Faint NEO Observations Using the UH-2.2m Telescope

Dora Föhring, Dave Tholen, Denise Hung
Motivation

- 2005 Congress task: discover 90% of NEOs larger than 140m. There are thought to be ~15,000 of these.

- Near-Earth Asteroid (NEA) follow-up is essential for refining the orbit asteroids and preventing them from getting lost, particularly for Virtual Impactors (VIs): asteroids with non-zero impact solutions.

- Increasing rate of NEO discovery due to new facilities coming online such as PS-2, ZTF, and future addition of LSST, follow-up of targets towards the faint magnitudes becomes crucial.
Overview of the UH NEO Follow-Up Program

Focus:
Follow-Up of VIs, PHAs and current and previous one-opposition NEOs with V>21.

Observation:
- **UH-2.2m telescope**
  - 8 nights a lunation
  - Field of View: 7.5’ x 7.5’ (TEK)
  - 14.5’ x 14.5’ (STA)

- **CFHT MegaCam**
  - ~15h per year in queue
  - FoV: ~ 1° x 1°

- **SUBARU HSC**
  - ~4h per year in queue
  - FoV: ~ 1.5° x 1.5°

UH-2.2m Target Selection:
- V-Magnitude: ≤ 25.5
- Declination: -55° to 90°
- Solar elongation: 45° to 180°
- 1-sigma sky-plane uncertainty: 0” to 500”

Dora Föhring
IAA PDC
April 30 2019
NEO Follow-Up Methodology

- No filter
- Non-Sidereal tracking
- PSF fitting on trailed background stars
- Depending on seeing, stacking images with V>24 to obtain a Signal-to-Noise > ~5

Dora Föhring

IAA PDC

April 30 2019
NEO Follow-Up Methodology

- No filter
- Non-Sidereal tracking
- PSF fitting on trailed background stars
- Depending on seeing, stacking images with \( V > 24 \) to obtain a Signal-to-Noise > \( \sim 5 \)
NEO Follow-Up Methodology

- No filter
- Non-Sidereal tracking
- PSF fitting on trailed background stars
- Depending on seeing, stacking images with $V > 24$ to obtain a Signal-to-Noise $> 5$
NEO Follow-Up Methodology

- No filter
- Non-Sidereal tracking
- PSF fitting on trailed background stars
- Depending on seeing, stacking images with V>24 to obtain a Signal-to-Noise > ~5
NEO Follow-Up Methodology

- No filter
- Non-Sidereal tracking
- PSF fitting on trailed background stars
- Depending on seeing, stacking images with $V > 24$ to obtain a Signal-to-Noise $> \sim 5$

Dora Föhring
IAA PDC
April 30 2019

UH-2.2m Follow-Up Statistics 2018
Median measured seeing at the UH-2.2m: 1.0"

Regularly achieve RMS residuals of the astrometric fit and of the orbital solution of 0.05” using GAIA.

Approximate time per magnitude:
- 99942 Apophis: record for highest Palermo value ever reached.

- Routine monitoring since May 2018 at a very low altitudes of 16 degrees, pushing the observing limit of our telescope.

- Monitoring for Yarkovsky acceleration.
V=25.3±0.3
SNR ~ 4
6.25 hours of observation time
over two nights

1 night stack of 4 960s exposures

Recent Follow-Up Highlights:
2017 RH16
- VI Second-opposition recovery
- $V=25.5 \pm 0.5$

- 2017 RH16
- CFHT
- individual exposures

UH-2.2m Follow-Up Developments
• Extensive interior and exterior refurbishment, replacement dome drive from hydraulic to electric.

• Increasing the automation in the observing procedures and we are optimising our observations with the aid of in-house software to prioritise observations, which takes an object’s future orbital uncertainty into account.

Summary

With the increasing rate of NEO discovery due to new facilities coming online, there is a greater need for efficient observation and prioritization strategies.
With the increasing rate of NEO discovery due to new facilities coming online such as PS-2, ZTF, and future addition of LSST, follow-up of targets is crucial to prevent them from getting lost.

- There is an increasing need for facilities capable of performing follow-up of objects towards the fainter end of observability.

- The UH NEO Follow-Up Program is at the forefront of being able to respond to critical and challenging follow-up requirements.