TRAJECTORY DESIGN FOR OBSERVING NEA WITH DIFFERENT MINERALOGIES

Zhemin Chi[(1)], Hongwei Yang[(2)], and Junfeng Li[(3)]

[(1)]*Tsinghua University, 100084 Beijing, chizhemin1021@163.com*
[(2)]*Tsinghua University,100084 Beijing, yang.hw.thu@gmail.com*
[(3)]*Tsinghua University,100084 Beijing, lijunf@tsinghua.edu.cn*

BACKGROUND

Near-Earth Asteroids (NEAs) are considered as a unique component of the solar system and provide key information about the origin and the evolution of the solar system. Many of them may constitute a serious risk for the Earth because of the not-so-remote distance. Therefore, a good knowledge about the chemical and physical compositions of the target object is essential. NEAs can be classified according to orbital characteristics, geometric characteristics and compositions, etc. Recently, Dunn et al. [1] used Infrared Telescope Facility (IRTF) to determine the mineralogies and source regions of NEAs. Based on the observed spectral parameters of the 47 NEAs, 15% of these have H chondrite mineralogies, 10% have L chondrite mineralogies, 60% have LL chondrite mineralogies, and 15% have mineralogies that are either the L or LL chondrites.

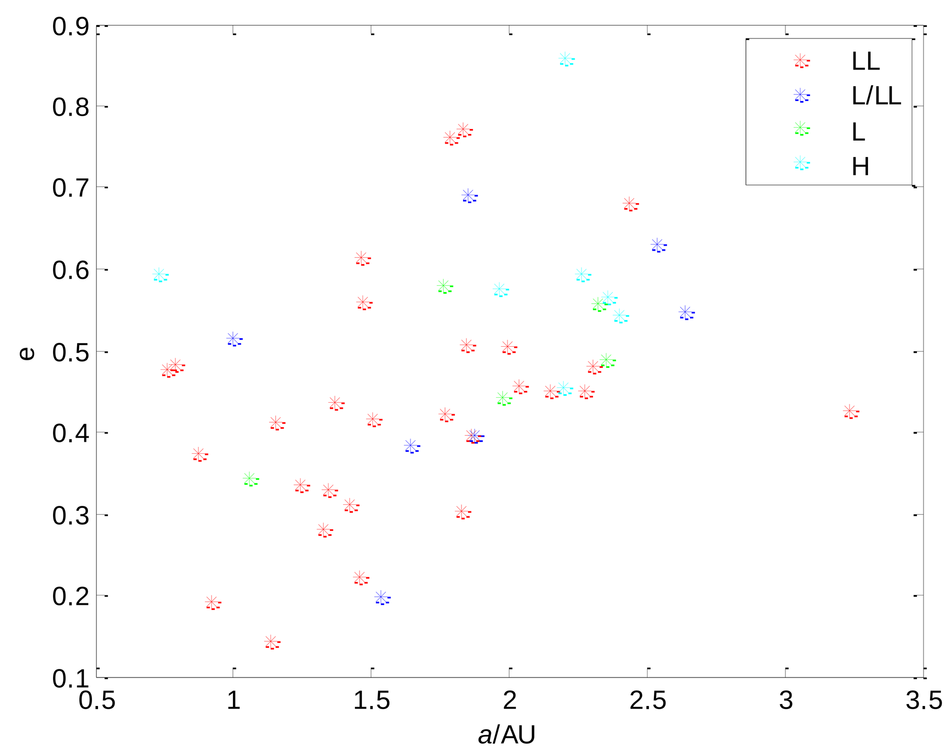
ABSTRACT

In order to get more detailed and accurate information about potential hazard of NEAs, close-up observations via asteroid rendezvous to all these types of NEAs are necessary and beneficial. Compared with a single-rendezvous mission, a multiple NEA rendezvous mission has great advantage in fuel consumption. Trajectory design for multiple asteroid missions has been investigated in great details. In the last IAA Planetary Defense Conference Peloni et al. [2] presented solar-sailing trajectory design for close-up NEA multiple-rendezvous mission. Yang et al. [3] studied low-thrust trajectory between asteroids with distant orbits. However, little literature has been published about multiple asteroid mission which has constraint of visiting NEAs with different mineralogies. In this paper, the NEAs are firstly categorized based on their compositions. Then, optimization problems with or without gravity assists to different NEAs are formulated. The particle swarm optimization (PSO) method is employed to solve the formulated problems. The optimized results will be presented in the final paper.

PROBLEM DESCRIPTION

- ◆47 NEAs;
- ◆4 types of chondrite mineralogies: H, L, LL and L/LL chondrite mineralogies ;
- ◆Close-up observations via asteroid rendezvous to each type of NEAs (a total of 4 NEAs).

On the basis of *a-e*, we get the distribution diagram:



DESIGN PROCEDURE

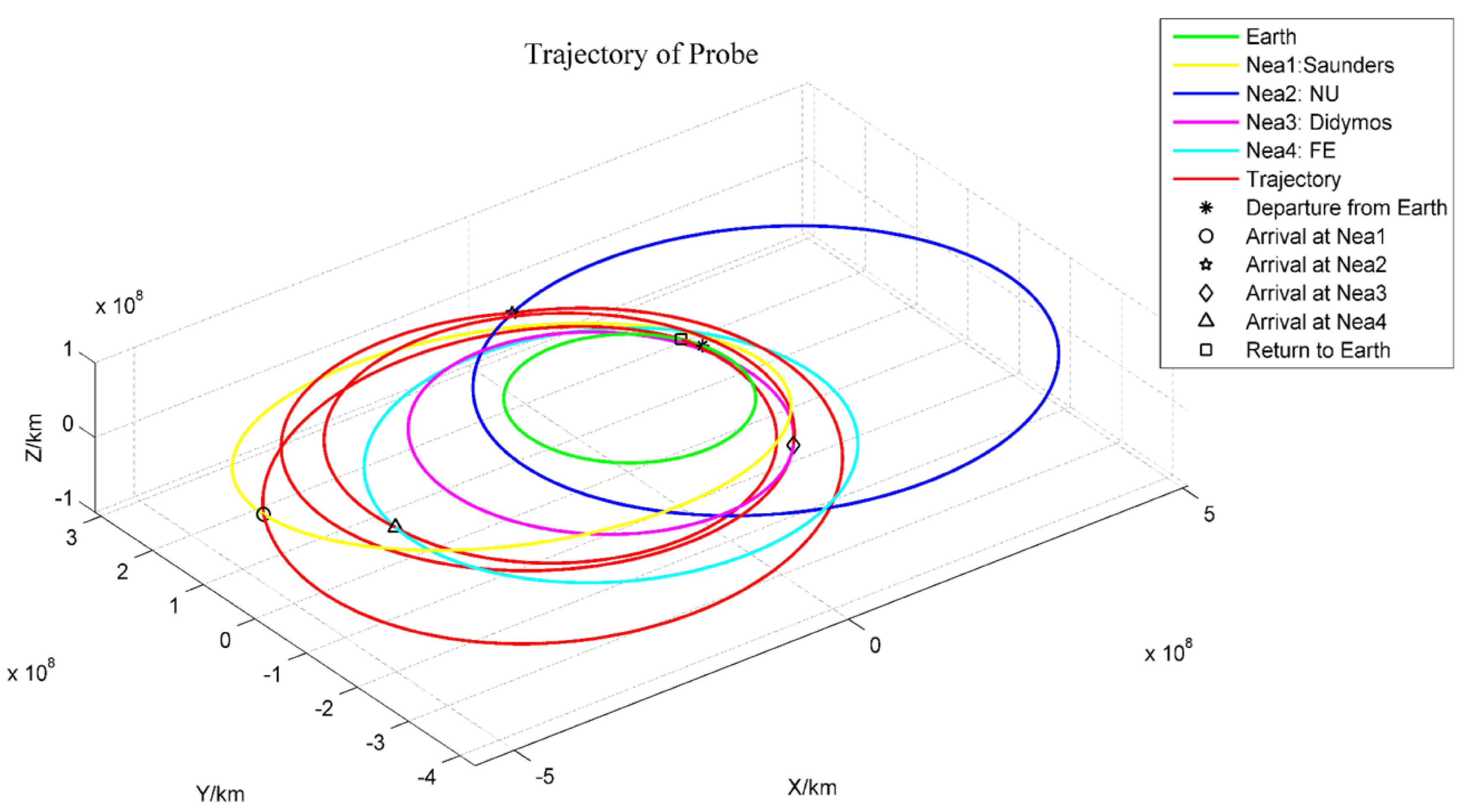
According to the above diagram, we choose 4 NEAs, whose orbits are approximate compared with others:

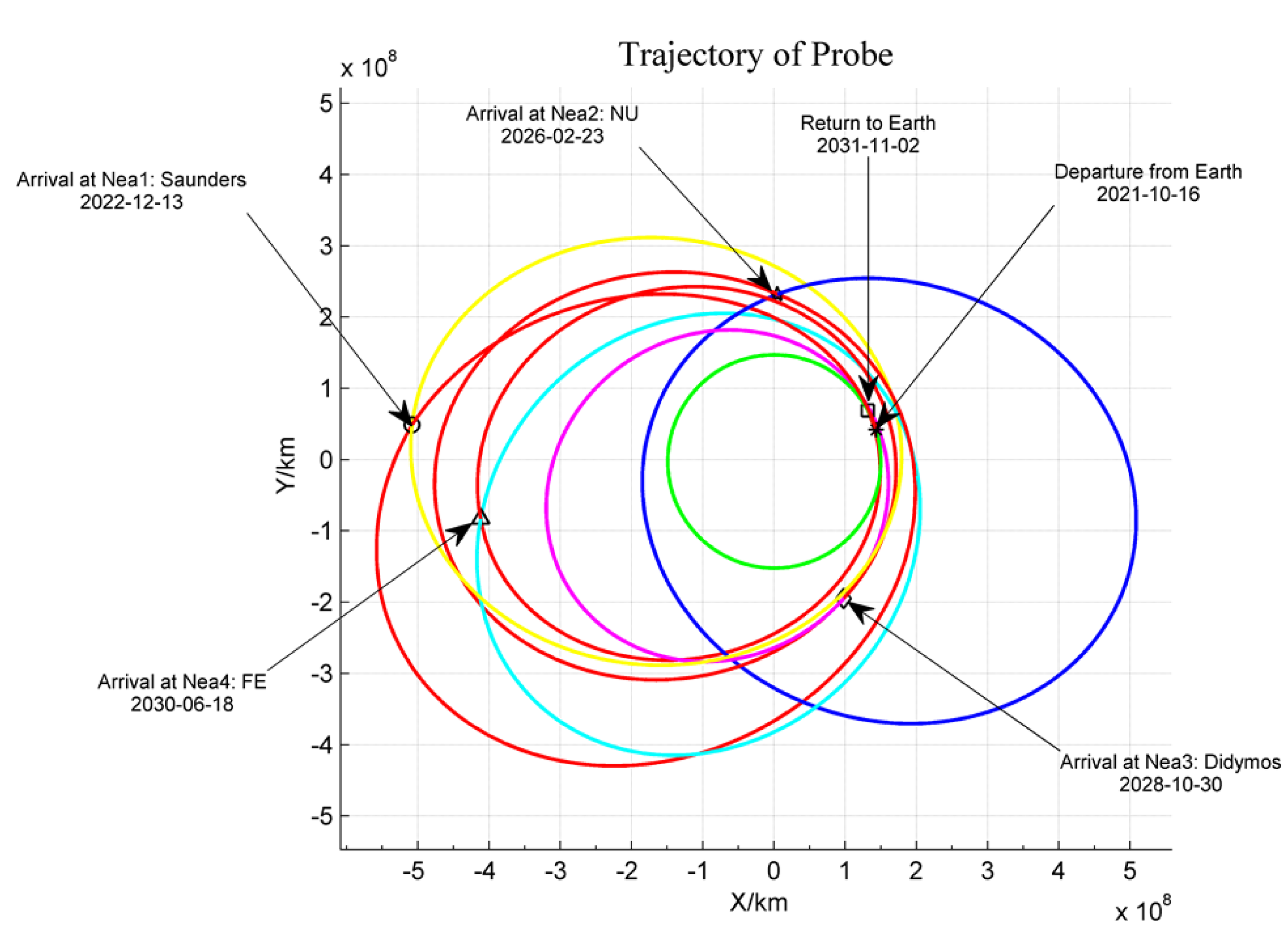
Name	Epoch	a	e	i	RAAN	w	M	Type
FE	57800	2.1956477	0.45390291	3.85419	173.26306	231.42959	71.9411069	H
NU	57800	2.3530615	0.48818963	2.80638	297.55158	222.82036	154.552728	L
Saunders	57800	2.3051087	0.4812401	7.19556	174.49552	181.49264	297.397956	LL
Didymos	57800	1.6445886	0.38383287	3.40768	73.22186	319.25159	110.7962295	L/LL

There are 24 types of missions，the minimum velocity increment △v is chosen as (A denotes FE, B denotes NU, C denotes Saunders and D denotes Didymos), taking no account of initial velocity increment (escaping from Earth) :

Permutation	Δv(km/s)	Permutation	Δv(km/s)	Permutation	Δv(km/s)	Permutation	Δv(km/s)
A-B-C-D	14.37	**B-A-C-D**	19.17	**C-A-B-D**	18.81	**D-A-B-C**	19.99
A-B-D-C	20.81	**B-A-D-C**	21.91	**C-A-D-B**	14.61	**D-A-C-B**	14.07
A-C-B-D	15.20	**B-C-A-D**	19.19	**C-B-A-D**	13.65	**D-B-A-C**	20.32
A-C-D-B	13.70	**B-C-D-A**	18.51	**C-B-D-A**	12.44	**D-B-C-A**	24.09
A-D-B-C	21.50	**B-D-A-C**	18.25	**C-D-A-B**	19.48	**D-C-A-B**	17.77
A-D-C-B	14.60	**B-D-C-A**	18.90	**C-D-B-A**	21.39	**D-C-B-A**	17.07

RESULTS





REFERENCES

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[2] Peloni A, Ceriotti M, Dachwald B. Solar-Sailing Trajectory Design for Close-up NEA Observations Mission[J]. 4th IAA Planetary Defense Conference – PDC 2015, Roma, Italy
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