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Nongravitational Acceleration in 1998 KY26 Fuels Debate Between Dark Comet Physics and the Lost Phobos 1 Spacecraft Hypothesis

Environment * Climate Change * Atmospheric Physics

A roughly 11-meter (36-foot) near-Earth object designated 1998 KY26 -- the target of Japan's Hayabusa2 extended mission -- has become the center of a sharp public and scientific debate over what drives its measured nongravitational acceleration. After NASA Administrator Jared Isaacman stated that available evidence points to a standard near-Earth asteroid posing no threat to Earth, Harvard astrophysicist Avi Loeb publicly disputed that characterization, arguing that 1998 KY26 may instead be the lost 1988 Soviet Mars probe Phobos 1 rather than a natural rocky body.

Beneath the headlines lies a genuine astrodynamics puzzle. High-precision astrometry shows that 1998 KY26 experiences subtle orbital accelerations that cannot be accounted for by Newtonian gravity and planetary perturbations alone, yet deep optical observations have detected no visible dust coma or gas tail. Explaining that combination -- measurable thrust without obvious outgassing -- has split researchers between natural "dark comet " mechanisms, thermal-radiation effects, and the controversial artificial-debris hypothesis.

The Nongravitational Acceleration Puzzle in 1998 KY26

In orbital mechanics , small solar-system bodies occasionally deviate from purely Keplerian trajectories due to nongravitational forces. For active comets, sublimation of water or carbon -monoxide ice creates gas jets that impart small but cumulative recoil accelerations. For tiny asteroids, asymmetric absorption and re-emission of sunlight -- known as the Yarkovsky effect -- can also drift an orbit over decades, though typically at lower magnitudes than those seen in active "dark comets."

Discovered in 1998 and selected by the Japan Aerospace Exploration Agency (JAXA) as the 2031 rendezvous target for the Hayabusa2# extended mission, 1998 KY26 is an exceptionally fast rotator and has an estimated diameter near 11 meters (36 feet). Because its rapid spin rate exceeds the cohesion limit of a loose rubble pile held together solely by self-gravity, planetary scientists have long regarded 1998 KY26 as either a monolithic rock fragment or a body bound by cohesive internal forces.

| Object / Mission Metric | | Observed or Projected Value | | Scientific / Dynamical Relevance |

| Designation | | 1998 KY26 | | Fast-spinning near-Earth object with measurable nongravitational acceleration |

| Estimated Size | | ~11 meters (~36 feet) | | Small enough that surface-area-to-mass ratio amplifies radiation pressure |

| Mainstream Natural Model | | Fast-rotating asteroid / dark comet | | Challenged

thermally by Hansen & Hirabayashi (Icarus , 2026) |

| Alternative Hypothesis | | Lost Soviet spacecraft Phobos 1 (1988) | | Proposes solar radiation pressure on low-density metallic hardware |

| Direct Verification | | JAXA Hayabusa2# rendezvous (July 2031) | | In situ imaging and mass measurement will settle composition |

Why Thermal Modeling Complicates the Dark Comet Explanation

Until recently, one leading natural explanation grouped 1998 KY26 among "dark comets" -- objects that look asteroidal in telescope images yet exhibit comet-like nongravitational accelerations from weak, unseen subsurface outgassing. However, a 2026 peer-reviewed study in Icarus by Georgia Institute of Technology researchers Korbin Hansen and Masatoshi Hirabayashi modeled the internal thermal profile of 1998 KY26 and found conditions thermally unfavorable for preserving volatile ices.

Because 1998 KY26 is only about 11 meters across and orbits relatively close to the Sun in near-Earth space, solar heating penetrates deeply into its interior over repeated perihelion passages. According to Hansen and Hirabayashi's thermal-evolution calculations, any primordial water ice or hypervolatile pockets near the surface or core would struggle to survive intact over typical near-Earth dynamical lifetimes. That finding narrows the parameter space for classical ice-sublimation models and raises the question of whether alternative physical processes -- or unusual material properties -- must explain the observed orbital drift.

Evaluating the Phobos 1 Spacecraft Hypothesis

Seizing on the thermal challenge to volatile outgassing, Avi Loeb, Adam Hibberd, and Adam Crowl published a 2026 analysis examining whether 1998 KY26 could be Phobos 1, an uncrewed Soviet spacecraft launched toward Mars in July 1988 that lost attitude control and went silent after an erroneous ground command. Their argument centers on area-to-mass ratio: a hollow metallic spacecraft carrying solar arrays has a far lower bulk density than solid silicate rock, allowing ordinary solar radiation pressure (photons bouncing off reflective surfaces) to generate noticeable nongravitational acceleration without requiring any volatile outgassing.

Loeb and colleagues further argued that the rapid brightness variations and high apparent reflectivity of 1998 KY26 could align with specular glints from flat spacecraft panels and cylindrical propellant structures. Mainstream planetary astronomers and NASA leadership remain skeptical, noting that artificial hardware hypotheses require extraordinary dynamical back-tracking across nearly four decades of unmonitored orbital perturbations, and that natural explanations -- including unrecognized radiation-pressure geometries, low-density porous regolith, or residual outgassing mechanisms -- remain viable within observational uncertainties.

Hayabusa2# Will Settle the Debate in July 2031

Unlike remote debates over distant interstellar visitors that pass through the Solar System only once, 1998 KY26 orbits close enough to Earth to be visited directly. JAXA's Hayabusa2 spacecraft -- which successfully sampled asteroid Ryugu and returned pristine carbonaceous material to Earth in 2020 -- is currently cruising on

an extended trajectory toward a scheduled rendezvous and touchdown with 1998 KY26 in July 2031.

Once Hayabusa2# arrives on station, optical navigation cameras, near-infrared spectrometers, and radio-science gravity tracking will immediately resolve the controversy. Direct imaging will reveal whether 1998 KY26 is a battered silicate or carbonaceous boulder or an engineered structure, while close-range spacecraft tracking will measure its exact mass, bulk density, and surface reflectivity. Until 2031, 1998 KY26 stands as a compelling natural laboratory for testing the limits of nongravitational force modeling on decameter-scale near-Earth objects.

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