

# Near-Earth Asteroid Follow-up Observations at the SAAO

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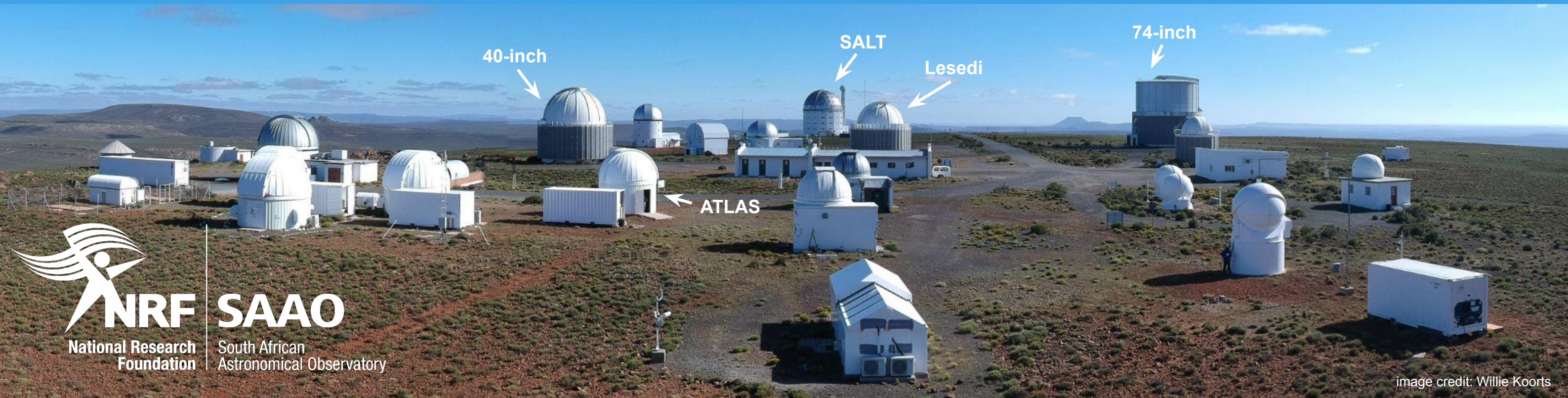


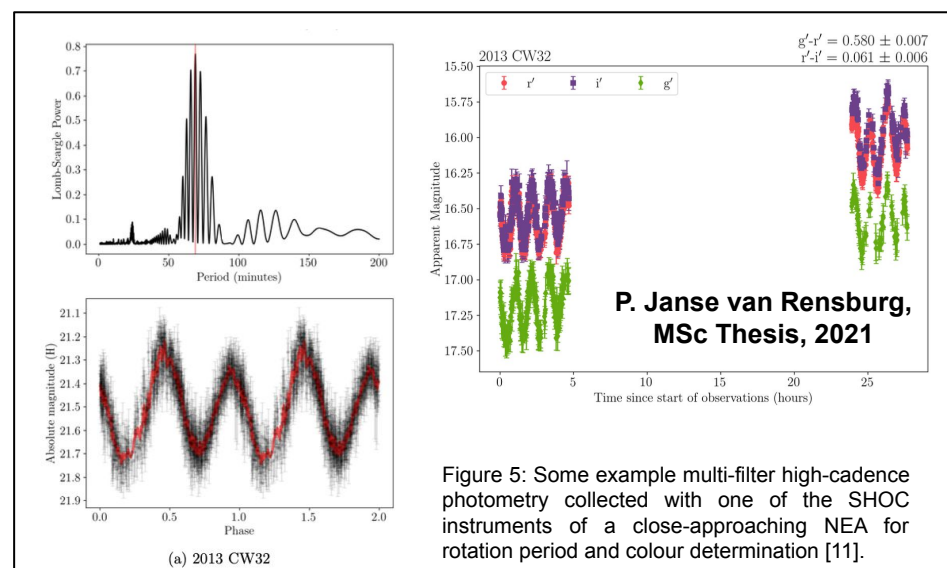
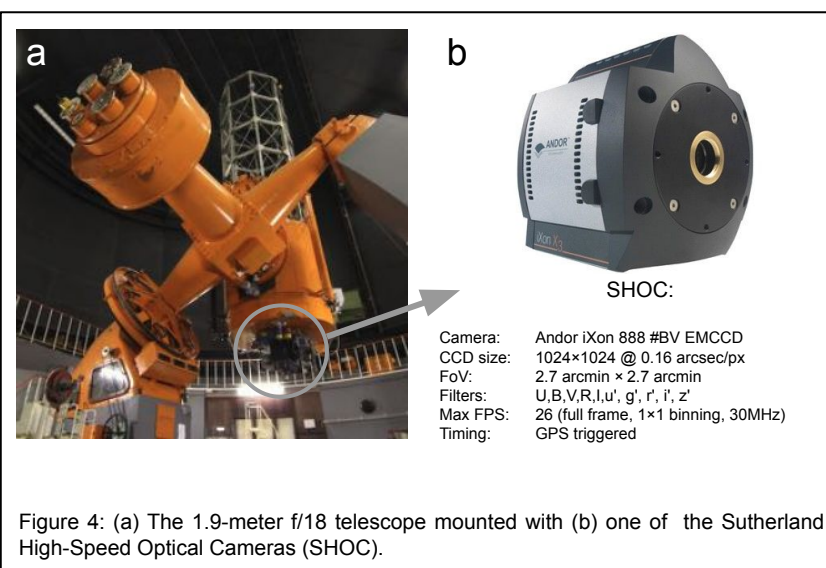
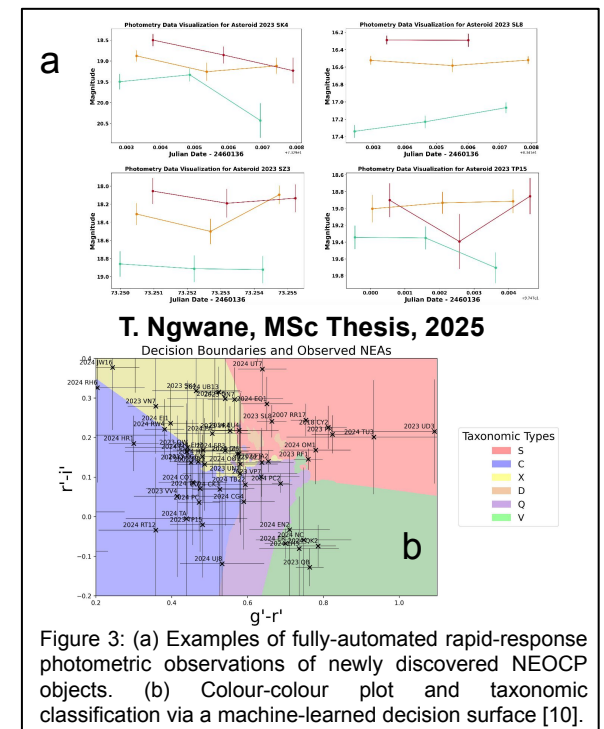
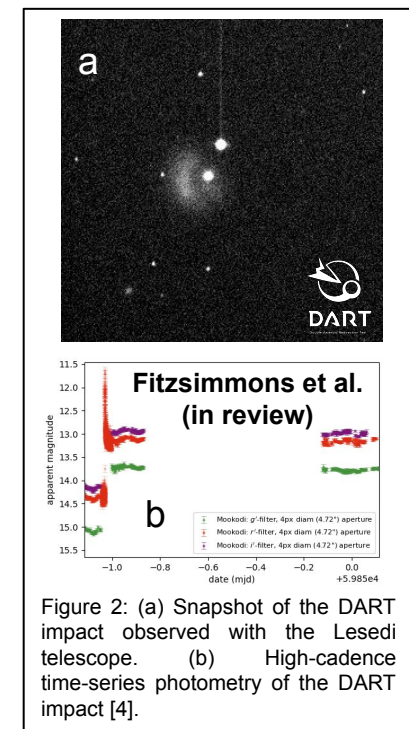
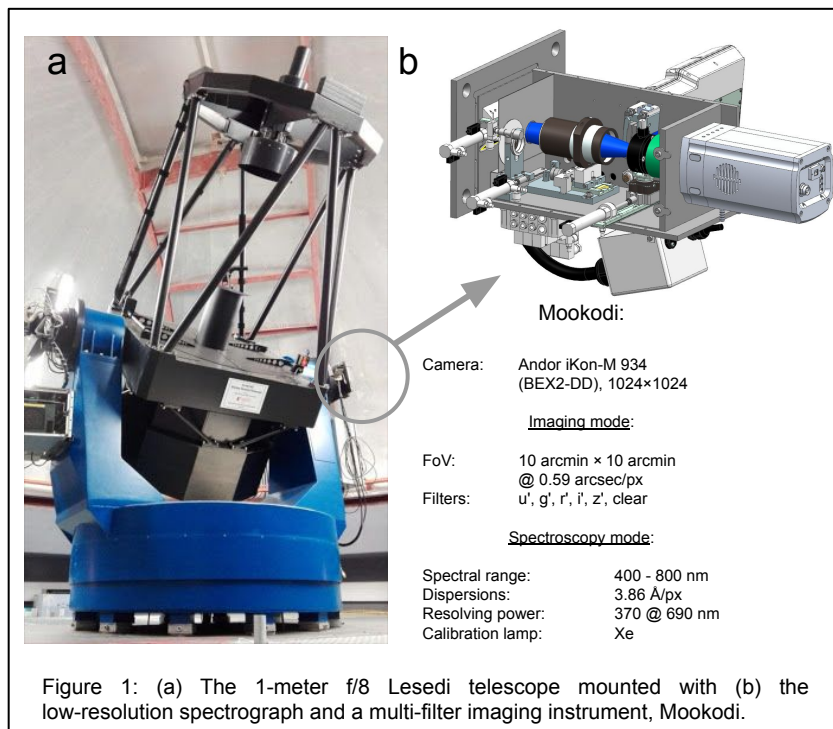
image credit: Willie Koorts

## INTRODUCTION and BACKGROUND:

The South African Astronomical Observatory (SAAO) has made significant contributions to the observation and characterisation of near-Earth asteroids (NEAs), supporting global planetary defense efforts. Located near the town of Sutherland in the Northern Cape, SAAO's diverse array of telescopes, ranging from 10-m to 1-m in diameter, offers capabilities in spectroscopy, multi-filter photometry, and polarimetry, with rapid-response options enabled by the robotic 1.0-meter Lesedi telescope. Many of these facilities have contributed data to the international NEA planetary defense exercises organised by the International Asteroid Warning Network (IAWN), including participation in the "2012 TC" [1], "Apophis" [2], and, most recently, the "2023 DZ2" [3] campaigns. Several telescopes located at the SAAO also contributed to the ground-based monitoring of the DART spacecraft's impact with Dimorphos [4]. With SAAO hosting one of the nodes of the Asteroid Terrestrial-impact Last Alert System (ATLAS, [5]) and making good progress with its "Intelligent Observatory" or "IO" initiative [6], the observatory has significantly enhanced its automated follow-up capabilities. This setup now allows for rapid same-night follow-up observations of newly discovered NEAs identified by ATLAS.

## LESEDI + MOOKODI

**Lesedi** [7] is a 1-meter f/8 alt-azimuth telescope that can accommodate instruments on both Nasmyth ports, utilising a rotating tertiary mirror to direct the science beam to the relevant port. On one of the ports is mounted with **Mookodi** [8], a multipurpose instrument with a low-resolution spectrograph mode and a multi-filter imaging mode available (see Figure 1 for specifications). Mookodi has been fully integrated into the SAAO's "Intelligent Observatory" via the recently open-sourced Observatory Control System (OCS) software [9] developed by the Las Cumbres Observatory (LCO) and completely queue scheduled and robotically operated. Mookodi is therefore ideal for fully automated rapid-response (e.g., follow-up of newly discovered NEAs, see Figure 3) but has also been used for target-of-opportunity type of observations (e.g., ground-based observations of the DART impact, see Figure 2) or other individual high interest NEAs (e.g., several of the IAWN campaigns).

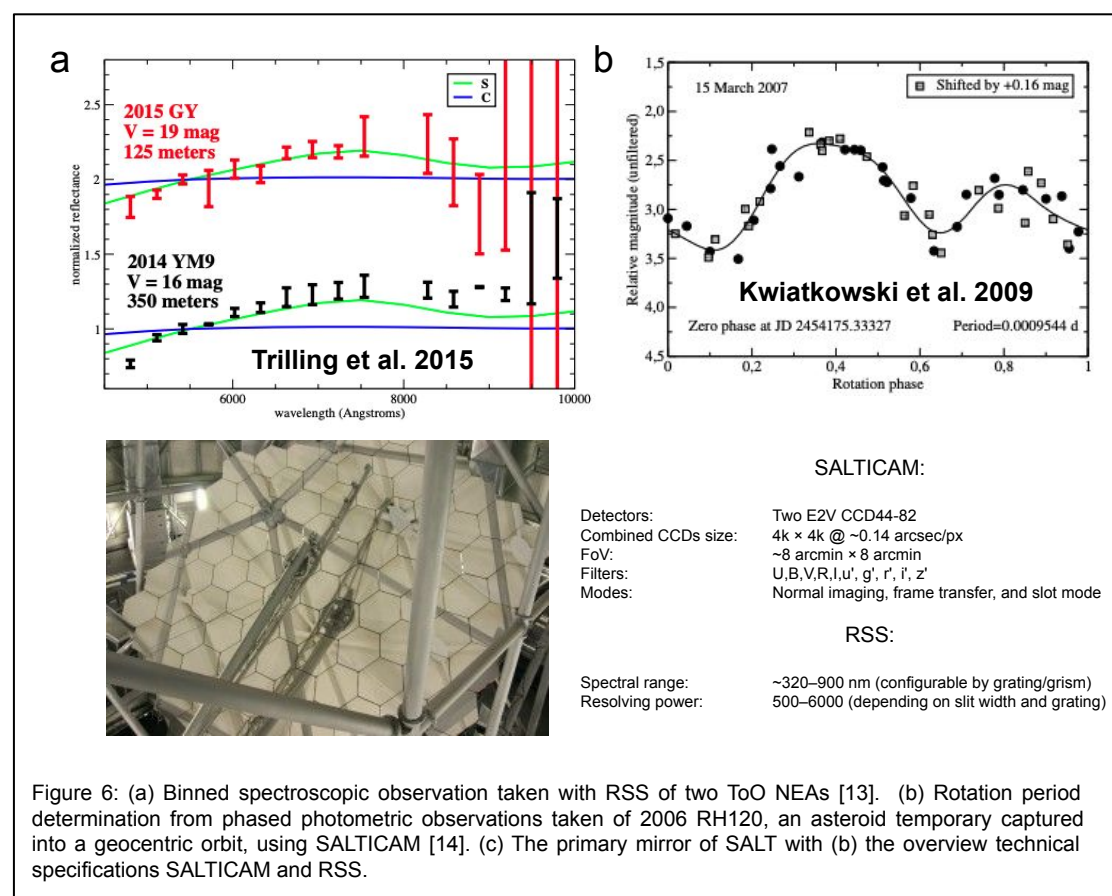


## 74- and 40-INCH + SHOC

The **74- and 40-inch** are a 1.9-meter f/18 and a 1.0-meter f/16 telescope respectively. The 74-inch can be fitted with a medium resolution spectrograph or a high-speed polarimeter but also has one of the Sutherland **High-Speed Optical Cameras** (SHOC [12], see Figure 4 for specifications) permanently available. The 40-inch is currently permanently mounted with another SHOC. Both telescopes are remotely operable from anywhere in the world and well suited for, but not limited to, time-critical observations where high-resolution time-series photometry is beneficial (e.g., stellar occultations by small bodies). The SHOC instruments have also been used successfully for follow-up characterisation (e.g., determining rotation periods and colours) of NEAs (see Figure 5).

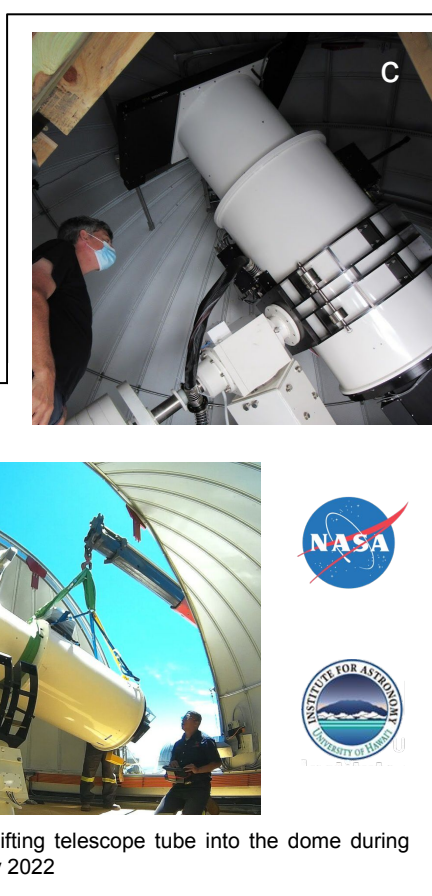
## SALT + SALTICAM and RSS

The queue-scheduled **10-m SALT** (Southern African Large Telescope) offers both imaging and spectroscopic capabilities, including spectropolarimetry. Due to its fixed-altitude design, the entire visible sky is not accessible at all times during the night; however, SALT has still been successfully used for follow-up observations of NEAs. Figures 6 (a) and (b) illustrate examples where the low- to medium-resolution Robert Stobie Spectrograph (RSS) and SALTICAM were employed for spectral classification and rotation period determination.



## ATLAS

The SAAO site in Sutherland hosts one of the Asteroid Terrestrial-impact Last Alert System (ATLAS, [5]) telescopes, which plays a crucial role in the discovery of potentially hazardous near-Earth asteroids (NEAs). Many of the objects we follow up are ATLAS discoveries.



## FUTURE WORK:

Looking ahead, we aim to expand our rapid-response capabilities for NEAs by making greater use of the telescopes available to us, specifically increasing the use of SALT for follow-up of fainter discoveries. We are also exploring the potential of incorporating more polarimetric observations of NEAs, as several of our polarimetric instruments, currently underutilised for Solar System science, could provide valuable data to enhance NEA characterization.

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