# *Target Asteroids!* Observing campaigns For April Through June 2017

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Asteroid campaigns to be conducted by the *Target Asteroids!* program during the April-June 2017 quarter are described. In addition to asteroids on the original *Target Asteroids!* list of easily accessible spacecraft targets, an effort has been made to identify other asteroids that are 1) brighter and easier to observe for small telescope users and 2) analogous to (101955) Bennu and (162173) Ryugu, targets of the OSIRIS-REx and Hayabusa-2 sample return missions.

Introduction

The *Target Asteroids!* program strives to engage telescope users of all skill levels and telescope apertures to observe asteroids that are viable targets for robotic sample return. The program also focuses on the study of asteroids that are analogous to (101955) Bennu and (162173) Ryugu, the target asteroids of the NASA OSIRIS-REx and JAXA Hayabusa-2 sample return missions respectively. Most target asteroids are near-Earth asteroids (NEA) though observations of relevant Main Belt asteroids (MBA) are also requested.

Even though many of the observable objects in this program are faint, acquiring a large number of low S/N observations allows many important parameters to be determined. For example, an asteroid’s phase function can be measured by obtaining photometry taken over a wide range of phase angles. The albedo can be constrained from the phase angle observations, as there is a direct correlation between phase function and albedo (Belskaya and Shevchenko 2000). The absolute magnitude can be estimated by extrapolating the phase function to a phase angle of 0°. By combining the albedo and absolute magnitude, the size of the object can be estimated.

An overview of the *Target Asteroids!* program can be found at Hergenrother and Hill (2013).

Current Campaigns

*Target Asteroids!* continues to conduct a number of dedicated campaigns on select NEAs and analog carbonaceous MBAs during the quarter. These campaigns have a primary goal of conducting photometric measurements over a large range of phase angles.

*Target Asteroids!* objects brighter than V = 17.0 are presented in detail. A short summary of our knowledge of each asteroid and 10-day (shorter intervals for objects that warrant it) ephemerides are presented. The ephemerides include rough RA and Dec positions, distance from the Sun in AU (r), distance from Earth in AU (Δ), V magnitude, phase angle in degrees (PH) and elongation from the Sun in degrees (Elong).

We ask observers with access to large telescopes to attempt observations of spacecraft accessible asteroids that are between V magnitude ~17.0 and ~20.0 during the quarter (contained in the table below).

Asteroid Peak V Time of Peak

Number Name Mag Brightness

(136635) 1994 VA1 19.6 early Apr

(137799) 1999 YB 19.6 late Jun

(141018) 2001 WC47 16.7 late Jun

The campaign targets are split up into two sections: carbonaceous MBAs that are analogous to Bennu and Ryugu; and NEAs analogous to the Bennu and Ryugu or provide an opportunity to fill some of the gaps in our knowledge of these spacecraft targets (examples include very low and high phase angle observations, phase functions in different filters and color changes with phase angle).

The ephemerides listed below are just for planning purposes. In order to produce ephemerides for your observing location, date and time, please use the Minor Planet Center’s Minor Planet and Comet Ephemeris Service:

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

or the *Target Asteroids!* specific site created by Tomas Vorobjov and Sergio Foglia of the International Astronomical Search Collaboration (IASC) at

<http://iasc.scibuff.com/osiris-rex.php>

Analog Carbonaceous Main Belt Asteroid Campaigns

**(62) Erato (a=3.13 AU, e=0.17, i=2.2°, H = 8.8)**

Asteroid Erato is the 5th brightest member of the carbonaceous Themis family at H = 8.8 (Nesvorny 2015). The family’s namesake asteroid has been observed to have water ice and organics on its surface (Campins et al. 2010, Rivkin and Emery 2010). Some members also exhibit cometary activity confirming the presence of ices.

Erato reached a minimum phase angle of 0.1° and peak brightness of V = 13.9 on March 1. Maximum phase angle occurs in late May at 17.1°. It is a Ch or B type asteroid with a rotation period of 9.2 hours and a small amplitude of ~0.15 magnitudes (Hanus et al. 2011, Harris et al. 2015, Neese 2010). Time series lightcurve and color photometry across a range of phase angles are requested. Observations of Erato continue our request from the previous quarter.

DATE RA DEC ∆ r V PH Elong

04/01 10 28 +11 33 2.51 3.36 14.1 10 143

04/11 10 25 +11 52 2.62 3.38 14.2 12 133

04/21 10 23 +11 59 2.75 3.39 14.4 14 123

05/01 10 24 +11 54 2.89 3.41 14.6 15 113

05/11 10 26 +11 39 3.04 3.42 14.7 16 104

05/21 10 30 +11 14 3.19 3.43 14.9 17 95

**(379) Huenna (a=3.14 AU, e=0.19, i=1.7°, H = 8.9)**

Similar to Erato, Huenna is also a member of the Themis family. It ranks as the 6th brightest Themis member at H = 8.9 (Nesvorny 2015). Similar to other Themis objects, Huenna is carbonaceous (B or C type) (Neese 2010).

Huenna reached a minimum phase angle of 0.6° and peak brightness of V = 13.3 on February 28. It has a rotation period of 14.1 hours with a small amplitude of ~0.1 magnitudes (Behrend 2014, Warner 2010). Both Huenna and Erato are located within a few degrees of each other for the entire quarter providing an easy opportunity to observe two large Themis family objects during the night. Time series lightcurve and color photometry across a range of phase angles are requested. Observations of Huenna continue our request from the previous quarter.

DATE RA DEC ∆ r V PH Elong

04/01 10 28 +09 13 2.85 3.71 14.6 9 144

04/11 10 25 +09 37 2.95 3.71 14.8 11 134

04/21 10 23 +09 52 3.07 3.72 14.9 13 123

05/01 10 23 +09 57 3.20 3.72 15.1 14 113

05/11 10 24 +09 51 3.34 3.72 15.2 15 104

05/21 10 27 +09 36 3.49 3.72 15.3 15 95

Near-Earth Asteroid Campaign Targets

**(143404) 2003 BD44 (a=1.97 AU, e=0.61, i=2.7°, H = 16.8)**

Little is known about 2003 BD44 other than its Apollo type orbit that takes it from 0.77 to 3.16 AU from the Sun. On March 20, it passes through opposition and reaches a very low phase angle of 0.3°. It will remain bright for a few weeks after opposition as it peaks at V = 13.3 on April 12 and passes within 0.056 AU of Earth on April 18. The asteroid finally fades below V = 17 on April 22 when it phase angle will reach over 130°. Time series lightcurve and color photometry across a range of phase angles are requested.

DATE RA DEC ∆ r V PH Elong

04/01 11 31 +05 42 0.16 1.15 14.0 17 160

04/04 11 19 +08 30 0.13 1.12 13.8 24 153

04/07 11 02 +12 20 0.11 1.09 13.6 32 144

04/10 10 36 +17 47 0.09 1.07 13.4 43 133

04/13 09 54 +25 36 0.07 1.04 13.3 58 118

04/16 08 40 +35 38 0.06 1.01 13.5 80 97

04/19 06 39 +43 15 0.06 0.99 14.5 107 70

04/22 04 32 +41 55 0.06 0.96 16.7 133 45

**2014 JO25 (a=2.07 AU, e=0.89, i=25.2°, H = 18.1)**

2014 JO25 is another NEA of which we know little about its physical characteristics. JO25 starts the quarter interior to Earth and difficult to observe. On April 17, it blasts out of the Sun’s glare and becomes visible at V = 17-18. Close approach occurs on April 19 at 0.012 AU. Peak brightness occurs on April 19/20 at V = 10.7. The close flyby results in an optimal time of observation of only a few days. Time series lightcurve and color photometry across a range of phase angles are requested.

DATE RA DEC ∆ r V PH Elong

04/18 23 32 +36 22 0.03 0.98 17.4 140 39

04/19 22 06 +60 33 0.02 1.00 13.6 115 64

04/20 13 17 +32 34 0.02 1.02 10.7 44 135

04/21 12 35 +05 04 0.03 1.03 11.8 25 154

04/22 12 24 -03 00 0.05 1.05 12.8 24 155

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