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Observing Solar System Bodies with Twinkle

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Abstract

Twinkle is a 45cm space telescope conceived to characterise extrasolar planets and Solar System objects over a broad wavelength range. The system design and mission implementation are based on existing, well studied concepts pioneered by Surrey Satellite Technology Ltd for low-Earth orbit Earth Observation satellites, supported by a novel international access model to allow facility access to researchers worldwide.

Twinkle's ability to study Solar System objects has been explored by determining when objects are observable as well as the data quality and resolution obtainable. The targets considered in this work include planets, moons, dwarf planets and asteroids

1. Introduction

Twinkle is designed for operation in a low Earth, sun-synchronous orbit. The instrumentation consists of three spectrometers which cover the spectral range 0.4 - 4.5μm with a resolving power of R$\sim$250 ($\lambda <$ 2.42μm) and R$\sim$60 ($\lambda >$ 2.42μm). As a space-based general observatory, Twinkle has the capability to provide significant new data on Solar System objects, especially in regions of the spectrum dominated by telluric absorption.

2. Results

A model has been created to calculate the exposure time required to achieve a desired SNR and resolution for Solar Systems bodies based either on their physical characteristics (radius, temperature, albedo) or visible magnitude [1]. Figure 1 highlights Twinkle's capabilities with 100s of integration time.

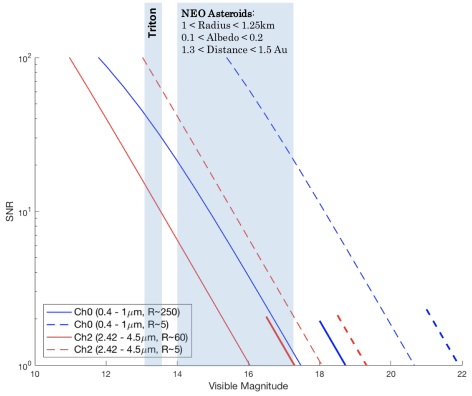

Figure 1: From the Twinkle Solar System model [1]: For an object of a given visible magnitude, the SNR achievable with an exposure time of 100s at different resolutions in channel 0 and channel 2. The capabilities of Twinkle to observe an object varies over the channels and the capability of channel 1 lies between channel 0 and channel 2. The short lines at the bottom of the diagram indicate the SNR possible with 1000s of observation time. The approximate visible magnitude of Titan and small NEO asteroids are also shown for reference.

3. Summary and Conclusions

It was found that many celestial bodies would have long periods during which they could be observed with observation windows occurring on a periodic basis. Having determined that a target was observable, the SNR for photometric and spectroscopic data was calculated for a given exposure time. For a number of targets, including the outer planets, their large moons and bright asteroids, the model created predicts short exposure times will achieve high quality (SNR > 100), high resolution (R $\sim$ 250, $\lambda <$ 2.42μm; R$\sim$60, $\lambda >$ 2.42μm) spectroscopic data.

For other targets this is found to not be achievable in one observation and thus multiple observations will be required if resolution or data quality cannot be reduced. Very small or distant objects (e.g. the outer dwarf planets, Haumea and Eris) are deemed too faint for Twinkle to obtain photometric or spectroscopic data of reasonable quality (SNR > 10) without requiring large amounts of observation time.

In conclusion, the Solar System is found to be permeated with targets which could be readily observed by Twinkle at visible and near infrared wavelengths.

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References

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