Near-Earth Asteroid observations with Ariel

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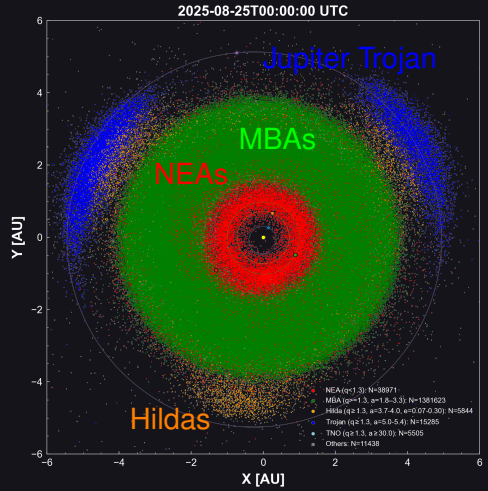
Near-Earth Asteroids, NEAs

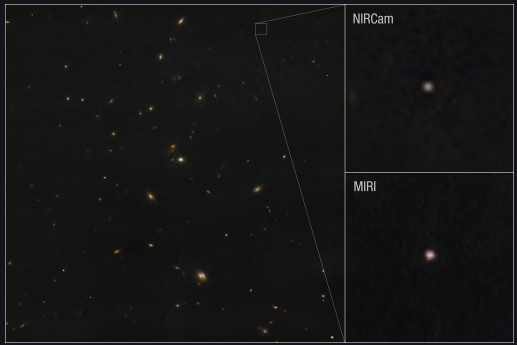
- Asteroids with perihelion distance $q \leq 1.3$ AU
- N=38900 (as of Aug. 22, 2025)
- Motivations
  - Planetary defense
  - Material transportation
  - Physical properties distinct from MBAs
    - Size (diameter)
    - Spin
    - Composition



Minor Planet Center

Observational difficulties: NEAs are generally fast-moving

- Typical sky motion
  - MBAs $\leq$ 0.1 arcsec min^{-1} (Observable with Ariel)
  - NEAs $\sim$ 0.1-100 arcsec min^{-1} (Strongly dependent on geometry)
- Some NEAs were observed with JWST, also at Sun–Earth L_2.
  - Didymos (D $\sim$ 780 m)
  - 2024 YR_4 (D $\sim$ 60 m)

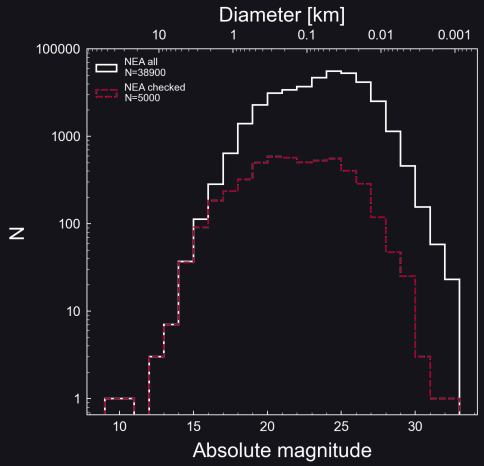


JWST observations of 2024 YR_4
Image: NASA, ESA, CSA, STScI, Andrew Rivkin (APL)

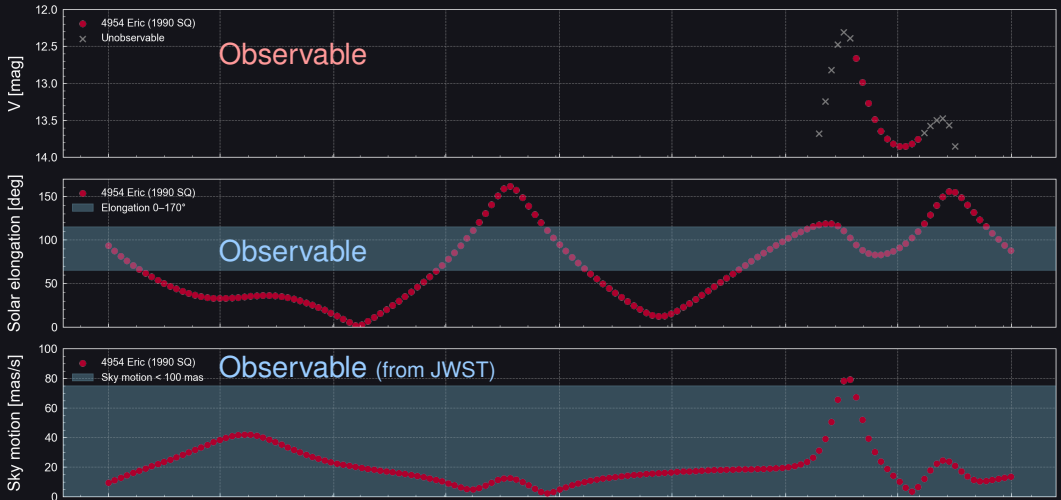
Rivkin et al. (2023), Rivkin et al. (2025)

NEA survey with Ariel

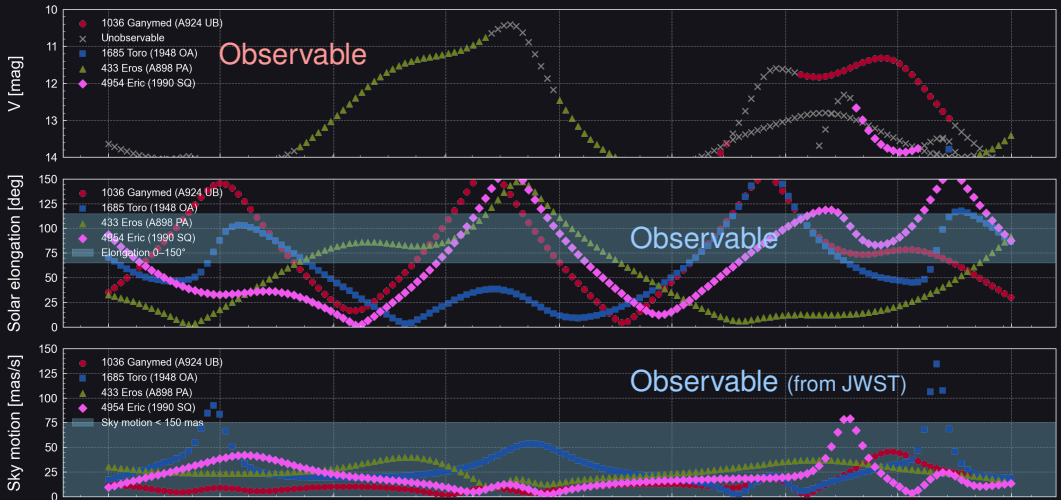
- Check observabilities of NEAs as MBAs
  - NASA JPL Horizons, from Gaia orbit
  - 2030-01-01–2033-12-31 (t_{step}: 10 days)
  - 5000 NEAs (out of $\sim$ 40000)
  - Requirements
    - $V < 14$
      (fainter than the nominal limit)
    - $65^\circ <$ Solar elong. $< 115^\circ$
      (planned)
    - Sky motion < 75 mas/s
      (requirement for JWST)



An observable example: (4954) Eric from Ariel

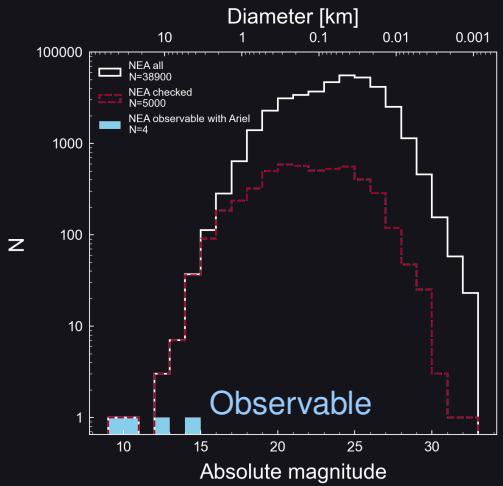


4 NEAs are observable from Ariel



Result. Only 4 NEAs are observable

- *4 large NEAs* observable (next page)
- 0–2 NEAs observable at any time
- LSST and NEO Surveyor will discover more NEAs in the coming years. However, bright (large) NEAs have already been discovered.
  →No significant increase for Ariel
  (to be confirmed)



Ivezić et al. (2019), Mainzer et al. (2023)

Physical Properties of 4 NEAs observable with Ariel

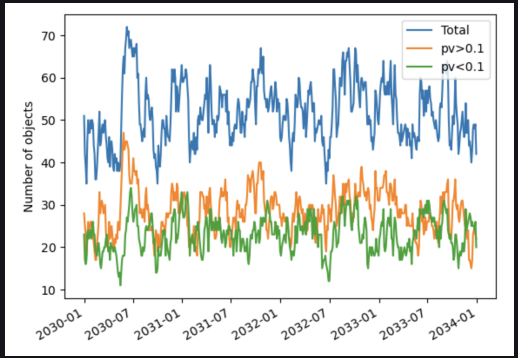
No.	Name	Spec. type	P_{rot}	p_V	3 μm	Note
1	(433) Eros	S-type	5.27 hr	0.25	Yes	Rivkin+2018
2	(1036) Ganymed	S-type	10.297 hr	0.238	Yes	Rivkin+2018
3	(1685) Toro	S-type	10.1995 hr	0.31	Non detection	McGraw+2022
4	(4954) Eric	S-type	12.056 hr	0.176	—	

- P_{rot} is longer than 1 CS observing block ($\sim$1 hr).
  → Rotationally resolved spec. seems difficult.
- Possible detections of 3 μm feature on (433) Eros and (1036) Ganymed (ground-based spec.)
  → Investigation (confirmation) of 3 μm features with Ariel

Rivkin et al. (2018), McGraw et al. (2022)

Summary

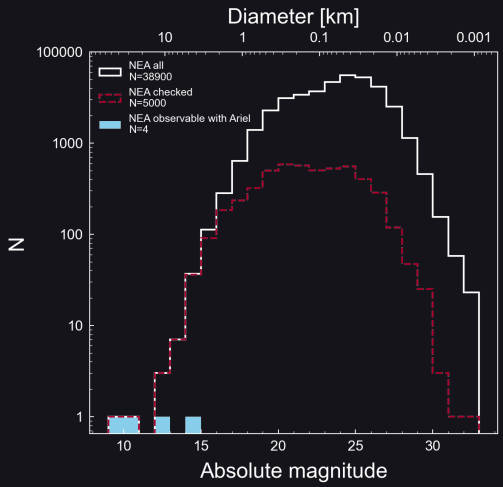
- MBAs preserve the early Solar System record.
  - N$\sim$50 visible targets at any observation time
  - N$\sim$20 low albedo ($p_v \leq 0.1$) possibly primitive asteroids
  - Various targets (dynamical zones, taxonomy, families)
- NEAs ($q \leq 1.3$ AU) are also potential targets for Ariel CS
  - N=4 visible targets
  - Investigation of 3 μm feature
- Technical challenges
  - Lower effective wavelength resolution
  - Significant thermal emission in MIR



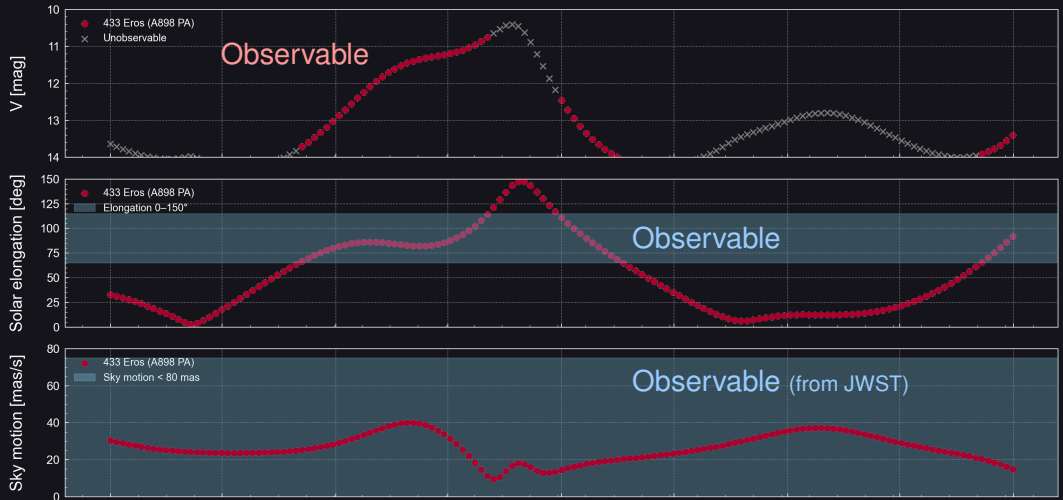
Backup

Summary & Future works

- NEAs ($q \leq 1.3$ AU) are also potential targets for Ariel CS
  - Planetary defense
  - Material transportation
  - Physical properties distinct from MBAs
- 4 NEAs can be observable from 2031-01-01 to 2033-12-31
- Next steps
  - Sensitivity estimate
  - Investigation of phase reddening, 3 μm feature, thermal properties etc.
  - Observation campaign of the 4 NEAs to maximize scientific return from Ariel

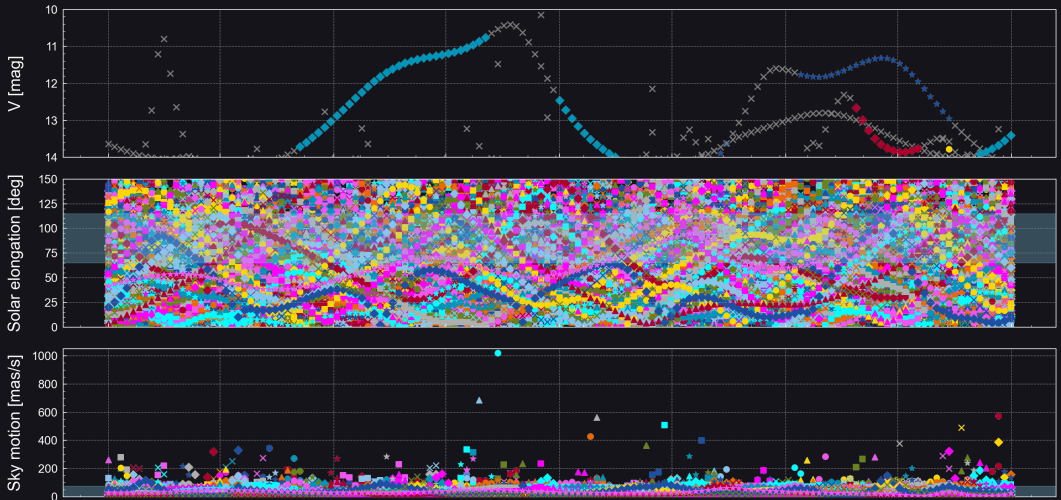


An observable example: (433) Eros from Ariel



NEAs from Ariel

All NEAs from Ariel



NEAs potentially observable with Ariel

Physical properties are from JPL/SBDB if no reference is provided.

- Best candidate (N=4)

No.	Name	Spec. type	P_{rot}	pv	3 μm	Note
1	(433) Eros	S-type	5.27 hr	0.25	Yes	Rivkin+2018
2	(1036) Ganymed	S-type	10.297 hr	0.238	Yes	Rivkin+2018
3	(1685) Toro	S-type	10.1995 hr	0.31	Non detection	McGraw+2022
4	(4954) Eric	S-type	12.056 hr	0.176	—	

- Potentially Observable NEAs (N=7)

No.	Name	Spec. type	P_{rot}	pv	3 μm	Note
1	(1866) Sisyphus	S-type	2.4 hr	0.15		$v > 75$ mas s^{-1}
2	(2212) Hephaistos	S-type	48 hr	0.163		$v > 75$ mas s^{-1}, de Leon+2010
3	(3752) Camillo	L-type	37.846 hr	0.21		$v > 75$ mas s^{-1}
4	(3753) Cruithne	Q-type	27.3099 hr	0.365		$v > 75$ mas s^{-1}
5	(11405) 1999 CV3	Sq-type	6.504 hr	0.112		$v > 75$ mas s^{-1}
6	(139211) 2001 GN2					$v > 75$ mas s^{-1}
7	(163243) 2002 FB3	S-complex	6.231 hr	0.172		$v > 75$ mas s^{-1}, Binzel+2019

Rivkin et al. (2002), McGraw et al. (2022), de León et al. (2010), Binzel et al. (2019)

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