

# Accessing and Visualising Orbital Data of Near-Earth Objects



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## Introduction

The NEO Coordination Centre (NEOCC) plays an important role in the Planetary Defence Office of ESA's Space Safety Programme. As part of its Information Provision, the NEOCC is responsible for providing accurate and up-to-date orbital data on near-Earth objects (NEOs) to the scientific community, industry, and the general public. Here we highlight two key resources developed by the NEOCC to accomplish this mission: the NEOCC Application Programming Interface (API) system and the NEO Toolkit. These resources provide a comprehensive suite of data and tools for accessing and visualising orbital, observational, and physical information of NEOs. Both the NEOCC API and the NEO Toolkit offer valuable resources that can benefit researchers, educators, and software developers.

## NEOCC Services

### Accessing NEO Data through API Queries

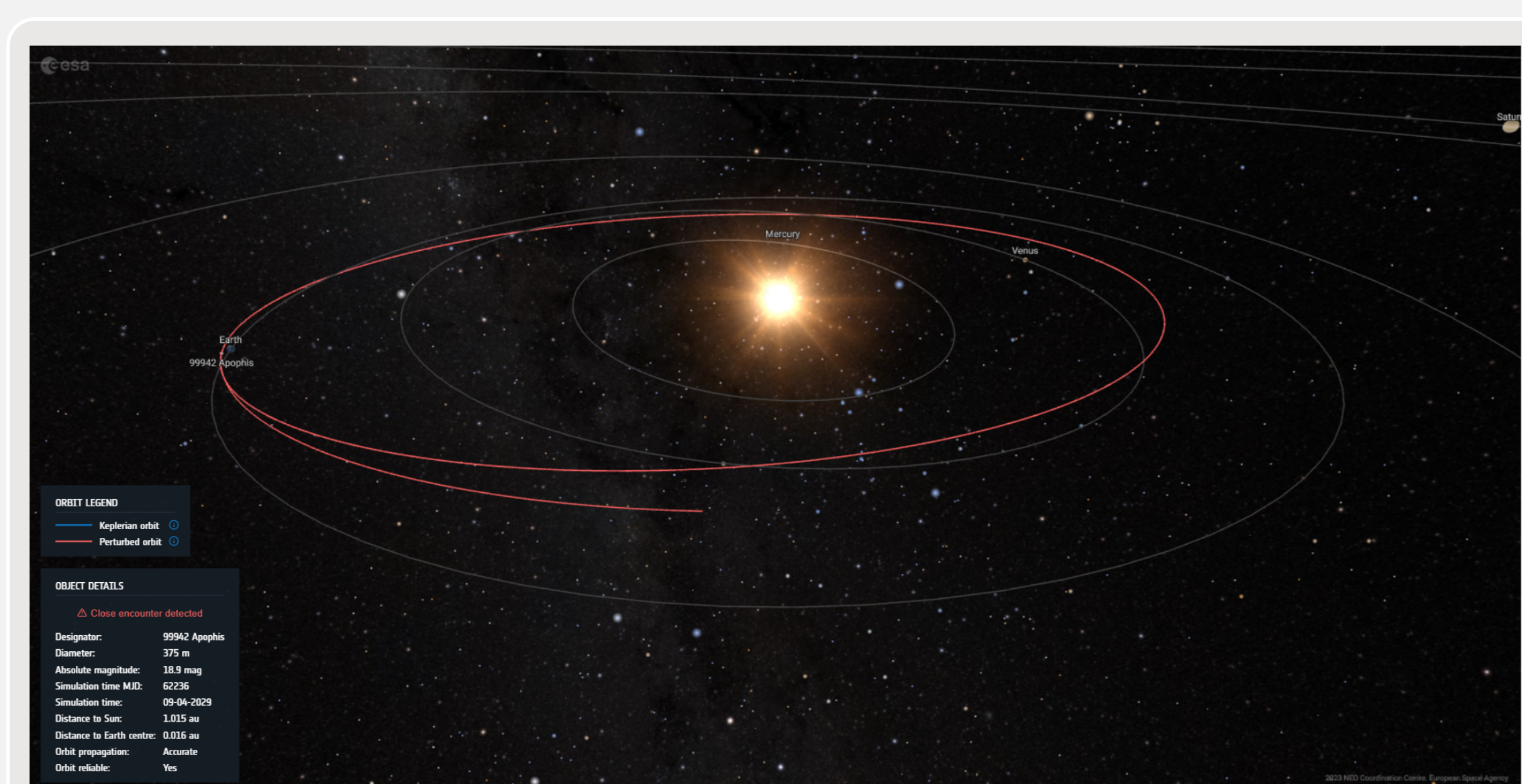
The NEOCC API system provides a flexible and complete resource for a wide range of applications, offering accurate and up-to-date information on NEOs produced by NEOCC's asteroid orbit determination and impact monitoring system, called "Aegis". The data includes the list of known NEOs, the orbital element catalogue, the risk list of asteroids with a probability of impacting Earth, and the close approaches list. Users can customise their queries and specify the exact data they need, making the service a useful tool for researchers, educators, software developers, and anyone seeking detailed information on NEOs.

In fact, users can also access detailed information about specific NEOs, including their orbital elements, physical properties, ephemerides, observations, close approaches, and potential impacts with Earth. These data provide valuable insights into the characteristics and behavior of NEOs, and can be used to develop new tools and applications for monitoring and studying these objects.

### NEO Toolkit

The NEO Toolkit is a powerful suite of astronomical tools consisting of four complementary components, each with a specific goal. They provide high-accuracy ephemerides and precise information on the location and orbits of near-Earth objects. The four tools in the NEO Toolkit are:

**Orbit Visualisation Tool (OVT):** this tool displays collections of asteroids and the Keplerian and perturbed orbits of NEOs in a 3D environment of the Solar System. Users can visualise the position and motion of NEOs in relation to the planets, asteroids, and other objects in the Solar System. The tool also enables the visualisation of NEO groups, families, and spectral classes.

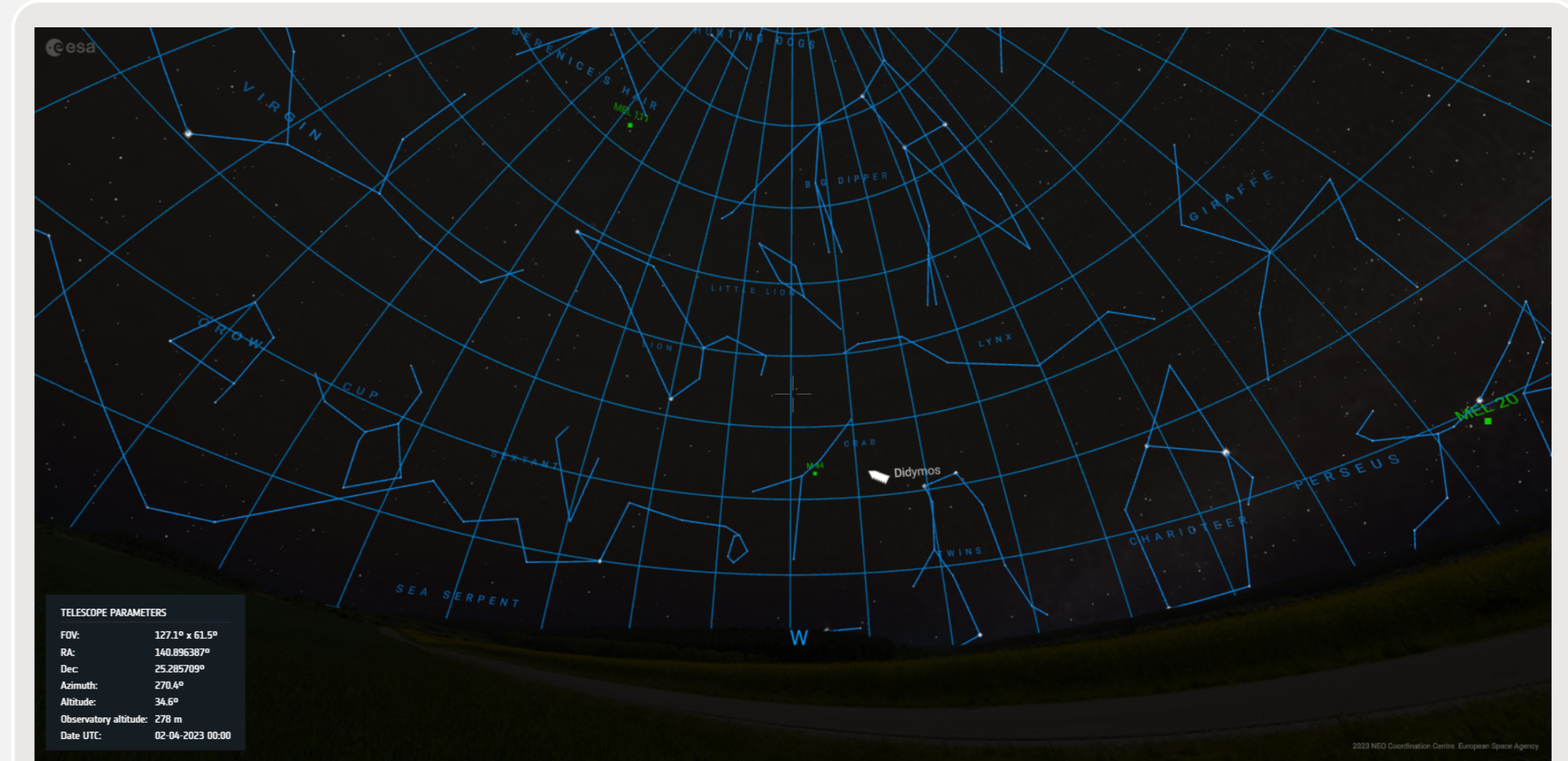


OVT-generated image showing the evolution of the perturbed orbit of (99942) Apophis circa its close approach in April 2029.

**Flyby Visualisation Tool (FVT):** it produces high-precision graphical representation of NEOs in their close approach to Earth. These simulations can help researchers and developers to better understand the behavior and characteristics of NEOs during close encounters.

**Observation Planning Tool (OPT):** this tool allows astronomers to plan their observations by providing precise ephemerides and observational conditions for any observer's position and time, including target NEO location and motion, its magnitude, orbit uncertainty, sun elongation, galactic latitude, and background star density (among others).

**Sky Chart Display Tool (SCDT):** it locates the path in the sky followed by the objects of interest as observed from any coordinates on Earth. This tool, in combination with the OPT, is particularly useful for astronomers who wish to observe NEOs, as it allows them to plan their observations and locate the objects in the night sky with precision.



Sky chart displaying the position of asteroid (65803) Didymos from 02/04/2023 to 07/04/2023 as seen from Vienna, generated by the SCDT. The chart also shows the constellation grid lines and boundaries, and the Azimuthal grid.

## Application

The NEOCC API system and NEO Toolkit offer a wealth of data and tools for researchers, educators, and the general public to access and explore information on NEOs. Here are some potential applications of these resources.

**Research:** the accurate and up-to-date data provided by the NEOCC API system and the NEO Toolkit's tools can be used by researchers to study NEOs' orbital dynamics, physical characteristics, and potential impact risks.

**Software development:** the NEOCC API system provides a platform for developers to build new applications and tools that utilise NEO data. Developers can use the system to access accurate and up-to-date NEO data and incorporate it into their own applications. Soon the APIs will also be integrated into Astroquery Python library. For more details: <https://github.com/astroquery/astroquery/pull/2254>

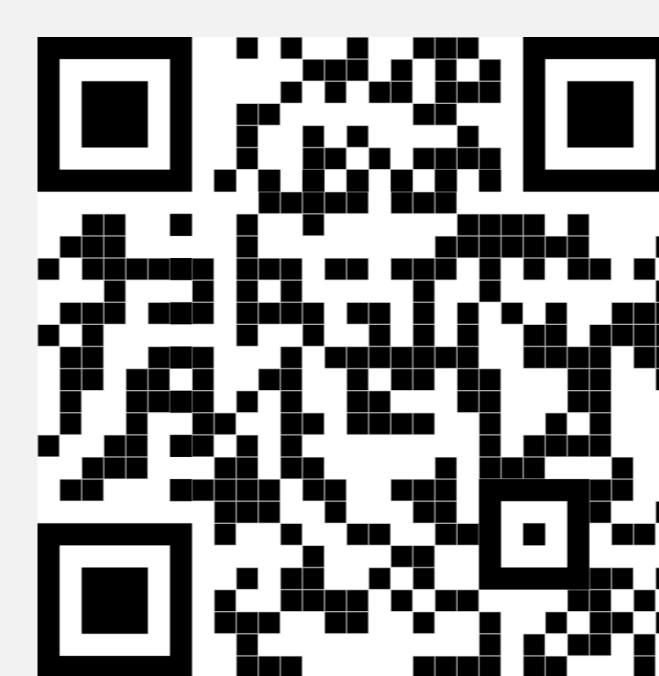
**Education:** the NEO Toolkit's components can be used by educators to create engaging and interactive lessons on astronomy and planetary science. The tools allow students to visualise the positions and motions of NEOs in the Solar System and the night sky.

**Public awareness:** the NEOCC API system and NEO Toolkit can help raise public awareness of the importance of studying NEOs and the potential risks they pose to Earth. By providing easy access to data and tools, more people can learn about NEOs and the ongoing work to monitor and study them. This increased awareness can lead to a better understanding of the risks associated with NEOs and the need for continued efforts to monitor and study them.

## Conclusions

The NEO Coordination Centre's API system and NEO Toolkit provide users with an easy way to access and visualise orbital information of NEOs. By providing accurate and up-to-date NEO data to the scientific community, industry, and the general public, these resources help us better understand and monitor the behavior of NEOs, and mitigate the potential risks they pose to our planet.

## NEOCC Links



Scan the QR code to go to the **NEOCC web portal**



Scan the QR code to go to the **NEOCC NEO Toolkit**



Scan the QR code to go to the **NEOCC APIs**