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Assessments of blast deflection of asteroids

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Abstract

In the presentation the results of estimations of efficacy of blast deflection of asteroids are discussed. Firstly there are examined on-surface and buried explosions. The known approximations of industrial nuclear explosions are remade into relations for mechanical impulses. The results are compared with known numerical calculations for buried impacts on asteroids. It is provided additional valuable awareness of the obtained formulas. Then a special attention is paid to remote explosions. In these cases the mechanical impulse given to the asteroid is less and the risk of fragmentation of the dangerous asteroid is considerably less too than in the case of the buried explosions. There are discussed in details the three main problems which needed to be solved in estimations of distance effects: transport, thermodynamic and mechanic problems.

It is supposed that a nuclear charge gives mainly an X-rays yield, so the transport problem of X-rays in the matter of an asteroid is considered. The spectrum of the X-rays depends on a construction of the nuclear charge and could be varied to some extent. The transport problem is considerably similar to ones which had been solved before eighties but here we are standing before a specific subsurface energy release problem, not a deeper transmission. It is something other although simpler task. This problem is solved using Monte Carlo calculations of three collisions of a quantum.

The next thermodynamic problem about sublimation and high temperature decomposition of the matter of asteroid is solved using data on thermodynamics of magnesium and iron silicates and oxides.

The problem about spreading vapourized material is solved using the well known energy integral approach. The numerical calculations confirm that this approach allows to get rather accurate values of mechanical impulse.

It is supposed that we have a deal with an asteroid of chondrite type but the chondrules have very wide spectrum of sizes and are packed rather tightly. Such conclusion can be made from the picture of Itokawa asteroid and the known values of average densities of asteroids. It allows to neglect effects of porosity on the radiation transport and vapor motion in such preliminary investigations.

There are also given comparisons with other mitigation conceptions which could help to determine the place of the blast deflection in the row of possible mitigation approaches.

The presented work is based on the following conceptions.

1. A dangerous asteroid will be revealed long before its impact on the Earth. Initially there must be attempts to deflect it by gravitation tractor or kinetic impactor, for example. And a nuclear explosion method could be considered as a backup system that we should have in such serious problem. In this case we have a time to investigate composition and structure of an asteroid and use a distance blast

deflection. The distance explosion of a nuclear charge can be used at later instants than other things because it is much more effective.
2. Such asteroid will be revealed not long before its impact or it will be too large one. The most properties of an imminent asteroid which have drastically influence on the deflection will be unknown about up to launch of a mitigation mission. In this case the blast impact hasn't alternative one and a buried explosion should be used any way. And let hope that a danger of asteroid fragmentation is not so great as it is considered usually.