Using small telescopes to obtain phase function photometry

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South Africa Virtual Workshop on Asteroid Detection, Follow-up and Characterisation – 2014 March 10-11
Summary of Talk

- Phase function photometry
- How small telescope users can help
- How the OSIRIS-REx Target Asteroids! citizen science program uses phase function photometry
- How phase function data helps current and future spacecraft missions
The Goal of all asteroid characterization …

Turning a point of light …
The Goal of all asteroid characterization …

Turning a point of light …

… into a World!
INTRODUCING OSIRIS-REx

THE UNIVERSITY OF ARIZONA
Lunar and Planetary Laboratory

OSIRIS-REx
ASTEROID SAMPLE RETURN MISSION

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THE OSIRIS-REx TARGET ASTEROID

Launch in 2016
Arrive at Bennu in 2018
Acquire Sample of Bennu in 2019
Return Sample to Earth in 2023

(101955) Bennu
THE LONG ROAD TO BENNU...

600,000+ Asteroids
600,000+ Asteroids

10,000+ Near-Earth Asteroids
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South Africa Virtual Workshop on Asteroid Detection, Follow-up and Characterisation – 2014 March 10-11
600,000+ Asteroids

700+ on optimal orbits for sample return

80 with diameters greater than 200 meters

23 are spectrally classified

10,000+ Near-Earth Asteroids

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(101955) Bennu
The question was how could the typical backyard observer with a 8” (0.2-m) telescope and commercial CCD camera help characterize ‘faint’ spacecraft target NEAs

Most are too faint for work that requires high S/N obs

What could be done with low S/N photometry, especially lots of low S/N photometry
The question was how could the typical backyard observer with a 8” (0.2-m) telescope and commercial CCD camera help characterize ‘faint’ spacecraft target NEAs. Most are too faint for work that requires high S/N obs. What could be done with low S/N photometry, especially lots of low S/N photometry.
WHAT IS PHASE FUNCTION PHOTOMETRY

• Many low S/N photometric observations can be used to determine an asteroid’s phase function
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- Phase Function photometry is the measurement of the brightness of a planetary object at different phase angles
What is Phase Function Photometry

• Many low S/N photometric observations can be used to determine an asteroid’s phase function

• Phase Function photometry is the measurement of the brightness of a planetary object at different phase angles

• Phase angle is the Sun-Object-Observer angle
**What is Phase Function Photometry**

- Phase angle is the Sun-Object-Observer angle

![Diagram showing phase angle](image)
ANOTHER WAY TO LOOK AT PHASE ANGLE
PHASE ANGLES IN THE INNER SOLAR SYSTEM

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PHASE FUNCTIONS IN ACTION

Phase Function of NEA 2002 GT

R-band magnitude normalized to 1 AU from Earth and Sun

Phase Angle (degrees)
PHASE FUNCTIONS IN ACTION

Phase Function of NEA 2002 GT

IAU H-G phase model
PHASE FUNCTIONS IN ACTION

Phase Function of NEA 2002 GT

IAU H-G phase model

Linear slope

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RELATIONSHIP BETWEEN SLOPE OF PHASE FUNCTION AND ALBEDO

A graph illustrating the relationship between phase slope (in magnitudes per degree) and albedo.
PHASE FUNCTIONS IN ACTION

Phase Function of NEA 2002 GT

IAU H-G phase model

Linear slope = Albedo
**PHASE FUNCTIONS IN ACTION**

**Absolute Magnitude**

![Graph showing phase function of NEA 2002 GT with annotations for IAU H-G phase model, linear slope, and albedo.]

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PHASE FUNCTIONS IN ACTION

IAU H-G phase model

Absolue Magnitude

Absolute Magnitude + Albedo = Diameter

Linear slope = Albedo

Absolue Magnitude normalized to 1 AU from Earth and Sun

Phase Function of NEA 2002 GT

Absolute Magnitude

Albedo

Diameter
COLOR PHASE FUNCTIONS YIELD TAXONOMY

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YOU CAN NEVER HAVE TOO MUCH DATA…

• Bennu, the OSIRIS-REx target asteroid, is one of the best characterized NEAs not yet visited by a spacecraft

• Yet, there are still major gaps in our understanding

• These gaps directly affect mission planning and design

• Only by observing many objects can we fill in the holes in our understanding of any particular object
**THIS IS A WORLD-WIDE EFFORT**

- *Target Asteroids!* has attracted over 201 participants from 33 countries covering every continent except Antarctica

- But biases are obvious
WE NEED YOU!

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http://osiris-rex.lpl.arizona.edu/?q=target_asteroids

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