Travis Brashears\textsuperscript{(1)}, Philip Lubin\textsuperscript{(1)}, Gary B. Hughes\textsuperscript{(2)}, Jonathan Suen\textsuperscript{(1)}, Peter Meinhold\textsuperscript{(1)}, Caio Motta\textsuperscript{(1)}, Janelle Griswold\textsuperscript{(1)}, and Miikka Kangas\textsuperscript{(1)}

\textsuperscript{(1)}Physics Department, University of Santa Barbara, CA 93106, +1-805-893-8432  
\textsuperscript{(2)}Statistics Department, California Polytechnic State University, San Luis Obispo, CA 93407, +1-805-756-5648

Keywords: Planetary defense, directed energy, orbital deflection via laser, laboratory thrust measurements

ABSTRACT

We report on laboratory studies of the effectiveness of directed energy planetary defense as a part of the DE-STAR (Directed Energy System for Targeting of Asteroids and explROation) program. DE-STAR (Lubin et al., 2014) and DE-STARLITE (Kosmo et al., 2014) are directed energy "stand-off" and "stand-on" programs, respectively. These systems consist of a modular array of kilowatt-class lasers powered by photovoltaics, and are capable of heating a spot on the surface of an asteroid to the point of vaporization. Mass ejection, as a plume of evaporated material, creates a reactionary thrust capable of diverting the asteroid's orbit. In a series of papers, we have developed a theoretical basis and described numerical simulations for determining the thrust produced by material evaporating from the surface of an asteroid (Lubin et al., 2014; Kosmo et al., 2014; Hughes et al., 2014; Johansson et al., 2014). In the DE-STAR concept, the asteroid itself is used as the deflection "propellant". We compare this approach to other proposed techniques. This study presents results of experiments designed to measure the thrust created by evaporation from a laser directed energy spot. We constructed a vacuum chamber to simulate space conditions, and installed a torsion balance that holds an "asteroid" sample. The sample is illumination with a fiber array laser with flux levels up to 60 MW/m\textsuperscript{2} which allows us to simulate a mission level flux but on a small scale. We use a separate laser as well as a strain gauge torque sensor to readout the angular motion and can thus determine the thrust. We compare the measured thrust to the models will discuss scaling issues associated with small scale lab testing vs full scale missions.

References:
