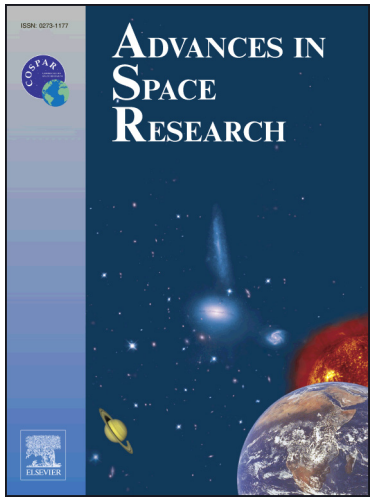

The Effect of Asteroid Topography on Surface Ablation Deflection

Jay W. McMahon, Daniel J. Scheeres

PII: S0273-1177(16)30637-8
DOI: http://dx.doi.org/10.1016/j.asr.2016.11.011
Reference: JASR 12968

To appear in: *Advances in Space Research*

Received Date: 9 April 2016
Revised Date: 3 October 2016
Accepted Date: 8 November 2016

Please cite this article as: McMahon, J.W., Scheeres, D.J., The Effect of Asteroid Topography on Surface Ablation Deflection, *Advances in Space Research* (2016), doi: http://dx.doi.org/10.1016/j.asr.2016.11.011

The Effect of Asteroid Topography on Surface Ablation Deflection

Jay W. McMahon and Daniel J. Scheeres[2,*]

University of Colorado Boulder, Boulder, CO, 80309

Abstract

Ablation techniques for deflecting hazardous asteroids deposit energy into the asteroid's surface, causing an effective thrust on the asteroid as the ablating material leaves normal to the surface. Although it has long been recognized that surface topography plays an important role in determining the deflection capabilities, most studies to date have ignored this aspect of the model. This paper focuses on understanding the topography for real asteroid shapes, and how this topography can change the deflection performance of an ablation technique. The near Earth asteroids Golevka, Bennu, and Itokawa are used as the basis for this study, as all three have high-resolution shape models available. This paper shows that naive targeting of an ablation method without accounting for the surface topography can lower the deflection performance by up to 20% in the cases studiedin terms of the amount of acceleration applied in the desired direction. If the ablation thrust level is assumed to be 100 N, as used elsewhere in the literature, this misapplication of thrust translates to tens of kilometers per year in decreased semimajor axis change. However, if the ablation method can freely target any visible point on the surface of the asteroid, almost all of this performance can be recovered.

Keywords: asteroids; hazardous asteroids; deflection

1. Introduction

Surface ablation can be used for hazardous asteroid deflection (1) through heating of the surface by using mirrors to reflect sunlight, or by directly heating the asteroid surface with lasers. In either case, the impulse from ablated material acts predominantly in the asteroid surface normal direction (2; 3). In order to optimize the deflection to maximize the minimum orbit intercept distance (MOID) between the asteroid and the Earth, the ΔV should generally be aligned with (or against) the asteroid's orbital velocity direction (4; 5), which efficiently changes the semi-major axis. Thus, to maximize the deflection, material should be ablated from portions of the surface where the normal is aligned with the orbital velocity direction. If the asteroid were a sphere, as is often assumed (6; 7),

*Corresponding author

Email address: jay.mcmahon@colorado.edu (Jay W. McMahon and Daniel J. Scheeres)

[1]Assistant Professor, Aerospace Engineering Sciences, 431 UCB

[2]A. Richard Seebass Endowed Chair Professor, Aerospace Engineering Sciences, 429 UCB