A STRATEGY TO DETECT NEOs: FROM GROUND–BASED TO LUNAR–BASED OBSERVATIONS

Syuzo Isobe

Japan NEO Team National Astronomical Observatory

There are near–earth objects (NEOs), having different collision probabilities with the earth depending on their sizes. To escape global or continental scale catastrophe, the activity which we should engage in at first is a detection of all NEOs.

All NEOs with diameters larger than 1 km can be detected during their passages through the asteroid belt by ground–based telescopes which are and will be in operation. All NEOs with diameters between 100 m and 1 km can be derected by space– borne or lunar–based telescope, but it takes over 50 years after completion of these telescopes.

Although the collision probability with the earth of a NEO having a diameter of 100 m is once every one thousand years, the next collision may occur within 50 years, during which we are trying to detect all these NEOs. Here, one should remember our results of close approach estimation of NEOs that 40% of NEOs approach the earth from an area within 30 degree from the sun. This means that a collision that a collision will occur without any warning time. Therefore, we need space–borne or lunar–based continuous in this area.

In Japan, there is a discussion to build a lunar station in which the NEO detection telescope(s) are also considered. Therefore, we are discussing a strategy of the NEO detection observations to minimize the possibility of being hit by a NEO. Our proposed strategy will be introduced in this paper.

An object approaching the earth with a velocity of 20 km/s for an asteroid and 60 km/s for a comet would release energy as shown in Table 1. Those collision probabilities are higher for smaller objects. An object with a diameter small than several tens of meters explodes in the upper terrestrial atmosphere and therefore give no damage on the terrestrial surface. An object with a diameter between 50 m — 500 m represents a local or continental hazard. An object larger than 500 m produces a global catastrophe and on occasion mass extinction.

65 million years ago, a 10 km size asteroid hit the Yucatan peninsula in Mexico and extinguished the dinosaurs. On a geological map there are many craters from impacts that produced local or continental damage. Because of their small size these objects are usually very faint (fainter than magnitude 23), and therefore, hard to detect using ground–based telescopes.

Table 1

Energies of bodies of various diameters

Asteroid (m)	Comet (m)	Energy (Mton TNT)
10	6	0.024
I Continental hazard:		
60	36	20
80	48	50
150	90	340
II Global catastrophe:		
500	300	13000
1000	600	100000
10000	6000	100000000
Hiroshima atomic bomb	0.02	
Nuclear winter	10000	

Recently, Isobe and Yoshikawa (1995) found that most asteroid crossing from inside to outside the earh`s orbit approach the earth from within 30° of the sun on the celestial sphere. An asteroid in this area (i. e., from a blind direction) cannot be observed by ground–based telescopes. Then it will suddenly hit the earth without any warning time.

In these situations we should use the strategy to detect the NEOs, as shown in table 2.

Table 2

Methods suitable for detecting various classes of NEOs

I Global Catastrophe	Ground–based obs. (1 m class telescopes)	$d > 0.5$ km; $m \leq 22$ mag. at asteroid belt
II Continental Hazard	Lunar–based obs. (1 m class telescopes)	0.5 km $> d >$ 50 m $m \leq 27$ mag. at asteroid belt
III Blind Direction	Satellite or lunar–based obs. (35 cm class telescopes)	Make warning time longer

The number of ground–based telescopes for the detection of NEOs is gradually increasing although we need much further effort. However, we certainly require the space–borne and / or the lunar telescope to detect objects representing local or continental hazards and coming from the blind direction.

We are suggesting the scheme shown in Fig. 1 as one proposal for the lunar mission arranged by the National Aeronautic and Space Development Agency in Japan. (It was decided that the first lunar mission will be launched in 2003). This idea is twin 1 m telescopes. However, we are intending to launch a small telescope and then step up as shown in Table 3. We are concentrating our efforts to realize this sequence of lunar telescopes.

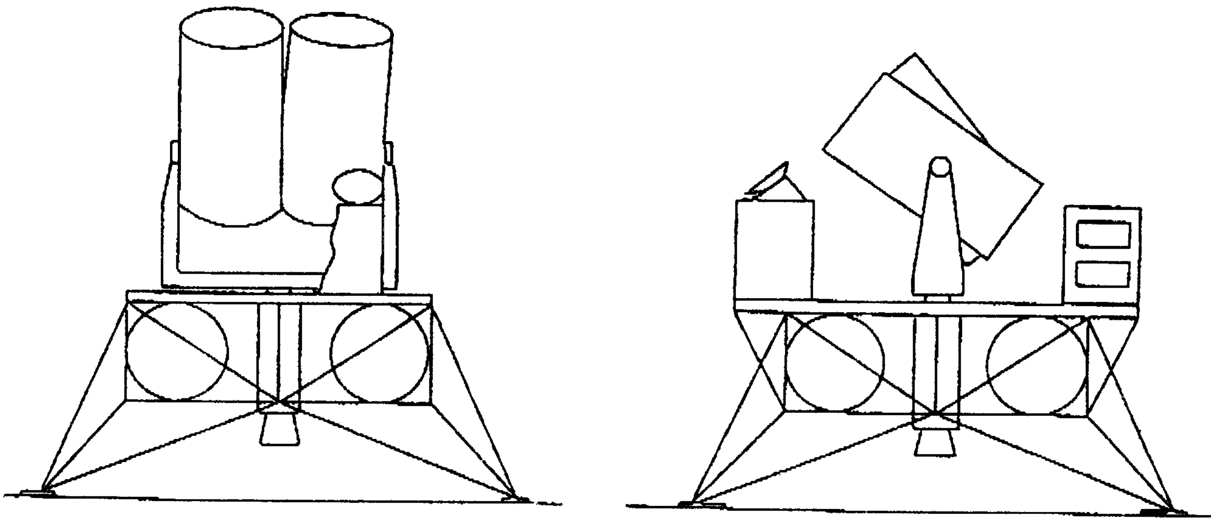
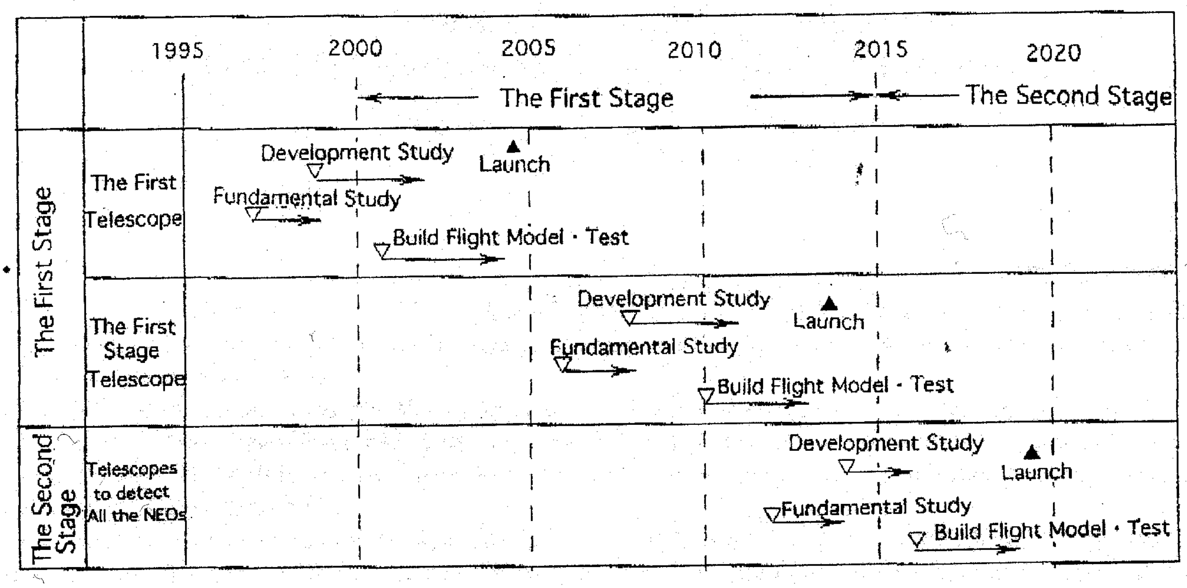


Fig. 1. Full spec twin telescopes.

Table 3

A plan to monitor asteroids hazardous to the earth



References

1. Isobe S., Yoshikawa, M. (1995). Earth, Moon and Planets, 72, p. 263–266.