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Asteroid Deflection by Broadside Impact

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ABSTRACT

This paper introduces the concept of a distributed ("Broadside") kinetic interception of an asteroid or comet, launched months or even years before a predicted Earth impact.

It also emphasises the need for a comprehensive segmentation strategy to match <u>all</u> asteroid approach scenarios to feasible solutions.

If an object has been identified that could impact the Earth, there are several existing proposed techniques for mitigating or eliminating this risk, covering many of the scenarios. The choice of technique depends on 4 principal parameters:

1) period from object detection to possible Earth impact
2) period from mission launch to object interception
3) object mass
4) object structure

The last of these may not be understood before an urgent interception mission must be launched – the object might not be a single solid rock, but may be a loose conglomerate of rocks, dust and ice. Statistically, a real-life situation is much more likely to be a smaller object, with minimal warning period.

It has previously been proposed that a kinetic impact using a simple projectile "rifle bullet" would work in some scenarios. The idea is that a small mass moving with very high relative velocity would impact a large mass, changing its velocity by a few cm/sec. This effect might be augmented by reverse ejecta.

However, large objects (> 200m) will not deflect sufficiently.

Also, a smaller object (< 200m) may be oddly shaped, soft, fragile, or fragmented (eg, Itokawa, comet 67P), and the projectile would pass through it, break it up (making the task much harder for follow-up missions), or spin it.

This author proposes a new technique. An adaptation of the kinetic approach is to disperse the payload shortly before impact, thereby transferring relative momentum across a broad impact surface ("**Broadside Strategy**"). This technique has a predictable outcome, reduces the time between launch and interception, and its success does not depend on the object's structure. The payload could comprise:

- Gas cloud, gas-filled balloons, or perhaps just a single large balloon, The gas (possibly CO_2 ?) is released just seconds before impact
- Liquid cloud, or liquid-filled balloons. A liquid must be chosen that does not solidify on ejection
- Powder, sand, expanded plastic (eg, polystyrene), foam
- Several small solid projectiles (a "shotgun" approach), thereby causing multiple impacts. The projectiles might pass through the object

There are other beneficial factors to consider with the Broadside Strategy:

- This is a straightforward Engineering solution, with a high probability of success
- The impacting materials can be configured just before impact for maximum effectiveness. The details of this can be worked out after the mission has been launched
- The technology is tried & tested, the maths is known, the physical chemistry is known, the engineering is relatively simple and low risk, there are no complex robots, the use of complex guidance and control systems is minimal
- It will create minimal debris, which necessarily is heading towards the Earth and its numerous artificial satellites
- There is no release of radioactive debris
- The "mothership" does not have to spend valuable time slowing down to synchronise orbits with the object
- Using an ion drive would increase the relative velocity (and momentum) of the projectiles
- For a larger object, several high-momentum missions would be required
- It would be appropriate for the "mothership" that launches the projectiles also to launch a secondary craft that monitors the impact for effectiveness & to gather science data