

Prediction of stellar occultation for Main Belt asteroids

(XI PLANETARY SCIENCE MEETING)

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Motivation: Main Belt Asteroids

- The Main Belt Asteroids are small Solar System bodies orbiting between the planets Mars and Jupiter. They contain information to understand the formation and evolution of the Solar System.
- The Minor Planet Center (MPC) has recorded about 1 million asteroids and the LSST estimates to observe 5.5 million asteroids.



Motivation: Stellar occultation

- Stellar occultation is a powerful technique for studying asteroids.
- A stellar occultation happens when a small body passes in front of a star interrupting the light flux.
- To observe a stellar occultation is necessary to know the exact time and the region on the surface of the Earth in which it will happen.

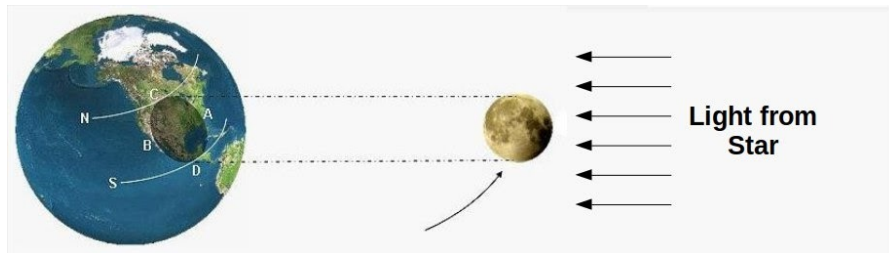


Figura 1: Geometry of a stellar occultation by a small body. Source: IOTA, Edited by Benedetti-Rossi

Objectives

General objective

- Develop a systematic methodology for doing predictions of stellar occultations by Main Belt asteroids.

Specific objectives

- Get asteroid information (diameter, ephemeris and its uncertainty, etc.) automatically.
- Use the SORA package^a (Gomes-Júnior *et al.* 2022) for doing the predictions.
- Compare our predictions using data from the literature.

^aStellar Occultation Reduction Analysis. <https://sora.readthedocs.io/>

Methodology

We develop codes in Python for:

Data preparation: Obtaining of diameters, ephemeris and their respective uncertainties, among other information, using Astroquery.

Execution of SORA: Predictions of stellar occultation for a given number of asteroids.

Management of results: Ephemeris, prediction events and prediction maps, among others.

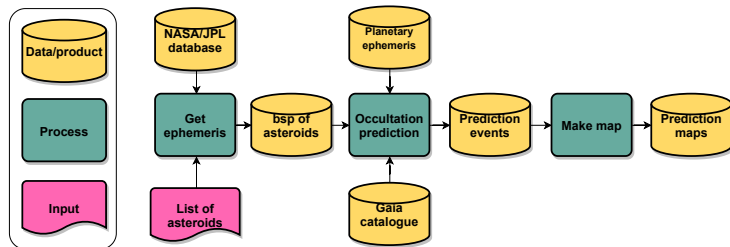


Figura 2: Flowchart with the main processes and the input/output data to do the predictions.

Results

We selected all predictions (October - November) from the Asteroid Occultation website to reproduce them with SORA.

	#objectNumber	Spkid	Radius	Uncertainty	JPL-Version
1	1000	2001000	23.89	1.0	JPL#46
2	1001	2001001	36.3555	0.149	JPL#68
3	1021	2001021	50.3825	0.804	JPL#57
4	10247	2010247	13.413	0.3465	JPL#37
5	10291	2010291	11.049	0.0675	JPL#36
6	1030	2001030	29.8585	0.113	JPL#46
7	1031	2001031	37.7	0.2485	JPL#52
8	105	2000105	47.432	11.611	JPL#124
9	106	2000106	103.9345	1.079	JPL#126
10	1091	2001091	17.589	0.054	JPL#53

Figura 3: Information of the first ten asteroids (being in total 261), where radius and uncertainty are in km. This information is one of the inputs for the SORA package.

Results

We found about 6,025 stellar occultation events for 261 asteroids for October and November 2021. It was necessary about 20 hours to identify the predictions events and about 5 hours to generate all prediction maps.

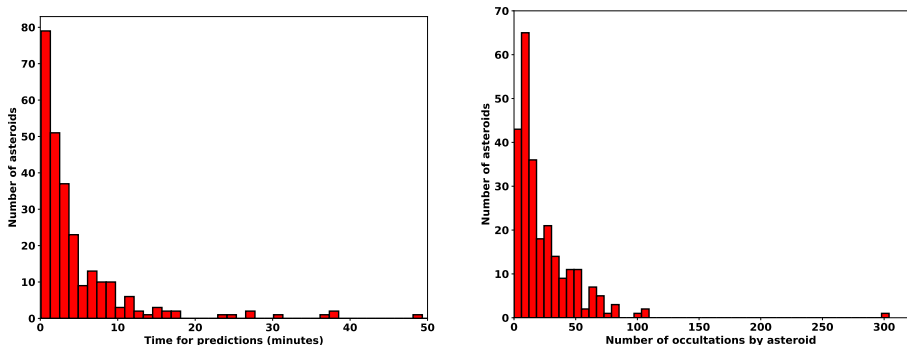


Figura 4: Histograms of stellar occultation predictions for 261 Main Belt asteroids for October and November 2021.

Comparison of predictions

We compare our predictions with those one available on the Asteroid Occultation website (<https://asteroidoccultation.com/>).

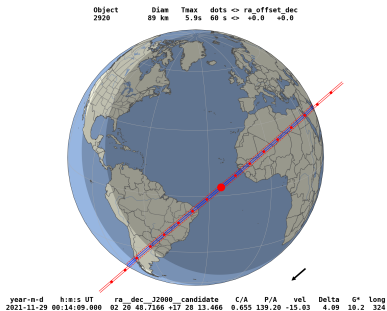
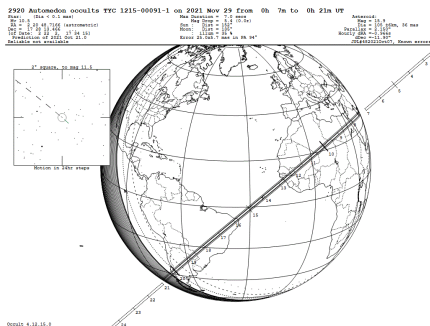


Figura 5: Prediction map for the object 2920 Automedon, retrieved from Asteroid Occultation website (in left panel) and generated with SORA (in right panel).

- Implement parallelization of prediction processes.
- Update of predictions for future months.
- Investigate APIs¹ to select observable events from a specific place (Continent, Country, etc.).
- Try to observe some of the stellar occultation events that took place in Brazil (in collaboration with F. Braga-Ribas).
- Implement the codes developed in the SSO portal (collaboration with the LIneA IT team).

¹Application programming interface.

Contribution with Solar System Portal

The screenshot shows the landing page of the LineA Solar System Portal. At the top, there is a navigation menu with links for HOME, ABOUT, TUTORIALS, and CONTACT. A user profile icon for 'M MARTIN.BANDA' is visible in the top right corner. The main header features the LineA logo and the text 'LineA Solar System Portal' against a background of a starry sky with planets and asteroids. Below the header, there are eight interactive tiles arranged in a 2x4 grid: 'Dashboard' (showing a field of asteroids), 'Discovery' (showing a star field), 'Download' (showing a glowing orange planet), 'Astrometry' (showing a grid of stars), 'Refine Orbits' (showing a comet's path), 'Prediction of Occultation' (showing Earth), 'Occultation' (showing a planet with occultation lines), and 'Occultation Calendar' (showing a calendar grid). Below the tiles, it states 'LineA is supported by' followed by logos for CAPES, CNPq, FAPERJ, Finep, and INCT e-Universo. At the bottom left, it says 'Testing 1.0.0' and at the bottom right, 'Powered by LineA'.

Figura 6: Landing page of Solar System Portal with each of its stages. Extracted from: <https://tno-dev.linea.gov.br/>