participants measure the computer images for astrometry (position with respect to background stars) and submit the data. Contact us at Target_Asteroids@lpl.arizona.edu for more information.

13. Where can I find help?

Sources of help are:

- FAQ "Where may I find helpful on-line resources?"
- *Target Asteroids!* partner organizations have websites and members who may guide you.
- Don't forget to check out your local astronomy club. You will meet friendly members who will be happy to help you. The NASA Night Sky Network and The Astronomical League websites can help you locate a club near you.
- And, of course, the *Target Asteroids!* team is happy to answer questions.

14. I don't have a CCD camera. May I use a digital single lens reflex (DSLR) camera?

Yes. You may use a DSLR for this program. Usually DSLRs are less sensitive than commercial astronomical CCDs, but there are many people who have been using them to do accurate variable star photometry. Many of the objects on the *Target Asteroids!* list are faint but a few get as bright as magnitude 14 to 16. For photometry we ask that broadband filters be used (BVRI or RGB). Photometry derived from a DSLR's 'green channel' is often similar enough to the V-band that a filter is not needed. You do not need filters to produce accurate astrometry.

15. I have an Apple computer. Can I use Astrometrica?

Most programs such as Astrometrica, IRIS, or Maxim DL require a Windows emulator, which runs Windows on the Mac. An alternative is to use one Mac computer for image acquisition and another PC for processing the astrometry.

16. I don't have an MPC code. Is it required? How do I get one?

While we do not require an MPC code, we strongly encourage it. The procedure to obtain an assigned "MPC code" (Minor Planet Center observer's code) requires observing "a number of low-numbered minor planets each on pairs of nearby nights" for asteroids numbered between 40 and 40000 (not too bright; not too faint). The MPC recommends starting with main belt asteroids. This is a good step before attempting some of the faint, fast-moving asteroids on the *Target Asteroids!* list. See the following sites for more information:

<http://www.minorplanetcenter.net/iau/info/Astrometry.html#HowObsCode>

<http://www.minorplanetcenter.net/iau/info/Astrometry.html#begin>

17. When should I make observations?

Because not all asteroids are visible at the same time or in the same part of the sky, the observers determine their own observing schedules. Many sky calendar software programs download the latest asteroid ephemerides (astronomical positions) from the IAU Minor Planet Center (MPC) that allow the observer to plan the evening's observing session. The MPC, Lowell Observatory, and Sergio Foglia have helpful aids for planning observing sessions:

<http://www.minorplanetcenter.net/iau/MPEph/MPEph.html>

Small Bodies What's Observable? <http://ssd.jpl.nasa.gov/sbwobs.cgi>

<ftp://ftp.lowell.edu/pub/elgb/astorb.html> <http://iasc.scibuff.com/osiris-rex.php> (easy on-line tool specifically for planning *Target Asteroids!* observing).

18. How do I know what asteroids are observable from my location?

Many sky calendar software programs download the latest asteroid ephemerides (astronomical positions) from the IAU Minor Planet Center (MPC) that allow the observer to plan the evening's observing session based on his/her location. See the helpful aids for planning observing sessions listed above. Go to the *Target Asteroids!* list webpage and copy asteroid designations and paste into your favorite ephemeris program.

19. What types of observations are needed?

Observations consist of *at least 3* images processed for flat field and dark subtraction and corresponding electronic files processed for one or more of the following:

- photometry to 0.1 magnitude accuracy; V or R is best;
- astrometry (precise, accurate positions against a star field); and
- spectroscopy while difficult for these faint objects is welcome.

20. What are some helpful hints from the experts?

Make sure:

- You are observing the correct asteroid and that it is a real object (not an image defect);
- There are 12 or more reference stars in the field of view for astrometry and/or photometry;
- Use the proper order fit correction;
- Place the asteroid of interest near the center of the field;
- For photometry, we recommend use of the UCAC4 or CMC-14 catalog if the UCAC4 does not cover the location of the asteroid. (Astrometrica and other astronomical software have access to these built in).

21. What is required for each asteroid observation?



The following information is required for each observation (containing 3 *or more* digital or photographic images) of the asteroid acquired over a ½ hour (or more) interval that illustrate the correct asteroid has been identified. Astrometry is optional but encouraged.

The ideal report consists of at least three images corrected for flat field and dark subtraction, along with corresponding photometry and astrometry in standard IAU Minor Planet Center format (used by the most popular astrometry programs). Refer to the excellent NASA Amateur Observing Program here:

<http://aop.astro.umd.edu/> and Brian Warner's Guide to Photometry:

<http://www.minorplanet.info/ObsGuides/Misc/photometryguide.htm>

See the *Target Asteroids!* Observer Instructions webpage for more detailed information.

22. What software or star catalogs are recommended?

There are many excellent software packages available that allow the observer to locate asteroids, capture images, and "track--and--stack" many images to reach the really faint asteroids. While *Target Asteroids!* does not endorse particular software, some resources are:

For finder maps:

- C2A (planetarium software)
- Planetarium programs such as HN Sky and others

For astrometry:

- Astrometrica
- MPO Canopus/PhotoRed
- Pinpoint/Maxim DL

For photometry:

- MPO Canopus/PhotoRed
- Landolt Reference Stars
- Carlsberg Meridian Catalog 14 (CMC-14)
- The AAVSO Photometric All--Sky Survey (APASS)
- Astrometrica

23. What format should I use to report astrometric observations?

The recommended format is the International Astronomical Union Minor Planet Center format that can be found here: <http://www.minorplanetcenter.net/iau/info/ObsDetails.html>

(See FAQ: "How do I submit my observations?" for an example). Note that some software save the data in this standardized format already. Additional email annotations are welcome.



24. How do I submit my observations?

See the *Target Asteroids!* Observer Instructions.

25. What will happen to my observations?

We will review and process observations for use by the OSIRIS-REx Science Team. They will be archived in existing data repositories at the International Astronomical Union's Minor Planet Center. Astronomical researchers may use data to refine orbits, create composite lightcurves, determine asteroid sizes, rotation periods, shape models, compositions, and evaluate the presence of companion asteroids. Your data remains yours and you are free to provide it to any other asteroid program you desire. You may also publish your work independently of the *Target Asteroids!* program (for example, in the Minor Planet Bulletin, or the journals of the ALPO and BAA). Even if you publish your work independently you can still be part of any *Target Asteroids!* publications containing your data.

26. How do I receive credit for my observations?

Observers and their accomplishments will be listed on the *Target Asteroids!* OSIRIS-REx mission website and newsletters. They will be acknowledged in related OSIRIS-REx publications and appear as co-authors on selected OSIRIS-REx publications and posters at scientific meetings

27. How do *Target Asteroids!* and *Target NEOs!* programs leave a legacy?

Target Asteroids! and *Target NEOs!* programs build a data legacy beyond the OSIRIS-REx mission lifetime as more nations move out into the Solar System because, as a stand-alone program, it does not require the mission to continue. The data repositories will be accessible to scientists and mission planners.

28. Where may I find helpful on-line resources?

- General asteroid information
 - [NASA Amateur Observing Program](#)
 - [International Astronomical Union Minor Planet Center](#)
 - [Near-Earth Object Program](#)
 - [Near-Earth Object Human Space Flight Accessible Targets Study \(NHATS\)](#)
- Interesting discovery information and orbits
 - [Near-Earth Object Program NASA-JPL](#)
- Observation planning
 - [Sergio Foglia and Tomas Vorobjov's \(IASC\) on-line tool designed for *Target Asteroids!*](#)
 - [International Astronomical Union Minor Planet Center](#)
 - [Lowell Observatory](#)
 - [IAU-MPC Guide to Minor Body Astrometry](#)
 - [Minor Planet.Info \(Brian Warner\)](#)
- Making asteroid observations
 - [IAU-MPC Guide to Minor Body Astrometry](#)



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- [Astrometrica \(Herbert Raab\)](#)
 - [Minor Planet Observer Canopus/PhotoRed software \(Brian Warner\)](#)
 - [Brian Warner's "A Guide to Minor Planet Photometry"](#)
 - [Astronomical League's Asteroid Observing Club](#)
 - Minor Planet Center format
 - [IAU Minor Planet Center](#)
29. Who are the *Target Asteroids!* leads, advisors, and partners?
- Target Asteroids co-leads
 - Carl Hergenrother (OSIRIS-REx Asteroid Astronomy Lead and *Target Asteroids!* Co-lead)
 - Dolores Hill (OSIRIS-REx *Target Asteroids!* Co-lead)
 - Program advisor
 - Anna Spitz (OSIRIS-REx Communication and Public Engagement Product Development Lead)
 - Asteroid science advisors
 - Ed Beshore (OSIRIS-REx Deputy Principal Investigator)
 - Mission science advisors
 - Dante Lauretta (OSIRIS-REx Principal Investigator)

30. Who are the *Target Asteroids!* partnering organizations and how may I contact them?

Association of Lunar & Planetary Observers (ALPO)

<http://www.alpo-astronomy.org/>

Frederick Pilcher

pilcher@ic.edu

Astronomical League (AL)

<http://www.astroleague.org/>

Aaron Clevenson (*Target NEOs!* Observer)

aaron@clevenson.org

AL *Target NEOs!* Observing Program

<http://www.astroleague.org/node/4017>

Dolores Hill and Carl Hergenrother, Co-coordinators

Target_NEOs@lpl.arizona.edu



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Catalina Sky Survey (University of Arizona's Lunar & Planetary Laboratory)

<http://www.lpl.arizona.edu/css/>

Eric Christensen

eric@lpl.arizona.edu

International Astronomical Search Collaboration (IASC)

<http://iasc.hsutx.edu/>

Dr. J. Patrick Miller (Hardin-Simmons University)

iascsearch@hsutx.edu

iTelescope.net

<http://www.itelescope.net/>

Peter Lake (*Target Asteroids!* observer)

plake@itelescope.net

Mt. Lemmon SkyCenter (University of Arizona)

<http://skycenter.arizona.edu/>

Dr. Alan Strauss

alans@email.arizona.edu

NASA Night Sky Network (NNSN)

<http://nightsky.jpl.nasa.gov/>

Vivian White

nightskyinfo@astrosociety.org

Oceanside Photo and Telescope (OPT)

<http://optcsf.com/target-asteroids/>

Ralph Emerson



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ralph@optcorp.com

Sierra Stars Observatory Network

<http://www.sierrastars.com/>

Richard Williams

richw@sierrastars.com

31. Help! I have a question not on this list. Whom do I contact?

Email your question to: Target_Asteroids@lpl.arizona.edu and someone will reply as soon as possible. Or, if you are a registered observer, contact a fellow observer who may have had the same question or experienced your problem through the listserv: ta_observers@lpl.arizona.edu.



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