Technical Report:

Asteroid Visibility Analysis Tool for the Large Binocular Telescope (LBT)

Software Version: Python Script (Visibility Checker)
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1. Introduction: The Large Binocular Telescope (LBT)

The Large Binocular Telescope (LBT), located on Mount Graham in Arizona, is one of the most advanced optical observatories in the world. Its dual 8.4-meter mirrors enable high-resolution imaging and spectroscopy, making it particularly suitable for the observation of faint Solar System objects such as asteroids.

Efficient observation planning requires accurate knowledge of target visibility under specific observational constraints. This document describes a Python-based software tool developed to evaluate the observability of a list of asteroids from the LBT site.

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2. Software Purpose

The software is designed to:

- Analyze the **visibility of a list of asteroids** provided as input
- Identify **time intervals suitable for observation**
- Apply **observational constraints** relevant for LBT operations
- Output **detailed observing windows** for each valid target

The tool is particularly useful for **pre-observation planning** and **feasibility checks**.

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3. Input Parameters and Configuration

The software requires the following inputs:

- **Target list file** (`targets.txt`)
  A plain text file containing asteroid identifiers (one per line)

- **Time range**

 START_TIME = "YYYY-MM-DD HH:MM"
STOP_TIME = "YYYY-MM-DD HH:MM"

- **Time sampling step**

 STEP_SIZE = "15m"

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4. Observational Constraints

The visibility of each asteroid is evaluated using the following constraints:

- **Minimum target elevation:**
 EL≥26∘EL \geq 26^\circEL≥26∘
- **Solar elevation constraint (dark conditions):**
 EL⊙≤−12∘EL_{\odot} \leq -12^\circEL⊙≤−12∘
 (astronomical twilight threshold)
- **Magnitude limit:**
 V≤23V \leq 23V≤23

These conditions ensure that:

- the target is sufficiently high above the horizon
- observations are performed in dark sky conditions
- the object is bright enough for detection

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5. Software Architecture

5.1 Ephemerides Retrieval

The software uses the **JPL Horizons system** via the `astroquery` interface to retrieve ephemerides:

- Target elevation (EL)
- Visual magnitude (V)
- Observation timestamps

5.2 Solar Position Computation

The solar altitude is computed locally using the **Astropy** library:

- Time conversion via `astropy.time.Time`
- Coordinate transformation using `AltAz`
- Solar position via `get_sun()`

This ensures consistency with the observatory location.

5.3 Visibility Filtering

The visibility condition is applied using a logical mask:

- Target above minimum elevation
- Sun below twilight threshold
- Magnitude within acceptable range

Only time steps satisfying **all conditions simultaneously** are selected.

5.4 Handling Missing Data

The JPL Horizons magnitude field may contain masked values.
These are replaced with a high value (99.9) to ensure automatic exclusion from valid results.

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6. Output Description

For each asteroid in the input list, the software provides:

Case 1: Visible Target

- Confirmation message ("TROVATO!")
- Table of valid observing times including:
  - Date (UTC)
  - Target elevation
  - Solar elevation
  - Visual magnitude

Case 2: Not Visible

- If geometrically visible but too faint:

Visibile geometricamente ma TROPPO DEBOLE

- If never visible:

NESSUNA finestra geometrica trovata

Output Example

```
DATE (UT)          | TGT_EL | SUN_EL | MAG
---------------------------------------------------
2026-Apr-03 02:15  |  45.20° | -18.30° | 21.50
...
```

To maintain readability, the output is limited to the first 15 valid entries per target.

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7. Observatory Configuration

The software is configured for the LBT site:

- **Location:** Mount Graham
- **Latitude:** 32.701°
- **Longitude:** -109.889°
- **Altitude:** 3221 m
- **Horizons Site Code:** G83

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8. SSL Handling and Network Considerations

The software includes a workaround that disables SSL certificate verification for HTTP requests.

Important:
This approach is intended to avoid connection issues with remote services but reduces security. It should be used only in controlled environments. A proper SSL configuration is recommended for production use.

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9. Conclusions

The developed tool provides an efficient and flexible method to evaluate asteroid visibility from the LBT.

Its main strengths include:

- Direct integration with JPL Horizons
- Accurate local computation of solar position
- Flexible configuration of observational constraints
- Detailed time-resolved output

This makes it particularly suitable for:

- Observation planning
- Target feasibility studies
- Rapid evaluation of multiple asteroids

Future developments may include:

- Graphical visualization of visibility windows
- Integration with scheduling pipelines
- Support for multiple observatories

The software is available upon request from the authors