Electrostatic Deflection of Asteroids

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Abstract

Earth has been visited by planetary rocks coming from space and brought more havoc on the planet. Though infrequent they are world-wide catastrophe and has caused environmental devastation, loss of lives, and destruction of properties. Testimonial to these are events like Tunguska forest fire in Siberia, meteor crater formation in Arizona, and the famous Chicxulub crater event in Yucatan peninsula. The last one caused the extinction of the dinosaurs and disappearance of hundreds of plant and animal species. These events resulted from collision of planetary rocks, usually asteroids, with the planet Earth. Man's fear of getting obliterated by an event similar to the fate of the dinosaurs has inflicted paranoid feeling and concern on the possible collision of an asteroid with our planet. Several technological solutions have been proposed but in this paper a method that is clean, simple, safer, robust, and faster mitigation of Earth-asteroid collision problem is presented.

Keywords: Earth-asteroid collision, electrostatic deflection, dipole machine, electric field intensity, surface charge.

1. Introduction

A global doomsday event occurred 65 million years ago that wiped out the dinosaurs and thousands of plant and animal species. That was the collision of a space rock with planet Earth occurred in Yucatan peninsula, Mexico. That event could happen again with a much larger asteroid and this time it will be the human race that could be the victim. Through the course of history of the planet Earth and its human inhabitants we have live and survive the rise and fall of human civilization and of world-wide calamity and devastation. We have undergone scientific development and achieved numerous discoveries but the danger of space annihilation in our planetary system is always lurking above us from a seemingly peaceful emptiness of space. This continuing world-wide catastrophic threat from the sky above is still waiting a technological solution. The threat of a collision with an unknown planetary rock in the form of asteroid or comet with our planet is a frightful event that anyone could imagine if he can envision the way the dinosaurs and other biological lives have vanished as cited earlier. As a consoling proposition to this scary global problem this paper describes an idea whereby the orbital path of the menacing asteroid can be diverted to avoid the catastrophic collision.

2. Survival Plan

The plan envisioned to avoid planetary collision between Earth and an asteroid is a two part system. The first part is to fly a spacecraft that will rendezvous with the asteroid and drop impactors on the asteroid surface. These impactors will have charge generators that will buildup electrical charges on the asteroid surface. The second part is to fly a second spacecraft carrying an electrostatic generator that will illuminate with electrostatic field the instrumented asteroid. The ensuing electrostatic force between electrostatic generator and instrumented asteroid will sufficiently deflect the asteroid up to a point in space and time until the desired safe separation distance is attained.

3. Part A: Instrumenting the Asteroid

Instrumenting the asteroid is performed as described in the following. Several devices, equipment, and instruments are packaged and assembled inside a canister and the unit is called an impactor.

This impactor will be loaded in a spacecraft and there maybe two or more of this unit. The integrated system of spacecraft and its payload of impactors will be carried by a heavy-lift rocket vehicle to be flown and ejected at a designated point above and beyond low earth orbit. From this point the loaded spacecraft will be navigated to fly and rendezvous with the asteroid. With the known mapped surface of the asteroid these impactors will be dropped at designated point and anchored to the asteroid surface. At the landed location the impactor will unload and deploy it's payload. There are three basic steps that need to be accomplished after the asteroid is instrumented.

These are : (1) modify the asteroid surface electrostatically, (2) control the electrical characteristics of the modified surface, (3) interact the altered electrostatic state of asteroid surface with a man-made electromagnetic field. The interaction is actually done by joint control of the asteroid surface and electric field intensity generated by the electrostatic field generator(electrostatic dipole machine) mounted on a spacecraft. These basic steps are described as follows.

3.1 Electromagnetic Modification of Asteroid Surface

Asteroid surface alteration will be performed on selected area of the asteroid. This is done by rolling out patches of charged sheets with the charged side laid widely exposed to the open space. A means will be designed to anchor these sheets firmly flat to theasteroid soil. Charging of the sheets will be done by a charge generator that is rested inside the anchored impactor. There will be redundancy such that at least two impactors each with charge generators will be deployed. Wide area coverage by the charged sheets will have to be extensively spread out.

3.2 Control of Surface Charge

The amount of surface charge density on the exposed surface do influences the force that will cause the asteroid to be deflected. The charge generator can be adjusted to generate the right amount of surface charge density on the sheet surface. The source of power for the charge generator and other electrical devices is the solar panel that will be deployed once impactor has firmly anchored. There is also a deployment of antenna for remote communication in controlling the surface charging process and other tasking involved.

3.3 Electrostatic Interaction with the Altered Surface

The spacecraft is loaded with impactors which will be designed to contain charge generator, rolled spread sheets, antenna system, and deployable solar panels. It will be dropped on the surface of the asteroid. Once it has landed on the asteroid it will be anchored firmly as stated earlier then spread sheets will be rolled out, antenna and solar panel will be deployed . The controlling scheme is a two way process. In conjunction with step 3.2 there are parameters in the dipole electrostatic generator that need to be adjusted and tuned to perform the proper interaction and this is remotely done through wireless communication with a relay station via the antenna either in an ISS or Earth based station. Thus a robust mechanism of controlling the asteroid deflection process is remotely performed.

4. Part B: Dipole Illuminator

The dipole machine (aka dipole illuminator) will be efficiently packaged and mounted on a spacecraft. Process of lifting the electrostatic dipole machine and accessories is similar to what was done on delivering payloads for instrumenting the asteroid. Dipole structure can be packaged as a folded mechanical structure and displayed to shape during space deployment. For an alternative design it can be a deflated pair of spherical rubber-like material with metallic coating such as mylar and be blown by compressed air to shape during deployment. The dipole is capable of 3D-axis motion. All electrical system for energizing dipole and auxiliary power for space deployment is available from the host spacecraft which carries solar panel for providing power generation. Inside the spacecraft is a high voltage DC generator that will generate very high potential difference between the two fix spherical probes. The spacecraft carrying these deployed equipment will be tracking and following the instrumented asteroid at a specified distance behind as shown in Figure 1. while pointing the appropriate **E**-field intensity at the instrumented asteroid.

5. Electrostatic Interaction

The charged asteroid surface will be illuminated with an electrostatic field generated by a dipole electrostatic machine. This dipole is an E-field generator mounted on spacecraft located r distance behind following the asteroid (see Figure 1).

The deflection force can be determined since the field intensity **E** generated by the dipole and the total charge q of the asteroid are known and both quantities can be varied independently. This force is quantified by the expression **F** = q**E** gives the magnitude of this force acting on the asteroid with same direction as the field intensity **E.** For this force to be effective the distance r must be sufficiently large compared to the geometric dimension of the dipole (r > d in Figure 1). The charge q and the field intensity **E** will be controlled by proper design of the system. The next step is applying Newton's law yielding **a =** q**E**/M is the asteroid acceleration, with M it's mass. The resulting kinematics follows a one-dimensional constant accelerated motion. We next choose a strategy on how to implement a combination of kinematical movement to reach the separation distance that would guarantee catastrophic collision will be avoided. The strategic combination of movement is, first a constant accelerated motion then followed by a constant velocity by simply removing the force and let asteroid glide freely.

This can be done repeatedly for the same or different length of time intervals. With this scheme the distance covered will be cumulative. Energy is conserved and this also helps in preserving the service life longevity of the electrostatic dipole machine due to allowed cooling-off time. An estimate of the energy consumed during the entire deflection period of operation can be compared with the energy storage capability of the deflecting machine. Implementation of the appropriate motion strategy and optimization of the deflection operation makes application of electrostatic method of deflecting asteroid a better system. There are other strategies that can be investigated and the one described in this writing is just to show the do-ability of the electrostatic deflection system. This method is cleaner, simpler, and safer than the nuclear explosion method. It can accomplish the mitigation process in shorter time thus making it more appealing and possibly more economical than the other proposed methods [1],[2]. Figure 1 shows relative position of dipole field generator and asteroid. Figure 2 gives dipole E-field pattern that will interact with the charged asteroid. A comprehensive treatment of this deflection method and extensive calculation supporting the concept can be found in reference [3].

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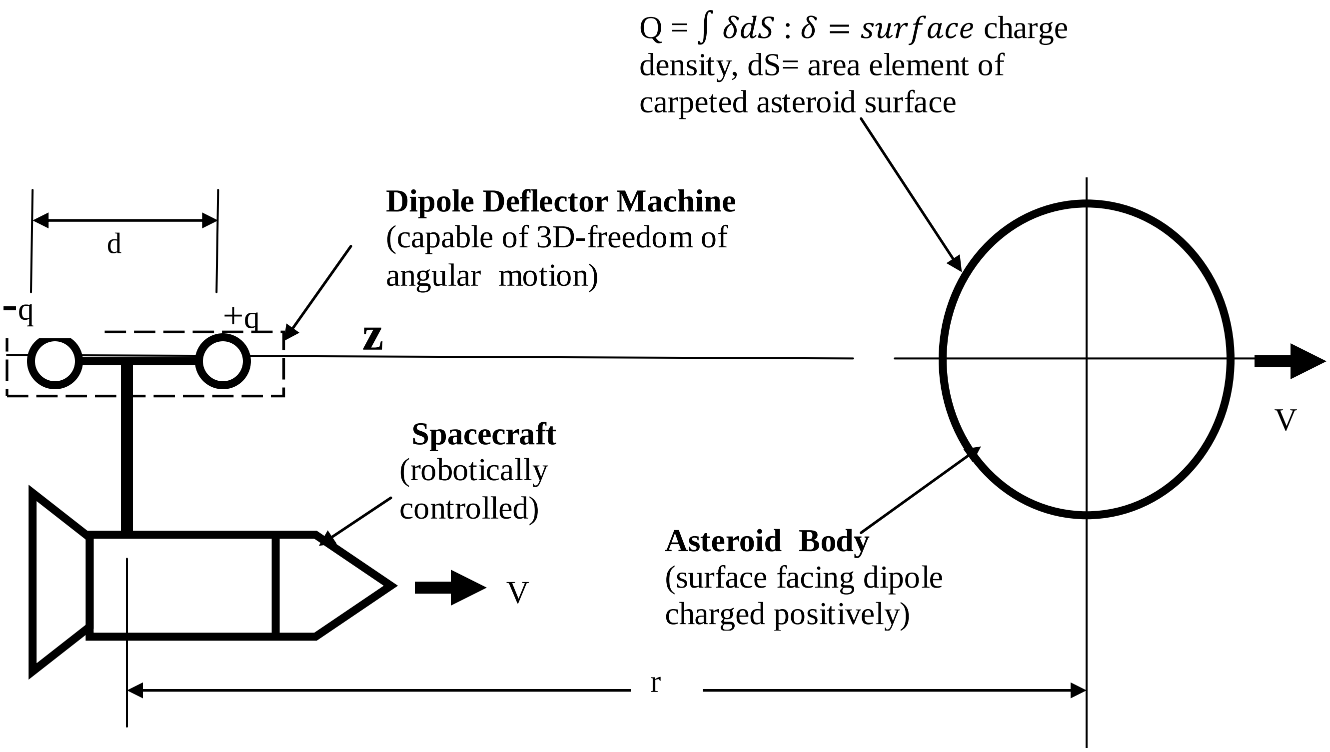

Figure 1. Electrostatic deflector illuminating an asteroid (not to scale). Spacecraft and asteroid move with velocity V in the same direction.

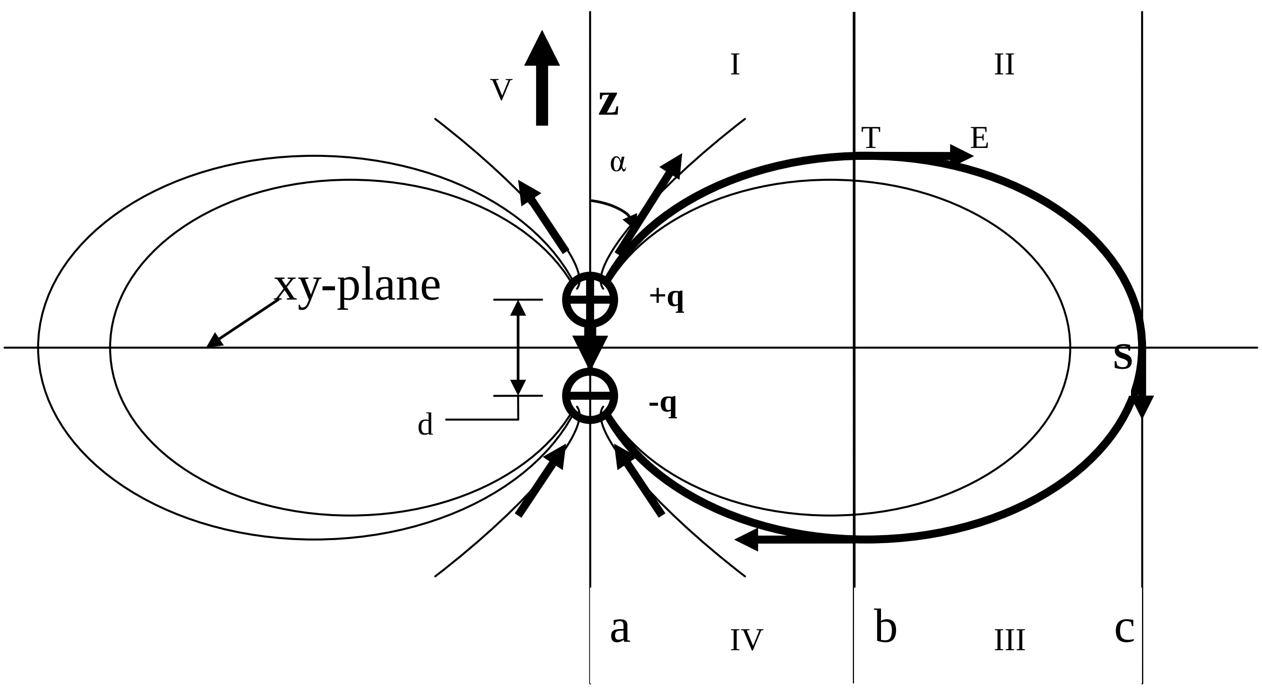

Figure 2. Field intensity E at different location of dipole field pattern