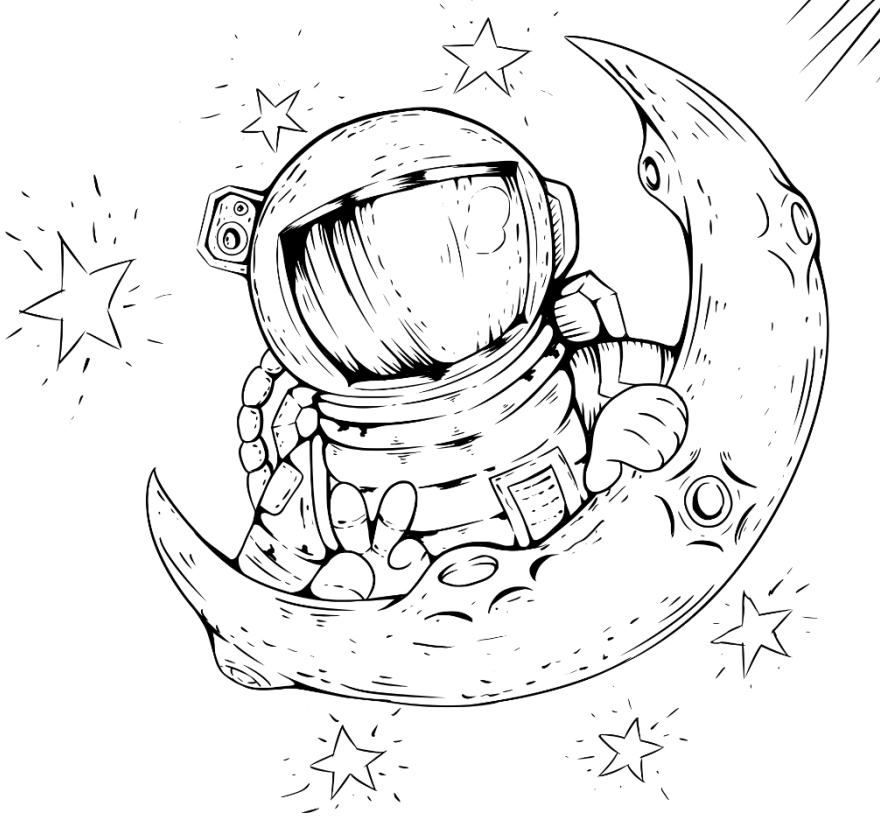
OPTIMAL TRAJECTORY DESIGN OF ASTEROID CAPTURE DURING CLOSE ENCOUNTER WITH EARTH



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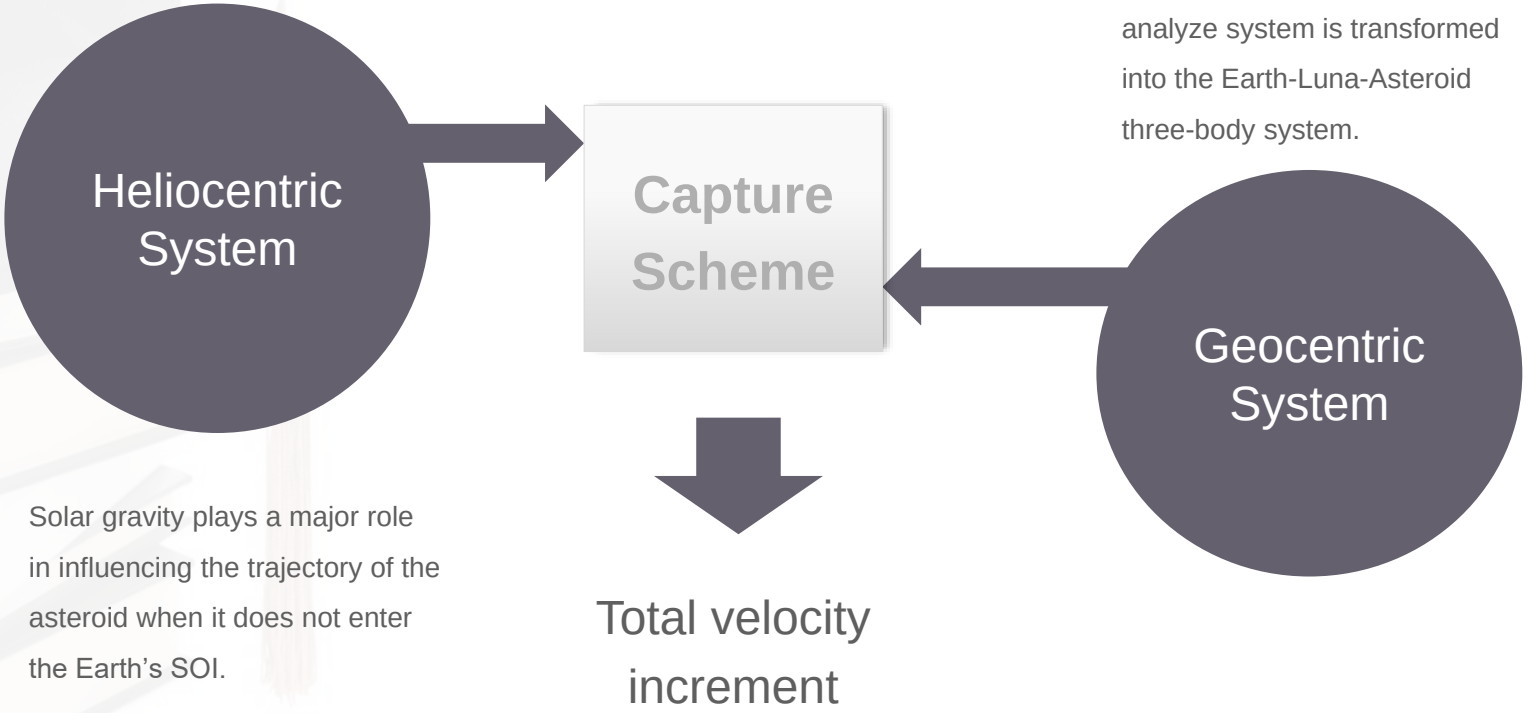
Introduction

NEOs pose an impact risk to Earth, especially some potentially hazardous objects (PHOs).

NEOs are rich in mineral resources, including many rare metals that are difficult to obtain on Earth.

Introduction



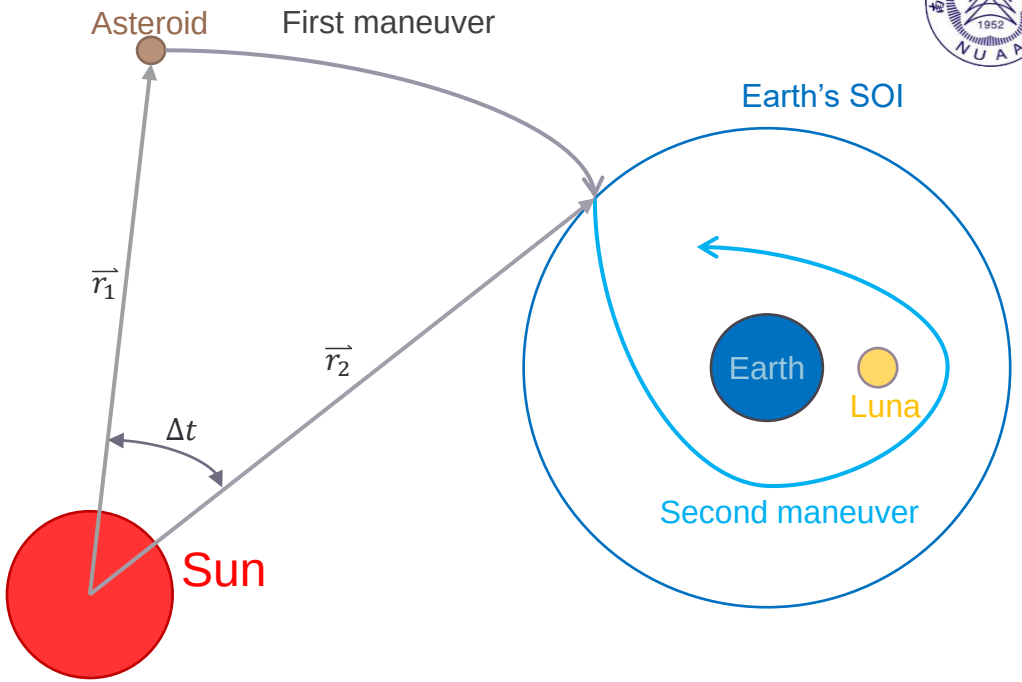
When the asteroid is less than 0.3 AU away from the Earth, the analyze system is transformed into the Earth-Luna-Asteroid three-body system.

Solar gravity plays a major role in influencing the trajectory of the asteroid when it does not enter the Earth's SOI.

Capture example

The first maneuver needs to be added to the asteroid so that it can fly from a point in the heliocentric system towards Earth and enter the Earth's SOI directly.

The second maneuver needs to be imposed to change the asteroid's Jacobian constant to restrict its allowable regions in the Earth-Luna rotating coordinate.



Keplerian elements of 2000SG344(Epoch: MJD 29200.5)*

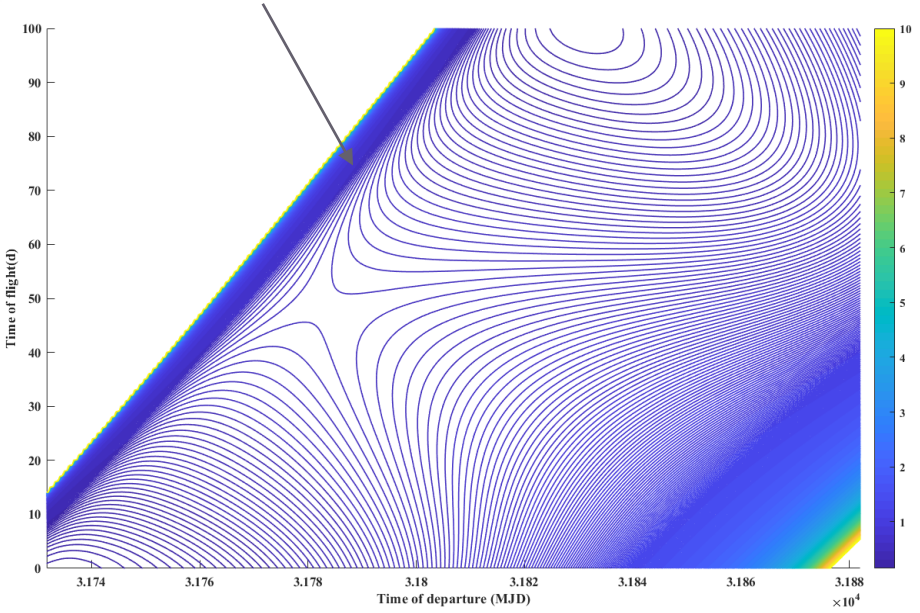
SMA (km)	ECC	INC (deg)	RA (deg)	AOP (deg)	TA (deg)
146219950.0954	0.066932	0.112	191.892	275.385	236.392

* https://newton.spacedys.com/neodys/

Capture example

The position vector of the asteroid in the heliocentric system is known as $\overrightarrow{r_1}$, the position vector of the Earth in the heliocentric system can be obtained from the ephemeris as $\overrightarrow{r_2}$.

The minimum velocity increment: 0.14315km/s

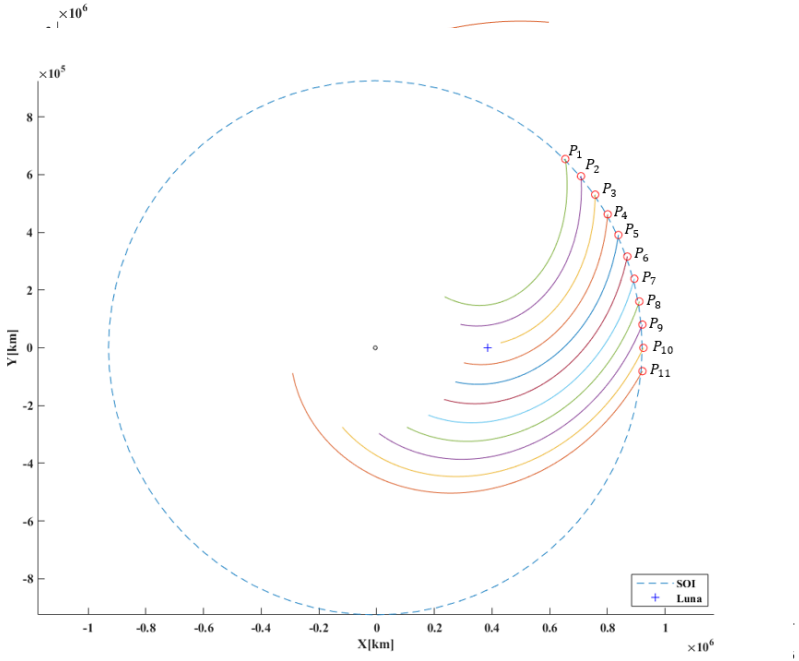


The time-of-flight interval is chosen to be 50 days before and after the date of the asteroid's original flight to perigee without maneuvering, which is a changing Δt.

Capture example

Substituting the $\overrightarrow{v_r}$ and $\overrightarrow{r_r}$ into the integrator and using the $x-y$ plane of the Earth-Luna rotating coordinate as the orbital plane, which requires eliminating the velocity component in the $z-$axis (0.1054787898km/s). The trajectory of 2000SG344 can be obtained, plotted at 30-degree intervals.

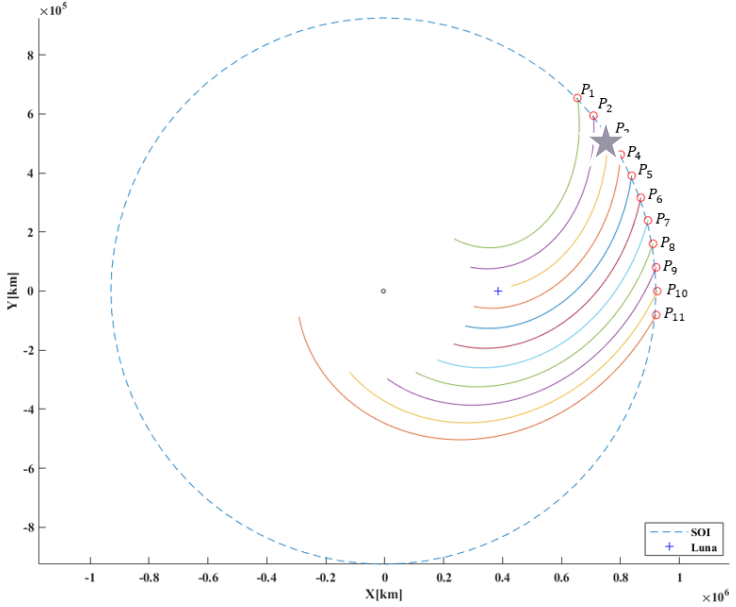
The entry positions which cause the flight away from the Earth's SOI should be deleted, the rest divided by a more precise 5-degree intervals.



Capture example

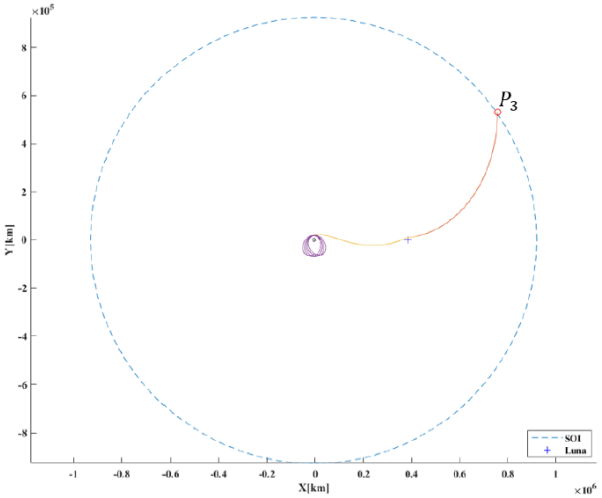
The increment of velocity from P_1 to P_{11}

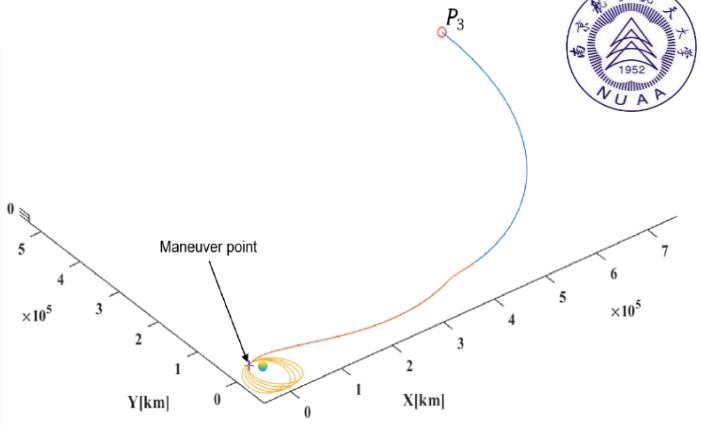
Position	The deltaV in the 2nd maneuver (km/s)	The total deltaV (km/s)
P_1	1.017342454	1.265972067
P_2	0.783093714	1.031723327
P_3	0.214050010	0.462679623
P_4	0.609679960	0.858309572
P_5	0.335962005	0.584591618
P_6	0.527457512	0.776087125
P_7	0.422720011	0.671349623
P_8	0.923680201	1.172309813
P_9	1.451125765	1.699755377
P_{10}	1.999106961	2.247736573
P_{11}	2.687000395	2.935630008

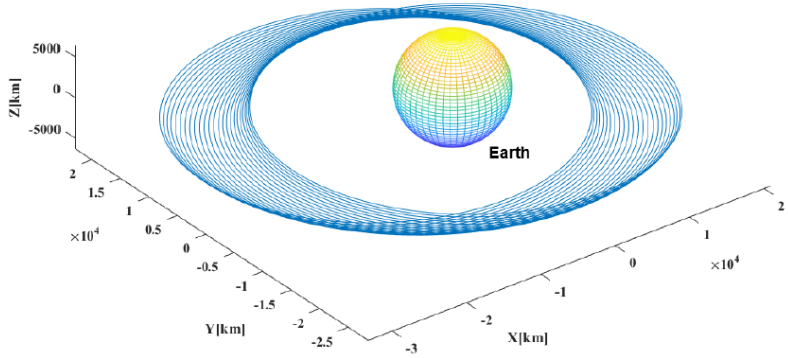


The minimum value of the velocity increment obtained at P_3, which is 0.462679623 km/s.

Conclusion







2000SG344 is firmly captured in an approximately elliptical trajectory about 12,000 km above the Earth's surface, where 2000SG344 will orbit long enough to let people observe and study its physical properties, with a total velocity increment of around 462 m/s.

THANKS FOR WATCHING!