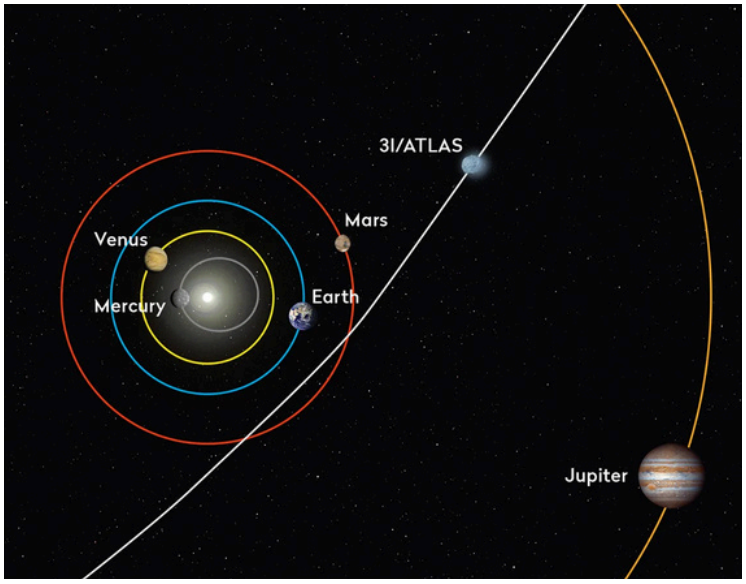
The Interstellar Object - 3I/ATLAS

In July 2025, astronomers announced the discovery of a mysterious new object racing through our Solar System — 3I/ATLAS. The prefix "3I" means it is the third confirmed interstellar object, following 'Oumuamua (1I/'Oumuamua, 2017) and 2I/Borisov (2019). Unlike asteroids or comets born within our Solar System, interstellar objects come from distant star systems, carrying with them ancient material that predates our Sun.

3I/ATLAS was discovered on 1 July 2025 by the Asteroid Terrestrial-impact Last Alert System (ATLAS) located in Chile, at about 4.5 AU from the Sun. Initially, it was considered a normal comet, but later its path was found to be hyperbolic, meaning it was clear that it had come from interstellar space and would never return.

The estimated orbital eccentricity of the object is about 6.15, much larger than 1, which implies it is unbound to the Sun. It came from a direction close to the constellation Sagittarius, implying that its origin may well be in the thick disk of the Milky Way, perhaps billions of years ago.

Orbital Trajectory of 3I/ATLAS



3I/ATLAS will be at perihelion at a distance of 1.36 AU on 29 October 2025, which is slightly beyond Earth's orbit.

"Its trajectory falls within just five degrees of the Earth's path around the Sun, or the ecliptic plane. There's only a 0.2 percent likelihood of this happening. 3I/ATLAS' arrival time takes it right past Mars and Jupiter—remarkable fine-tuning of the object's path."

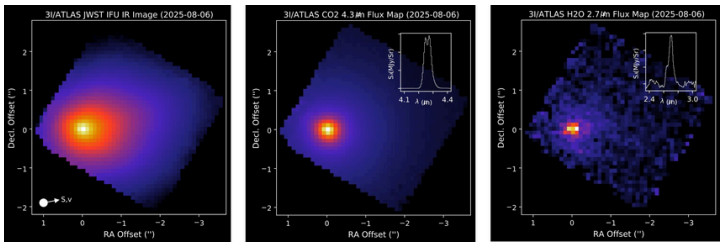
~ Avi Loeb, Professor of Science, Harvard University

PHYSICAL & CHEMICAL PROPERTIES

Observations with Hubble, JWST, and Swift make clear that 3I/ATLAS is an active comet displaying a bright coma and a long dust tail produced by the sublimation of volatile materials as the comet approaches the Sun. Its nucleus should be a width of approximately 0.3–5 km, though precise measurement is rather difficult owing to the presence of surrounding gas and dust. The surface is likely a mixture of ices-water, carbon dioxide, methane, and ammonia-along with silicate dust grains.

Spectroscopic analysis indicates that the molecular composition is dominated by CO_2, with the CO_2/H_2O ratio being about 8:1, higher than any other comet observed so far. Water vapor is indeed detected as evidenced from the ultraviolet emissions from the hydroxyl radicals. The dust tail appears to be dense and extended, indicating a more or less continuous outflow of small particles rather than large chunks, and suggesting moderate surface activity along with stable rotation.

These characteristics are indicative that 3I/ATLAS has not undergone any drastic changes since its formation and thus preserved the primordial material from its parent star system. Its icy surface is likely coated with a dark organic crust formed by cosmic ray exposure during billions of years of travel through interstellar space. This makes 3I/ATLAS a rare and valuable window into the composition and conditions of other planetary systems.

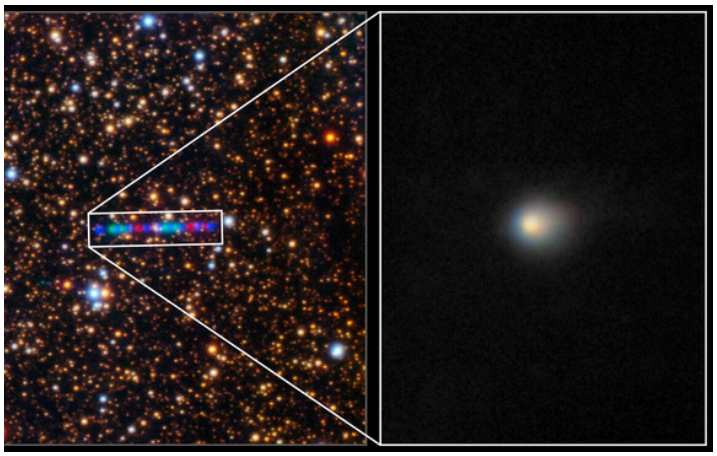


NASA's James Webb Space Telescope observed interstellar comet 3I/ATLAS Aug. 6, with its Near-Infrared Spectrograph instrument (NASA Science)

SCIENTIFIC IMPORTANCE & FUTURE

3I/ATLAS provides a unique opportunity to learn about the composition of material formed around another star. Through gas, dust, and orbit analysis, scientists will be able to compare its makeup against that of comets in the Solar System and help determine similarities and differences in the planetary formation process.

This object challenges the existing models, which predict that interstellar visitors should be small and inactive. Its large size and activity suggest that large icy bodies are much more common in the Galaxy than is generally considered. The study of 3I/ATLAS also offers fresh insights into how material is exchanged between different star systems, thereby connecting the Solar System to the wider Milky Way.



Using the Gemini North telescope, astronomers have captured 3I/ATLAS (NOIRLab)

Global observing campaigns are underway as 3I/ATLAS approaches perihelion. Observatories responsible for the observation of brightness, gas composition, and dust production include ground facilities such as VLT, Gemini North, and space telescopes like JWST, Hubble, and Swift.
While no spacecraft can intercept 3I/ATLAS because of its speed and timing, missions such as ESA's Comet Interceptor, planned for future launches, are in development to study the next interstellar visitor. The data gathered from 3I/ATLAS will help guide such future missions and continue to refine our knowledge about interstellar comets.