THE INFLUENCE OF ASTEROID SHAPE ON THE YARKOVSKY EFFECT - A NUMERICAL STUDY. E. D. Rosenberg, P. R. Weissman, S. D. Wolters, Planetary Science Section, Jet Propulsion Laboratory, Mail stop 183-301, 4800 Oak Grove Drive, Pasadena, CA 91109. (eric.d.rosenberg@jpl.nasa.gov),(paul.r.weissman@jpl.nasa.gov),(stephen.wolters@jpl.nasa.gov)

Introduction: The Yarkovsky effect is the non-gravitational force exerted on an asteroid due to anisotropic thermal emission. The Yarkovsky effect has been recognized as a significant influence on orbital dynamics over an extended period of time, especially for near-Earth asteroids (NEAs) (e.g. [1] and references therein). The Yarkovsky effect has been detected in two NEAs, *1992 BF* [2] and (6489) *Golevka* [3], both irregular sub-km asteroids. Theoretical models of the effect use a spherical approximation to generalize the thermal calculations (e.g. [4]). Studies have explored varying parameters such as obliquity and albedo [5], but there has not yet been a systematic study to explore varying shape. We present a study of the Yarkovsky effect on non-spherical (prolate and oblate spheroid) objects at various obliquities. We suggest that a spherical approximation might not always be sufficient, and that large-scale variations to the asteroid shape may cause significant differences. This work may help link specific Yarkovsky detection cases to an understanding of the evolution of the near-Earth asteroids in general, given a known overall distribution of axial ratios and pole orientations measured to the techniques such as optical lightcurve inversion and radar.

We use a hypothetical object with the orbital parameters of *Golevka* (see Table 1) for our simulation. For the numerical calculations we use a 3-dimensional cometary nuclus thermophysical model [6] that was modified for spheroidal shapes and asteroidal surfaces. The model uses an implicit numerical scheme in spheroidal coordinates and calculates heat flow in porous media.

Table 1: Orbital parameters of asteroid 6489 *Golevka*

Parameter	Description	Value	Units
a	Semi-major axis	2.499	AU
e	Eccentricity	0.6049	
$P_{\rm rot}$	Spin period	6.026	hours
R_{eff}	Effective radius	265	m

The Parameter Field: We have calculated the accumulated influence of the Yarkovsky effect over an orbit for both prolate and oblate spheroidals with varied axial ratios. The radii were chosen so that the total volume of all the objects remain constant. The axial ratios were taken between 0.1 (extreme spheroidal) and 1.0 (sphere) with intervals of 0.1. Both the prolate and oblate models are rotated around the minor axis. For each shape model, obliquities between 0 and 180 degrees with intervals of 20 degrees were tested and obliquity-azimuth (see definition in [6]) varied at intervals of 45 degrees.

Results: It was found that the sphericity influences not only the magnitude of the Yarkovsky effect but also affects the direction of the force. For example, for an oblate spheroid with polar:equatorial axial ratio of 0.5, at low obliquities the Yarkovsky force is less than for a sphere (as seen in Fig. 1), and initially positive for increasing semi-major axis. At high obliquities it is much greater than that for a sphere and negative, the maximum increase in the Yarkovsky force compared to a sphere is ~70% at an obliquity of 100 degrees. The behavior for the prolate model is similar but not as great as the prolate model.

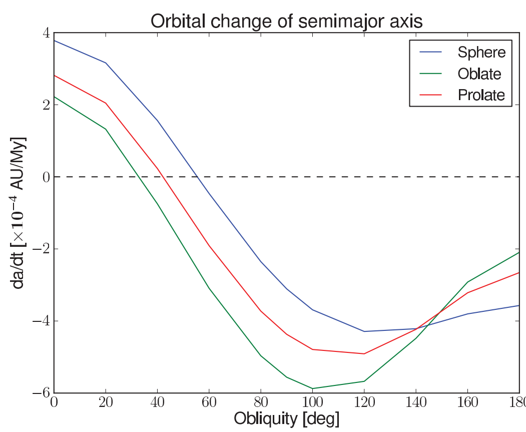

Figure 1: Orbital change of semimajor axis for spherical, oblate, and prolate shapes with axial ratio of 0.5 for obliquity-azimuth, J=0.

References: [1] W. F. Bottke et al. (2006), *Ann. Rev. Earth Planet Sci., 34,* 157. [2] D. Vokrouhlický et al. (2008), *Astron. J., 135,* 2336-2340. [3] S.R. Chesley et al. (2003), *Science, 302,* 1739-1742. [4] D. Vokrouhlický et al. (2000), *Icarus, 148,* 118-138. [5] D. Vokrouhlický et al. (2006), *A&A, 459,* 275-282. [6] E. D. Rosenberg et al. (2007), *New Astronomy, 12,* 523-532