GIANT IMPACTS CAN DRIVE ASTEROID DYNAMICS: LESSONS FOR VESTA . B. E. Schmidt[1] and W. B. Moore[2], [1]UCLA-IGPP (britneys@ucla.edu), [2]Hampton University (bmoore@ess.ucla.edu).

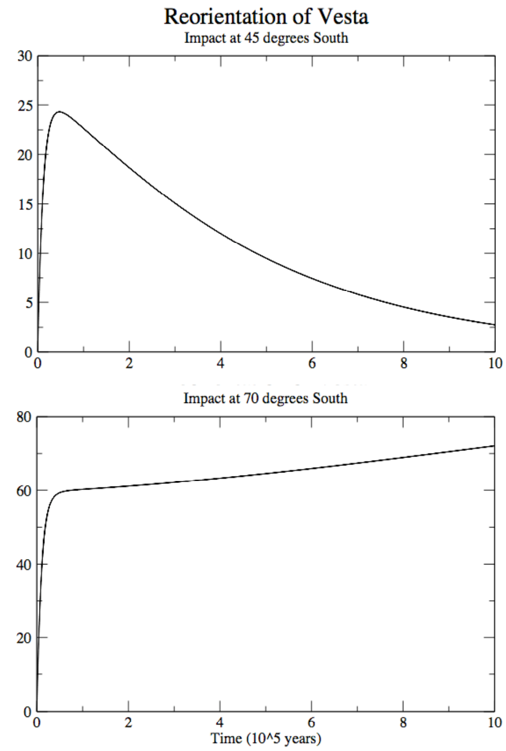
Figure 1: HST image of Vesta [1].

Introduction: Hubble Space Telescope imaging revealed that the south pole of Vesta is characterized by a large basin 460 km in diameter and ~ 13km deep[1]. Variations in reflectance and composition across Vesta, have been attributed to the exposure of deep crustal and possibly mantle materials, and its spectral link to the HED meteorites further suggests that Vesta was differentiated prior to the impact[e.g., 2]. It is probably not a coincidence that such a large topographic feature, in this case a negative mass anomaly imposed by the impact basin, is located at Vesta's south pole, suggesting that Vesta has undergone at least some degree of reorientation. And, since the body is largely relaxed about its current rotation axis, it is probable that the body has deformed to a changing rotational potential since the impact occurred.

We present the result of geophysical modeling of Vesta to determine its interior state prior to impact and the subsequent surface deformation and rotational and thermal evolution of the asteroid.

Models: We developed a code to track the evolution of Vesta's shape and rotation as funtion of time after the emplacement of a giant basin. We track the body's shape through its degree-two gravitational coefficients from an initial state where the body is fully relaxed around its principle rotation axis, and also track the evolution of its rotational state and degree of reorientation via the magnitude of its rotation vector.

The basin is modeled as an instantaneous degree-two perturbation to the shape from the crater (a large negative spherical cap load), and corresponding ejecta blanket (thin shell load). We solve for the gravity harmonics due to the loads as a function of the incident angle of the impact. We vary the impact from polar to nearly equatorial, allowing us to explore the degree of polar wander Vesta undergoes as a function of the location of the impact.



We assume that prior to impact Vesta has achieved a steady state and use the relaxation timescale for the mantle as a proxy for its internal state. We explore the timescales from 10^5-10^{10} years to treat cases where the impact occurs early when Vesta's mantle is still fluid (the elastic case), to cases where the matle is extremely viscous or solidified (the rigid case).

We also can vary the degree of differentiation Vesta has undergone. We do so by virtue of the the k2 Love number of the body which expresses the radial mass distribution.

Results: The result is a constraint on the degree of reorientation, physical deformation and rotational change that Vesta can sustain as a function of its initial interior state, rotation and the incident angle of the impact.

Initial results indicate that for impacts from 90-60 S, Vesta initially rotates toward placing the crater at the pole, and then as the body deforms, the crater evolves away more quckly than the rotational bulge, causing Vesta to drift back towards its initial rotation state. For impacts below about 60 S, depending upon mantle rigidity, Vesta will quickly rotate to place the crater at the pole and then drift toward a total reorientation. An important note is that as of this abstract, we have not coupled Vesta's thermal evolution into our models. The initial behavior demonstrated should not change, however the long term evolution wil be impacted.

Additional Considerations and Implications for Dawn: The goal of this study is to predict observables for the Dawn mission, due to arrive at Vesta in 2011. Our current model will be expanded by coupling thermal evolution of the body and considering higher-order harmonics that are responsible for additional deformation. In this manner we can offer geophysical constraints on the timing of the south polar basin and how its emplacement and the subsequent true polar wander undergone by Vesta has affected the observable surface and interior of the body.

References: [1] Thomas, P.C. et al., (1997) *Science, 277,* 1492–1495. [2] Drake, M. J. (2001) *Meteoritics & Planet. Sci., 36,* 501-513.