Searching for Brazil Nuts on Q-type near-Earth Asteroids

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Q-type asteroids, the best spectral analogs of ordinary chondrite meteorites have only been definitively detected in near-Earth space. S-type asteroids, the space weathered counterparts of Q-types, however, are common, indicating that surfaces exposed to the space environment are rapidly weathered. Nevertheless, the existence of Q-type asteroids is evidence that one or more processes act to freshen asteroid surfaces, overturning the regolith to expose the un-weathered material that lies beneath. Nearly all Q-type near-Earth asteroids have been shown to currently or recently exist in orbits that bring them within close proximity to at least one terrestrial planet (i.e. a few planetary radii away). This observation has been used to infer that tidal interactions during close planetary encounters cause regolith mobilization on these bodies. This mechanism may lead to particle size segregation on the surface and interior of these bodies, particularly the sorting of large boulders to the surface. Because a large number of boulders raises the average surface thermal inertia, we hypothesize that the thermal inertia of Q-type asteroids are systematically larger than the average near-Earth asteroid population.

To test this hypothesis, we determine the thermal inertia of approximately one dozen Q-type near-Earth asteroids from measurements of their thermal emission. The targets for this study are selected based on known rotation periods and observations that are made at pre- and post-opposition, with a large difference in solar phase angle. This observing geometry is crucial in constraining thermal inertia, which influences the surficial diurnal temperature variation and thus the thermal emission as a function of phase angle. We have been acquiring observations at 3.6 and 4.5 μm with the InfraRed Array Camera (IRAC) on the Spitzer Space Telescope. At these wavelengths, the measured flux is generally dominated by thermal flux, but may contain a component of reflected flux. A model that removes the reflected light component is therefore used to isolate the thermal flux. We will present the thermal flux measurements along with our thermal inertia estimates in the context of the "tidal freshening" hypothesis.