



Left: minor planets (indicated by green circles) in the inner solar system. Objects with perihelia within 1.3 AU are plotted as red circles. Orbits of major planets are shown in light blue. Image courtesy Minor Planet Center. Right: Gaia is ideally situated to probe the asteroid blind spot between the Sun and Earth. As this schematic diagram shows, some regions of the sky that are unobservable from Earth can be observed by Gaia.

While tracking stars with its telescopes, Gaia will also observe solar system objects by the thousands, primarily asteroids of the main belt circling the Sun between the orbits of Mars and Jupiter. With its ability to detect faint and fast-moving objects, it is expected that Gaia will also detect several thousand Near-Earth Objects (NEOs), which are thought to be comets and asteroids that have been nudged by the gravitational attraction of nearby planets into orbits that allow them to enter the Earth’s neighbourhood. Much further away, beyond the orbit of Neptune, bigger objects are clustered in the Kuiper belt. The largest of these will also be detected with Gaia.

The scientific interest in asteroids is due largely to their status as the remnant debris left over from the process that formed the inner planets, including Earth. Asteroids are also the source of most meteorites that have struck the Earth’s surface and many of these objects have already been subjected to chemical and physical analyses.

Due to its vantage point of observation at the Lagrange point L2 and its ability to observe down to an angular distance of 45 degrees from the Sun, Gaia will be ideally situated to probe the asteroid blind spot between the Sun and Earth and to discover small bodies orbiting the Sun inside the Earth’s orbit, a region virtually unreachable from the Earth. In the course of its all-sky survey, Gaia will also observe the sky far from the ecliptic, where ground-based surveys of minor planets are predominantly active, an instance very favorable to the discovery of objects roaming the solar system on exotic orbits.

Gaia will accurately measure the positions and velocities of asteroids over the five years of the mission leading to a determination of their orbits with an unprecedented precision. Orbital parameters are essential to compute well in advance when and where a stellar occultation by a small body will be observable. Such events yield a wealth of information on the sizes and shapes, and when the masses are known, on the densities of these objects. Orbits are also a key element in identifying members of ‘orbital families’ sharing a common origin.

The tiny gravitational pull experienced by asteroids during close approaches between two bodies – thousands of such encounters are predicted to take place during Gaia’s operational life – pushes them away from their path. This small deviation will be recorded in the Gaia astrometric measurements, leading to the mass of the perturber. About 150 asteroid masses will thus be determined to better than 50% by Gaia, as compared to the approximately 20 known today.

Beyond astrometry, Gaia’s multi-epoch photometric data will reveal the surface properties of minor planets by telling us how much light is reflected in a particular colour. A refined classification of the population of minor bodies will emerge from this giant database, revealing the kinship between asteroids, NEOs, and meteorites. In addition, the variation of the physical parameters with the distance to the Sun will also be studied.